SCIENTIFIC AND TECHNICAL PROGRAMME – EBC 2019

MONDAY, 3 JUNE

PLENARY SESSION Queen Elisabeth Hall (Level 1)

Sustainability and Climate Change

Chair: Tiago Brandao (Project Director, The Browers Company, Porto, Portugal)

8h30 – 9h00 **L1:** Sustainable brewing of the future

Zoran Gojkovic[1]

1 - Carlsberg, Denmark

9h00 – 9h30 **L2:** Impact of the climate change on hops – exemplified by the Hallertau Growing Region.

Florian Schüll[1]; Adrian Forster[1]; Andreas Gahr[2]

1 - HVG Hopfenverwertungsgenossenschaft; **2 -** Hopfenveredlung St. Johann

9h30 – 10h00 **L3:** Processing Brewer's Spent Grains & Trub for Food Ingredients.

Timothy Hobley[1]; Preben Hansen[1]; Matias Bjerregaard[1]; Radhakrishna Shetty[1,2]; Helena Pastell[3]; Shiwen Zhuang[1]; Angelos Charalampidis[1]; Rasmus Froding[1]; Katrine Rorby[1]; Charlotte Jacobsen[1]; Manuel Pinelo[1]; Nina Gringer[1]

1 - Technical University Denmark; **2 -** Carlsberg Research Laboratory; **3 -** Finnish Food Safety Authority Evira

10h00 – 10h30 **L4:** Comparison of Saaz growing in climatically different and challenging years.

Andreas Gahr[1]; Adrian Forster[2]

1 - Hopfenveredlung St. Johann; **2 -** HVG Hopfenverwertungsgenossenschaft Eg

10h30 – 11h00 Coffee / Tea, followed by joint BF / EBC plenary 11h00 – 12h30

12h30 – 14h00 Lunch

AFTERNOON PARALLEL SESSION 1 Darwin Room (Level 1)

Yeast & Fermentation

Chair: Sandra Stelma (Head of Science, Diageo, Dublin, Ireland)

14h00 – 14h30 **L5:** Use of wine non-Saccharomyces yeast for brewing.

Fotini Drosou[1]; Panagiotis Tataridis[2]; Vasso Oreopoulou[1]; Vassilis Dourtoglou[2]

1 - Department of Chemical Engineering, National Technical Univesity of Athens; **2 -** Department of Wine, Vine & Beverage Sciences, University of West Attica

14h30 – 15h00 **L6:** Yeast proteomics during beer fermentation: challenges and prospects.

Magda Costa[1]; David Laureys[1]; Soren Planckaert[2]; Bart Devreese[2]; Anita Van Landschoot[1]; Jessika De Clippeleer[1,3]

1 - Ghent University, Faculty of Bioscience Engineering, Department of Biotechnology, Research Group Brewing Science & Technology, Campus Schoonmeersen, Valentin Vaerwyckweg 1, B-9000 Ghent, Belgium; **2 -** Ghent University, Faculty of Science, Department of Biochemistry and Microbiology, Laboratory for Microbiology, Campus Ledeganck, KL Ledeganckstraat 35, B-9000 Ghent, Belgium; **3 -** University College Ghent, Faculty of Science and Technology, Department of Natural and Food Sciences, Research Group Brewing Science & Technology, Campus Schoonmeersen, Valentin Vaerwyckweg 1, B-9000 Ghent, Belgium

15h00 – 15h30 **L7:** Saccharomyces cerevisiae var. diastaticus- friend or foe?

Tim Meier-Dornberg[1]; Fritz Jacob[1]; Mathias Hutzler[1]

1 - TU Munchen - Research Center Weihenstephan for Brewing and Food Quality

15h30 – 16h00 **L8:** The Guinness Yeast: 250 Years in the Making.

Daniel Kerruish[1]; Sandra Stelma[2]

1 - Group Microbiologist, Diageo Global Supply, Science and Technology, St James's Gate Brewery, Dublin 8, Ireland; **2 -** Head of Science, Diageo Global Supply, Science and Technology, St James's Gate Brewery, Dublin 8, Ireland

AFTERNOON PARALLEL SESSION 2 Gorilla 4-5 Room (Level 1)

Technical reviews and insights

Chair: Stefan Lustig (President DBMB: German Brew- and Malt-Masters Association, Munich)

14h00 – 14h30 **L9:** Teff (Eragrostis tef (zucc.) Trotter) and quinoa (Chenopodium quinoa W.) as novel raw materials for brewing.

Ombretta Marconi[1]; Valeria Sileoni[1]; Giovanni De Francesco[1]; Lidia Di Ghionno[2]; Giuseppe Perretti[1]

1 - University of Perugia-Italian Brewing Research Centre; **2 -** University of Perugia, Department of Agricultural, Food and Environomental Sciences

14h30 – 15h00 **L10:** Process innovation at Asahi Breweries – The pursuit of ultimate consistency of quality in Asahi Super Dry.

Yoshinori Ito[1]; Shigekuni Noba[1]; Minoru Kobayashi[1]; Kazuhiko Uemura[1]

1 - Asahi breweries, Ltd, Japan

15h00 – 15h30 **L11:** Identification of factors at the origin of the phenomenon of beer gushing in order to develop a premature detection technique of gushing risk.

Julien Billard[1]; Sophie Schwebel[1]; Romain Kapel[2]; Marc Schmitt[1]

1 - IFBM; **2 -** University of Lorraine, Nancy, France

15h30 – 16h00 **L12:** Sourdough cultures as a source of speciality yeast for the brewing industry.

Brian Gibson[2]; Jarkko Nikulin[2]; Linnea Johansson[1]; Frederico Magalhaes[2]; Kristoffer Krogerus[2]; Elina Sohlberg[2]; Paula Jouhten[2]; Linnea Laitila[2]

1 - Metropolia University of Applied Sciences; **2 -** VTT Technical Research Centre of Finland

16h00 – 16h30 Coffee / Tea / Beer

LATE - AFTERNOON PARALLEL SESSION 1 Darwin Room (Level 1)

Yeast & Fermentation

Chair: Sandra Stelma (Head of Science, Diageo, Dublin, Ireland)

16h30 – 17h00 **L13:** Exploiting Yeast Diversity For Product and Process Optimisation.

Katherine Smart[1]

1 - University of Cambridge, UK

17h00 – 17h30 **L14:** Impact of Fermentation Parameters and Hops on the Flavour Expression of Beer Yeasts.

Gabriela Montandon[1]; Philippe Janssens[1]; Yves Gosselin[1]; Stephane Meulemans[1]

1 - Fermentis, Lille, France

17h30 – 18h00 **L15:** Rapid Assessment of Yeast Phenotypic Diversity through the Application of Raman Spectroscopy.

Yang He[1]; Hua Yin[1]; Jianjun Dong[1]; Junhong Yin[1]; Lu Chen[1]

1 - Tsingtao Brewery Co. Ltd., China

LATE - AFTERNOON PARALLEL SESSION 2 Gorilla 4-5 Room (Level 1)

Technical reviews and insights

Chair: Stefan Lustig (President DBMB: German Brew- and Malt-Masters Association, Munich)

16h30 – 17h00 **L16:** The copper binding affinity of wort during the brewing process.

Marcus Pagenstecher[1]; Morten J. Bjerrum[2]; Mogens L. Andersen[1]

1 - Department of Food Science, University of Copenhagen, Denmark; **2 -** Department of Chemistry, University of Copenhagen, Denmark

17h00 – 17h30 **L17:** Unlocking the potential of lactic acid bacteria and their application in malting and brewing.

Elke Arendt[1,2]; Kieran Lynch[3]; Emanuele Zannini[3]

1 - School of Food and Nutritional Sciences and APC Microbiome Institute, University College Cork, Ireland; **2 -** Cork; **3 -** School of Food and Nutritional Sciences, University College Cork, Ireland

17h30 – 18h00 **L18:** Challenging the assumptions around the pasteurisation requirements of beer spoilage bacteria.

Grzegorz Rachon[1]; Christopher Rice[1]; Karin Pawlowsky[1]; Christopher Raleigh[1]

1 - CampdenBRI, Nutfield (Surrey) UK

TUESDAY, 4 JUNE

MORNING PARALLEL SESSION 1 Darwin Room (Level 1)

Hops in Beer

Chair: Paul Lefebvre (Owner, Brasserie Lefebvre, Belgium)

8h30 – 9h00 **L19:** Taking hop aroma apart: Supercritical CO2 fractionated oils offers new flavour possibilities for brewers.

Christina Dietz[1]; David Cook[1]; Ray Marriott[2]; Colin Wilson[2]; Rebecca Ford[1]

1 - University of Nottingham, School of Biosciences, Division of Food Sciences, Sutton Bonington Campus, Loughborough, UK; **2 -** Totally Natural Solutions Ltd, Unit 3a Arnold Business Park, Branbridges Road, East Peckham, Kent, UK

9h00 – 9h30 **L20:** Exploring hop derived contributors to beer bitterness using data-independent acquisition (DIA).

Nils Rettberg[1]; Laura Knoke[1]; Julia Hildebrandt[1]; Sarah Thorner[1]; Jorg Maxminer[1]

1 - VLB Berlin - Research Institute for Beer and Beverage Analysis, Berlin, Germany

9h30 – 10h00 **L21:** Dimethyl sulfide in beer: the potential role of hops.

Elise Salanouve[1]; Stephane Delpech[1]; Clement Viel[1]; Scott R. Lafontaine[1]; Thomas H. Shellhammer[2]; Laurent Dagan[1]

1 - NYSEOS, ZA Parc 2000, 53 rue Claude Francois, 34080 Montpellier, France; **2 -** Department of Food Science and Technology, Oregon State University, 100 Wiegand Hall, Corvallis, Oregon 97331, United States

MORNING PARALLEL SESSION 2 Gorilla 4-5 Room (Level 1)

Wood & Beer

Chair: Lene Bech (Senior Laboratory and Regulatory Manager, Carlsberg A/S, Copenhagen, Denmark)

8h30 – 9h00 **L22:** Beech wood sawdust as a sustainable filter aid for pre-coat filtration.

Max Panglisch[1]; Thomas Kunz[1]; Frank-Jurgen Methner[1]

1 - Technische Universitat Berlin

9h00 – 9h30 **L23:** Wooden barrels are an additional source of microorganisms for lambic beer production.

Jonas De Roos[1]; Luc De Vuyst[1]

1 - Research Group of Industrial Microbiology and Food Biotechnology, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, Belgium

9h30 – 10h00 **L24:** How aging in tropical wood barrels may create an identity for Brazilian beer.

Giovanni Casagrande Silvello[1]; Aline Marques Bortoletto[1]; Ana Carolina Correa[1]; Mariana Costa De Castro[1]; Andre Ricardo Alcarde[1]

1 - University of Sao Paulo, USP-ESALQ, Piracicaba, Sao Paulo, Brazil

10h00 – 10h30 Coffee / Tea

MID - MORNING PARALLEL SESSION 1 Darwin Room (Level 1)

Malting Processes

Chair: Frank-Jurgen Methner (Former Head of Dept. of Brewing Science, TU Berlin)

10h30 – 11h00 **L25:** Malting barley agronomy & quality: evolution of the raw material qualities other 20 years in France.

Marc Schmitt[1]

1 - IFBM-Qualtech, Nancy, France

11h00 – 11h30 **L26:** Germination Kilning Combo Drum – an old method combined with new technology.

Christoph Remmelberger[1]; Johannes Lauer[2]

1 - Kaspar Schulz Brauereimaschinenfabrik& Apparatebauanstalt GmbH; **2 -** Kaspar Schulz Brauereimaschinenfabrik & Apparatebauanstalt GmbH

11h30 – 12h00 **L27:** First time quantification of cysteinylated aldehydes in malt and brewery samples.

Paula Bustillo Trueba[1]; Barbara Jaskula-Goiris[1]; Mark Sanders[3]; Jean-Paul Vincken[3]; Jessika De Clippeleer[2]; Erik Van Der Eycken[1]; Joshep De Brabanter[1]; Luc De Cooman[1]; Gert De Rouck[1]; Guido Aerts[1]

1 - KU Leuven; **2 -** Ghent University, Belgium; **3 -** Wageningen University & Research, The Netherlands

12h00 – 12h30 **L28:** Quantitative monitoring of beer staling aldehydes during the malting process.

Weronika Filipowska[1]; Maciej Ditrych[1]; Barbara Jaskula-Goiris[1]; Guido Aerts[1]; Gert De Rouck[1]; Luc De Cooman[1]

1 - KU Leuven, Bioengineering Technology TC, Ghent Technology Campus, Belgium

MID - MORNING PARALLEL SESSION 2 Gorilla 4-5 Room (Level 1)

Beer Styles, including non-alc. / low-alc. Beer

Chair: David De Schutter (Innovation & Technology Development Director Europe, AB-Inbev, Leuven, Belgium

10h30 – 11h00 **L29:** Non-Starch Carbohydrates from unmalted cereals as mouthfeel contributors in NABLAB and Light beers.

Niels A. Langenaeken[1]; Pieter Ieven[1]; Christian Clasen[3]; David De Schutter[2]; Christophe M. Courtin[1]

1 - Laboratory of Food Chemistry and Biochemistry and Leuven Food Science and Nutrition Research Centre (LFoRCe), KU Leuven, Kasteelpark Arenberg 20, 3001 Heverlee, Belgium; **2 -** Fund Baillet-Latour, Brouwerijplein 1, 3000 Leuven, Belgium; **3 -** Soft Matter, Rheology and Technology, KU Leuven, Celestijnenlaan 200f, 3001 Heverlee, Belgium

11h00 – 11h30 **L30:** Chance and Challenge: Non-Saccharomyces yeasts in non-alcoholic and low alcohol beer brewing.

Konstantin Bellut[1]; Elke Arendt[1,2]

1 - University College Cork, Cork, Ireland; **2 -** APC Microbiome Institute

11h30 – 12h00 **L31:** An innovative production of low alcohol beer using a Mrakia gelida.

Valeria Sileoni[1]; Giovanni De Francesco[1]; Ombretta Marconi[1]; Ciro Sannino[2]; Giuseppe Perretti[3]

1 - Italian Brewing Research Centre, University of Perugia; **2 -** Department of Agriculture, Food and Environmental Science, Industrial Yeasts

Collection DBVPG, University of Perugia; **3 -** Department of Agriculture, Food and Environmental Science, University of Perugia

12h00 – 12h30 **L32:** Temporal dominance of sensations (TDS) paired with dynamic wanting: A new method of sensory evaluation with consumers for a better understanding of beer drinkability.

Takahiro Wakihira[1]; Seiko Miyashita[1]; Minoru Kobayashi[1]; Kazuhiko Uemura[1]; Pascal Schlich[2]

1 - Asahi Breweries, Ltd., Research Laboratories for Alcohol Beverages, Moriya, Japan; **2 -** Centre des Sciences du Gout et de l'Alimentation, AgroSup Dijon, CNRS, INRA, Univ. Bourgogne Franche-Comte, F-21000 Dijon, France

12h30 – 14h00 Lunch

AFTERNOON PARALLEL SESSION 1 Darwin Room (Level 1)

Malt, Hops & Flavour

Chair: Monica Mandrutiu (Brewing & Innovation Lead, Asahi Breweries Europe Group, Czech Republic)

14h00 – 14h30 **L33:** Understanding aromatic stability in dry-hopped beer.

Margaux Huismann[1]; Fraser Gormley[2]; Dzeti Dzait[2]; Alex Speers[3]; Dawn Maskell[1]

1 - International Centre for Brewing & Distilling, Edinburgh, UK; **2 -** BrewDog; **3 -** Canadian Institute of Fermentation Technology

14h30 – 15h00 **L34:** Influence of whirlpool temperature on hop aroma intensity in ale beers.

Marius Hartmann[1]; Christina Schoenberger[1]; Mark Zunkel[1]

1 - Barth-Haas Group, Nuremberg, Germany

15h00 – 15h30 **L35:** How to optimize the utilization of hop cysteine and glutathione S-conjugates in late and dry hopping: Focus on dual hops and Saaz.

Cécile Chenot[1]; Sonia Collin[1]

1 - UCL, Louvain-la-Neuve, Belgium

15h30 – 16h00 **L36:** Functionality of hop proanthocyanidins in brewing: an alternative to tannic acid?

Arthur Gadon[1]; David Cook[1]

1 - University of Nottingham, UK

AFTERNOON PARALLEL SESSION 2 Gorilla 4-5 Room (Level 1)

Filtration, Stabilisation & Packaging

Chair: Carsten Zufall (Corporate Manager Technology and Innovation, Polar Group, Venezuela)

14h00 – 14h30 **L37:** Microplastic in beer.

Ursula Brendel-Thimmel[1], Reiner Gaub[1]

1 - Pall Filtersystems GmbH, Germany

14h30 – 15h00 **L38:** Functional prediction of beer cross-flow membrane filtration efficiency from malt quality.

Evan Evans[1]; Claudio Cornaggia[2]; Claudio Anna[2]; David Mangan[2]

1 - TBD Consulting and School of Natural Science, University of Tasmania; **2 -** Megazyme, Ireland

15h00 – 15h30 **L39:** New insights into the cleanliness of washed returnable bottles.

Roland Pahl[1]; Mick Holewa[1]; Alfons Ahrens[1]

1 - VLB Berlin, Germany

15h30 – 16h00 **L40:** Status and Trends in Beer Filtration – A Brewery Managers' Perspective.

Stefan Lustig[1]

1 - DBMB (German Brew- and Malt-Masters Association, Munich)

16h30 – 18h00 Coffee / Tea / Beer & Poster Session. Joint sundowner beers (BF & EBC)

WEDNESDAY, 5 JUNE

MORNING PARALLEL SESSION 1 Okapi 1-2-3 Room (Level 0)

Flavour Development in Fermentation

Chair: Martina Gastl (Head of Raw Materials and Beverage Technology, TU Munich, Germany)

9h00 – 9h30 **L41:** Sulphite content of beer : impact of raw material & fermentation parameters.

Sophie Schwebel[1]; Marc Schmitt[1]

1 - IFBM-Qualtech, Nancy, France

9h30 – 10h00 **L42:** Yeast Strain Specific Release of Cystein-Conjugated Thiols like 4-MSP by ß-Lyase Activity.

Maximilian Michel[1]; Korbinian Haslbeck[1]; Aofei Cheng[1]; Mathias Hutzler[1]; Mehmet Coelhan[1]; Martin Zarnkow[1]; Aofei Jacob[1]

1 - Research Center Weihenstephan for Brewing and Food quality, TU Munchen, Germany

10h00 – 10h30 **L43:** Metabolization of glycated amino acids from wort by different S. cerevisiae strains.

Michael Hellwig[1]; Anna-Lena Kertsch[1]; Thomas Henle[1]

1 - Technische Universitat Dresden, Chair of Food Chemistry

MORNING PARALLEL SESSION 2 Gorilla 1 Room (Level 1)

Brewing Technology

Chair: Jeff Potter (R&D Director, Lion Supply Group, Sydney, Australia)

9h00 – 9h30 **L44:** A rapid and objective method for in situ determination of a degree of sensory deterioration of beer caused by aging process.

Jana Olšovská[1]; Tomaš Vrzal[1,2]; Karel Štěrba[1]

1 - Research Institute of Brewing and Malting; **2 -** Charles University, Faculty of Science, Prague, Czech Republic

9h30 – 10h00 **L45:** More sustainable brewing and increased flavour stability due to the AB InBev Simmer & Strip technology.

David De Schutter[1]; Mario Rottiers[2]; Mario Thiry[3]

1 - R&D Director Europe at AB InBev; **2 -** Process Development Specialist; **3 -** Global Process Development Specialist, Leuven, Belgium

10h00 – 10h30 **L46:** Influence of mashing parameters on filter cake structure and filterability in the lauter tun.

Martin Hennemann[1], Martina Gastl[1], Thomas Becker[1], Florian Lehnhardt[1]

1 - TU Munchen-Weihenstephan, Germany

10h30 – 11h00 Coffee / Tea

MID - MORNING PARALLEL SESSION 1 Okapi 1-2-3 Room (Level 0)

The concept of terroir in brewing materials

Chair: Chuck Skypeck (Technical Brewing Projects Manager, Brewers Association, Boulder / CO, USA)

11h00-11h30 **L47:** Development of the methodology for determination of the geographical origin of hops.

Iztok Jože Košir[1]; Marijan Nečemer[2]; Miha Ocvirk[1]

1 - Slovenian Institute of Hop Research and Brewing; **2 -** Institute Jozef Stefan

11h30 – 12h00 **L48:** Characterising the diversity of wild hops (Humulus lupulus) from Portugal.

Julio Cesar Machado Junior[1]; Miguel A. Faria[1]; Zita E. Martins[1]; Armindo Melo[1]; Sara C. Cunha[1]; Florian Lehnhardt[2]; Hubert Kollmannsberger[2]; Martina Gastl[2]; Thomas Becker[2]; Isabel M. P. L. V. O. Ferreira[1]

1 - LAQV/ REQUIMTE, Departamento de Ciencias Quimicas, Faculdade de Farmacia, Universidade do Porto; **2 -** School of Life Sciences Weihenstephan, Chair of Brewing and Beverage Technology, Technische Universitat Munchen

12h00 – 12h30 **L49:** Native yeasts from Ecuadorian chichas: insights into their potential application in beer production.

Nubia Jimena Grijalva Vallejos[1]; Kristoffer Krogerus[2,3]; Jarkko Nikulin[2,4]; Agustin Aranda[1]; Emilia Matallana[1]; Brian Gibson[2]

1 - Institute for Integrative Systems Biology (I2SysBio), Universitat de Valencia-CSIC, 46980 Paterna, Valencia, Spain.; **2 -** VTT Technical Research Centre of Finland Ltd, Tietotie 2, P.O. Box 1000, FI-02044 VTT, Espoo, Finland; **3 -** Department of Biotechnology and Chemical Technology, Aalto University, School of Chemical Technology, Kemistintie 1, Aalto, P.O. Box 16100, FI-00076 Espoo, Finland; **4 –** Chemical Process Engineering, Faculty of Technology, University of Oulu, P.O. Box 8000, FI-90014 Oulun Yliopisto, Finland

MID - MORNING PARALLEL SESSION 2 Gorilla 1 Room (Level 1)

Beer & Brewing Materials Analysis

Chair: Esko Pajunen (Former President EBC)

11h00 – 11h30 **L50:** Critical assessment of calibration strategies for effective beer flavor analysis by solid-phase microextraction (SPME).

Sarah Thorner[1]; Johanna Dennenlohr[1]; Nils Rettberg[1]

1 - VLB Berlin - Research Institute for Beer and Beverage Analysis

11h30 – 12h00 **L51:** International Calibration Standards for hop and beer analysis – Overview and News.

Biendl Martin[1]; Foster Robert, T.[2]; Maye John Paul[3]

1 - Hopsteiner HHV GmbH Mainburg, Germany; **2 -** Molson Coors; **3 -** S.S. Steiner, Inc.

12h00 – 12h30 **L52:** The influence of dry-hopping on selected chemical-physical characteristics of beer.

Martin Zarnkow[1]; A. Stallforth[1]; K. Haselbeck[1]; S. Cocuzza[2]; F. Jacob[1]

1 - TU Munchen Research Center for Brewing and Food Quality; **2 -** Hopsteiner, Simon H. Steiner Hopfen GmbH, Mainburg, Germany

12h30 – 14h00 Lunch

AFTERNOON PARALLEL SESSION 1 Okapi 1-2-3 Room (Level 0)

The concept of terroir in brewing materials

Chair: Chuck Skypeck (Technical Brewing Projects Manager, Brewers Association, Boulder / CO, USA)

14h00 – 14h30 **L53:** Genetic and biochemical approach to study the impact of terroir on the brewing value of hops.

Ann Van Holle[1,2]; Hilde Muylle[3]; Tom Ruttink[3]; Anita Van Landschoot[2]; Geert Haesaert[2]; Dirk Naudts[1]; Denis De Keukeleire[2]; Isabel Roldan-Ruiz[2,3]

1 - De Proefbrouwerij; **2 -** Ghent University; **3 -** Institute for Agricultural and Fisheries Research (ILVO), Ghent, Belgium

14h30 – 15h00 **L54:** Effect of harvest time on polyphenols profiles of Saaz hops and beer taste.

Takeshi Kumagai[1]; Takako Inui[1]; Takamasa Hasegawa[1]; Taichi Maruhashi[1]; Akira Kogin[1]; Seisuke Takaoka[1]

1 - Suntory Beer Ltd., Beer Development Department, Tokyo, Japan

AFTERNOON PARALLEL SESSION 2 Gorilla 1 Room (Level 1)

Beer & Brewing Materials Analysis

Chair: Esko Pajunen (Former President EBC)

14h00 – 14h30 **L55:** Insights on the lager beer volatile terpenic compounds through an advanced chromatographic tool.

Cátia Martins[1]; Tiago Brandao[2]; Adelaide Almeida[3]; Silvia M. Rocha[1]

1 - Departamento de Quimica & QOPNA, Universidade de Aveiro, Campus Universitario Santiago, 3810-193 Aveiro, Portugal; **2 -** Super Bock Group, Via Norte, 4465-764 Leca do Balio, Portugal; **3 -** Departamento de Biologia & CESAM, Universidade de Aveiro, Campus Universitario Santiago, 3810-193 Aveiro, Portugal

14h30 – 15h00 **L56:** Arabinoxylans in the brewing process – an underestimated substance class?

Michael Kupetz[1]; Martina Gastl[1]; Thomas Becker[1]

1 - Lehrstuhl fur Brau- und Getranketechnologie, TU Munchen, Germany

PLENARY SESSION Okapi 1-2-3 Room (Level 0)

15h00 – 16h30 **CLOSING PANEL DISCUSSION: Brewing Science: past milestones, future endeavours**

Moderated by Dr. Ina Verstl

Participants:

Prof. Dr. Guido Aerts, Prof. Dr. Charlie Bamforth, Ms. Kamini Dickie, Prof. em. Dr. Ludwig Narziss, Dr. Sandra Stelma

19h30 – 23h15 **FAREWELL PARTY**

Antwerpse Brouw Compagnie (Indiestr. 21, 2000 Antwerp).

SESSION CHAIRS

MONDAY, 3 JUNE

SUSTAINABILITY AND CLIMATE CHANGE

TIAGO BRANDÃO

President of the European Brewery Convention (EBC), nominated since 2016. Currently, accumulates roles as New Business Director for Beer & Brewing Projects at Super Bock Group.
Has more than 17 years of professional experience at the main brewing and beverage company in Portugal. Among other, experienced the following roles and responsibilities:

- Human Resources Director (between 2014 and 2017).
- New Product Development & Innovation Director, including the responsibility to manage the Research & Development team (from 2006 to 2014).
- Executive Board member at Maltiberica, the Malting company of Super Bock Group (from 2006 to 2013, in accumulation).
- Since 2001, performed several roles within Beer production and quality departments.

Owns a Biochemistry degree from Porto Science Faculty, and two Master of Science (MSc): in Biotechnology – by Leicester University; and in Brewing Engineering by the Scandinavian School of Brewing. Married with 2 daughters, he lives in Porto.

YEAST AND FERMENTATION

SANDRA STELMA

Sandra has a PhD in Biochemistry and brewing qualifications plus a 23 year career in Brewing R&D and brewing operations. She started her career with SABMiller in South Africa, while working in R&D she obtained first her MSc. and later her PhD on brewing related topics.
After finishing her brewing qualifications she moved across into production and held various roles in South Africa, Switzerland and Netherlands before joining Diageo, based in Dublin, 4 years ago. Here she is currently Head Of Science on the beer side of the business with a global remit heading up the R&D agenda, extensively supporting the African markets and the innovation agenda. Sandra is member of the EBC Executive team and the EBC Brewing Science Group and is active in the Brewers of Europe.

TECHNICAL REVIEWS AND INSIGHTS

STEFAN LUSTIG

Stefan Lustig is a brewing engineer graduated fromTU Munchen-Weihenstephan. After completion of his PhD in research on flavor stability under guidance of Prof. Ludwig Narziss, he joined Beck's brewery as head of development & technology.
After several leadership roles in quality, production, packaging and plant management, he joined the board of Anheuser-Busch InBev Germany as Director of Brewery Operations. Next he moved to Brau-Holding International, Germanys 6th largest brewing company, a joint venture with Heineken involvement. As Chief Operating Officer and Managing Director he was responsible for Supply, covering a network of 12 breweries and the construction of a 3.5 Mhl greenfield brewery. Currently he is president of "Deutscher Braumeister und Malzmeister Bund", Germanys largest brewmasters association.
Stefan's experience combines know how on brewing science/technology with the operational world of a brewery manager. His expertise covers the supply chain of the brewing industry from raw materials to logistics.

TUESDAY, 4 JUNE

HOPS IN BEER

PAUL LEFEBVRE

Paul Lefebvre was graduated as Industrial Engineer in Biochemistry (Master), Fermentation Section at Institut Meurice (Brussels) in 2002. He started to work in the family brewery as production, R&D and environnemental manger.
During 10 years, he completed the range of beer proposed by the brewery with some new creations such fruity and hoppy beers while the brewery was raised at a capacity of 120 000hl/ year. Since 2012, he is the CEO and 6th generation brewer of Brasserie Lefebvre. Active in the world of beer, Paul is member of the EBC Executive Team since 2014 and the Steering Committee of the Belgian Brewers since 2018.

WOOD & BEER

LENE BECH

Lene Mølskov Bech is Senior Laboratory and Regulatory Manager at Carlsberg Breweries A/S, responsible for Analytical and Regulatory in Carlsberg Group. Lene is MSc and Ph.D. from University of Copenhagen. For many years Lene's primary tasks have been Regulatory and Analytical support as well as development of new advanced analytical methods. She has previously worked with many aspects of beer quality, e.g. foam and foam proteins, flavour characterization, flavour stability and sensory analyses. Lene has a long tradition working with EBC as member of EBC Brewing Science Group, several of the Subgroups and of the expert team supporting the Analysis Group. Since January 2018 she is the Chair of the EBC Analysis Group. Lene is also a Carlsberg representative in Brewers of Europe's Product IMT dealing with regulatory activities such as labelling, additives, enzymes, ingredients and beer safety and member of the expert groups on Consumer Information, Food Improvement Agents, and Technical Information Sheets.

MALTING PROCESSES

FRANK-JURGEN METHNER

Prof. Dr. Frank-Jürgen Methner was graduating with a Diploma in Engineering at Technical University of Berlin in 1881. From 1982 to 1986 he was PhD-Student at TU Berlin graduating 1987. From 1987 til 2004 he was working as a Director at Bitburger Brauerei, Bitburg, Germany, with responsibilities in Brewing Technology, Development and Quality Management. Since winter-semester 2004/2005 he is leading the Department of Brewing Science at the TU Berlin.

BEER STYLES, INCLUDING NON-ALC./ LOW ALC. BEER

DAVID DE SCHUTTER

David De Schutter obtained his PhD degree at the Center for Malting and Brewing Science of the KULeuven under supervision of Prof. Delvaux and Prof. Derdelinckx. Before his career at AB InBev he made a passage outside the brewing industry at the R&D Center of Procter & Gamble in Brussels. He joined AB InBev as Product & Process Development Specialist where he was involved in the development of the first new generation non-alcoholic beer Then he became Global Director for Process Development and R&D Transformation in the Global Innovation & Technology Center in Leuven (GITEC). His current position is R&D Director for Europe at AB InBev. David is also representing AB InBev in the EBC Executive Committee, member of the BIR&D (Belgian Industrial Research and Development organization) and coordinator of the Brewing program of Fund Baillet Latour.

MALT, HOPS & FLAVOUR

MONICA MANDRUTIU

Monica Mandrutiu is Quality Lead at Asahi Breweries Europe Group.
She ensures the alignment with the regional and global quality strategy & standards, acting as quality improvement catalyst for eleven breweries across five countries. She joined the brewing industry in 1990 at Ursus Breweries in Romania, where she had various roles, such as QC Manager, Chief Brewer and Quality & Brewing Director. Since 2013, she held regional roles as Brewing Lead-Europe at SABMiller European Hub and Brewing & Innovation Lead at Asahi Breweries Europe Group. She has an MSc in Food technology (Galati University) and an MBA degree from Edinburgh Business School, Heriot-Watt University.
Monica is member of EBC Executive Team and EBC Brewing Science Group, Associate member of IBD, member of ASBC and MBAA. She is accredited Beer sommelier (Beer Academy, UK) and member of the tasting panels of many key beer competitions in the world.

FILTRATION, STABILISATION & PACKAGING

CARSTEN ZUFALL

Carsten Zufall is Head of Technology and Innovation at Polar Breweries (Venezuela), where he is responsible for brewing processes and technology, brewing materials, applied research and new product design. He graduated in Brewing Science from Berlin University of Technology in 1990 and subsequently completed a Ph. D. (Dr.-Ing.). Following postdoctoral lecture qualification, he was awarded Associate Professorship (Priv.-Doz.) in Brewing Science in 2001. Carsten is chairman of the EBC Brewing Science Group and a member of ASBC, MBAA, the German Brewmasters' and Maltmasters' Association (DBMB), the VLB Alumni Association, the Berlin Brewers' Guild and the Cerveceros Latinoamericanos association.
He serves with the Editorial Boards of the Journal of the Institute of Brewing, Brewing Science and the ASBC Journal and he is a past president of MBAA's District Venezuela. His current research activities include beer flavour stability, flavour chemistry, sensory analysis, microbiology and environmental topics.

WEDNESDAY, 5 JUNE

FLAVOUR DEVELOPMENT IN FERMENTATION

MARTINA GASTL

Martina Gastl apprenticed as a brewer and maltster from 1994 to 1996. She studied brewing and beverage technology at the Technische Universitat Munchen-Weihenstephan, Germany. She graduated as an engineer at 2002. From 2002 until 2006 she completed her phD concerning 'Technological influence on lipid degradation in terms of improvement of beer flavor stability'. She is currently assistant professor and head of the research group Raw Materials based Brewing and Beverage Technology at the 'Lehrstuhl fur Brau- und Getranketechnologie' in Weihenstephan.

BREWING TECHNOLOGY

JEFF POTTER

Jeff began his brewing career with Lion at Toohey's Brewery in Sydney in 1990. He has since held a wide range of roles including Brewer, QA Manager, NPD Manager, Head Brewer at both Tooheys and later Malt Shovel Breweries and several Group Technical roles providing brewing, technical and NPD support and leadership across Lions operations in Australia and New Zealand.

He is currently the Research & Development Director for Lion Supply Chain – responsible for brewing and beverage product and process innovation, licensed brewing and technical regulatory compliance. Jeff is a Fellow of the Institute of Brewing & Distilling, having served for 6 years on the Asia Pacific section Board of Management with 4 years as Chairman. He represents Lion on industry associations including Brewers Association of Australia and New Zealand, a Board Member of Barley Australia and is a member of the EBC Brewing Science Group.

THE CONCEPT OF TERROIR IN BREWING MATERIALS

CHUCK SKYPECK

A pioneer of craft brewing in the southeastern U.S., Chuck Skypeck opened Tennessee's first brewpub, Boscos, in 1992. As a founding owner and director of brewery operations for Boscos Brewing Company, he opened additional brewpubs in Memphis, Nashville and Little Rock, AR. In 2007, Skypeck opened and operated Ghost River Brewing in Memphis. He has served as chair of the Association of Brewers Board of Advisors, chair of the Association of Brewers Board of Directors and was a member of the first Board of Directors for the Brewers Association. Winner of the Brewers Association Recognition Award in 2006, Skypeck joined the Brewers Association staff in 2013 and serves as Technical Brewing Projects Manager.
In this capacity at the Brewers Association, Chuck works with the Technical Committee and Subcommittees to develop member resources and encourage and facilitate best practices in all phases of member's brewery operations.

BEER & BREWING MATERIALS ANALYSIS

ESKO PAJUNEN

Born 1945, graduated 1970 from Helsinki University of Technology as Chemical Engineer on biochemistry and food technology. Joined 1973 VTT Biotechnical Laboratory with focus on brewing and malting. Short visit to Finnish Food Industry Federaration as R&D Director, before joining Sinebrychoff Brewery as R&D Manager in 1979. In 1987 started as Production Director with responsibility on Kerava new brewery and continued as Senior Vice President R&D&I from 1992.Joined Carlsberg as Vice President R&D in 2006 heading Carlsberg Research Center until retirement in 2009. Esko joined the EBC Biochemistry Group in 1978, became EBC Council Member in 1987, Vice President in 1997 and acted as EBC President 1999 -2003 and Board Member until 2010. Acted also Director and Chairman of PBL, the ResearchLaboratory of the Finnish Brewers and Maltsters.

SENIOR'S PANEL

INA VERSTL

Dr Ina Verstl is Editor of Brauwelt International. Together with Ernst Faltermeier she wrote the book *The Beer Monopoly* (2016).

POSTER LIST / POSTER SESSION

POSTER SESSION on Tuesday, 4 June 2019 at 4.30 pm

TOPIC: ANALYSIS AND METHODOLOGY (raw materials, product, research)

P001	TURBIDITY IDENTIFICATION VIA RAMAN MICRO SPECTROSCOPY	Eva-Maria Kahle	Research Center Weihenstephan for Brewing and Food Quality
P002	NON-DESTRUCTIVE DETERMINATION OF HOP CONSTITUENTS BY NEAR INFRARED SPECTROSCOPY (NIRS)	Florian Schull	RMI Analytics
P003	SENSOMICS AS A PROMISING TOOL IN BREWING SCIENCE	Tomáš Vrzal	Research Institute of Brewing and Malting, PLC, Prague, Czech Republic
P004	THE CHARACTERIZATION OF A HOP OIL PROFILE OF HOP BY FLUIDIZED BED EXTRACTION AND GC-MS-QQQ WITH A HEART-CUT TECHNIQUE	Karel Štěrba	Research Institute of Brewing and Malting, Prague
P005	ANALYSIS OF HOP AROMA COMPONENTS AFTER FERMENTATION BASED ON CLOSE GENETIC BACKGROUND	Tetsu Sugimura	Kirin Company, Limited
P006	NON-DISCRIMINANT ANALYSIS OF BEER AGEING CHEMISTRY	Laura Knoke	VLB Berlin
P007	SENSORIAL AND ANALYTICAL CHARACTERIZATION OF THE NEW HÜLLER "SPECIAL FLAVOUR HOPS"	Klaus Kammhuber	Bavarian Hop research center
P008	COMPREHENSIVE ANALYSIS OF POLYFUNCTIONAL THIOLS IN A NEW FLAVOR HOP MOSAIC BY THIOL-SPECIFIC EXTRACTION WITH SELECTABLE 1D/2D/3D GC-SCD/Q-TOF-MS	Koji Takazumi	Frontier Laboratories for Value Creation, SAPPORO HOLDINGS LTD.
P009	UNIQUE VARIETAL AROMA OF THE 'SORACHI ACE' HOP ~EFFECTS OF THE COEXISTENCE OF GERANIC ACID AND OTHER HOP-DERIVED COMPOUNDS ON THE VARIETAL AROMAS	Ayako Sanekata	Frontier Laboratories of Value Creation, SAPPORO BREWERIES LTD.;
P010	WHICH HOP VARIETY FOR A BETTER FLAVOUR AND COLLOIDAL STABILITY OF DRY-HOPPED BEERS: EVIDENCE OF THE KEY-ROLE OF MINOR FLAVAN-3-OLS	Carlos Silva Ferreira	Université catholique de Louvain
P011	MYCOBIOME IN MODERN BREWERIES	Riikka Juvonen	VTT Technical Research Centre of Finland Ltd;
P012	EFFECT OF HOP VARIETIES ON BEER AROMA DURING DRY HOPPING	Damien Steyer	TWISTAROMA
P013	CANCELLED	----------	----------
P014	EVALUATION OF WATER AND ETHANOL EXTRACTS OF LEMON VERBENA, SAGE, CINNAMON AND HIBISCUS IN THE AROMATIC AND ORGANOLEPTIC PROFILE OF BEER	Avgoustinos Evripiotis	Department of Wine, Vine & Beverage Sciences, University of West Attica, Ag. Spyridonos str., 12243 Egaleo, Greece
P015	BENEFITS OF BLEND-HOPPING WITH CASCADE, CENTENNIAL, AND CHINOOK DURING DRY-HOPPING	Thomas Shellhammer	Oregon State University, Food Science and Technology
P016	DRY HOPPING POTENTIAL OF EUREKA!, A NEW HOP VARIETY.	Christina Schmidt	Hopsteiner
P017	A NOVEL TECHNIQUE FOR ASSESSING ENERGY AND UTILITY CONSUMPTION IN BREWING	Sebastian Schmid	Technical University of Munich
P018	THE RAPID VISCO ANALYSER AS A RHEOLOGICAL TOOL TO DETERMINE THE POTENTIAL BREWING QUALITY OF BARLEY AND MALT	Bruno Godin	Walloon Agricultural Research Center
P019	INFLUENCE OF PASTEURIZATION ON DRY HOPPED BEERS	Frank Peifer	Hopsteiner

P020	FACTORS AFFECTING HUMULINONE FORMATION IN HOPS	Philip Wietstock	Technische Universität Berlin
P021	ARABINOXYLAN AND B-GLUCAN IN BARLEY ENDOSPERM CELL WALLS: MICROSTRUCTURE ANALYSIS USING CLSM AND CRYO-SEM	Niels A. Langenaeken	Laboratory of Food Chemistry and Biochemistry and Leuven Food Science and Nutrition Research Centre (LFoRCe), KU Leuven, Kasteelpark Arenberg 20, 3001 Leuven, Belgium;
P022	BREWING YEAST STRAIN DIFFERENTIATION: PRACTICAL RESULTS AND COMPARISON OF GENOTYPE AND PHENOTYPE BASED TECHNIQUES	Marta Orive Camprubí	Mahou-San Miguel
P023	UNEXPECTED RESULTS IN ALE YEAST DNA FINGERPRINTING	Nuria Feliu-Besora	Mahou S.A
P024	BEEROMICS FROM MALT AND MASHING TO BEER	Ida Kallehauge Nielsen	Technical University of Denmark
P025	NORWEGIAN PRODUCTION OF MALTING BARLEY AND HOPS	Mette Goul Thomsen	NIBIO
P026	ION MOBILITY SPECTROMETRY BASED HEADSPACE DETECTION OF VOLATILE ORGANIC COMPOUNDS PRODUCED BY MOLD FUNGI	Thomas Kunz	Technical University Berlin
P027	NON-INVASIVE ON-LINE MONITORING OF THE SECONDARY BOTTLE FERMENTATION PROCESS USING NEAR INFRARED SPECTROSCOPY	Manuel Zimmer	Institute of Food Technology NRW
P028	PORTUGUESE WILD HOPS GENOTYPING BY HRMA OF A MINIMAL SNP SET	Miguel Faria	LAQV/REQUIMTE, Laboratório de Bromatologia e Hidrologia, Departamento de Ciências Químicas, Faculdade de Farmácia, Universidade do Porto
P029	METABOLOMICS STRATEGY FOR MAPPING OF VOLATILE EXOMETABOLOME FROM SACCHAROMYCES SPP. WIDELY USED IN BREWING BASED ON COMPREHENSIVE TWO-DIMENSIONAL GAS CHROMATOGRAPHY	Silvia Rocha	Departamento de Química & QOPNA, Universidade de Aveiro, Campus Universitário Santiago, 3810-193 Aveiro, Portugal
P030	IN SITU IDENTIFICATION OF ANTIOXIDANT MOLECULES IN BEER BY HPTLC/BIOASSAY/MS	Pablo Murath	Universidad de Concepcion
P031	WINEBEER: A BEER WITH IMPROVED FUNCTIONAL PROPERTIES THROUGH GRAPE-SKIN EXTRACT ADDITION	Stephanie Hoffmann	Universidad de Concepcion
P032	THE USE OF HIBISCUS SABDARIFFA FLOWERS IN BREWING	Panagiotis Tataridis	Department of Wine, Vine & Beverage Sciences, University of West Attica, Athens, Greece
P033	THE EFFECT OF MAGNESIUM AND ZINC IONS ON THE RATE OF LACTIC ACID FERMENTATION FOR SOUR BEER PRODUCTION	Aleksander Poreda	University of Agriculture in Krakow, Faculty of Food Technology
P034	OPTIMIZATION OF MASHING PROCESSES USING INLINE CARBOHYDRATE PROFILING	Andreas Kunov-Kruse	Specshell ApS
P035	CANCELLED	----------	----------
P036	A SIMPLE AND ACCURATE METHOD FOR THE DETERMINATION OF VERY LOW ALCOHOL CONCENTRATIONS IN 0.0 BEERS AND 0.0 BEER MIXED BEVERAGES USING NEAR INFRARED SPECTROSCOPY	Helmut Klein	Brau Union Österreich AG

TOPIC: BARLEY BREEDING AND AGRONOMY

P037	SCREENING OF DROUGHT TOLERANCE IN SPRING BARLEY	Bram Marynissen	University College Ghent
P038	THE IMPACT OF A REDUCED INPUT GROWING REGIME ON MALTING CAPABILITY OF BARLEY AND WHEAT	Calum Holmes	Heriot-Watt University
P039	TR15245: A NEW TWO-ROW MALTING BARLEY COMBINES DESIRABLE AGRONOMICS, DISEASE RESISTANCE AND QUALITY INCLUDING REDUCED PHYTATE	Ana Badea	Agriculture and Agri-Food Canada, Brandon Research and Development Centre
P040	EFFECTS OF PLANT GROWTH REGULATOR APPLICATION ON THE MALTING QUALITY OF BARLEY	Marta Izydorczyk	Grain Research Laboratory, Canadian Grain Commission, Winnipeg MB Canada

TOPIC: BEER QUALITY - FOAM

P041	RELATIONSHIP BETWEEN BEER FOAM AND SURFACE MOLECULES INVESTIGATED USING SUM-FREQUENCY GENERATION SPECTROSCOPY	Takayuki Miyamae	National Institute of Advanced Industrial Science and Technology
P042	TOWARDS A BIOMIMETIC SENSOR FOR HYDROPHOBIN DETECTION IN BEER	Fatemeh Bajoul Kakahi	Soft-Matter Physics and Biophysics Section, Department of Physics and Astronomy, KULeuven
P043	INVESTIGATION OF FACTORS AFFECTING BEER FOAM COLOR APPLYING A NOVEL TECHNIQUE USING TWO-DIMENSIONAL COLORIMETER	Azusa Asai	SAPPORO BREWERIES LTD., Research and Development Institute for Alcoholic Beverages, Yaizu, Japan

TOPIC: BEER QUALITY - SENSORY

P044	INFLUENCE OF POST-FERMENTATION PROCESSES ON HOP AROMA IN BEER	Ray Marriott	Totally Natural Solutions Ltd
P045	HIDDEN SECRETES OF THE NEW ENGLAND IPA	John Paul Maye	Hopsteiner
P046	THE CONTRIBUTION OF STALING ALDEHYDES TO THE FLAVOR (IN)STABILITY OF TOP FERMENTED, HOPPY BEERS	Sarah Thörner	VLB Berlin - Research Institute for Beer and Beverage
P047	DISENTANGLING SENSORY EXPERIENCES OF BEER WITH ARTIFICIAL INTELLIGENCE	Supinya Piampongsant	VIB – KU Leuven Center for Microbiology, Gaston Geenslaan 1, B-3001 Leuven, Belgium
P048	A NEW METHODOLOGY FOR DYNAMIC "EASINESS TO DRINK" WITH TEMPORAL DOMINANCE OF SENSATIONS (TDS) - GOOD KIRE (CRISPNESS) OF BEER LEADING TO EASINESS OF DRINKING	Takahiro Wakihira	Asahi Breweries, Ltd., Research Laboratories for Alcohol Beverages, Moriya, Japan
P049	THE IMPACT OF BREWING WITH UNMALTED CEREAL ADJUNCTS ON THE SENSORY AND ANALYTICAL PROFILE OF BEER	Joanna Yorke	University of Nottingham
P050	INFLUENCE ON BEER BITTER QUALITY BY USING DIFFERENT HOP PRODUCTS	Dominique Dixius	Bitburger Braugruppe GmbH
P051	WOOD AGED IMPACTS: COMPARISON BETWEEN BRAZILIAN SPECIES AND AMERICAN OAK CHIPS	Ana Carolina Corrêa	University of São Paulo - College of Agriculture "Luiz de Queiroz"
P052	EUROPEAN HOPS VARIETIES ANALYSED WITH SENSORY AND ANALYTICAL BEST PRACTICES	Boris Gadzov	FLAVORACTIV LIMITED

P053	DETERMINATION OF POTENTIAL FLAVOUR DEFICIENCIES OF COMMERCIAL NON-ALCOHOLIC BEERS	Jeroen Bauwens	KU Leuven, Department of Microbial and Molecular Systems (M^2S), Cluster for Bioengineering Technology (CBeT), Laboratory of Enzyme, Fermentation and Brewing Technology (EFBT), Technology Campus Ghent, GebroedersDe Smetstraat1, 9000 Ghent, Belgium
P054	FLAVOR COMPOSITION OF BEER AGED IN BARRELS OF OAK AND BRAZILIAN WOODS - A PROPOSED SENSORY WHEEL	Aline Marques Bortoletto	University of São Paulo
P055	ASSESSMENT OF QUALITY CONTROL METRICES FOR MEASURING BEER FRESHNESS IN THE LAB USING THE MICROESR TECHNOLOG	Mangethe Zwane	FlavorActiV
P056	INTRODUCTION OF A STANDARD BEER FOR QUALITY CONTROL ASSESSMENT OF BEER FRESHNESS IN THE LABORATORY USING THE MICROESR TECHNOLOGY	Mangethe Zwane	FlavorActiV
P057	SENSORY IMPACT OF ESTER-RICH SPECIAL BEER VIA RETRONASAL AROMA ANALYSIS	Kazuki Maruyama	SAPPORO HOLDINGS LTD

TOPIC: BEER, SOCIETY, HEALTH AND NUTRITION

P058	DEVELOPMENT OF NOVEL, MATURED, HOP-DERIVED MILD BITTER ACIDS THAT IMPROVE COGNITIVE FUNCTION	Takafumi Fukuda	Kirin Company, Limited, Research Laboratories for Health Science and Food Technologies, Yokohama, Japan
P059	SHOULD WE WORRY ABOUT NICKEL CONTENT IN BEERS ON THE BELGIAN MARKET?	Anneleen Decloedt	Ghent University, Department of Veterinary Public Health and Food Safety, Laboratory of Chemical Analysis, Salisburylaan 133, B-9820 Merelbeke, Belgium
P060	CAN BEER CONSUMPTION CONTRIBUTE TO THE DAILY INTAKE OF ESSENTIAL MINERALS ELEMENTS?	Edgar Pinto	University of Porto -Faculty of Pharmacy

TOPIC: CONSUMER STUDIES

P061	CANCELLED	----------	----------
P062	REVEALING PATTERNS OF CONSUMER INTEREST IN GLUTEN-FREE BEERS	Edyta Kordialik-Bogacka	Institute of Fermentation Technology and Microbiology, Lodz University of Technology, Wólczańska 171/173, 90-530, Łódź, Poland
P063	PATHS FOR SMART TOURISM OPPORTUNITIES TOWARDS BEER CONSUMERS	Jan Lichota	UNED - Universidad Nacional de Educación a Distancia

TOPIC: END OF BEER PROCESSING INCLUDING AUXILIARY AND PROCESS AIDS

P064	YEAST PROTEIN EXTRACT (YPE), A NATURAL INNOVATIVE AND SUSTAINABLE SOLUTION FOR WHITE BEER HAZE STABILITY	Olivier Caille	FERMENTIS Lesaffre for beverage
P065	STUDY OF BEER-SPOILAGE LACTOBACILLUS NAGELII HARBORING HOP RESISTANCE GENE HORA	Minami Umegatani	Asahi Breweries, Ltd., Research Laboratories for Alcohol Beverages, Moriya, Japan
P066	IMPACT OF HIGH PRESSURE PROCESSING ON THE FOAM STABILITY OF UNFILTERED BEER	Katerina Stulikova	University of Chemistry and Technology, Prague

TOPIC: ENVIRONMENTAL ISSUES AND SUSTAINABILITY

P067	RENEWABLE ENERGIES IN BREWERY MICRO GRIDS	Holger Schmidt	ABB Automation Products GmBH
P068	UNLOCKING PRODUCTION EFFICIENCY	Holger Schmidt	ABB Automation Products GmBH
P069	THE RE-USE OF PVPP-REGENERATION-CAUSTIC FOR CIP-CLEANING	Deniz Bilge	VLB Berlin
P070	HEATING WITH BEER - DISTRICT HEATING BY HEAT RECOVERY FROM THE COOLING PROCESS OF THE BREWERY PUNTIGAM	Gerald Zanker	Brau Union Österreich - Heineken
P071	BREWING WITH GREEN MALT FOR AN ENERGY AND WATER EFFICIENT FUTURE	Celina Dugulin	International Centre for Brewing Science, Bioenergy and Brewing Science Building, University of Nottingham, School of Biosciences, Sutton Bonington Campus, Loughborough, LE12 5RD, UK
P072	BULIDING A PILOT REACTOR - VALORIZING CO2 THROUGH POWER-TO-GAS AND BIOCATALYTIC METHANISATION	Timo Broeker	Institute of Food Technology ILT.NRW

TOPIC: FILTRATION

P073	REDUCED IRON ENTRY DURING KIESELGUHR FILTRATION VIA PRE-TREATED FUNCTIONAL VISCOSE FIBERS TO IMPROVE OXIDATIVE AND COLLOIDAL BEER STABILITY	Frank Jürgen Methner	Technical University Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Seestraße 13, 13353 Berlin, Germany
P074	BEECH WOOD SAWDUST AND GALLOTANNIN COMBINATION AS A SUSTAINABLE FILTER AID	Thomas Kunz	Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Seestraße 13, 13353 Berlin, Germany
P075	FIRST EXPERIENCE OF THE 'BREWERY 4.0' – THE INTERNET OF THINGS CONCEPT APPLIED IN AN OPERATIONAL BEER FILTRATION UNIT	Roland Folz	Roland Folz
P076	A NEW APPROACH TO ASSESS THE CROSSFLOW MEMBRANE FILTRATION OF BEER	Michael Kupetz	Lehrstuhl für Brau- und Getränketechnologie, TU München
P077	PRACTICAL EXPERIENCE WITH THE KRONES MEMBRANE FILTER PHOEBUS	Joerg Zacharias	Krones AG
P078	NOVEL CERAMIC MEMBRANE FOR CROSSFLOW FILTRATION OF BEER	Kohei Watanabe	Asahi Breweries, Ltd., Production Technology Center, Moriya, Japan

TOPIC: HOP BREEDING, AGRONOMY AND PROCESSING

P079	HOP OIL PROFILING TO MITIGATE CLIMATE CHANGE IMPACT ON TRADITIONAL HOP VARIETIES	Ray Marriott	Totally Natural Solutions Ltd
P080	BREWING QUALITY ATTRIBUTES OF UMBRIAN WILD HOPS	Valeria Sileoni	Italian Brewing Research Centre, University of Perugia;
P081	THE APPLICATION OF METABOLOMICS AND GENOMICS IN HOP BREEDING	Alexander Feiner	Simon H. Steiner, Hopfen, GmbH;
P082	IMPACT OF KILN TEMPERATURES ON THE AROMA AND ENZYMATIC POTENTIAL OF HOPS	Scott Lafontaine	Oregon State University, Department of Food Science and Technology
P083	"VAKUPACK" – WHOLE HOPS PACKAGED UNDER AN INERT ATMOSPHERE	Adrian Forster	HVG Hopfenverwertungsgenossenschaft e.G
P084	EVALUATION OF CASCADE HOPS QUALITY CULTIVATED IN NORTH OF ITALY	Paolo Passaghe	University of Udine, Italy, Dept. of Agricultural, Food, Animal and Environmental Sciences
P085	WHAT CAN CRYO HOPS® AND AMERICAN NOBLE HOPS™ DO FOR YOUR BEER?	Cynthia Almaguer	Yakima Chief, Louvain-la-Neuve

TOPIC: MALTING: MALT PRODUCTION AND QUALITY

P086	CHARACTERIZATION OF MALTS BY SENSORY ANALYSIS AND ANALYSIS OF VOLATILES	Michael Féchir	Trier University of Applied Sciences;
P087	AN EXAMINATION OF CHANGES IN PASTING BEHAVIOR OF IN-PROCESS MALT USING RAPID VISCO ANALYZER (RVA)	Xiang S Yin	Rahr Corporation, USA
P088	UNDERSTANDING THE COMPONENTS OF SPECIFIC WEIGHT IN MALTING BARLEY	Aaron Hoyle	Scotland's Rural College
P089	ECONOMIC CONSIDERATIONS ON A SMALL SIZE DRUM MALTING PLANT	Stefano Buiatti	University of Udine, Italy, Dept. of Agricultural, Food, Animal and Environmental Sciences;
P090	EVALUATION OF GERMINATION PARAMETERS DURING MALTING REGARDING PHENOLIC ACID RELEASE DURING WORT PRODUCTION USING RESPONSE SURFACE METHODOLOGY	Torsten Seewald	Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science

TOPIC: NEW PROCESS DEVELOPMENT

P091	LABORATORY PLANT FOR A CONTINUOUS CLOSED LOOP CONTROLLED MASHING AIDED BY DIGITAL TECHNOLOGIES	Patrick Wefing	Institute of Food Technology ILT.NRW;
P092	PRE-TREATMENT OF BARREL: CONTROL TOOL FOR AGING OF BEERS	Mariana Costa De Castro	University of São Paulo, USP-ESALQ, Piracicaba, São Paulo, Brazil
P093	CANCELLED	----------	----------
P094	ADJUNCT CUM MASH TUN FIRST OF ITS KIND IN COMMERCIAL SCALE BREWING IN ASIA.	Gopal Krishnan	Carlsberg India
P095	MICROBIAL EXOPOLYSACCHARIDES AS AN ALTERNATIVE FOR DECLARABLE STABILIZERS AND OPACIFIERS	Julian Huchtmann	ILT.NRW;

P096	SIMULATION OF DRY HOPPING IN LABORATORY-SCALE HOP EXTRACTOR	Lukáš Jelínek	University of Chemistry and Technology Prague, Department of Biotechnology

TOPIC: NEW PRODUCT DEVELOPMENT

P097	FASTER AND SAFE TANK CLEANING USING CONTROLLED JET MOTION	Thomas Weyrauch	Hohe Tanne GmbH
P098	USE OF WOOD CHIPS IN BREWING : IMPACT OF PROCESS AND MATERIALS	Brabant Pierre	IFBM
P099	TRANSFER OF CHARACTERISTIC MARKERS DURING AGING OF BEER WITH DIFFERENT OAK CHIPS	Marcel Karabín	University of Chemistry and Technology Prague, Department of Biotechnology, Prague, Czech Republic
P100	HIGH PROLYL-ENDOPEPTIDASE ENZYME DOSAGES FOR THE PRODUCTION OF GLUTEN-FREE WHEAT BEER: A LAB-SCALE CASE STUDY	Hellen Watson	Ghent University, Faculty of Bioscience Engineering, Department of Biotechnology, Brewing Science and Technology Research group, Ghent, Belgium
P101	WHY BREWER'S YEASTS ARE THE BEST "HEALTH BENEFIT" PARTNERS OF KOMBUCHA MICROORGANISMS CONSORTIUM?	Van Nedervelde Laurence	Labiris

TOPIC: NOVEL RAW MATERIALS FOR BEER PRODUCTION

P102	BREWING WITH 10/20 % LENTIL MALT ADDITION IN A MICROBREW SCALE	Jonas Trummer	University of Agriculture in Krakow
P103	HOW RESEARCH ON ALTERNATIVE GRAINS CAN BOOST THE BREWING INDUSTRY	Jessika De Clippeleer	Ghent University
P104	RAW MATERIALS INCLUDING ANTHOCYANINS COULD CHANGE THE CONCENTRATION OF DIACETYL IN BREWING.	Atsushi Tanigawa	SAPPORO BREWERIES LTD
P105	TASTE PROPERTIES AFFECTING BEER OF POLYPHENOLS DERIVED FROM HERBS AND SPICES	Takako Inui	Suntory Beer Ltd., Beer Development Department, Osaka, Japan
P106	TRITORDEUM A NOVEL INGREDIENT FOR BREWING	Jose Luis Olmedo	Hijos de Rivera Inversiones Corporativas, S.L.
P107	OLIVE LEAVES AS NUTRACEUTICAL INGREDIENT IN CRAFT BEER PRODUCTION	Manfredi Guglielmotti	University of Udine, Italy, Dept. of Agricultural, Food, Animal and Environmental Sciences

TOPIC: WORT PRODUCTION

P108	SPECIAL MALT ADAPTED HOP DOSAGE TO IMPROVE OXIDATIVE BEER STABILITY	Thomas Kunz	Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Seestraße 13, 13353 Berlin, Germany
P109	AND IN THE END, IT'S ALWAYS BEER - A COMPARISON OF THREE LAUTERING SYSTEMS	Nele Bastgen	Ziemann Holvrieka GmbH

P110	INVESTIGATING THE EVOLUTION OF STALING ALDEHYDES DURING THE BREWING PROCESS AND BEER AGING	Maciej Ditrych	KU Leuven, Faculty of Engineering Technology, Technology Campus Ghent, Laboratory of Enzyme, Fermentation and Brewing Technology, Ghent, Belgium
P111	A FRESH LOOK AT SMALL AND LARGE STARCH GRANULES IN BARLEY MALT	Charlotte De Schepper	Laboratory of Food Chemistry and Biochemistry (KU Leuven)
P112	INFLUENCE OF COMPOSITION OF WORT ON THE QUALITY OF LAGERS	Pavel Dostálek	Department of Biotechnology, University of Chemistry and Technology, Prague
P113	ASSESSMENT OF METAL CHELATION DURING THE MASHING STAGE OF BREWING	Tuur Mertens	Technical University of Berlin, Institute of Food Technology and Food Chemistry, Department of Brewing Science, Berlin (Germany)
P114	PREDICTION MODEL FOR EXTRACT AND FERMENTABLE SUGARS	Héctor Hugo Rivera Yerena	Tecnológico Nacional de México en Celaya
P115	NEAR INFRARED SPECTROSCOPY AND MASHING – A PROMISING APPROACH FOR REAL TIME INLINE QUALITY CONTROL?	Florian Conradi	ILT.NRW - Institute of Food Technology.NRW
P116	HYDROGEN PEROXIDE FORMATION AND -INACTIVATION BY MALT-DERIVED THIOLS DURING MASHING	Matthias Baldus	Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science
P117	VARIETAL DEPENDENCE OF FE, MN AND CU CONTENT AND CONTRIBUTION INTO BREWERS WORT IN POLISH AND AMERICAN HOPS	Olga Szczepanik	University of Agriculture in Krakow
P118	MASH HOPPING - A PERFECT SOLUTION FOR A HOPPY SOUR BEER	Aleksander Poreda	University of Agriculture in Krakow, Faculty of Food Technology

TOPIC: YEAST AND FERMENTATION

P119	A NEW METHOD FOR SCREENING INDUSTRIAL YEASTS WITH FERULIC ACID DECARBOXYLATION ACTIVITY BASED ON SNP MARKERS	Chen Lu	State Key Laboratory of Biological Fermentation Engineering of Beer
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LECTURE ABSTRACTS

L1 – KEY NOTE: SUSTAINABLE BREWING OF THE FUTURE

Zoran Gojkovic1
1 - Carlsberg, Denmark

Abstract

Barley (Hordeum vulgare) was one of the first crops domesticated by humans. Today, barley is the fourth most important crop in the world and it is the primary cereal for brewing beer. Modern breeding techniques produced high yielding varieties, but the selection and breeding of a small number of varieties resulted in significant loss of genetic diversity in barley.

The best malting varieties rapidly take up water during steeping, deliver high enzyme activity and high extract potential. The majority of brewers value these characteristics more than the choice of barley variety and its impact on flavor and quality. The barley breeding effort of Carlsberg Research Laboratory combines decades of expertise to provide both beer lovers and brewers with barley varieties delivering good taste, quality and even positive environmental impact.

Today, an intensive breeding effort is focused on climate tolerance – in order to develop varieties that better can tolerate more extreme weather conditions. As the interest for different barleys continues to increase, the work on trying to develop different varieties will never stop.

Short biography

50 years old, Master and Ph.D. in molecular biology completed at University of Copenhagen, Brew Master from Scandinavian School of brewing.

Worked with different scientific areas: yeast genetics, biodiversity, gene therapy & stem cells, probiotics and functional beverages. Started as researcher and innovator, changed into biotech business and at the moment focuses on beer flavor stability to provide a perfect drinking experience. Another important research area is the development of new sustainable brewing technological processes.

L2 - IMPACT OF THE CLIMATE CHANGE ON HOPS - EXEMPLIFIED BY THE HALLERTAU GROWING REGION

Florian Schull[1]; Adrian Forster[1]; Andreas Gahr[2]

1 - HVG Hopfenverwertungsgenossenschaft; 2 - Hopfenveredlung St. Johann

Abstract

In the past 15 years an accumulation of hot and dry summers and as a consequence poor hop crops could be observed in the European hop-growing regions. Based on the weather conditions in the Hallertau it can be shown that the climate change is not a threat of the future, it is in full swing. A calculating model with a significant correlation will be introduced to estimate the relation between weather data and the hop crop in terms of quantity and α-acids. Beside these two commercially most relevant factors the investigation of the climate impact on β-acids, selected flavour substances and polyphenols is part of this study. One conclusion is, that hop varieties react to a different degree on erratic weather conditions. Especially the traditional aroma hops show a strong dependence and therefore could be the first victims of the climate change. It is questionable whether the current range of varieties is available on a long term. The knowledge about the climate sensibility of certain hop varieties opens brewers the opportunity to adapt recipes and consequently to align their variety portfolio. Moreover, breeders have to examine new varieties for their ability to cope with hot and dry summers.

Short biography

Since 05/2015 Technical Manager for Hops at HVG, Hopfenverwertungsgenossenschaft, Wolnzach

07/2010 – 05/2015 Head of research brewery atTU -München / Weihenstephan, Lehrstuhl für Brau- und Getränketechnologie

Since 05/2008 - 07/2010 Assistant laboratory manager of the raw material lab at TU-München / Weihenstephan, Lehrstuhl für Brau- und Getränketechnologie

01/2007 – 02/2012 PhD Student TU-München / Weihenstephan, Lehrstuhl für Brau- und Getränketechnologie

10/2000 - 10/2006 Study Brauwesen und Getränketechnologie TU-München / Weihenstephan

L3 - PROCESSING BREWER'S SPENT GRAIN AND TRUB TO FOOD INGREDIENTS

Timothy Hobley[1]; Preben Hansen[1]; Matias Bjerregaard[1]; Radhakrishna Shetty[1,2]; Helena Pastell[3]; Shiwen Zhuang[1]; Angelos Charalampidis[1]; Rasmus Frøding[1]; Katrine Rørby[1]; Charlotte Jacobsen[1]; Manuel Pinelo[1]; Nina Gringer[1]

1 - Technical University Denmark; 2 - Carlsberg Research Laboratory; 3 - Finnish Food Safety Authority Evira

Abstract

We report a new process at pilot scale (1 ton/h) for separation of brewer's spent grain and trub to solid and liquid streams that can be added back into the brewing process or used as food ingredients. A new energy efficient continuous rotary drum press processed hot BSG or trub directly to produce a liquid filtrate and a solids filter cake. The filtrate composed 50% of the starting mass of BSG and the filter cake composed 50%. For trub, 92.8% ended as filtrate and 7.8% as a filter cake. The dry weight of the BSG was raised from 23% to over 35% in the filter cake (in some cases up to 42%). Insoluble dietary fibre and phenolics were up-concentrated in the filter cake, but soluble sugars, proteins and fibre were not. Replacing 80% of the water and 10% of the flour in bread dough with BSG filtrate and filter cake lead to similar bread as a control, when texture analysis was conducted. A 100 micron filter in the rotary drum press reduced the solids in the filtrate compared to a 300 micron filter. Disc-stack centrifugation of the BSG filtrate led to a clarified supernatant and a paste and to concentration of insoluble dietary fibre and phenolics in the paste. Concentration of soluble species and recovery of water in supernatants for brewing, by forward osmosis, is also examined. All operations are fully scaleable and approved for food production, and a feasible route now exists for direct processing of brewing byproducts.

Short biography

Associate Professor, Ph.D. Timothy Hobley has a long research career in fermentation and downstream processing and over the last 6 years has focused on reseach, innovation and teaching in the areas of yeast strain development, fermentation and new unit operations for mashing and processing of brewing by-products.

L4 – A COMPARISON OF SAAZ HOPS GROWN IN TWO REGIONS (CZ AND DE) IN YEARS OF STRONG CLIMATE FLUCTUATION, FROM 2016 TO 2018

Andreas Gahr[1]; Adrian Forster[2]
1 – Hopfenveredlung St. Johann; 2 – HVG Hopfenverwerungsgenossenschaft Eg

Abstract

Several hop varieties are cultivated in different regions; for instance, Perle, Nugget, Cascade, Comet and Amarillo are grown both in the USA and Germany. One reason for this is the desire to spread the area under cultivation and thus reduce the risks inherent to fluctuations in climate. Growing regions are now being displaced by ever more drastic aberrations in weather conditions, which is an result of climate change. Using the Saaz hop variety, the phenomena of growing region and weather is here investigated in greater detail. For several years now, Saaz hops have been cultivated outside of the Czech Republic, namely in Germany, in the Elbe-Saale region but also in the Hallertau. A comparison of the composition of bitter substances, polyphenols and aroma compounds in hops harvested from these regions shows also the effects of the different weather conditions present from 2016 through 2018 (2016 was ideal; 2017/18

hot, dry conditions). The particular region appears to have no significant influence on the compounds present in hops. The climate, by contrast, has a considerably greater effect. The dry, hot weather conditions experienced from May to September – the most important period of growth for the plants – had the greatest impact on the alpha acids, followed by the beta acids and the aroma compounds. Conversely, the polyphenols remained largely unchanged. To supplement these data, pellets from Saaz hops cultivated in Czech and German regions and 2 crops were compared in two late-hopped pilsner beers. No systematic differences were found in the beers produced with the Saaz hops harvested the same year from the two different growing regions.

Short biography

Mr Gahr was trained on the job of a brewer and maltster at the Augustiner Brewery, Munich, received a brewmaster degree from the Technical University Munich-Weihenstephan in 1994 and worked for another four years at the university for the Chair of Brewing Technology I. Since 1998 Andreas is the head of the Research Brewery St. Johann and deals with all kinds of hop related brewing trials and product development as well as technological and raw material trials for suppliers and the whole brewing industry. He is an experienced taster and judges for a number of beer and brewing competitions. Together with others he wrote several publications and a book on hops and received together with others the MBAA Inge Russel Best Paper Award 2010 and the Ludwig Narziss Price for Brewing Science in 2015.

L5 - USE OF WINE NON-SACCHAROMYCES YEASTS FOR BREWING

Fotini Drosou[1]; Panagiotis Tataridis[2]; Vasso Oreopoulou[1]; Vassilis Dourtoglou[2]

1 - Department of Chemical Engineering, National Technical Univesity of Athens; 2 - Department of Wine, Vine & Beverage Sciences, University of West Attica

Abstract

For the small craft brewers who want to provide seasonal specialty products, with novel and more complex flavors, the use of non-*Saccharomyces* wine yeasts may be a new solution. However, experimentation is needed in order to assess the fermentation rate of each sugar, as well as to define the optimal parameters for non-*Saccharomyces* yeast strains, in order to produce a normal gravity beer with the desirable features.

In the present study, two different non-*Saccharomyces* yeasts were tested for their ability to metabolize wort sugars, as well as the aroma and flavor profile of the produced beer were examined. In particular, the yeast strains that were used are *Torulaspora delbrueckii* and *Metschnikowia pulcherrima* in both pure and mixed cultures with a *Saccharomyces cerevisiae* strain. In the first series of experiments, we studied the ability of the two non-*Saccharomyces* to ferment the three basic sugars of wort (glycose, fructose and maltose) in synthetic substrates rich in nutrients. In the second series, four different yeast cultures were evaluated for a Pale Ale beer production. Pure cultures of *T. delbrueckii*, *M. pulcherrima* and *S. cerevisiae,* and a

mixed culture of *S. cerevisiae* with *T. delbrueckii* at a 1:10 ratio, were used to ferment wort at 20 °C and 13 °C.

This work presents the fermentation kinetics, and the chemical and sensory analysis of the products. *T. delbrueckii* showed higher values for isoamyl and phenyl ethyl alcohol than *M. pulcherrima* and *S. Cerevisiae* which leads to beers with more distinct floral/fruity aromas, such as rose.

Short biography

Fotini Drosou is a PhD researcher in the Department of Chemical Engineering at National Technical Univesity of Athens and in the Department of Wine, Vine & Beverage Sciences at University of West Attica. Her research focuses on brewing with non-Saccharomyces yeasts and their contribution to the final aromatic and flavor profile. She has graduated as Oenologist of the Department of Wine, Vine & Beverage Sciences at University of West Attica and is a M.Sc. in brewing of the same faculty.

L6 - YEAST PROTEOMICS DURING BEER FERMENTATION: CHALLENGES AND PROSPECTS

Magda Costa[1]; David Laureys[1]; Sören Planckaert[2]; Bart Devreese[2]; Anita Van Landschoot[1]; Jessika De Clippeleer[1,3]

1 - Ghent University, Faculty of Bioscience Engineering, Department of Biotechnology, Research Group Brewing Science & Technology, Campus Schoonmeersen, Valentin Vaerwyckweg 1, B-9000 Ghent, Belgium; 2 - Ghent University, Faculty of Science, Department of Biochemistry and Microbiology, Laboratory for Microbiology, Campus Ledeganck, KL Ledeganckstraat 35, B-9000 Ghent, Belgium; 3 - University College Ghent, Faculty of Science and Technology, Department of Natural and Food Sciences, Research Group Brewing Science & Technology, Campus Schoonmeersen, Valentin Vaerwyckweg 1, B-9000 Ghent, Belgium

Abstract

The alcoholic fermentation of wort by yeast is a crucial step during the production of beer. The overall conditions during this process have an impact on the behaviour of the yeast cells, which is itself determined by the yeast proteome. Therefore, monitoring the yeast proteome via targeted proteomics might provide more insight into the response of the yeast cells to the fermentation conditions. Mass spectrometry proteomics has already been used to describe the dynamics of the wort untargeted proteome during nanoscale beer production but has not yet been applied to follow and quantify the yeast proteome during beer production. In this study, a framework is being developed to monitor the yeast proteome during the fermentation process of beer via liquid chromatography electrospray ionization mass spectrometry (LC-ESI-MS). Hereto, a selection of around 25 enzymes responsible for the production of desirable (e.g. esters and higher alcohols) and undesirable flavours (e.g. DMS and diacetyl), are quantified during the fermentation process, and the results are compared with the substrates assimilation profiles and the metabolites production profiles. A variety of yeast enzymes is already monitored with this technique, but the reliable quantification remains a challenge and is currently being investigated. The established framework will be used to shed new light on the reaction of different yeast strains to innovative raw materials and adjuncts, and

differences in gravity and temperature. These insights may help the development of novel beer flavours and more sustainable production processes for beer.

Short biography

Magda Costa (1993, Portugal) is currently a PhD student of the Research Group Brewing Science & Technology in the Department of Biotechnology at Ghent University, Belgium, under the project 'European Joint Doctorate in Food Science', funded by the European Union's Horizon 2020 research and innovation program with the Marie Skłodowska-Curie grant agreement No 722166. Magda has a MSc degree in Biological Engineering from Técnico Lisboa, Portugal (2016), and an Erasmus experience at the University of Amsterdam, The Netherlands, for her MSc thesis in biocatalysis (2016). She moved to Belgium (2017) to start her doctoral thesis research work related to the fermentation in the brewing process, more specifically the study of the yeast cell proteome.

L7 - SACCHAROMYCES CEREVISIAE VAR. DIASTATICUS - FRIEND OR FOE

Tim Meier-Dörnberg[1]; Fritz Jacob[1]; Mathias Hutzler[1]

1 - TU München - Research Center Weihenstephan for Brewing and Food Quality

Abstract

Saccharomyces cerevisiae variety diastaticus is generally considered to be an obligatory spoilage microorganism and spoilage yeast in beer and beer-mixed beverages. Their super-attenuating ability causes increased carbon dioxide concentrations, beer gushing and potential bottle explosion along with changes in flavor, sedimentation and increased turbidity. This research shows clear differences in the super-attenuating properties of S. cerevisiae var. diastaticus yeast strains and their potential for industrial brewing applications. Nineteen unknown spoilage yeast cultures were obtained as isolates and characterized using a broad spectrum of genetic and phenotypic methods. Results indicated that all isolates represent genetically different *S. cerevisiae* var. *diastaticus* strains except for strain TUM PI BA 124. Yeast strains were screened for their super-attenuating ability and sporulation. Even if the *STA1* gene responsible for super-attenuation by encoding for the enzyme glucoamylase could be verified by real-time polymerase chain reaction, no correlation to the spoilage potential could be demonstrated. Seven strains were further characterized focusing on brewing and sensory properties according to the yeast characterization platform developed by Meier-Dörnberg. Yeast strain TUM 3-H-2 cannot metabolize dextrin and soluble starch and showed no spoilage potential or super-attenuating ability even when the strain belongs to the species S. cerevisiae var. diastaticus. Overall, the beer produced with *S. cerevisiae* var. *diastaticus* has a dry and winey body with noticeable phenolic off-flavors desirable in German wheat beers.

Short biography

Born in 1978 in Regensburg, Germany. 1999-2004 course of study "Food Technology and Biotechnology" at the Technical University of Munich (TUM). 2004-2009 Scientific Assistant at

the Chair for Brewing Technology II (Prof. Geiger). TUM, Weihenstephan. Topic of doctoral thesis: Differentiation of industrial and spoilage yeasts based on novel rapid methods. Since 2009 division manager of the accredited laboratory for brewing/ beverage microbiology and the yeast center of the Research Center Weihenstephan for Beer and Food Quality (Prof. Jacob). Since 2013 associate lecturer for "Microbial Biodiversity of the Brewing Process" and "Beer Substances and Human Physiology" at the Department of Brewing Science (Prof. Methner), TU Berlin. Since 2014 MEBAK member and coordinator of the working committee microbiology. Research focus: brewing microbiology, yeast technology, alternative fermentations.

L8 - THE GUINNESS YEAST: 250 YEARS IN THE MAKING

Daniel Kerruish[1]; Sandra Stelma[2]

1 - Group Microbiologist, Diageo Global Supply, Science and Technology, St James's Gate Brewery, Dublin 8, Ireland; 2 - Head of Science, Diageo Global Supply, Science and Technology, St James's Gate Brewery, Dublin 8, Ireland

Abstract

The Guinness brewery was founded in 1759 by Arthur Guinness. The first record of yeast within the Guinness archive is from 1809, when a new Guinness brewery was commissioned on the St James's Gate brewery site. The Guinness brewery group were early exponents of the advancements in microbiology, and particularly yeast husbandry, that took place in Europe at the end of the 19th Century. Subsequently this led Guinness to establish the Guinness yeast library.

Today, using PCR based genetic fingerprinting and historical notes from the Guinness archive, the Guinness yeast library is being explored. The emphasis of this study was analysis of the Guinness yeast and in particular those yeast within the library that have been used to brew Guinness Stout and its variants. Using historical analysis 13 Guinness yeast were selected for assessment.

Giant Colony morphology established the different morphological traits of the 13 Guinness yeast. Subsequent genetic analysis of these morphologies established lineage, providing insights that corroborated historical analysis whilst also revealing unexpected attributes of the Guinness yeast. Furthermore phenotypic analysis of volatiles production, fermentation performance and flocculation characteristics demonstrated the differences and similarities between the Guinness yeast providing opportunities for future product and process development within the Guinness portfolio.

In this paper we present an analysis of the Guinness yeast within both a historical and scientific context.

Short biography

Originally from the Isle of Man, Daniel completed an undergraduate degree in microbiology at the University of Liverpool before continuing his studies in Microbiology by completing a PhD in environmental microbiology at King's College London. Daniel then spent a number of years brewing, gaining his brewing qualifications and MBA before taking up a research fellow position at the Brewing School in the University of Nottingham. After working at New Belgium Brewing Company, Fort Collins Colorado he took up a position with Cara Technology before moving to Ireland where he is presently employed as the Group Microbiologist for Diageo.

L9 - TEFF (ERAGROSTIS TEF (ZUCC.) TROTTER) AND QUINOA (CHENOPODIUM QUINOA W.) AS NOVEL RAW MATERIALS FOR BREWING

Ombretta Marconi[1]; Valeria Sileoni[1]; Giovanni De Francesco[1]; Lidia Di Ghionno[2]; Giuseppe Perretti[1]

1 - University of Perugia-Italian Brewing Research Centre; 2 - University of Perugia, Department of Agricultural, Food and Environomental Sciences

Abstract

Worldwide, barley is the main raw material used for malting and brewing and its suitability for malting and brewing is mainly due to the high content of starch, as well as the presence of hulls, which work as a filtering aid during brewing, and the high content of hydrolytic enzymes produced during germination, which ensure a high fermentable extract yield. However, because of its content of hordeins, barley is not suitable for people with celiac disease. As a consequence, an increasing number of studies have been focused on the evaluation of naturally gluten-free cereals and pseudocereals to replace gluten-containing raw materials in cereal-based food and beverages, including beer. Among these grains, rice, sorghum, millet, and buckwheat have been most widely studied for malting and brewing purposes, with promising results. In contrast, only very little published material is available on teff and quinoa. The aim of this work was the investigation of alternative cereal and pseudocereal as teff and quinoa that do not contain gluten protein to produce new fermented gluten-free beverages. The brewing performance of teff and quinoa in both raw and malted form was studied in order to obtain an all-teff and quinoa beer suitable for coeliac suffering people and to evaluate the possibility of avoiding the malting process. The results showed that the multiple-step infusion mash developed, and the fermentation with the traditional brewing yeast *Saccharomyces cerevisiae*, lead to a satisfactory wort and beer quality attributes in both raw and malted teff and quinoa trials performed.

Short biography

Di Ghionno, L., Marconi, O., Lee, E.G., Rice, C.J., Sileoni, V., Perretti, G. "Gluten-Free Sources of Fermentable Extract: Effect of Temperature and Germination Time on Quality Attributes of Teff [Eragrostis tef (zucc.) Trotter] Malt and Wort" Journal of Agricultural and Food Chemistry, 65, 23, 2017, 4777-4785

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Zarnkow, M., Geyer, T., Lindemann, B., Burberg, F., Back, W., Arendt, E. K., Kreisz S. (2007). The use of response surface methodology to optimise malting conditions of quinoa (Chenopodium quinoa W.) as a raw material for gluten-free foods. Brewing Science, 60, 2007, 118-126

L10 - PROCESS INNOVATION AT ASAHI BREWERIES -THE PURSUIT OF ULTIMATE CONSISTENCY OF QUALITY IN ASAHI SUPER DRY-

Yoshinori Ito[1]; Shigekuni Noba[1]; Minoru Kobayashi[1]; Kazuhiko Uemura[1]

1 - Asahi breweries, Ltd

Abstract

Fermented beverages have lot-to-lot variations in flavor due to the differences in raw materials and fermentation process. Asahi Breweries defies this conventional wisdom and places the utmost importance on producing beer with an extremely high level of consistency. One of our products, "Super Dry", has a delicate flavor, characterized by a smooth mouthfeel with no lingering aroma or aftertaste. Because of these reasons, even slight deviations in flavor profiles can easily compromise its quality. To confront these daunting challenges, we have put enormous efforts for over the 10 years in researching flavor stability improvement and off-flavor reducing technologies. As it turned out, these technologies became the essential key success factors behind the rigorous uniformity of our beer products. For instance, the concentration of trans-2-nonenal, which serves as an indicator of flavor stability, was halved from 0.2 ppb to 0.1 ppb at all our breweries. In addition, the lot-to-lot differences among the same product brands have been minimized to almost unnoticeable level by pursuing the off-flavor reducing technologies. Finally, we will talk about our evolving quality project, which is an integrated effort involving the research laboratories, head office and breweries. All breweries actively participated and the manufacturing operators have played a central role in the project. "Thinking" operators are the key strength of our company, who analyze and confirm samples during the brewing process to finely tune the brewing conditions. As a consequence, we are now able to achieve stable production of high quality beer with the unparalleled level of consistency.

Short biography

Yoshinori Ito joined Asahi breweries, Ltd in 1989. On joining the company, he led the new product development team, then moved to the brewing department of Nagoya Brewery in 1996. He became the Beer Product Development Manager in 1999 and moved to the Marketing Headquarters in 2000, there he led the marketing effort for "Honnama," Asahi Breweries first low-malt beet (happoshu), introduced in October, 2000. He moved to the Product Strategy department in 2003, became the Deputy General Manager of Ibaraki Brewery in 2006, and took over as the General Manager of the Production Technology Center in 2009.

Finally, he became Senior General Manager of Research & Development Headquarters in 2015, and took a role as a corporate officer in 2017.

L11 - IDENTIFICATION OF FACTORS AT THE ORIGIN OF THE PHENOMENON OF BEER GUSHING IN ORDER TO DEVELOP A PREMATURE DETECTION TECHNIQUE OF THE GUSHING RISK

Julien Billard[1]; Sophie Schwebel[1]; Romain Kapel[2]; Marc Schmitt[1]

1 - IFBM; 2 - University of Lorraine

Abstract

Beer gushing is a sometimes explosive over-generation of foam following the opening of a bottle. It is highly dependent on barley growing and harvesting climatic conditions and has been observed more frequently over the past years.

Current techniques, such as the modified Carlsberg test, only provide information on predictive gushing potential of malt with a big uncertainty. A rapid screening test on raw material leading to the identification of actual factor(s) responsible for the gushing is consequently highly demanded by the brewing industry.

The initial goal of this study was to determine the compounds involved in beer gushing. This approach has been applied to both naturally gushing positive malts and artificially contaminated barleys. Barley artificially contaminated was used as model to develop the extraction of gushing compounds. Then this method was used to screen and compare gushing positive and negative industrial malts in order to try to identify compounds with possible gushing potential.

The methodology and the results will be presented and discussed. The final objective of the work is the development of a simple test to quantify the gushing potential of raw material.

Short biography

PhD in food process and biotechnology, he works in the R&D department at IFBM on barley-to-beer themes. He also has worked on the identification of malt spoiling moulds by MALDI-TOF analyses during his MSC specialized in food process and biotechnology. He have worked 2 years with AEB group France on the screening and characterization of yeast strain for the fermentation of beer wort and the impact of the glutathione on the growth of brewing yeast.

L12 - SOURDOUGH CULTURES AS A SOURCE OF SPECIALITY YEAST FOR THE BREWING INDUSTRY

Brian Gibson[2]; Jarkko Nikulin[2]; Linnea Johansson[1]; Frederico Magalhães[2]; Kristoffer Krogerus[2]; Elina Sohlberg[2]; Paula Jouhten[2]; Linnea Laitila[2]

1 - Metropolia University of Applied Sciences; 2 - VTT Technical Research Centre of Finland

Abstract

Consumer demand for beers with novel flavour profiles and functional properties is stimulating an interest in the potential of non-conventional yeast for brewing. Sourdough cultures represent a rich source of yeast suitable for food production processes, including brewing. Here we describe the brewing properties of 12 yeast species isolated from de novo sourdough cultures prepared with flour from 10 different grains (including wheat, barley, rye and oat). The concentration of yeast cells varied with respect to grain type with, for example, 1000 times more yeast cells in malted rye cultures than in oat cultures. Next-generation sequencing revealed a diverse yeast population in each sourdough culture, but with each having a dominant yeast species present. Yeasts isolated from the cultures included members of the genera *Cyberlindnera*, *Hanseniaspora*, *Hyphopichia*, *Kazachstania*, *Kluyveromyces*, *Pichia*, *Torulaspora* and *Wickerhamomyces*. Strains were initially screened via 100ml wort fermentations, where fermentation profile, volatile aroma concentration, aldehyde content and 4-vinylguaiacol were assessed. Strains included were found to be maltose-negative and yielded low levels of alcohol. Aroma content was however relatively high in a number of species including *Kazachstania servazzi* and *Torulaspora delbrueckii*, and values compared favourably with a reference strain of *Saccharomycodes ludwigii*. Results indicate significant potential for sourdough-sourced yeast in low-alcohol beer production or bioflavouring in conjunction with standard brewing yeast.

Short biography

Brian Gibson is a Principal Scientist and Project Manager at VTT Technical Research Centre of Finland, Ltd. where he has worked since 2009. His research work is mainly focused on the biology of brewing yeast and how this impacts on fermentation performance and beer quality. Current topics of interest include improvement of yeast performance through hybridization and/or adaptive evolution as well as optimization of process conditions. The underlying mechanisms (genetic, molecular, physiological) that govern yeast performance are a particular interest. Brian's group is also actively engaged in projects related to other fermented and distilled beverages, bioethanol and baking.

Brian was awarded his PhD from University College Dublin in 2004, after which he carried out brewing research at Oxford Brookes University and the University of Nottingham.

L13 - EXPLOITING YEAST DIVERSITY FOR PRODUCT AND PROCESS OPTIMISATION

Katherine Smart[1]

1 - University of Cambridge

Abstract

Yeast species and strain diversity has been poorly exploited by the brewing industry. This is potentially due to the lack of effective assays to enable the selection of candidate strains for expensive larger scale trial work to be conducted. An assay specifically designed to assess the phenotypic diversity of yeast strains has been developed. This assay permits the examination of differential responses of yeast strains to new wort recipes for product development or enhanced stresses that might be encountered during brewing fermentation optimisation. The assay comprising a bespoke 96-well plate, with wort and stress effector challenge media, is assessed using a Phenotypic Microarray Omnilog reader. A redox reporter within the assay permits analysis of metabolic activity in aerobic and/or anaerobic conditions. Results from the assay compare well with traditional growth on spot plates and tolerance assays in which maintenance of viability was assessed. Perhaps more critically the data obtained appears to provide a predictive assessment when compared to larger scale fermentations. For the first time a high throughput assessment of yeast strain fitness for fermentation has been developed.

Short biography

Katherine Smart holds the role of University Lecturer in Brewing and Distilling at the University of Cambridge. She is a Co-Founder and the Distiller of The Surrey Copper Distillery Limited. Until October 2017, Katherine was the Global Chief Brewer of ABInBev and SABMiller PLC. For SABMiller PLC she was responsible for research, innovation, brewing strategy, raw material strategy and technical stewardship of global brands. Katherine has 21 years' academic experience at the Universities of Cambridge, Oxford Brookes and Nottingham. At Nottingham she was the SABMiller Professor of Brewing Science from 2005 to 2012 and she is currently an honorary Professor. She founded the National Brewing Library at Oxford Brookes University and the Bioenergy and Brewing Science Centre at the University of Nottingham. Katherine has holds three doctorates and successfully completed her DSc by publication in December 2016. She is an author of scientific papers and technical books.

L14 - IMPACT OF FERMENTATION PARAMETERS AND HOPS ON THE FLAVOUR EXPRESSION OF BEER YEASTS

Gabriela Montandon[1]; Philippe Janssens[1]; Yves Gosselin[1]; Stephane Meulemans[1]

1 - Fermentis

Abstract

Beer is a complex matrix expressing taste, aromas and flavours based on a large combination of factors amongst which yeast, raw materials and processing parameters are important contributors. The genetic diversity of yeast and hops will largely impact on a certain flavour characteristic of beer; but a given genotype of yeast and hop can lead to a wider diversity of flavours based on the processing parameters as well. The objectives of this work were to evaluate fermentation performances and flavour expressions (phenotype) of genetically

diverse beer yeasts, at first as a baseline; and then study the impact of a range of fermentation parameters such as wort gravity, fermentation temperature and pitching rate on the baseline flavour expression. For that purpose, beer worts were produced and fermentation trials were performed at two scales. The fermentations were performed at lab scale in 200mL flasks and at pilot scale in 50L cylindro-conical tanks using different strains and fermentation conditions. At both scales the beer wort gravity was ranging from 12ºP to 20ºP, the fermentation temperature from 12ºC to 24ºC and the pitching rate from 25g/hL to 200g/hL. Fermentation performances were measured daily by weight losses for the lab scale and apparent degree of fermentation for the pilot scale trials. Analytical parameters (sugars, higher alcohols, acetate esters, ethyl esters, 4VG and diacetyl - HPLC and GC-MS) were evaluated and a sensory profile by Quantitative Descriptive Analysis by a trained panel was done in the final beers. Secondly, it was assessed the impact on the flavour expression of those yeast strains using Cascade hop variety in different hop regimes; by the end of boiling or/and in the whirlpool or/and during maturation. It was observed that different yeasts strains provide substantially diverse fermentation and hop flavours to the final beer as well a scaling-up effect, which may be considered for practical brewing application. Results are illustrated more specifically with a lager yeast strain and an ale strain.

Short biography

Member of Fermentis Research and Development team (Lille - France, 2017), participates in projects related to yeast and sensory expression. PhD in Microbiology (UFMG, Brazil; KU Leuven, Gent, Belgium, 2016), international beer taster (BJCP 2010), participating in the largest beer competitions in the world. Strong experience in the field of flavours and beer fermentation. Co-founder of Grimor beers (2010).

L15 - RAPID ASSESSMENT OF YEAST PHENOTYPIC DIVERSITY THROUGH THE APPLICATION OF RAMAN SPECTROSCOPY

Yang He[1]; Hua Yin[1]; Jianjun Dong[1]; Junhong Yin[1]; Lu Chen[1]

1 - Tsingtao Brewery Co. Ltd.

Abstract

Brewing yeast of isogenic population has long been recognized as phenotypic heterogeneity in cell growth, metabolites accumulation, stress resistance and other bioprocesses, which have significant impact on the yeast fermentation performance and the final production of aroma-active compounds. Traditionally, small scale fermentation experiments were conducted to evaluate and predict their phenotypic quality, which is time-consuming and heavy-loaded. Rapid and label-free strategies for yeast phenotypic and metabolic measurements are of significant importance. Raman spectroscopy can directly detect the changes of metabolite profile in a yeast cell and thus can potentially satisfy the purposes by providing an intrinsic chemical “fingerprint”.

Different colonies of the industrial brewing lager yeast TT-21 were analyzed by Raman spectroscopy after incubation of 72 h in YPD liquid. Yeast cells were captured by a 532-nm laser and the Raman spectra were acquired by the same laser. Raman spectra result revealed the heterogeneity among the isogenic industrial brewing yeast cells. The Raman spectra were able to discriminate similarities between different candidates by using ANOSIM test. Furthermore, a correlation coefficient of 0.797 ($p < 0.01$) between yeast Ramanome and phenome data was shown for the Mantel test, which indicated that Ramanome was strongly positive correlated with phenome. Thus Raman spectroscopy can serve as a global evaluation for phenome without need of tedious and time-consuming measurements and having the potential to resolve the unmeasurable or unknown phenotypes that should be measured as the phenome.

L16 - THE COPPER BINDING AFFINITY OF WORT DURING THE BREWING PROCESS

Marcus Pagenstecher[1]; Morten J. Bjerrum[2]; Mogens L. Andersen[1]

1 - Department of Food Science, University of Copenhagen, Denmark; 2 - Department of Chemistry, University of Copenhagen, Denmark

Abstract

Trace levels of copper in beer catalyze oxidative reactions and have been shown to have a negative impact on flavor stability. The main sources of the copper ions arise from the raw materials, with over 90 % originating from malt. Past research has indicated that spent grains significantly level the concentrations of minerals during lautering with an additional loss of minerals during hot break separation. The brewing liquors have binding capacity of copper(II) ions which may counteract their removal. The binding capacities throughout the brewing process – from water to beer – have been characterized based on copper(II) titration curves using ion-selective electrodes. The main focus is on mashing as the main uptake and removal step, and the inherent competition with the spent grains. Roasting malt significantly affects the copper(II) ion binding capacity of brewing liquor. The copper binding capacities have been correlated to the oxidative stabilities of the brewing liquors.

Short biography

Marcus Pagenstecher is a PhD student at the University of Copenhagen. He studied Chemistry at the TU Munich, whith a focus on Organic and Analytical Chemistry. Marcus received his MSc degree in 2016, with a thesis on antibacterial hydroxyapatite/titania sol-gel coatings on stainless steel. He is now doing his PhD on “Malts for control of trace elements with pro-oxidative effects during the brewing process and in finished beer” under the supervision of Prof. Mogens L. Andersen. He is part of the Marie Curie innovative training network European Joint Doctorate in Food Science. True to his study years, Marcus has a particular fondness of wheat beers.

L17 - UNLOCKING THE POTENTIAL OF LACTIC ACID BACTERIA AND THEIR APPLICATION IN MALTING AND BREWING

Elke Arendt[1,2]; Kieran Lynch[3]; Emanuele Zannini[3]

1 - School of Food and Nutritional Sciences and APC Microbiome Institute, University College Cork, Ireland; 2 - Cork; 3 - School of Food and Nutritional Sciences, University College Cork, Ireland

Abstract

Lactic acid bacteria (LAB) have been extensively used for centuries as starter cultures to carry out food fermentations and are looked upon as a burgeoning 'cell factory' for the production host of functional bio molecules and food ingredients. In recent years, multiple functional compounds have been isolated, identified and shown to be active in food / beverage systems. This presentation gives an overview of the use of Lactic acid bacteria in the malting and brewing / beverage industry. It will concentrate on three areas where specific metabolites of LAB can be used to improve the malting and brewing process. The first part will concentrate on the isolation and characterisation of antifungal compounds from LAB and their application in malting and brewing. The second part will deal with the use of specifically selected LAB and their application in reducing the malting loss and the third part will focus on the application of LAB for the production of sour beers and explore their potential for the production of novel wort based beverages. Novel options to combat beer spoiling LAB will also be explored.

Short biography

Professor Arendt is a native of Stuttgart, Germany. She graduated as an engineer of food technology at Hohenheim University in 1988 (M.Sc.) and received her Ph.D. degree from the same institute in 1991. The same year, she moved to University College Cork (Ireland) as a postdoctoral scientist funded by a Marie Curie fellowship. In 1993, she was appointed as a faculty member at UCC where she established an externally-funded research group, which was consistently supported by grants from national, EUn and industry sources. In 2007, she was awarded a D.Sc. degree from the National University of Ireland for her published work in the area of fermented foods. In 2016, she was appointed as principal investigator at the APC Microbiome Institute. In her research field, she was listed as one of the most highly cited researchers in world in 2017 (Clarivate Analytics) and has a H-Index of 63 (Google Scholar). She lectures and carries out research in the areas of malting, brewing, and cereal science. Specific research topics include: lactic acid bacteria and their application in malting and brewing as well as cereal products, gluten-free malting and brewing, and functional cereal-based foods and beverages. Professor Arendt is currently the head of a group of 25 research staff and Ph.D. students.

L18 - CHALLENGING THE ASSUMPTIONS AROUND THE PASTEURISATION REQUIREMENTS OF BEER SPOILAGE BACTERIA

Grzegorz Rachon[1]; Christopher Rice[1]; Karin Pawlowsky[1]; Christopher Raleigh[1]

1 - Campden BRI

Abstract

Current recommendations for beer pasteurisation are based on the study in 1951 by Del Vecchio and coworkers. In this work, 14 beer spoilage bacteria were screened for their ability to grow or survive in ale and stout together with the determination of their thermo tolerance at 60°C. Using a capillary tube method, the D-value (decimal reduction time) and z-value (temperature resistance coefficient) of the three thermo tolerant bacteria (*Acetobacterpasteurianus*, *Lactobacillus brevis* and *Lactobacillus hilgardii*) were determined. Validation of pasteurisation at a range of pasteurisation units (PU) in packaged product were performed in a tunnel pasteuriser. This study showed that eight of the 14 microorganisms were able to grow in both beer styles, whilst different thermo tolerances were observed amongst the spoilage bacteria. Effective pasteurisation of the selected microorganisms was achieved at significantly lower PU values than those recommended by the European Brewery Convention Manual of Good Practice. In package pasteurisation conducted at 1.6 PU resulted in greater than an 8-log reduction in viable cell numbers, resulting in 'commercial sterility'. Although this study demonstrated that successful pasteurisation was achieved for vegetative cells at significantly lower PU values than those recommended, further studies are required to demonstrate the optimal level of pasteurisation for spore forming bacteria and for yeast.

Short biography

Grzegorz Rachon was awarded Masters Degree in Food Technology and Nutrition at the University of Life Sciences in Lublin (Poland) in 1998. 20 years later he becomes Doctor of Agriculture and Food, completing the AFTP (Advanced Food Training Partnership) at the University of Reading and the University of Birmingham (United Kingdom). Grzegorz has over 15 years of industry experience in Food, Drink and Pharmaceutical microbiology working for Leatherhead Food Research, Nelsons Natural World and Thermo Fisher Scientific - Oxoid. Currently, he is employed by the Campden BRI (Nutfield - Brewing Division) as a Project Manager and he is responsible for process validation trials, challenge testing and stability of traditional and novel beverages.

L19 - TAKING HOP AROMA APART: SUPERCRITICAL CO2 FRACTIONATED OILS OFFERS NEW FLAVOUR POSSIBILITIES FOR BREWERS.

Christina Dietz[1]; David Cook[1]; Ray Marriott[2]; Colin Wilson[2]; Rebecca Ford[1]

1 - University of Nottingham, School of Biosciences, Division of Food Sciences, Sutton Bonington Campus, Loughborough, UK; 2 - Totally Natural Solutions Ltd, Unit 3a Arnold Business Park, Branbridges Road, East Peckham, Kent, UK

Abstract

Advanced, clean label hop products obtained by sustainable extraction are required to comply with future legislation and to manage fluctuations in hop oil content and composition caused by climate change. Hop oil fractions with unique sensory characteristics can be produced by

sequential extraction using organic solvents. However, little research is available regarding the sensory characterisation of hop oil fractions. Two studies were designed to measure olfactory, gustatory and trigeminal-type differences between supercritical (sc)CO2 fractions and sub-fractions.
Magnum hop oil was fractionated into five fractions of different polarities. The total oil and fractions were evaluated in 4% EtOH/H2O by a trained sensory panel (n=10) using a newly developed attribute lexicon with a modified quantitative descriptive analysis (QDA) approach. Significant differences were found between all samples for multiple olfactory, gustatory, and trigeminal sensations. In addition, the chemical profiles of the samples were analysed using gas chromatography-mass spectrometry (GCMS). Interestingly, Principal Component Analysis of sensory and analytical data revealed that particularly the polar mono- and sesquiterpene alcohol sub-fractions are responsible for cross-modal interactions eliciting both aroma and/or taste and trigeminal sensations.
In order to identify compounds driving these cross-modal interactions, selected fractions were further divided into smaller characterised sub-fractions and individual molecules. These were applied in a lager beer base (4.5% v/v) and profiled analytically using GC-MS and sensorially by a trained panel using QDA. The outcomes of each study indicate that matrix-, concentration-, and perceptual interaction effects determine sensory impressions of the sub-fractions.

Short biography
Christina is a Sensory and Brewing Science PhD researcher at the University of Nottingham (UK) holding a BSc degree in Food Management from Weihenstephan-Triesdorf University of Applied Sciences (Germany) and a MSc degree in Food Technology from Wageningen University (The Netherlands). Since February 2017, Christina is working on her PhD project, which focuses on multimodal stimuli (gustatory/olfactory/trigeminal) in hops that contribute to different sensory characteristics in beer. Her PhD project is sponsored by Totally Natural Solutions Ltd (UK).

L20 - EXPLORING HOP DERIVED CONTRIBUTORS TO BEER BITTERNESS USING DATA-INDEPENDENT ACQUISITION (DIA)

Nils Rettberg[1]; Laura Knoke[1]; Julia Hildebrandt[1]; Sarah Thörner[1]; Jörg Maxminer[1]

1 - VLB Berlin - Research Institute for Beer and Beverage Analysis

Abstract

Untargeted metabolite profiling (UMP) has become a relevant method to understand molecular dynamics of complex processes such as beer production. UMP targets a non-discriminative comparison of samples in order to identify significant (unknown) metabolites that relate to product quality. UMP methods commonly do not use any sample cleanup steps and use generic LC-methods combined with high resolution mass spectrometry.

Beer quality control is based on multiple well established quantitative methods and it seems unlikely that UMP substitutes those in near future. However, additional information for quantification can be retrospectively extracted from UMP data. Therefore, it seemed reasonable

to evaluate, if and to which extend, UMP and quantification of beer key quality attributes can be combined in a single LC run.

The aim of the current study was to evaluate if quantitation of beer bitter acids, representing a complex and relevant group of non-volatile beer metabolites, can be integrated into an UPLC-Q-TOF based UMP. In order to identify and quantify the full spectrum of major and minor beer bitter compounds we employed a DIA approach on beer samples varying in their bitterness characteristics. An accurate mass database for bitter acids ionized by ESI (-) and fragmented MS^e by was compiled, calibration was established by either using hop extracts or bitter acid DCHA-salts. The data collected by UPLC-Q-TOF MS is discussed in comparison with results of conventional beer bitter acid analysis (EBC 9.8 and EBC 9.47) as well as sensory evaluation (quantitative descriptive analysis).

Short biography

Nils (born 1983) is a trained brewer and maltster holding a diploma in biotechnology with focus on brewing science from TU Berlin (TUB). After accumulating sufficient skills in brewing and drinking beer, he developed a deep interest in analyzing molecules that make this excellent beverage either taste terribly good or horribly stale. Therefore, after graduating in 2011, Nils worked as research associate at TU Berlin (Chair of Bioanalytics) and VLB Berlin (Research Institute for Special Analyses). In 2014 he successfully defended his doctoral thesis on "Comprehensive analysis of hop secondary metabolites". He is currently in charge of the VLB Research Institute for Beer and Beverage Analysis. This Institute comprises an accredited lab for beer and beverage analysis, as well a group of scientists dedicated to versatile research projects in the field of hops and beer.

L21 - DIMETHYL SULFIDE IN BEER: THE POTENTIAL ROLE OF HOPS

Elise Salanouve[1]; Stéphane Delpech[1]; Clément Viel[1]; Scott R. Lafontaine[1]; Thomas H. Shellhammer[2]; Laurent Dagan[1]

1 - NYSEOS, ZA Parc 2000, 53 rue Claude François, 34080 Montpellier, France; 2 - Department of Food Science and Technology, Oregon State University, 100 Wiegand Hall, Corvallis, Oregon 97331, United States

Abstract

Dimethyl sulfide (DMS) is typically considered an off-flavor in beer, with a cooked-vegetable aroma, at a low flavor threshold of 30 □g/L. DMS has a significant effect on the flavor of beer and at low levels may contribute to beer aroma complexity.[1] Brewers tend to control DMS amount by focusing on its precursors and their decomposition during the brewing process. The conventional wisdom is that malted barley is the principal source of DMS precursors since DMS mainly results from the thermal decomposition of S-methyl methionine (SMM) in malt and from the reduction of DMSO during fermentation.[2] Focusing on this key parameter, we have

hypothesized that hops contain SMM since it has been reported in the literature that SMM plays a major role in sulfur transport in plants.[3,4] A screening of American commercial IPA's revealed high concentrations of DMS and its precursors. Based on these results, experiments were conducted probing the role of hops on the release of DMS after bottling. Our results demonstrated that hops can contribute to DMS in beer, and dry-hopped beers contain significant concentrations of DMS precursors that may be released upon storage depending on hopping rate, storage time and temperature. Our work then highlights the necessity to better analyze and understand the role of hops as potential sources of DMS in beer.

(1) Bamforth, C. *et al. J. Am. Soc. Brew. Chem.* **2014**

(2) Baldus, M. *et al. Brew. Sci.* **2018**

(3) Bourgis, F. *et al. The Plant Cell* **1999**

(4) Trossat, C. *et al. Plant Physiology* **1996**

Short biography

Dr. Elise Salanouve obtained her PhD in Molecular chemistry at Université Pierre et Marie Curie in Paris in 2014. She worked in a biotech start-up as a R&D scientist focusing on agronomy and bio-sourced chemistry. Since 2018, she has joined NYSEOS, as a R&D project manager, a laboratory specialized on aroma compounds analysis in the fields of enology and brewing. She is in charge of R&D programs that support actively winemakers and brewers to better understand and control their aroma beverages.

L22 - BEECH WOOD SAWDUST AS A SUSTAINABLE FILTER AID FOR PRE-COAT FILTRATION

Max Panglisch[1]; Thomas Kunz[1]; Frank-Jürgen Methner[1]

1 - Technische Universität Berlin

Abstract

To evaluate the usability of beech wood sawdust as a sustainable filter aid for beer filtration, laboratory pre-trials as well as several filtration tests at a pre-coating filtration pilot plant were carried out. The main issue under review was the comparison with kieselguhr which is state of the art filter aid used for beer filtration. Beside evaluation of filtration performance, samples of unfiltered and filtrated beers were taken to analyze the main beer parameters including ICP-OES (Fe), ESR-spectroscopy (EAP-/ T-value) and sensorial analysis.

Beech wood sawdust contains water-soluble substances being turbidity active and having a wooden astringent aroma profile. According to this, a pre-treatment procedure was developed to counteract those unwanted influences for beer. Beers filtrated with sawdust do not differ in technological and sensorial matter from reference beer filtrated with kieselguhr. Beside an improved antioxidative stability because of significantly lower iron entry, important beer parameters as foam stability, pH-value, bitterness, ß-glucans, nitrogen and sulphur dioxide

content are not influenced. A sensorial panel figured out that beer filtrated with pre-treated sawdust cannot be distinguished from kieselguhr filtrate. Currently, turbidity values lay roughly around sensing threshold of 2 EBC, therefore the filtration with beech wood sawdust is especially interesting for dark beers, juices, extracts or preliminary filtration of bright beers. A further experiment with tannins as a stabilization aid showed that there is an adequate potential of reducing turbidity.

Beech wood sawdust is an attractive and sustainable filter aid, due to good technological characteristics and low prizes regarding acquisition and disposal.

Short biography

After finishing his apprenticeship as "Brewer and Maltster" at Brauerei Königshof, Krefeld in 2013, Max Panglisch worked as a brewer for a few month. He started his studies of "brewery and beverage technologies" in the same year at Technische Universität Berlin. He is actually working on his M.Sc. degree after finishing his B.Sc. studies in 2017 doing scientific researches on beech wood sawdust application as a filter aid for filtration. Since 2015 Max Panglisch works as a student assistant at the Chair of Brewing Science of TU Berlin where he supports several scientific works and assists in students' education.

L23 - WOODEN BARRELS ARE AN ADDITIONAL SOURCE OF MICROORGANISMS FOR LAMBIC BEER PRODUCTION

Jonas De Roos[1]; Luc De Vuyst[1]

1 - Research Group of Industrial Microbiology and Food Biotechnology, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, Belgium

Abstract

Wooden barrels are predominantly used for flavour formation in (port)wine and whiskey production by extracting wood compounds during maturation. These compounds are lost after extensive barrel usage. Further, due to their physical inertness and porosity, wooden surfaces are difficult to sanitize and, therefore, harbor a resident microbiota that can negatively impact the organoleptic properties of wines. However, old (port)wine barrels play an important role in the spontaneous fermentation and maturation process of lambic beers. Although the extraction of wood compounds is of no interest during lambic beer production, the resident microbiota are further exploited, as shown during the present study. By comparing lambic beer production, both microbiologically and metabolically, in wooden casks and stainless steel vats, it became evident that the use of the latter was far from straightforward, as heat transfer and microoxygenation were not optimal. Moreover, a higher batch-to-batch variability occurred in the stainless steel vats, as microbial inoculation only depended on the wort preparation step. In particular, acetic acid bacteria could reach high counts. In contrast, the wooden barrels helped in establishing a stable microbial ecosystem during fermentation and maturation by acting as an additional microbial inoculation source, next to the air during the coolship step. They also provided a microaerobic environment, which aided in achieving the desirable succession of microbial communities for a successful lambic beer production process.

Moreover, these conditions prevented excessive growth of acetic acid bacteria and, therefore, excessive production of acetic acid and acetoin, which may lead to flavor deviations in lambic beer.

Short biography

Luc De Vuyst obtained a PhD in Agricultural Sciences at Ghent University (Ghent, Belgium) in 1990. After research stays in The Netherlands, Canada, and New Zealand, he became professor industrial microbiology and food biotechnology at the Vrije Universiteit Brussel (VUB) in 1994. Since then he is head of the Research Group of Industrial Microbiology and Food Biotechnology (IMDO) of the Faculty of Sciences and Bioengineering Sciences of the VUB. His research deals with numerous (spontaneous) food fermentation processes, among which lambic beer production. He was promotor of 38 PhD theses and currently supervises 18 PhD students. He is author of more than 300 peer-reviewed papers, 39 book chapters, and more than 370 communications worldwide. His work counts more than 13,000 citations and he has an h-index of 62. He is ranked among the Thomson Reuters highly cited researchers and the world's most scientific influential minds (top 1% researchers) since 2014.

L24 - HOW AGING IN TROPICAL WOOD BARRELS MAY CREATE AN IDENTITY FOR BRAZILIAN BEER

Giovanni Casagrande Silvello[1]; Aline Marques Bortoletto[1]; Ana Carolina Corrêa[1]; Mariana Costa De Castro[1]; André Ricardo Alcarde[1]

1 - University of São Paulo, USP-ESALQ, Piracicaba, São Paulo, Brazil

Abstract

Different regions of the globe has developed their own brewing culture over centuries, such as Belgium, Britain and Germany, or over decades, e.g. the USA. Brazilian craft breweries recently started exploring native raw materials, such as fruits and other plant products, to bring unique sensory characteristics to national products. National cooperage have been traditionally employing tropical native woods for the typical Brazilian sugar cane distilled spirit, namely *cachaça*, and at nowadays scenario for craft breweries interested in product innovation. Studies over different Brazilian wood species investigated their raw and alcoholic-extract compositions, identifying markers for different species and comparing the proportion of main aging-marker congeners for spirits. The present study investigated the perceived difference between an English Barleywine style beer aged for 180 days in different wood species, namely American Oak (*Quercus alba*), Amburana (*Amburana cearensis*) and Cabreúva (*Myrocarpus frondosus*), using a sensory method called projective mapping (Napping) that allowed the discrimination between treatments, associated to Ultraflash profile (UFP) which enabled understanding the criteria for differentiate samples. It was performed a Multiple Factor Analysis (MFA) to understand the variation between samples. Wood-aged beer profiles differentiated from non-aged beer according to descriptors that match with phenolic input from wood. The sensory difference

between wood species is probably due to descriptors of minor compounds such as coumarins, monophenols and sesquiterpenes.

Short biography

Giovanni Casagrande Silvello obtained his Bioengineer degree at University of São Paulo (USP – ESALQ) in 2016. During graduation activities, he participated on projects at the Laboratory of Alcoholic Beverages from 2011 to 2014. He attended to Advanced Master in Brewing Engineering, at Université Chatolique de Louvain (UCL) in 2014-2015 as an exchange student and was intern at the Brewing Industry Unity (INBR). From 2016 to 2018 he developed his Master project on Food Science and Technology exploring Brazilian native woods for barrel-aging beers and its impacts on chemistry and sensory composition.

L25 - MALTING BARLEY AGRONOMY & QUALITY : EVOLUTION OF THE RAW MATERIAL QUALITIES OTHER 20 YEARS IN FRANCE

Marc Schmitt[1]

1 – IFBM-Qualtech, Nancy, France

Abstract

In France, the registration of a new barley variety is very structured. Three main organisations take part in the process : the **CTPS** (Permanent Technical Committee of Breeding) which is involved in the registration on the French catalogue and on the malting barley variety list, the **CBMO** (Beer Malt Barley Committee) which is involved in the testing for registration on the Malteurs and Brasseurs de France preferred variety list and **IFBM** which is the technical tool for tests (micromalting, pilot malting and brewing, analyses on barley, malts, worts and beers).

Such a system is aimed at selecting new barley varieties according to Breeder, Maltster and Brewer needs.

The presentation will describe and discuss the evolution of the quality other the last 20 years for the 2 row spring, the 2 row & 6 row winter barleys. The lecture will be documented with the data of barley registration and the pilot tests made for the CBMO.

Short biography

Marc SCHMITT is Scientific Director at IFBM, the French Institute of Malting and Brewing. He joined the Institute at the beginning of 2002. His first job at IFBM was Malting & Brewing Laboratory Manager. He became R&D manager in 2008 and Deputy Scientific Director in 2014. His works concern mainly raw materials. Since 2008, he is in charge of the works of CBMO (barley – malt – beer committee) in France. He has made several presentations for congresses et technical meetings.

He has been lecturer in biochemistry and biosciences engineering at Nancy University. He completed his PhD in food biochemistry which was awarded by Nancy University (1996).

From 1994 to 2002, he managed the Central laboratory of the French Cheese Institute.

Member of the Steering Committee of EBC Analysis Committee, he is chairman of the "Barley – Malt" subcommittee..

Member of the EBC "Brewing Science Group"

Chairman of the Malting Barley Ring test of BIPEA.

L26 - GERMINATION KILNING COMBO DRUM - AN OLD METHOD COMBINED WITH NEW TECHNOLOGY

Christoph Remmelberger[1]; Johannes Lauer[2]

1 - Kaspar Schulz Brauereimaschinenfabrik& Apparatebauanstalt GmbH; 2 - Kaspar Schulz Brauereimaschinenfabrik & Apparatebauanstalt GmbH

Abstract

The Malting Drum Technology: The Revival of an Old Malting Method

The malting drum disappeared in the middle of the last century due to a concentration of production process in malting factories. However, the technology of the malting drum in regards to the production of high quality malts and various malting types is indisputable. We want to re-introduce the malting drum as an option for malting. This system consists of an external steeping vessel and a Germination Kilning Combo Drum. Combined with modern Technology, it enables breweries and distilleries to produce their own malt once more. We want to talk about the flexibility of the malting system regarding heating technology, product varieties, and the Integration in operating Units of breweries, malting plants, and distilleries. Although limited in batch sizes, it provides a wide range of advantages to the malt producing industry, which we want to present.

Short biography

Diplom Braumeister Christoph Remmelberger did an apprenticeship as brewer and maltster in a Bavarian Pub brewery from 2006-2008 and finished his academic studies at TUM, Weihenstephan as Diplom Braumeister in 2011. Following his studies he started his professional Career as technical head of productino in an Artisanal brewery in France for one year, afterwards he continued with the research for a Start Up Craft Beer Distribution in Rio de Janeiro Brasil at the end of 2012. To fnish his world wide travel he combined work and travel in Australia where he was employed as quality assurance member in a contract brewery in Sydney and as Receival Point Operator in grain harvesting in Corrigin, Western Australia 2013. After being back in Germany he linked farming and brewing as head of production in a German Speciality Malt facility from 2014 to 2017. Since August 2017 Diplom Braumeister Christoph

Remmelberger is responsible for the technical sales of the malting plants at Kaspar Schulz GmbH.

L27 - FIRST TIME QUANTIFICATION OF CYSTEINYLATED ALDEHYDES IN MALT AND BREWERY SAMPLES

Paula Bustillo Trueba[1]; Barbara Jaskula-Goiris[1]; Mark Sanders[3]; Jean-Paul Vincken[3]; Jessika De Clippeleer[2]; Erik Van Der Eycken[1]; Joshep De Brabanter[1]; Luc De Cooman[1]; Gert De Rouck[1]; Guido Aerts[1]

1 - KU Leuven; 2 - Ghent University, Belgium; 3 - Wageningen University & Research, The Netherlands

Abstract

Beer flavour is not stable during storage. The mechanisms of formation of aldehydes, which are considered as a major cause of off-flavours during beer aging, remain uncertain. Increase in aldehydes by *de novo* formation or the release from bound-state precursors have been suggested as the cause of aldehyde appearance. In a previous study, we proposed the bound form between cysteine and aldehydes, also called cysteine-bound aldehydes or 2-substituted 1,3-thiazolidine-4-carboxylic acids, as potential sources of the increasing aldehyde levels found during beer aging. In this study, cysteine-bound aldehydes of selected marker aldehydes were synthesized and used as reference compounds. Implementation of the methodology for the detection and quantification of these compounds was done by Liquid Chromatography-Mass Spectrometry (LC-MS). Malt samples and samples collected at different points during the brewing process (from the onset of mashing until the fresh beer, as well as during beer aging) were analysed for their free and cysteine-bound aldehydes content using HS-SPME-GC-MS (Headspace-Solid Phase Microextraction-Gas Chromatography-Mass Spectrometry) and LC-MS (Liquid Chromatography-Mass Spectrometry), respectively. In malt, we were able to quantify all selected aldehyde markers, both free and cysteine-bound. Furthermore, quantification of free aldehydes was possible in all brewing samples, whereas cysteine-bound aldehydes detection and quantification was dependent on the nature of the 2-substitution in the thiazolidine ring. In conclusion, even though cysteine-bound aldehydes were not identified unambiguously in the final beer, our experimental data support the general concept of bound-state aldehydes as potential contributors to increasing aldehyde levels and, therefore, to beer flavour deterioration.

Short biography

Paula Bustillo Trueba. Obtained degree in Chemistry by the University of Salamanca (Spain) in 2015. At the moment PhD student at the University of Leuven (KU Leuven, Belgium) in the cluster for Bioengineering Technology (CBeT), Laboratory of Enzyme, Fermentation and Brewing Technology (EFBT). The research topic is "Unravelling formation and/or release of beer staling aldehydes".

L28 - QUANTITATIVE MONITORING OF BEER STALING ALDEHYDES DURING THE MALTING PROCESS

Weronika Filipowska[1]; Maciej Ditrych[1]; Barbara Jaskula-Goiris[1]; Guido Aerts[1]; Gert De Rouck[1]; Luc De Cooman[1]

1 - KU Leuven, Bioengineering Technology TC, Ghent Technology Campus

Abstract

With time, many (bio)chemical transformations take place in packaged beer, resulting in the appearance of off-flavours – in particular the so-called "staling aldehydes". These volatiles can be formed via *e.g.* Maillard reactions, fatty acids oxidation, Strecker degradation of amino acids or they can be released from their bound-state forms (*e.g.* bound to bisulfite and/or cysteine). To date, the origin of beer staling aldehydes and their precursors still remains unknown. Malt, being the major raw material used in the brewing process, contains relatively high concentrations of beer staling aldehydes.

In this study, a novel HS-SPME-GC-MS methodology was used to evaluate the behaviour of aldehydes during the industrial-scale malting process. The critical factors influencing the formation of aldehydes and their precursors were investigated. Additionally, various malting treatments (*e.g.* sulphuring during drying, different kilning temperatures) were compared and levels of aldehydes were correlated with standard quality parameters of malt (colour, pH, moisture, free amino nitrogen *etc.*).

The results showed that the malting process considerably impacts the amount of aldehydes introduced into the brewing process. Heat-load plays the key role in the aldehyde formation/release. Aeration and barley variety also have an impact. In turn, sulfuring seems to be less important. The presentation on the one hand discusses the relevance of the malting technology on malt quality and beer flavour stability, and, on the other hand, it introduces analytical methodology allowing to monitor the levels of staling aldehydes at the very early stage of the brewing process starting with the selection of the raw materials.

Short biography

Biotechnologist, graduated BSc in 2015 and MSc in 2016 at Wroclaw University of Environmental and Life Sciences, Poland. Industrial and research intern in multiple countries (Poland, Iceland, Spain) working on the projects of biofuel production, yeast cell stress and sustainable production in the food industry.

Currently Marie Sklodowska-Curie Fellow within European Joint Doctorate in Food Science (EJDFoodSCI) project. PhD student at the Laboratory of Enzyme, Fermentation and Brewing Technology at KU Leuven, Belgium. PhD student at Bioenergy & Brewing Science Department at University of Nottingham, United Kingdom. Interested in relation between malting process and beer flavour instability.

L29 - NON-STARCH CARBOHYDRATES FROM UNMALTED CEREALS AS MOUTHFEEL CONTRIBUTORS IN NABLAB AND LIGHT BEERS

Niels A. Langenaeken[1]; Pieter Ieven[1]; Christian Clasen[3]; David De Schutter[2]; Christophe M. Courtin[1]

1 - Laboratory of Food Chemistry and Biochemistry and Leuven Food Science and Nutrition Research Centre (LFoRCe), KU Leuven, Kasteelpark Arenberg 20, 3001 Heverlee, Belgium; 2 - Fund Baillet-Latour, Brouwerijplein 1, 3000 Leuven, Belgium; 3 - Soft Matter, Rheology and Technology, KU Leuven, Celestijnenlaan 200f, 3001 Heverlee, Belgium

Abstract

A satisfying mouthfeel is essential for non-alcoholic and low-alcohol beers (NABLAB) or light beers. This paper highlights the importance of non-starch carbohydrates as mouthfeel contributors in such beers. Beers were brewed on lab-scale with a 20% grits substitution of finely milled unmalted barley, rye or oats. While the dextrin content of all adjunct beers increased with 11-14% compared to the control, the β-glucan concentration increased by 303% for barley, 77% for rye and 210% for oats. The total arabinoxylan (AX) concentration decreased by 11% and 18% for barley and oats, respectively, but increased by 53% for the rye beer. Interestingly, the average degree of polymerization of AX (avDP-AX) also increased to 50, compared to 30 for the control. These beers were examined instrumentally to estimate their mouthfeel performance. Kinematic viscosities of 1.48, 1.53, 1.85 and 1.51 mm^2/s were observed for the control, barley, rye and oat beer, respectively. Moreover it was found that the tribological friction factor of the rye beer was decreased by 8.5% compared to the control. This value reflects the possible impact on the improved lubrication behavior of the rye beer in the oral cavity. The addition of xylanase to a control brew resulted in a large amount of small AX oligomers, which had a similar effect on the friction factor. Multivariate analysis underlined the role of AX content on the lubrication behavior of beer, while avDP-AX was correlated with beer viscosity. These experiments suggest that finely milled unmalted rye might provide a clean label solution to enhance beer mouthfeel. Future experiments will include sensory tests of the different beers.

Short biography

Niels Langenaeken is a third-year PhD candidate at the KU Leuven Laboratory of Food Chemistry and Biochemistry. After he graduated as a Bio-Science Engineer in 2015, he was awarded the 21st scholarship of the Baillet-Latour Fund to start his PhD. His research focusses on the mobilization of non-starch carbohydrates in beer making to improve brew-house yield on one hand and to assess the impact hereof on quality parameters on the other hand. He is co-founder of Brouwerij Polygoon, a small scale beer company with a yearly production of 50 hL.

L30 - CHANCE AND CHALLENGE: NON-SACCHAROMYCES YEASTS IN NON-ALCOHOLIC AND LOW ALCOHOL BEER BREWING

Konstantin Bellut[1]; Elke Arendt[1,2]

1 - University College Cork; 2 - APC Microbiome Institute

Abstract

Background: The non-alcoholic and low alcohol beer (NABLAB) market enjoyed significant growth in the past years and is forecasted to keep growing. However, NABLAB has organoleptic issues and lacks acceptance from the consumers. While dealcoholization methods focus on gentle and the most selective ways possible to remove ethanol from normal strength beers so as not to compromise the taste, biological methods focus on the limited production of ethanol during fermentation. In particular, investigations into the application of yeasts from the non-*Saccharomyces* sector have gained momentum in the recent years, which can show great potential to introduce new flavors to NABLAB without the necessity of any special equipment.

Scope: This paper gives an introduction into the NABLAB market and reasons behind its growth dynamics. The use of non-*Saccharomyces* yeasts in the production of NABLAB is discussed in detail and recent consumer studies with NABLAB give recommendations for marketers and product developers through insights into the consumers' likings, emotions, and expectations when consuming NABLAB.

Key findings: Research in the use of non-*Saccharomyces* yeasts for the production of NABLAB demonstrates promising results. However, for most species, the research is still in the early stages and requires further investigation into flavor characteristics and the practicality of up-scaling. Nonetheless, the application of non-*Saccharomyces* species could introduce new, non-conventional flavors into NABLAB brewing in an easy to apply manner. Regarding product development and marketing, it might be useful to regard NABLAB as a product category on its own, independent from normal strength beer.

Short biography

Konstantin Bellut graduated with a Bachelor and Master in Brewing and Beverage Technology from the TU Munich in Weihenstephan. During his studies, he was awarded the UnternehmerTUM scholarship where he had the opportunity to showcase his entrepreneurial talents while participating in various consulting and founding projects. However, his passion for science and brewing eventually led him to the University College Cork, where he enrolled for a PhD program under the supervision of Prof. Elke Arendt. He is a recipient of the Fund Baillet Latour Fellowship and his research focuses on innovative low-alcohol and alcohol-free beer production methods.

L31 - AN INNOVATIVE PRODUCTION OF LOW ALCOHOL BEER USING A MRAKIA GELIDA

Valeria Sileoni[1]; Giovanni De Francesco[1]; Ombretta Marconi[1]; Ciro Sannino[2]; Giuseppe Perretti[3]

1 - Italian Brewing Research Centre, University of Perugia; 2 - Department of Agriculture, Food and Environmental Science, Industrial Yeasts Collection DBVPG, University of Perugia; 3 - Department of Agriculture, Food and Environmental Science, University of Perugia

Abstract

Due to the increasing consumer demand, the production of low alcoholic and non alcoholic beer is a new goal of the present brewing producers. Although the beer with reduced alcohol content is mainly obtained by physical methods, the use of non-*Saccharomyces* yeast, with low fermentation capacities, may represent an interesting biological approach. Although the fermentation aptitude of *Mrakia* spp. strains has been previously preliminary investigated, little is known about the ability of *Mrakia* to produce low alcohol beer in a pilot scale brewing plant. In the present study the low alcohol beer produced by *Mrakia gelida* DBVPG 5952 was compared with a low alcohol beer obtained using a commercial starter. In this study the ethanol content and the volatile profile of a beer obtained using the basidiomycetous psychrophilic yeast strain *Mrakia gelida* DBVPG 5952 was compared with that produced by a commercial starter for low alcohol beers, *Saccharomycodes ludwigii* WSL17.

The main quality attributes of the obtained beers were similar. The two beers were characterized by a low alcohol content (1.40% and 1.32% v/v) and by a low diacetyl production (5.04 and 5.20 µg/L). However, the organoleptic characteristics of the beer obtained using *M. gelida* were more appreciated by the panellists, in comparison to the analogous produced with *S. ludwigii*.

Short biography

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2. Marconi, O., Rossi, S., Galgano, F., Sileoni, V., Perretti, G., 2016. Influence of yeast strain, priming solution and temperature on beer bottle conditioning. J. Sci. Food Agric. 96, 4106–4115.

3. De Francesco, G., Turchetti, B., Sileoni, V., Marconi, O., Perretti, G., 2015b. Screening of new strains of *Saccharomycodes ludwigii* and *Zygosaccharomyces rouxii* to produce lowalcohol beer. J. Inst. Brew. 121, 113–121.

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L32 - TEMPORAL DOMINANCE OF SENSATIONS (TDS) PAIRED WITH DYNAMIC WANTING: A NEW METHOD OF SENSORY EVALUATION WITH CONSUMERS FOR A BETTER UNDERSTANDING OF BEER DRINKABILITY

Takahiro Wakihira[1]; Seiko Miyashita[1]; Minoru Kobayashi[1]; Kazuhiko Uemura[1]; Pascal Schlich[2]

1 - Asahi Breweries, Ltd., Research Laboratories for Alcohol Beverages, Moriya, Japan; 2 - Centre des Sciences du Goût et de l'Alimentation, AgroSup Dijon, CNRS, INRA, Univ. Bourgogne Franche-Comté, F-21000 Dijon, France

Abstract

While drinkability is of paramount importance when discussing beer, there is no established methodology to assess it. This paper reports the development of a new method based on Temporal Dominance of Sensations (TDS) alternated along sips with scoring of ease of drinking and wanting during the consumption by consumers of a full glass of beer. This presentation shows test designs and results from two studies of four commercial Japanese beers, one conducted with an expert sensory panel and the other with a naive panel of consumers. The results reveal the importance of monitoring dynamic wanting over sips. In both studies, product differences in wanting, almost nonexistent at the beginning, gradually became larger. However, the ease of drinking scores differed among products throughout the experiment. Products with lower ease of drinking scores at the beginning were lower in wanting at the end, indicating that ease of drinking can be a good predictor of wanting at the end. These studies also elicited characteristics of beer with high drinkability. The product that gained the highest wanting scores in both studies was perceived as having less standout flavor, thereby producing less build-up effects on sensory perceptions, which suggests that the more the sensory load delivered by a beer the less one wants to drink it continuously. This methodology should be used with different types of beers and consumers to gain a broader understanding of the sensory drivers of beer drinkability and consumer satisfaction.

Short biography

Takahiro Wakihira is the Sensory and Consumer Research Team leader at the Research Laboratories for Alcohol Beverages at Asahi Breweries, Ltd., with a focus on brewing science. He graduated from the Department of Natural Science at the Graduate School of Kobe University before joining Research International Japan in 2000. After gaining 5 years of experience as a consumer goods project manager, he joined Unilever Japan to study consumer technical insights at the company's research and development center. In 2010, after 6 years of working on the sensory and consumer science of personal care products at Unilever, he joined Asahi Breweries, Ltd. to facilitate the company's endeavor to better understand consumer behavior and preference.

L33 - UNDERSTANDING AROMATIC STABILITY IN DRY-HOPPED BEER

Margaux Huismann[1]; Fraser Gormley[2]; Dzeti Dzait[2]; Alex Speers[3]; Dawn Maskell[1]

1 - International Centre for Brewing & Distilling; 2 - BrewDog; 3 - Canadian Institute of Fermentation Technology

Abstract

Considerable research has been conducted in an effort to understand hop aroma and how it influences dry-hopped beer. A large component of flavour/ aroma in hops are terpenes and terpenoids. However, little is understood about the extraction of terpenes and terpenoids during dry hopping and their overall stability in beer. It was hypothesised that as hop dose and ethanol content increased, the concentration of terpenes/ terpenoids extracted would be greater. A two-factor study examining the effect of hop dose rate and ethanol content was designed to test the hypothesis. The study found that terpene and terpenoid extraction did not linearly increase with higher dose rates and ethanol content, but that solubility might be dependent on the polarity of the specific terpenes and terpenoids. With this in mind, a second study was undertaken to assess the stability of terpenes and terpenoids in packaged beer. As sensory panels have suggested that 'fresh' hop aromas decrease over time, it was hypothesised that terpene/ terpenoid concentration declines over time. A dry-hopped ale was aged at 4°C and 20°C over the course of 120 days with bi-weekly sensory and GC/MS-SPME examination. The results of this experiment found some terpene/ terpenoid compounds to decrease over time (e.g., myrcene) while others were observed to increase after 40-60 days of bottle storage (e.g., *trans*-geraniol). These results may be due to yeast mediated biotransformation or changes in other analytes in bottle. Increasing our understanding of dry-hop aroma stability is crucial to beer quality.

Short biography

Margaux Huismann received a B.Sc. in Microbiology from the University of Wisconsin-La Crosse in 2014. Over the course of 2014-2015, she completed her M.Sc. in Brewing and Distilling at Heriot-Watt University at the International Centre for Brewing and Distilling (ICBD) in Edinburgh. During her Master's, she was employed at Stewart Brewing and Barney's Beer and worked with a team of ICBD Master's students to create Edinburgh Gin's Seaside Gin. She began her Ph.D in 2015 and was a young member committee representative of the Scottish Section of the Institute of Brewing and Distilling. Her Ph.D. research focuses on 'Understanding the Physical-Chemical Stability of Dry-Hopped Beer', and is jointly funded by Interface Food & Drink, the Institute of Brewing & Distilling and BrewDog.

L34 - INFLUENCE OF WHIRPOOL TEMPERATURE ON HOP AROMA INTENSITY IN ALE BEERS

Marius Hartmann[1]; Christina Schoenberger[1]; Mark Zunkel[1]

1 - Barth Haas Group

Abstract

Many brewers try to maximise the hop flavour and aroma in different craft beers. A lot of research is focussing on the impact of different dry hop parameters to increase the hop flavour impact. However there is also the trend in craft brewing to increase hop additions on the hot side, often in the whirlpool or just before the end of boil. Brewers go as far as leaving out the bitterness addition in the beginning of boil and purely adding high amounts of hops in the whirlpool for aroma, flavour and bitterness. The whirpool parameter are poorly investigated. For pilsner type beers it is known that it is benifitial to lower the temperature in the whirlpool

to obtain higher concentrations of certain aroma compounds. In this work we test this theory for ale type beers but with much higher amounts of hops (according to actual craft beer recipes) and considering results of recent hop aroma research about the impact of very aroma active thiols and their precursor structures in the used hop variety.

Short biography

Marius Hartmann finished his brewers apprenticeship in 2011. After finishing his education at the Doemens Academy he studied brewing technologies at the Fachhochschule Weihenstephan Triesdorf. During his studies he did various interships in breweries in Germany and USA. He joined the Barth Haas Group in 2018 as Head of the concept brewery.

L35 - HOW TO OPTIMIZE THE UTILIZATION OF HOP CYSTEINE AND GLUTATHIONE S-CONJUGATES IN LATE AND DRY HOPPING : FOCUS ON DUAL HOPS AND SAAZ

Cécile Chenot[1]; Sonia Collin[1]

1 – UCL, Louvain-La-Neuve, Belgium

Abstract

After the evidence in hop of the cysteinylated precursors of 3-sulfanyl-4-methylpentan-1-ol (3S4MPol) and 3-sulfanylhexan-1-ol (3SHol), S-glutathione precursors were recently discovered in Amarillo, Hallertau Blanc, Mosaic, Citra and Sorachi Ace. The next step was logically to optimize both cysteinylated and glutathionylated precursors extraction from hop pellets and to assess the linked-potential in new promising dual varieties and in the well-known Saaz. While S-3-(4-methyl-1-hydroxypentyl)glutathione (G-3S4MPol) revealed more specific of the Hallertau Blanc variety, the occurrence of S-3-(1-hydroxyhexyl)glutathione (G-3SHol) was confirmed in all cultivars. Surprisingly, even in the Saaz variety where the cysteinylated counterpart was absent, very high concentrations of G-3SHol were found. In order to optimize the utilization of this high flavor potential, the impact of boiling, primary fermentation, maturation, bottle refermentation and use of enzymes will be discussed.

Short biography

Cécile got a master degree in chemical sciences from University of Namur in 2016. Between 2016 and 2017 she studied brewing engineering at UCL (advanced master). Since she graduated, she became PhD student in the unit of brewery and food sciences runs by Prof. Sonia Collin at UCL. Her thesis project is focusing on an innovative utilization of dual and aromatic hops. Focus on aroma precursors in dual-purpose hops cultivars.

L36 - FUNCTIONALITY OF HOP PROANTHOCYANIDINS IN BREWING: AN ALTERNATIVE TO TANNIC ACID?

Arthur Gadon[1]; David Cook[1]

1 - University of Nottingham, UK

Abstract

The polyphenolic fraction of hops contains proanthocyanidin polymers, also known as tannins, which can bind to metal ions and haze active proteins, thus yielding potential benefits for beer flavour and colloidal stability. Our group has demonstrated that polyphenol-rich extracts of hops, and of spent hops resulting from the CO_2 extraction of alpha, have fining activity when added post-fermentation. Activity is attributed to the proanthocyanidins (flavan-3-ol polymers) crosslinking yeast cells and haze active proteins, to form flocs which settle out and fine the resulting beer. Fining activity is related to the size of aggregates formed. In recent work we applied analytical ultracentrifugation (AUC) to characterise the molecular weight ranges of polyphenols extracted from different hop varieties. This has demonstrated the presence of high molecular weight polymers within these extracts with molecular weights of up to 90 kDa. Fining activity of extracts has been shown to correlate with the presence of such high molecular weight tannins, with Saaz hops consistently found to out-perform other varieties in this regard. The functionality of proanthocyanidin rich hop extracts has parallels with the known activities of tannic acids. Logically, researchers have also investigated the addition of polyphenolic fractions of hops in the brewhouse as a part of the overall strategy of stabilising beers. This paper will review current knowledge of the functionality of hop proanthocyanidins in brewing and raises the possibility that these co-products of hop processing might provide sustainable and clean label solutions as a part of overall fining strategies in the brewery.

Short biography

David Cook is AB InBev Professor in Brewing Science at the University of Nottingham, UK and has more than 20 years of experience conducting research and teaching relating to brewing, analytical food chemistry and flavour technology.

David is Course Director for the University of Nottingham's innovative e-learning based Masters courses in Brewing Science, which are designed to be studied part-time as Continuing Professional Development courses for brewers and allied professionals.

The Cook group specialises in applied research and interacts extensively with the malting and brewing sectors. Current research activity focuses on malting science and technology, beer flavour formation and stability and the reduction of primary energy usage in malting and brewing. Sustainable bioprocessing of raw materials and co-products is a core focus of the group.

L37 - MICROPLASTIC IN BEER

Ursula Brendel-Thimmel[1], Reiner Gaub[1]

1 – Pall Filtersystems GmbH, Germany

Abstract

Microplastics in Food & Beverage products are drawing increased attention from consumers. Recent publications in the press describe findings of plastic particles in beverages, however, sound conclusions around particle type, size and source are lacking, with the applied measurement process, test method and statistical validity being unclear.

To investigate and specify any potential impact from membrane cartridge filtration on Microplastics in beer, Pall has initiated a detailed experimental program. A test method was developed to measure and analyze micro particles in beer upstream and downstream of a membrane filtration step over time. The sampling method, particle analysis method and initial results from investigations of different beers are presented, combined with a critical review of already published information

Short biography

 Apprenticeship in German craft brewery and malteries (2,5 Y)

 Working as brewer in filter departments for various breweries (2 Y)

 Diploma - Brew master degree from Technical University Berlin/VLB

 Line brew master Filtration at major German breweries (3 Y)

 Diplom Ingenieur degree for Food Technology from Technical University Berlin, Thesis on replacement of kieselguhr

 Technical consultant for filtration at VLB Berlin; Prof. Dr.Ing. Wackerbauer (2Y)

 Head of filter department at Handtmann Filter systems (5 Y)

 Various positions within Pall Corporation;
actual Director Brewing Systems (23 Y)

L38 - FUNCTIONAL PREDICTION OF BEER CROSS-FLOW MEMBRANE FILTRATION EFFECIENCY FROM MALT QUALITY

Evan Evans[1]; Claudio Cornaggia[2]; Claudio Anna[2]; David Mangan[2]

1 - TBD Consulting and School of Natural Science, University of Tasmania; 2 - Megazyme, Ireland

Abstract

Cross-flow membrane technology (CFM) is increasingly being adopted by brewers for bright beer production, either replacing or being used in combination with more traditional methods, such as diatomaceous earth filtration (DE). A challenge with CFM is the need for improved control of malt quality for brewing. Current malt quality specifications do not fully inform brewers how a malt batch will perform during beer production. Prof Barry Axcell (SAB/Miller Chief Brewer) clearly identified the case for change, calling for malt quality specifications that

describe the functional malt properties for beer quality and production. Brewers currently rely on conventional malt specifications including KI, wort viscosity, and □-glucan level to predict CFM and DE filtration. However, many other malt-derived components such as arabinoxylans and proteins aren't effectively measured. One approach is to emulate the filtration process by adopting a cause agnostic approach as with the Small-scale Wort Filtration Test (SWIFT). This simple inexpensive test draws wort through a 0.45□m nylon filter, with the greater amount filtered indicating better filtration performance. Alternatively, enzymes assays can be conducted on the key enzymes expected to control filterability such as □-glucanase, xylanase and cellulase using the Megazyme assays. In this trial consisting of 34 high quality European malts, viscosity was negatively correlated with both SWIFT (r=-0.756) and xylanase activity (r=-0.856). Multiple linear regression analysis (MLR) showed that 86.5% of variation in viscosity was predicted by xylanase, SWIFT, wort □-glucan and friability. Conversely, MLR showed that 67.6% of variation in viscosity was predicted by viscosity, xylanase and KI.

Short biography

Evan Evans graduated with a B. Agr. Sc. (Hons) in 1986, followed by a Ph.D. in 1990, both at the University of Melbourne. In 1992, he joined the University of Adelaide where he developed his interest in malting barley and brewing. Between 2002 and 2013 he relocated to the University of Tasmania working towards improving malt quality to improve beer quality and the efficiency of the brewing process. Dr Evans is currently serving on the IBD Awards Committee and has authored more than 50 peer reviewd papers on brewing and malt quality issues. In 2005, Dr Evans was made a Fellow of the Institute of Brewing and Distilling.

L39 - NEW INSIGHTS INTO THE CLEANLINESS OF WASHED RETURNABLE BOTTLES

Roland Pahl[1]; Mick Holewa[1]; Alfons Ahrens[1]

1 - VLB Berlin

Abstract

Washing the bottles is a very important task when filling returnables. The process that is used is being optimized in two directions: it needs to be effective and it needs to be efficient. In this tension field new technologies are being implemented into the process to achieve best possible cleaning results while using only a minimum of effort.

VLB has recently carried out many investigations with respect to the chemical and physical cleanliness of the bottles after cleaning process. These investigations include new methods and also such that are long published but recent developments made it necessary to re-determine thresholds and levels of established guiding values.

Short biography

Roland Pahl has built up his brewing profession from scratch starting with his technical apprenticeship as a Brewer & Maltster at the Schultheiss Brewery in Berlin up to his doctorate degree in brewing technology. After university education he started his career working at VLB Berlin, as a scientific assistant to the Chair of Brewing Technology of the Technical University Berlin. He then changed to work at VLB's *Institute for Engineering and Packaging Technology* which he was heading from 2007 to 2014. From 2014 Roland leads VLB's *Research Institute for Beer and Beverage Production*, This experienced team works on the entire supply chain from milling via all production stages up to filling. Roland holds lectureships at the Technical University Berlin and at the Beuth University of Applied Science in Berlin.

L40 - STATUS AND TRENDS IN BEER FILTRATION - A BREWERY MANAGERS' PERSPECTIVE

Stefan Lustig[1]

1 – DBMB (German Brew and Malt-Masters Association, Munich)

Abstract

A new generation of kieselgur-free filtration technologies has been gaining ground in the brewing industry during the last decade. This evolution triggers the neccessity for an overview on established kieselgur systems in comparison to recently developed kieselgur free concepts.

After an introductional view on biochemistry and technical process parameters of filtration, an assessment of parameters to influence filterability in the brewing process will be presented.

The specific process technology of modern filtration systems will be compared. Kieselgur technologies, concepts with alternative filter aids and membrane technologies will be discussed and evaluated in detail. This assessment will include key layout parameters of the systems, performance criteria and economic impact based on operational experience and supplier market information.

Methods to guarantee colloidal shelf life will be discussed in the framework of modern filtration systems as well as the required infrastructure of a state-of-the art filtration area.

An important focus is the role of filtration in the Supply Chain from a brewery managers' perspective of large scale as well as small and medium sized breweries. In today's competitive environment, aspects on health and safety, quality management, financial impact and LEAN/maintenance strategies are important criteria in the responsibility of leaders in the brewing department.

The overview on current filtration technologies will be completed by a quick glance into the role of filtration in craft breweries. An outlook on future developments will conclude this comprehensive review on filtration technology.

Short biography

Stefan Lustig is a brewing engineer graduated fromTU München-Weihenstephan. After completion of his PhD in research on flavor stability under guidance of Prof. Ludwig Narziss, he joined Beck's brewery as head of development & technology.

After several leadership roles in quality, production, packaging and plant management, he joined the board of Anheuser-Busch InBev Germany as Director of Brewery Operations.

Next he moved to Brau-Holding International, Germanys 6thlargest brewing company, a joint venture with Heineken involvement. As Chief Operating Officer and Managing Director he was responsible for Supply, covering a network of 12 breweries and the construction of a 3.5 Mhl greenfield brewery. Currently he is president of "Deutscher Braumeister und Malzmeister Bund", Germanys largest brewmasters association.

Stefan's experience combines know how on brewing science/technology with the operational world of a brewery manager. His expertise covers the supply chain of the brewing industry from raw materials to logistics.

L41 - SULPHITE CONTENT OF BEER : IMPACT OF RAW MATERIAL & FERMENTATION PARAMETERS

Sophie Schwebel[1]; Marc Schmitt[1]

1 – IFBM-Qualtech, Nancy, France

Abstract

Sulfur dioxide is a natural antioxydant. It can be added by the brewer or naturally produced by the yeast. It is identified as an allergen and thus must be labelled if its content is higher than

10 mg/l. In lager beer, the concentration in the final beer must be lower than 20 mg/l. However, beer SO_2 content can vary from one brew to another without any clear explanation for the brewer.

The purpose of this work is to evaluate the impact of raw material and process (fermentation) parameters on SO_2 content in lager beer.

In a first part, the transfer from malt to wort was investigated. In a second part, the influence of fermentation parameters were assessed.

Data collection was performed thanks a design of experiment built in order to study the influence of wort gravity, oxygenation and pitching rate with interactions. Several yeast generations were also tested. The influence of the parameters on fermentation duration and on sulphite production are discussed.

Short biography

She is a research engineer in the research and development department at IFBM.

She received a Higher National Diploma in Technology (DUT) in Biology and Biochemistry from Strasbourg University (2011), and a postgraduate degree in Biotechnology from ESBS (Ecole Supérieure de Biotechnologies de Strasbourg) in 2014.

Today, she participates to the projects management in the barley to beer chain at IFBM (technological issues solving, method development, participation to collaborative projects...).

L42 - YEAST STRAIN SPECIFIC RELEASE OF CYSTEIN-CONJUGATED THIOLS LIKE 4-MSP BY B-LYASE ACTIVITY

Maximilian Michel[1]; Korbinian Haslbeck[1]; Aofei Cheng[1]; Mathias Hutzler[1]; Mehmet Coelhan[1]; Martin Zarnkow[1]; Aofei Jacob[1]

1 - Research Center Weihenstephan for Brewing and Food quality, TU München, Germany

Abstract

To improve the yield of the hop dosage and to increase the flavor of hops, bound aroma compounds can be released by enzymes like β-glucosidases or potentially β-lyases. Recent studies on hops have revealed 4-MSP (4-methyl-4-sulfanylpentan-2-one) and a couple of more thiols as main contributors to a highly desired hoppy flavor in beer. These thiols can partly be found as cysteine-S-conjugated compounds that are aroma inactive. The amount of these bound thiols varies due to hop variety and hop growing conditions. β-lyases have been found to be capable to release these thiols and turn them in aroma active compounds. These enzymes are present in different yeast species with highly differing activity levels. It was also reported that one gene (*IRC7*) is mainly responsible for the ability of *Saccharomyces cerevisiae* strains to be able to produce β-lyases and therefore set free thiols. A selective media was used in our study to screen for the ability of about 100 *Saccharomyces* brewing yeast strains (top

and bottom fermenting and 10 non-*Saccharomyces*) to release aroma inactive thiols. Further DNA-fingerprinting of the gene (*IRC7*) was performed and new real-time PCR primers were designed to detect gene changes in highly active strains. High variability was found in between the 100 strains. Fermentation trials with one hop variety (Mosaic) with strains found to have a high ß-lyase activity as well as low activity verified the results of the screening and showed higher yields with higher enzyme activity.

Short biography

Maximilian Michel finished his studies in brewing and beverage technology with a Dipl.-Ing. Degree from TU München in 2014. He then started a PhD program at the Research Center Weihenstephan for Brewing and Food Quality, TU München with the aim of developing a screening system for non-*Saccharomyces* yeasts for the beer industry. He finished his PhD in January 2018. He now works as a consultant for the brewing industry at the Research Center Weihenstephan.

L43 - METABOLIZATION OF GLYCATED AMINO ACIDS FROM WORT BY DIFFERENT S. CEREVISIAE STRAINS

Michael Hellwig[1]; Anna-Lena Kertsch[1]; Thomas Henle[1]

1 - Technische Universität Dresden, Chair of Food Chemistry

Abstract

Products of non-enzymatic browning (Maillard reaction, glycation) are decisive for the color and aroma of beer. Important products of this reaction are covalently modified ("glycated") amino acids. Moreover, amino acid fermentation in the Ehrlich pathway leads to the generation of important flavor compounds such as 2-phenylethanol and 3-methylbutanol.

Our recent works have shown that many glycated amino acids can be metabolized by brewer's yeast (*S. cerevisiae*) in the Ehrlich pathway to novel hydroxy acids and higher alcohols ("fusel alcohols"). Higher alcohols such as pyrralinol (up to 200 µg/L) and formylinol (up to 50 µg/mL), formed from the lysine derivatives pyrraline and formyline, respectively, were occurring especially in wheat beers (Hellwig et al., 2018; J. Agric. Food Chem. 66, 7451-7460). Metabolization of other Maillard reaction products (MRPs) such as 3-deoxyglucosone and 5-hydroxymethylfurfural (HMF) was also observed.

Top- and bottom fermenting yeasts differed in the extent of formation of these novel metabolites. In our present project, metabolization of MRPs such as pyrraline, HMF, and 3-deoxyglucosone by commercially available brewer's yeast strains are evaluated. The results will be compared to commonly assessed phenotypic characteristics such as cold tolerance, 4-vinylguaiacol formation and fermentability of maltotriose.

These works will contribute to the knowledge about the phenotypic changes of brewer's yeast strains which occurred during domestication and answer the question as to whether cultivation

of yeast in MRP-rich wort solutions may have entailed the ability of individual strains to utilize MRPs.

Short biography

After the diploma thesis in Food Chemistry in 2004, Michael Hellwig worked as a PhD student in the group of Prof. T. Henle at the Technische Universität Dresden (Germany) from 2006 to 2011 in a cooperative project with the Universität Halle-Wittenberg on the synthesis, chromatographic analysis, and membrane transport of glycated amino acids and peptides.

Since 2011 he has been working on the microbial metabolism of protein glycation and oxidation products at the Technische Universität Dresden and is now employed as a Principal Investigator on a topic about mechanisms and products of protein oxidation in model systems and food.

L44 - A RAPID AND OBJECTIVE METHOD FOR IN SITU DETERMINATION OF A DEGREE OF SENSORY DETERIORATION OF BEER CAUSED BY AGING PROCESS

Jana Olšovská[1]; Tomáš Vrzal[1,2]; Karel Štěrba[1]

1 - Research Institute of Brewing and Malting; 2 - , Charles University, Faculty of Science

Abstract

A rapid, mobile and objective method for in situ determination of a degree of sensory deterioration of beer caused by the aging process was developed and validated. The method is based on current reflectometric determination of 5-(hydroxymethyl)furan-2-carbaldehyde (HMF), as according to our previous study, HMF is a very good indicator of a stale flavor in beer determined by a sensory analysis (correlation higher than 0.96). It requires a mobile reflectometer with test strips and therefore is available for everyone and everywhere outside the laboratory as a taste sensor in the meaning of “an artificial tongue”. The reflectometric signal is transformed to the degree of the stale flavor using a specified algorithm, which was derived from this study and it is being patented. The method provides results comparable with the sensory analysis by a trained sensory panel for lager beers and also an objective reflection of beer deterioration for other beer styles. The stability of a QC sample was a crucial parameter for avoiding false positives/negatives, therefore, the assay of stabilization of HMF standard was simultaneously developed. The reproducibility of the method derived from a comparison of data sets from three individual reflectometers by t-test ($p<0.05$) and expressed as a relative deviation was 7.3%. Finally, monitoring of the stale flavor in real beer from the local market was proved. Nearly 56% of the tested samples were positive. Weak/medium deterioration was noted in 41% of the samples and 15% of samples were damaged significantly (medium/strong).

Short biography

Jana Olšovská has worked for nearly 15 years as an analytical chemist in a biomedical field. She is an expert in modern separation techniques such as HPLC with UV, FL and MS detection. She started to work in brewery research in 2011; since 2013 she has been an expert on the

Analytical Committee of EBC. Presently, she is a manager of the Analytical Testing Laboratory EN ISO/IEC 17025:2005, a manager of the Sensory Laboratory and a member of a professional sensory panel of the Research Institute of Brewing and Malting, Prague. She is an author of more than 50 papers in international impacted journals and a new book "Sensory analysis of beer", Kvasny Prum, Czech Republic, 2017. She is also involved in pedagogical activities, she has already been a supervisor of many BSc., MSc., and Ph.D. students.

L45 - MORE SUSTAINABLE BREWING AND INCREASED FLAVOUR STABILITY DUE TO THE AB INBEV SIMMER & STRIP TECHNOLOGY

David De Schutter[1]; Mario Rottiers[2]; Mario Thiry[3]

1 - R&D Director Europe at AB InBev; 2 - Process Development Specialist; 3 - Global Process Development Specialist, Leuven, Belgium

Abstract

Wort boiling is the most energy-intensive step in the brewing process. A wide range of technologies for reducing energy usage or recovering energy have been developed in the past and are implemented in many breweries with different challenges and benefits.

The technology developed by AB InBev consists of a new disruptive way of conducting the 'boiling' step while the evaporation is replaced by a stripping of an inert gas. This gas is directly injected in the kettle and the wort is kept just below the boiling point. This technology aims to reduce both wort heat load and energy consumption.

In the regular boiling process, the energy is primarily used for the evaporation which is required for flavour stripping. DMS is traditionally considered as a marker for this purpose. To maintain highest quality standards, the monitoring of Strecker aldehydes with even lower volatility such as 3-methylbutanal and Maillard components like 2-furfural have been considered and measured in the brewhouse as well as in the final product. A third marker, 2-Ethyl-3,5-dimethylpyrazine, has been identified for its very low volatility and its extremely low sensory threshold (< 1ppb).

The efficiency of the stripping and the impact of the thermal load on flavour stability of the beer have been assessed and correlated with a standard forced aging test. The objective of this will present and discuss the impact of this new proprietary boiling technology on those markers during the process from boiling to final product.

Short biography

David De Schutter obtained his PhD degree at the Center for Malting and Brewing Science of the KULeuven under supervision of Prof. Delvaux and Prof. Derdelinckx. Before his career at AB InBev he made a passage outside the brewing industry at the R&D Center of Procter & Gamble in Brussels. He joined AB InBev as Product & Process Development Specialist where he was involved in the development of the first new generation non-alcoholic beer Then he became

Global Director for Process Development and R&D Transformation in the Global Innovation & Technology Center in Leuven (GITEC). His current position is R&D Director for Europe at AB InBev. David is also representing AB InBev in the EBC Executive Committee, member of the BIR&D (Belgian Industrial Research and Development organization) and coordinator of the Brewing program of Fund Baillet Latour.

L46 - INFLUENCE OF MASHING PARAMETERS ON FILTER CAKE STRUCTURE AND FILTERABILITY IN THE LAUTER TUN

Martin Hennemann[1], Martina Gastl[1], Thomas Becker[1], Florian Lehnhardt[1]

1 - TUM Munchen-Weihenstephan, Germany

Abstract

Lautering is the most time consuming step in wort production. It is an exceptional filtration process in food industry based on the combination of cake filtration and extraction of value-giving substances.
In the lauter tun, fine particles of mash contribute to the formation of a jelly-like layer on top of the filter cake. This blocking layer is known for filtration problems during lautering. Therefore, a reduction of the filtration limiting effects of the fine layer is desirable.
Attempts were made to reduce the size of this fine layer by incorporating fine particles homogeneously into the filter cake structure. In order to achieve this, varied mash parameters, for example pH-value or ion concentration, were tested. The influence on the homogeneity of the filter cake structure was analysed by particle size measurement. Wort filtration time was measured to determine filterability of mash with different parameters. To prevent the influence of the grist composition, finely milled malt was used for the filtration tests.

Short biography

Martin Hennemann is a research assistant at the Chair of Brewing and Beverage Technology of TU Munchen-Weihenstephan. Hennemann started his career with an apprenticeship as brewer and maltster. Afterwards, he attended the Doemens Academy in Grafelfing for advanced training as brewing technician in 2009. Hennemann received a Bachelor's and Master's degree in chemistry and biochemistry at the LMU Munchen and completed his Master's thesis in 2016 at the Birkbeck College in London. Since 2017, Hennemann deals with the lautering process as part of his PhD at the research group Raw Material based Brewing and Beverage Technology at TUM.

L47 - DEVELOPMENT OF THE METHODOLOGY FOR DETERMINATION OF THE GEOGRAPHICAL ORIGIN OF HOPS

Iztok Jože Košir[1]; Marijan Nečemer[2]; Miha Ocvirk[1]

1 - Slovenian Institute of Hop Research and Brewing; 2 - Institute Jozef Stefan

Abstract

A need exists for a reliable method for determining the geographical and botanical origin of hops. For brewers, it is important to know the geographical origins of the hop products (*Humulus lupulus* L.) used in their brewing processes since the contents and compositions of the bitter resins and essential oils in them depend not only on the genetic but also on the environmental conditions during their growth.

For this study samples of hops from the 10 world's main growing regions were collected. The samples were analyzed using Isotope Ratio Mass Spectrometry to obtain a range of stable isotope ratios δ13C, $\delta^{15}N$, $\delta^{34}S$, $\delta^{2}H$, $\delta^{18}O$ and $\delta^{206}Pb$. The $\delta^{15}N$, $\delta^{34}S$ and $\delta^{206}Pb$ values proved to be the most discriminating parameters for classifying hops according to geographical origin. Use of stable isotopes ratios of $\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$ and $\delta^{206}Pb$ could be used as a new powerful tool for differentiating hops according to geographical origin and can be of use to the brewing industry or to the hop traders in resolving issues relating to authenticity. Method is uncomplicated, fast and relatively cheap, comparable to standard GC or HPLC techniques and does not need any special sample pretreatment except weighting.(1)

Furthermore the multi-elemental profiles of hop products from each of the world's main growing regions were determined by non-destructive energy dispersive X-ray fluorescence spectrometry (EDXRF) covering a broad range of 13 elements (Si, P, S, Cl, K, Ca, Ti, Mn, Fe, Zn, Br, Rb, and Sr). After applying the suitable chemometric methods complete discrimination of samples between different regions was achieved. Understanding the multi-element profiles of the plants could be a useful tool in determining the geographic origins of produced hop plants.(2)

1. OCVIRK, M. et al.,, Determination of the geographical and botanical origin of hops (*Humulus lupulus* L.) using stable Isotopes of C, N, and S. *J.Agric.Food Chem.*, 2018, vol. 66, p. 2021-2026.

2. OCVIRK, M. et al., Determination of the geographical and botanical origin of hops (*Humulus lupulus* L.) using stable Isotopes of C, N, and S. *Food Chem.*, in press.

Short biography

dr. Iztok Jože Košir is the head of the Department for agrochemistry and brewing at the Slovenian Institute of Hop Research and Brewing since 2001. His field of work are brewing technologies with the emphasis on hop and authenticity studies of agrifood products using different analytical methods. Over last decades he published more than 60 papers from the field of research.

L48 - CHARACTERIZING THE DIVERSITY OF WILD HOPS (HUMULUS LUPULUS) FROM PORTUGAL

Julio Cesar Machado Junior[1]; Miguel A. Faria[1]; Zita E. Martins[1]; Armindo Melo[1]; Sara C. Cunha[1]; Florian Lehnhardt[2]; Hubert Kollmannsberger[2]; Martina Gastl[2]; Thomas Becker[2]; Isabel M. P. L. V. O. Ferreira[1]

1 - LAQV/ REQUIMTE, Departamento de Ciências Químicas, Faculdade de Farmácia, Universidade do Porto; 2 - School of Life Sciences Weihenstephan, Chair of Brewing and Beverage Technology, Technische Universität München

Abstract

Wild hops are an important source of new varieties and genetic variation for breeding. In this study, 109 accessions of wild Portuguese hops were characterized at the genetic (SNP), sensorial, and chemical levels (total oil, volatile profile, α/β-acids and xanthohumol); by HRMA, a semi-trained panel, and steam distillation, GC-MS, GC-MS-Olfactometry and HPLC, respectively. Additionally, 4 accessions were selected and their behavior in dry-hoping was evaluated by volatile compounds and sensorial analysis with a trained panel.

At the sensorial level Portuguese hops presented resinous, spicy, and floral aromas, whereas control commercial hops used (European and North-American varieties) were, in general, more citrus, fruity/ sweet, and floral. These differences were confirmed chromatographically by different volatile profiles presented. Relative area data showed that around 15% of compounds detected justify the big majority of volatiles mass, in Portuguese hops, whilst this value raise to 85% in commercial hop samples. Genetic analysis showed a great diversity amongst accessions and a clear cluster separation from most of the commercial references used, demonstrating the potential genetic richness of the germplasm. Concerning the chemical characterization total oil was, in average, 0.72 (± 0.35) mL/ 100g, ranging from 0.23 to 1.84 mL/ 100g. The α-acids contents were around or lower than 5%, β-acids ranged from 0.4% to 6.3% and xanthohumol contented up to 0.5% of weight. One particular sample should be underlined based on its α-acids content (10.6 ± 0.2%) and volatile profile showing high similarity with reputable varieties in the worldwide market, as Northern Brewer, Nugget and Citra®.

Short biography

PhD student in the Pharmaceutical Sciences program, specializing in Nutrition and Food Chemistry at the Faculty of Pharmacy of the University of Porto.

Master in Pharmaceutical Sciences from the Federal University of Paraná, graduated in

Pharmacy and Biochemistry from the Universidade do Vale do Itajaí.

Experience in clinical analysis, physical-chemical, and sensory analyzes of foods, with emphasis on beers.

L49 - NATIVE YEASTS FROM ECUADORIAN CHICHAS: INSIGHTS INTO THEIR POTENTIAL APPLICATION IN BEER PRODUCTION

Nubia Jimena Grijalva Vallejos[1]; Kristoffer Krogerus[2,3]; Jarkko Nikulin[2,4]; Agustín Aranda[1]; Emilia Matallana[1]; Brian Gibson[2]

1 - Institute for Integrative Systems Biology (I2SysBio), Universitat de València-CSIC, 46980 Paterna, Valencia, Spain.; 2 - VTT Technical Research Centre of Finland Ltd, Tietotie 2, P.O. Box 1000, FI-02044 VTT, Espoo, Finland; 3 - Department of Biotechnology and Chemical Technology, Aalto University, School of Chemical Technology, Kemistintie 1, Aalto, P.O. Box

16100, FI-00076 Espoo, Finland; 4 - Chemical Process Engineering, Faculty of Technology, University of Oulu, P.O. Box 8000, FI-90014 Oulun Yliopisto, Finland

Abstract

Traditional fermented beverages could be an important source of new yeast strains with a high potential in beer production (Araújo et al., 2018; Bellut et al., 2018). Several investigations have shown a high diversity of yeasts associated with the fermentation of chicha or indigenous Andean beer (Mendoza et al.,2017; Piló et al., 2018; Vallejo et al., 2013). In our recent study, we have found a high genetic and phenotypic variability of *Saccharomyces* strains isolated from chicha fermentations, and the presence of interesting species, from a bioflavoring perspective, of the genera *Candida*, *Torulaspora*, *Pichia* and *Hanseniaspora*. Three *S. cerevisiae* strains and one *T. delbrueckii* strain isolated from four Ecuadorian chichas were compared to *S. cerevisiae* and *S. pastorianus* (ale and lager beer strains, respectively) from the VTT Culture Collection. Strains were characterized for their sugar fermentation, phenolic off-flavor production and flocculation. Trial fermentations were performed in 15°P all-malt wort and in model chicha substrate at 12°C and 20°C; the aroma profile was also studied. Among the strains tested, only one *S. cerevisiae* strain was able to ferment maltose and maltotriose. Fermentations with all the Ecuadorian strains were poor in wort at 12°C relative to 20°C, but were similar in model chicha substrate at both temperatures. The aromatic profile was different between species and strains. One of the chicha strains showed suitable characteristics for ale fermentation while the other strains have potential in low alcohol beer and chicha production.

Short biography

Araújo, T. M., et al. (2018). Cachaça yeast strains: alternative starters to produce beer and bioethanol. *Antonie van Leeuwenhoek,* 111, 1749.

Bellut, K., Michel, M., ...& Arendt, E. (2018). Application of non-*Saccharomyces* yeasts isolated from Kombucha in the production of alcohol-free beer. *Fermentation*, 4, 66.

Mendoza, L. M., Neef, A., Vignolo, G., & Belloch, C. (2017). Yeast diversity during the fermentation of Andean chicha: A comparison of high-throughput sequencing and culture-dependent approaches. *Food Microbiology*, 67, 1–10.

Piló, F., Carvajal-Barriga, E., … & Rosa, C. (2018). *Saccharomyces cerevisiae* populations and other yeasts associated with indigenous beers (chicha) of Ecuador. *Brazilian Journal of Microbiology*, in press.

Vallejo, J. A., Miranda, P., … & Villa, T. G. (2013). Atypical yeasts identified as *Saccharomyces cerevisiae* by MALDI-TOF MS and gene sequencing are the main responsible of fermentation of chicha, a traditional beverage from Peru. *Systematic and Applied Microbiology*, 36(8), 560–564.

L50 - CRITICAL ASSESSMENT OF CALIBRATION STRATEGIES FOR EFFECTIVE BEER FLAVOR ANALYSIS BY SOLID-PHASE MICROEXTRACTION (SPME)

Sarah Thörner[1]; Johanna Dennenlöhr[1]; Nils Rettberg[1]

1 - VLB Berlin - Research Institute for Beer and Beverage Analysis

Abstract

Solid phase microextraction (SPME) is the most commonly used automated sample preparation technique in beer flavor analysis. Interfaced to GC or GC-MS it is, amongst others, used in the analysis of hop aroma compounds, staling aldehydes, pyrazines, esters, and volatile fatty acids. The popularity of SPME relates to the availability of multiple SPME-fibers with different polarities. Those enable efficient extraction of volatiles from complex samples, whereas solvents and sample volumes are reduced to a minimum. Those features meet the demands of many analysts in breweries and academia.

Compared to other sample preparation techniques, SPME is rather straightforward on first view. However, the absolute recovery of some aroma compounds from beer or other brewing samples may only lie within a small percentage of their total amount (equilibrium extraction). Thus, matrix effects caused by either high or low alcohol content, pronounced hop aroma or fermentation by-product spectrum might strongly influence GC peak areas. Consequently some analysts complain about SPME performance being poor in terms of reproducibility and repeatability.

In the current paper we critically assess and compare different calibration strategies for SPME based flavor analysis. Focusing on hop aroma compounds and staling aldehydes we discuss the selection of suitable standards and matrices for matrix matched calibration. GC-MS data collected over the period of 24 month highlights the stability of properly designed SPME based methods. Also we outline a strategy to widen the method working range, which is important to the wealth of different beer styles currently available on the market.

Short biography

Sarah is a state approved food chemist who graduated from the University of Münster (WWU) in 2009. From 2010 to 2015 she performed her doctoral thesis on the “Characterization of enzymatic conversion of cis-[3,4-2H2]-3,4-epoxydecanoate in Saccharomyces strains” at TU Berlin. Simultaneously, Sarah was employed as a research associate at VLB (Research Institute for Special Analyses). Here, her field of activity included method development for various GC-MS applications, as well as the analytical assistance of versatile research projects. Since October 2015 Sarah is the Department Head for Special Analyses at the VLB Research Institute for Beer and Beverage Analysis. Her work is focused on the analysis of flavor and off-flavor in beer and beverages by GC, GC-MS, and GC-MS/MS.

L51 - INTERNATIONAL CALIBRATION STANDARDS FOR HOP AND BEER ANALYSIS – OVERVIEW AND NEWS

Biendl Martin[1]; Foster Robert, T.[2]; Maye John Paul[3]

1 - Hopsteiner HHV GmbH; 2 - Molson Coors; 3 - S.S. Steiner, Inc.

Abstract

More than 20 years ago, the first international cooperation was started with the purpose of production, release and maintenance of highly purified and stable HPLC calibration standards for use in the quantitative determinations of hop bitter components in hops and beer. Since 2001, the International Hop Standards Committee (IHSC), with experts from EBC, ASBC, BCOJ and IBD, has been responsible for this task. In addition to the International Calibration Extract (ICE), a carbon dioxide extract of assigned composition to be used for measurements of alpha- and beta-acids in hops and hop products, dicyclohexylamine complexes of various bitter acids present in beer have also been made available. These include iso-alpha-acids, rho-iso-alpha acids and hexahydro-iso-alpha-acids. Only the tetrahydro-iso-alpha-acids hop standards are released in pure form. In addition to iso-alpha-acids that are formed during wort boiling, considerable amounts of humulinones and non-isomerized alpha-acids can be transferred into beer via dry-hopping, where they contribute both to the analytical IBU and sensory bitterness values. In order to quantitate these contributory hop bitters in HPLC standard analysis (i.e. Analytica-EBC 9.47 method), new high purity standards needed to be synthesized. The IHSC recently succeeded in preparing both humulinones and alpha-acids as stable dicyclohexylamine complexes and approved each as new international calibration standards (ICS). Additionally, in consideration of ongoing worldwide research on its health benefits and new dry-hopping techniques in-use, in 2018, a pure xanthohumol has been made available as ICS. Finally, after purity validation and approval, the IHSC supplies the packaged hop standards to Labor Veritas (Switzerland) and Scientific Societies (USA) who sell them worldwide under the EBC and ASBC labels. To show all the steps and cooperation involved behind releasing a new standard, an example of how the production and purity assignments of dicyclohexylamine-humulinones is described.

Short biography

Martin Biendl received a Ph.D. degree in organic chemistry from Regensburg University in 1990. He is head of the R&D/Analytical Department at the German branch of the Hopsteiner group, one of the largest international hop growing, trading and processing firms. His research experience is in the field of hop-related needs for the brewing industry and beyond. He is the representative of the International Hop Industry Cooperation in the EBC Analysis Committee and, since 2001, chairman of the Hops Subcommittee. As EBC representative he is also co-chairman of the International Hop Standards Committee. In 2007 he was elected to the board of the Association of the German Hop Trade.

L52 - THE INFLUENCE OF DRY-HOPPING ON SELECTED CHEMICAL-PHYSICAL CHARACTERISTICS OF BEER

Martin Zarnkow[1]; A. Stallforth[1]; K. Haselbeck[1]; S. Cocuzza[2]; F. Jacob[1]

1 - TU München Research Center for Brewing and Food Quality; 2 - Hopsteiner, Simon H. Steiner, Hopfen, GmbH

Abstract

In the course of this work it was investigated how a linearly increasing hopping rate affects the selected chemical-physical characteristics of beer. The aim was to analyse the modifications of the following characteristics: bitter units, α and iso α acid, humulinone, total polyphenols, flavanoids, iso- and xanthohumol¬, real extract, alcohol by volume (ABV), pH value, foam stability, a-pinen, b-pinen, b-myrcen, d-limonen, caryophyllen, humulene, a-terpeniol, damascenon, geraniol, sensory evaluation and turbidity due to dry hopping. It was also necessary to check whether the plant material added by dry hopping showed significant effects on the examined characteristics. For this purpose dry hopping trials using spent hop pellets from a CO_2-extraction were performed.

First a base beer was brewed and fermented. This young beer was the basis for the subsequent dry hopping experiments with a hopping rate ranging from 0 to 1500 g/hl. In addition, a test series has been dry hopped with spent hop pellets (1000 g/hl).

With regard to the bitter units it can be stated that dry hopping with both Cascade and spent hop pellets has no significant influence. On the other hand, the iso-α-acid decreased by 1,4 mg/l per 100 g/hl when dry hopped with Cascade pellets. Due to the high α-acid content in the reference beer, no clear increase can be observed. The humulinone content increases by 1 mg/l per 100 g/hl when dry hopped with Cascade pellets.

In summary, dry hopping has a significant effect on some characteristics of beer. Clearly modifications show the decrease in iso-α-acid and foam stability, as well as the increase in humulinone, pH value and total polyphenols. In contrast, no definitely conclusion can be made to the influence of dry hopping on the flavanoid, xanthohumol and alcohol content as well as the turbidity and the bitter units.

Short biography

Apprenticed as a brewer and maltster from 1989-1991 at a small brewery in Frankonia. Finishing a Diplom-Ingenieur (FH) graduation, option brewing technology, 1996 at the TU München Weihenstephan. Worked as a brew master for one year in a medium-sized brewery in Germany. Since 1997 at TU München. Head of research and development at research institute Weihenstephan for brewing and food quality. Finished 2010 his external PhD research at the University College of Cork, Ireland on the subject: “Proso Millet (Panicum miliaceum L.) a Sustainable Raw Material for the Malting and Brewing Process”.

L53 - GENETIC AND BIOCHEMICAL APPROACH TO STUDY THE IMPACT OF TERROIR ON THE BREWING VALUE OF HOPS

Ann Van Holle[1,2]; Hilde Muylle[3]; Tom Ruttink[3]; Anita Van Landschoot[2]; Geert Haesaert[2]; Dirk Naudts[1]; Denis De Keukeleire[2]; Isabel Roldán-Ruiz[2,3]

1 - De Proefbrouwerij; 2 - Ghent University; 3 - Institute for Agricultural and Fisheries Research (ILVO)

Abstract

The impact of the growing area (in general terms known as 'terroir') on the brewing value of hops is evident. A recent study of our research group clearly established that hop pellets of the Amarillo variety, grown at different locations in North-western USA (Idaho and Washington), led to divergent flavour characteristics in Amarillo-derived single hop beers (Van Holle et al., 2017). As a consequence, brewers must rely on Amarillo hops from the same terroir in order to achieve a consistent hoppy aroma in their final beer.

To investigate to which extent this applies to other hop varieties, samples were collected from 20 commercially relevant hop varieties originating from different hop growing areas in the world (Australia, Belgium, Czech Republic, Germany, New-Zealand, United States) and for 3 successive harvest years (2015, 2016, 2017). To confirm that samples of the same hop variety harvested in various locations were genetically identical, SNP (Single Nucleotide Polymorphism) marker genotyping was performed. In parallel, the biochemical characteristics of the hop samples and the potential impact on the taste and the hoppy aroma of the beers, were also evaluated.

The set of SNP markers used was able to discriminate all tested hop varieties, and new biochemical marker information offered added value to characterize hop samples of different geographical origins and thus for the brewing value of hops from distinct terroirs.

Van Holle et al. (2017) Journal of the Institute of Brewing 123, 312-318.

Short biography

Ann Van Holle graduated in 2010 as a Master of Science in Bioscience Engineering from Ghent University, Belgium.

Since 2011 she is working as a research scientist at the R&D department of De Proefbrouwerij, Lochristi, Belgium. From 2011 to 2014 she was managing the 'Single Hop Technology' project in order to gain insight in and control over hops as a raw material in the brewing process. In continuation of this project, she started a PhD study on the impact of terroir on the brewing value of pure hop varieties at the research group Biochemistry and Brewing of Ghent University.

L54 - EFFECT OF HARVEST TIME ON POLYPHENOLS PROFILES OF SAAZ HOPS AND BEER TASTE

Takeshi Kumagai[1]; Takako Inui[1]; Takamasa Hasegawa[1]; Taichi Maruhashi[1]; Akira Kogin[1]; Seisuke Takaoka[1]

1 - Suntory Beer Ltd., Beer Development Department, Tokyo, Japan

Abstract

Hop polyphenols are requisite components those contribute to the whole taste such as fullness, bitterness and astringency in beer. In this study, we investigated the taste characters of various hop polyphenols in beer and their changes in different hop harvest time using LC-MS/MS. As results, it was confirmed that the prenylated flavonoid like isoxanthohumol contributed to a bad bitter taste in beer, but on the other, proanthocyanidin dimers and trimers to a preferable fullness. Interestingly, harvest time had a significant impact on the amount of these compounds, especially prenylated flavonoid increased for later harvest time, and proanthocyanidin dimers and trimers increased for earlier harvest time. Therefore, different harvest time resulted in the differences of beer taste, in terms of fullness and after bitter taste. Furthermore, we examined the behavior of these polyphenols during wort boiling.

In conclusion, our results suggest that the combination of harvest time and the timing of hop addition could be the effective method to control the taste characters in beer.

Short biography

Takeshi Kumagai was graduated from Nagoya University with a master's degree in Agricultural Science in 2008. After joining Suntory, he worked for three years in Suntory Kyoto Brewery and for two and a half years in Suntory Tonegawa brewery as an assistant brew master. He then worked in Beer Production Department as a product manager in 2013. In 2015, he attended the Chair of Brewing and Beverage Technology at the Technical University of Munich, Weihenstephan, as a guest researcher for two years. Since 2017, he has been working in Beer Development Department and mainly engaging in developing new brewing technology and products.

L55 - INSIGHTS ON THE LAGER BEER VOLATILE TERPENIC COMPOUNDS THROUGH AN ADVANCED CHROMATOGRAPHIC TOOL

Cátia Martins[1]; Tiago Brandão[2]; Adelaide Almeida[3]; Sílvia M. Rocha[1]

1 - Departamento de Química & QOPNA, Universidade de Aveiro, Campus Universitário Santiago, 3810-193 Aveiro, Portugal; 2 - Super Bock Group, Via Norte, 4465-764 Leça do Balio, Portugal; 3 - Departamento de Biologia & CESAM, Universidade de Aveiro, Campus Universitário Santiago, 3810-193 Aveiro, Portugal

Abstract

Beer volatile terpenic compounds are originated from a variables' network (plant raw-materials metabolism, yeast metabolism [1], etc), and may undergo modifications during brewing. Therefore, for increasing their molecular understanding, this work aims to achieve the comprehensive characterization of volatile terpenic compounds on lager beer. It was used an advanced multidimensional chromatographic methodology previously optimized [2,3]. Several lager beers produced at different countries and breweries were analyzed.

This targeted analysis allowed the putative identification of 94 mono and sesquiterpenic compounds, from 6 chemical families: alcohols, aldehydes, esters, ketones, hydrocarbons, and oxide. Their volatile profiles allowed to achieve the lager beer terpen-typing, i.e. the samples' category clustering depending on 2 main classes: macro and micro-brewer beers. As far as we know, this is the most detailed screening of lager beer terpenic compounds in beer, which may be further applied in large-scale studies in different contexts, e.g. to comprehend distinctive beer styles or for beer typing.

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[3] Martins, C.; Brandão, T.; Almeida, A.; Rocha, S.M. Food Res Int. **2018**, *114*, 199-207.

Short biography

Cátia Martins is MSc in Food Biotechnology (University of Aveiro). In 2018, she obtained the degree of Doctor in Biochemistry from University of Aveiro. The main objective of her PhD thesis was to advance in lager beer aroma comprehension through yeasts and beers volatile metabolomic profiling. Currently, she has a Pos-Doc scholarship at University of Aveiro.

L56 - ARABINOXYLANS IN THE BREWING PROCESS - AN UNDERESTIMATED SUBSTANCE CLASS?

Michael Kupetz[1]; Martina Gastl[1]; Thomas Becker[1]

1 - Lehrstuhl für Brau- und Getränketechnologie, TU München, Germany

Abstract

Problem-free processing of raw materials with a short processing time and optimal yield is a basis in modern brewing. According to the literature, cytolytic substances like β-glucans and arabinoxylans in malt are particularly important due to their impact on lautering and filterability. For this reason, a method for the classification of the raw materials with respect to arabinoxylan and β-glucans is important. According to EBC-analytica, β-glucans can be analysed using microtiter scale, optimal malt extraction methods are known and standard values can be found. However, comparable information is not available for arabinoxylans. Thus, aim of this study was to investigate various influencing factors like the impact of oxygen due to cross-linking and

extraction temperatures on total arabinoxylans content. After identification of an optimal mashing procedure, standard values for malt were recorded. In addition, molecular weight distribution of arabinoxylans in malts with different modifications was investigated. Total arabinoxylans ranged between 400 and 1000 mg/l in barley malt, whereby a higher total concentration could be measured in high-modified varieties. In addition, these varieties had a higher proportion of high-molecular-weight fractions (> 50 kDa) of up to 35%. Besides, activity of arabinoxylan-degrading enzymes such as xylanase and arabinofuranosidase are important for characterization of raw materials. It could be shown that medium-modified varieties had a higher xylanase activity. Characterizing the substance class of arabinoxylans and their degrading enzymes with the help of the described methods can result in a better monitoring of brewing processes, which not only affects process times, but the beer quality.

Short biography

Michael Kupetz graduated in 2011 as a graduate engineer for brewing and beverage technology at the Technical University of Munich. In July 2017 he received his doctorate at the Chair of Brewing and Beverage Technology in Weihenstephan on the topic "Comparative identification of filtration-inhibiting substances in the membrane and kieselguhr filtration of beer". In addition, he is head of the Analytical Laboratory for malt, wort and beer quality since July 2016. His research topics are in the fields of method development with a focus on polysaccharides and method automation as well as filterability of beer.

POSTER ABSTRACTS

TOPIC: ANALYSIS AND METHODOLOGY (raw materials, product, research)

P001 - TURBIDITY IDENTIFICATION VIA RAMAN MICRO SPECTROSCOPY

Eva-Maria Kahle[1]; Fritz Jacob[1]; Martin Zarnkow[1]

1 - Research Center Weihenstephan for Brewing and Food Quality

Abstract

In recent years Raman Micro spectroscopy has already been established as a powerful tool in many research fields like biology, medicine and archaeology. In addition to beer foam, the most important visual quality characteristic of filtered beer is, above all, its gloss fineness. Even a slight opalescence disturbs the appearance and reduces the consumer's acceptance. In addition, turbidity or particles in beer imply a potential health risk to the consumer, which also results in a reduction in the quality of beer. Accordingly, the turbidity along the entire value chain is given a high level of attention and, in the ideal case, countered in advance by suitable countermeasures. Consequently, in the case of an undesirable haze, it is first necessary to identify the haze particles. However, the analysis is often limited to optical, enzymatic and microscopic analyzes. Raman Micro Spectroscopy (RMS) offers another possibility for the identification and characterization of turbidity causing particles. The advantage of RMS over

other methods is that it provides a fast, non-invasive, nondestructive and high-resolution measurement. In addition, RMS offers a high information density in the recorded spectra. Big exceptions are complex media, such as beer, since these require due to the variety of ingredients accurate knowledge of the composition and their Raman spectra. This multitude of organic constituents can cause fluorescence, leading to drift movements in the Raman spectra, which superimpose the actual Raman signals. Also, the treatment is more elaborate in that the samples must be prepared in advance. For this purpose, a suitable method must be developed which divides beer into its individual constituents and thereafter can be measured step by step.

Short biography

Eva-Maria Kahle finished her studies in brewing and beverage technology with a Dipl.-Ing. degree from TU München in 2017. She wrote her diploma thesis on the topic of N-nitrosodimethylamine (NDMA) in malt. Since september 2017 she has been working as a scientific employee at the Research Center Weihenstephan for Brewing and Food Quality and started a PhD program with the aim of developing a method for identification of turbidity via Raman Micro Spectroscopy (RMS) for the beer industry. She supports the research and development department.

P002 - NON-DESTRUCTIVE DETERMINATION OF HOP CONSTITUENTS BY NEAR INFRARED SPECTROSCOPY (NIRS)

Christian Temme[1]; Florian Schüll[2]; Kirsten Kramer[3]

1 - RMI Analytics; 2 - HVG; 3 - Eurofins QTA

Abstract

NIRS is a rapid, non-destructive and cost effective analytical technique which is gaining wide acceptance in a variety of industries. For over 30 years, there have been efforts to establish NIRS analysis for hops and hop products but the accuracy has been a concern for commercial applications. The raw data from NIRS, a multi-point spectrum, contains broad absorbance features of several overlapped constituents, requiring chemometrics and multivariate regression for the analysis. To implement NIRS successfully, two key elements are critical: the quality of the data and careful construction of the calibration. Data from a highest cost, high quality instrument is useless if the calibration is not constructed properly and conversely, if the spectral quality is low or lab results are of high error, then even an expert chemometrician cannot create a useful calibration. In a new approach, Fourier Transform (FT) instrumentation combined with robust chemometric modeling has allowed NIRS to be implemented with success in accuracy, reliability and ruggedness for determining hop constituents. We will present the method developments and quality indicators for the NIR calibrations for the prediction of moisture (EBC 7.2), lead conductance value (EBC 7.4 and 7.5), alpha-acid (EBC 7.7), and total oils (EBC 7.10) in pellets and powder. Based on these results we reasonably expect that further hop constituents can be calibrated in the near future and that this valid

and rapid method is applicable to both, screening and routine purposes within the whole processing chain.

Short biography

Christian Temme is an analytical chemist with a long history in research and development of analytical methods and their application in the food and beverage industry.

He is the CEO of RMI Analytics GmbH in Hamburg, one of only a few independent advisory firms in the world specialized in brewing raw materials. He holds a PhD in Analytical Chemistry from the University of Jena and was the leading author of several international publications for the development of new analytical methods in selected environmental and food matrices.

P003 - SENSOMICS AS A PROMISING TOOL IN BREWING SCIENCE

Tomáš Vrzal[1]; Karel Štěrba[1]; Jana Olšovská[1]

1 - Research Institute of Brewing and Malting, PLC, Prague, Czech Republic

Abstract

Nowadays, using *-omics* is essential for acquiring new knowledge in many fields of science. The main advantage of these modern disciplines is a comprehensive view on studied objects. Beer, from the chemical point of view, is a very complex sample and the comprehensive view is important in understanding many aspects of sensory properties of this worldwide popular beverage. The sensomics, a member of a wider family of -omics technologies applied to food, e.g., foodomics, food metabolomics and flavoromics, aims to describe sensory properties of foodstuffs at a molecular level. Last few years our research group has been focused on expansion of this field in brewing science. As it is obvious from many scientific papers, not only volatiles and/or compounds above their flavor threshold but also non-volatiles and compounds at sub-threshold concentrations can influence the final sensory impression of a given product. The sensory impact of the secondly named groups were usually neglected in sensory studies in the past. The sensomics in our conception operates with both groups, however, the extension of a list of beer compounds so far unknown is the main challenge to the future.

The presented lecture will be mainly focused on the explanation of basic principles, steps and tools in the sensomics, as a design of experiment, performance of an experiment and analysis, data treatment and evaluation. Examples of typical problems for the application of sensomics in brewing science will be introduced and discussed. A successful application of sensomics on a study of sensory properties of European lager beer will be demonstrated.

Short biography

Tomáš Vrzal finished the MSc degree at Faculty of Science, Charles University, in 2014. Currently, he is a 4th year PhD student of Analytical Chemistry at Charles University, and simultaneously, he has been working as a researcher in the Research Institute of Brewing and Malting, PLC (Prague, Czech Republic). His PhD thesis is mainly focused on novel methods of nitroso compound detection/determination in brewery matrices. He is also interested in sensory active compounds in beer and chemometric data evaluation which is used in a wide range of scientific projects at the Institute. He is also one of the leading members of a scientific project focusing on *Sensomics* of beer and utilization of this modern technology in brewing science.

P004 - THE CHARACTERIZATION OF A HOP OIL PROFILE OF HOP BY FLUIDIZED BED EXTRACTION AND GC-MS-QQQ WITH A HEART-CUT TECHNIQUE

Karel Štěrba[1]; Tomáš Vrzal[1,2]; Jana Olšovská[1]; Tereza Zlochová[1,2]

1 - Research Institute of Brewing and Malting, Prague; 2 - Faculty of Science, Department of Analytical Chemistry, Charles University, Prague

Abstract

Hop is an important source of beer flavor not only because of bitter compounds but also due to its hop oil content. It is difficult to separate volatile compounds from hop and to determine their content in a single GC analysis because of a high number of compounds with a wide range of concentrations. A new possibility is offered by a GC technique called “heart-cut”, which enables to “cut” one or more parts of the chromatogram and send it to another column with different parameters and subsequently to a second detector, in this case FID. This enables to determine poorly separated compounds from one type of column as well as to determine compounds of different amounts (like ppm and ppb) reliably in a single analysis without the contamination of more sensitive mass spectrometric detector.

Short biography

Karel Štěrba has worked in the Research Institute of Brewing and Malting, Prague, since 2011. Since 2015 he has been a member of MEBAK. He is an expert on GC, GC-MS, AAS and electrochemical analyses. Since 2017 he has also been a manager of a professional sensory panel of the Research Institute of Brewing and Malting, Prague.

P005 - ANALYSIS OF HOP AROMA COMPONENTS AFTER FERMENTATION BASED ON CLOSE GENETIC BACKGROUND

Tetsu Sugimura[1]; Klaus Kammhuber[2]; Anton Lutz[2]; Elisabeth Seigner[2]; Martina Gastl[3]; Thomas Becker[3]

1 - Kirin Company, Limited; 2 - LfL Bavarian State Research Center for Agriculture; 3 - Technical University of Munich

Abstract

Various hop varieties with unique aroma and flavor have been bred and released recently. Many brewers are fascinated by the special flavor and use these special hops for their new products. However, the important components which contribute to the characteristic aroma are still unknown. In addition, the causal relationship between the aroma component in hop cones (indicator for breeding) and that in beer (indicator for brewing) is also unclear.
In this study, sisters from a progeny derived from crosses with Mandarina Bavaria (MBA) and Huell Melon (HMN), respectively were used as material. Such material allows comparing samples with close genetic background, with the objective to identify key aroma components. Furthermore, we used a simple small-scale fermentation test containing no malt-derived components focusing to detect hop-derived aroma components after the fermentation. Here, the results of hop aroma using sisters deriving from crosses with the German new flavor hops MBA or HMN are presented.
The hop aroma was analyzed by principal component analysis and sensory evaluation revealing the component groups that contribute to various characteristic aroma groups. In conclusion, it was found that this strategy is the best way to reveal complicated hop-derived key aroma components in fermentation. Furthermore, these results are highly informative for brewers and breeders as well.

Short biography
Tetsu Sugimura joined Kirin Brewery Company, Ltd. in 2008 after receiving Master's degree of Agricultural Science at Tohoku University. He had researched on the secondary metabolism of hops and presented at the EBC Symposium 2010 on the identification of linalool synthase genes. After that he was engaged in research on lactic acid bacteria and received the JSBBA Award for Achievement in Technological Research in 2016. From 2016 to 2018, he had been in Technical University of Munich as guest scientist, and researched on hop aroma components collaborating with LfL Bavarian State Research Center for Agriculture. Now he continues his research on hops at Research Laboratories for Alcoholic Beverage Technologies, Kirin Company, Ltd.

P006 - NON-DISCRIMINANT ANALYSIS OF BEER AGEING CHEMISTRY

Laura Knoke[1]; Henning Schiebenhöfer[1]; Sarah Thörner[1]; Nils Rettberg[1]

1 - VLB Berlin - Research Institute for Beer and Beverage Analysis

Abstract

Economic production of high quality and stable beer is a major concern of brewers. Their brewing operations aim to maximize shelf life by reducing e.g. thermal stress and oxygen uptake.

Multiple dedicated quality control systems, using either targeted instrumental and/or sensory analysis are used in industry. Whereas common instrumental methods target a specified list of analytes (e.g. aldehydes), sensory provides a comprehensive picture of beer flavor. Flavor (in)stability depends on beer style and obviously relates to interactions between several thousand molecules. Its prediction and evaluation based on analytical markers frequently fails or at least does not necessarily correlate well with sensory.

In order to tackle the complexity of events during beer staling, it seems reasonable to use analytical techniques that enable non-discriminative data collection of which untargeted metabolomic profiling (UMP) is a promising approach. UMP aims to map all metabolites (molecules < 1200 Da) of a particular sample and thereby generates a metabolic profile that is used for comparison within a sample set. UMP commonly uses chromatography interfaced with (high-resolution) mass spectrometry and bioinformatics to analyze the complex datasets.

The current work shows results of an UPLC-ESI-Q-ToF based UMP study focusing on beer ageing. Statistical analysis enabled rapid estimation of the similarities and differences within the sample set (different beer styles), which is compared with results from targeted instrumental analysis and sensory evaluation. Further, identification of metabolites that evidently distinguished beers within the sample set is described.

Short biography

Laura Knoke graduated from Technical University Berlin (Germany) with Diplom-Ingenieur (graduate engineer) in biotechnology in 2016. She is now a research associate at the Department for Special Analysis at the Research and Teaching Institute for Brewing in Berlin (VLB). Laura's scientific work is focused on the development of an untargeted metabolomics workflow and its application to brewing related topics.

P007 - SENSORIAL AND ANALYTICAL CHARACTERIZATION OF THE NEW HÜLLER "SPECIAL FLAVOUR HOPS

Klaus Kammhuber[1]

1 - Bavarian Hop Research Center

Abstract

Craft Brewers want hop varieties with unusual flavors, such as fruity, citrusy and floral aroma notes. The hop research center in Hüll has responded to this trend and has approved six new hop varieties in the recent years, which correspond to these properties.

These are Mandarina Bavaria, Hallertau Blanc, Huell Melon, Polaris, Callista and Ariana. In the presentation, the sensorial properties and a detailed presentation of the analysis data will be presented. In addition to the routine determination of the bitter substances by HPLC, Wöllmer analyzes were also carried out to determine the unspecific soft and hard resins for getting statements about the bitter quality.

The aroma substances of the new Hüller varieties are compared with the variety Cascade, as this variety is a standard for the Craftbrewers. Sensory-important sulfur compounds such as 4-mercapto-4-methyl-pentanone, 3-mercaptohexanol and 3-mercaptohexyl acetate are also detectable in the new Hüller cultivars.
Extensive biogenesis studies on the oils have also been made, and it has been found that the total oil content and the composition are highly depending on the harvest date. Sulfur compounds increase strongly only at late harvest dates. Hot and dry years even increase the oil content.

Finally, the total polyphenol content was determined according to EBC 7.14 and individual polyphenols such as quercetin and kaempferiol by HPLC. This extensive analytical presentation is certainly very helpful for the brewers to orient themselves in the selection of their hop varieties.

Short biography

born 26.3.1962 in Bad Reichenhall (Bavaria)

1983 - 1990 study of chemistry at the University of Regensburg

1990 Ph.D. in organic chemistry

1991 starting at the Bavarian hop Research Center in Hüll

since 1998 head of the department hop chemistry at the Institute in Hüll

Special interrests in aroma compounds and polyphenols

P008 - COMPREHENSIVE ANALYSIS OF POLYFUNCTIONAL THIOLS IN A NEW FLAVOR HOP MOSAIC BY THIOL-SPECIFIC EXTRACTION WITH SELECTABLE 1D/2D/3D GC-SCD/Q-TOF-MS.

Koji Takazumi[2]; Kikuo Sasamoto[1]; Nobuo Ochiai[1]; Takeshi Kaneko[2]; Yoichi Tsuchiya[2]

1 - GERSTEL K.K.; 2 - Frontier Laboratories for Value Creation, SAPPORO HOLDINGS LTD.

Abstract

Mosaic is a new variety of flavor hop. Beer brewed with Mosaic has citrus, tropical, floral, and ripe fruit aroma. Recent studies have revealed that polyfunctional thiols are important compounds for hop-derived characteristic aroma. Herein we investigated polyfunctional thiols in Mosaic by thiol-specific extraction with selectable 1D/2D/3D GC-SCD/Q-TOF-MS. Comparative analysis by GC x GC-SCD with typical flavor hops like Citra and Nelson Sauvin, revealed that Mosaic contained more thiols than these flavor hops. We tried to identify thiols in Mosaic by using 3D GC-Q-TOF-MS; 11 compounds were identified, some of which were identified for the first time from hop. The contents of thiols and other hop aroma compounds in test beer brewed with Mosaic were analyzed, and a recombination test and an omission test

were conducted. The results revealed that polyfunctional thiols are very important for the characteristic aroma of beer brewed with Mosaic.

Short biography

Koji Takazumi received an M.S. degree from the Department of Agriculture, Hokkaido University. He began employment with Sapporo Breweries, Ltd. in 2002 as an analytical chemist in the Frontier Laboratories for value creation. His current research focuses on hop-derived flavor compounds.

P009 - UNIQUE VARIETAL AROMA OF THE 'SORACHI ACE' HOP ~EFFECTS OF THE COEXISTENCE OF GERANIC ACID AND OTHER HOP-DERIVED COMPOUNDS ON THE VARIETAL AROMAS~

Ayako Sanekata[1]; Atsushi Tanigawa[2]; Kiyoshi Takoi[2]; Mitsuhiro Uemoto[3]; Takeshi Kaneko[1]; Youichi Tsuchiya[1]

1 - Frontier Laboratories of Value Creation, SAPPORO BREWERIES LTD.; 2 - Product & Technology Innovation Department, SAPPORO BREWERIES LTD.; 3 - Bioresources Research & Development Department, SAPPORO BREWERIES LTD.

Abstract

Hops are an important natural ingredient of beer, contributing not only to its bitterness but also to its flavour. In recent years, beer/hop researchers have shown great interest in the new varieties of hops, which have different characteristic flavours and are bred and grown worldwide. Amongst those new varieties, many craft brewers are interested in 'SORACHI ACE' hop, which was bred by SAPPORO BREWERIES LTD. originally about 35 years ago. This hop imparts a variety-specific flavour, such as woody, pine-like, citrus, dill-like and lemongrass-like, to the finished beers. However, the flavour compounds that contribute to its characteristic aroma have not been sufficiently investigated. In this direction, we have investigated the specific flavour compounds derived from 'SORACHI ACE' hop.

In WBC 2016 and EBC 36th Congress, we showed that 'geranic acid' is an important contributor to the varietal aroma of 'SORACHI ACE' hop. Furthermore we have also revealed that the coexistence of 'geranic acid' and the other hop-derived flavour compounds could form very characteristic varietal aroma of the 'SORACHI ACE' hop.

In this study, we have investigated the different compositions of the characteristic flavour compounds depending on the difference of the picking days and/or the production areas/countries of the 'SORACHI ACE' hop and others.

Short biography

Ayako Sanekata graduated from Kyushu University with a Master's degree in Bioresource and Bioenvironmental Sciences in 2004. In 2010, she joined Frontier Laboratories of Value Creation

of SAPPORO BREWERIES LTD. Since 2016 she is working at Frontier Laboratories for Value Creation of SAPPORO HOLDINGS.LTD. She has been engaged in chemical analysis related to quality assurance and study of the analysis of flavour components.

P010 - WHICH HOP VARIETY FOR A BETTER FLAVOUR AND COLLOIDAL STABILITY OF DRY-HOPPED BEERS: EVIDENCE OF THE KEY-ROLE OF MINOR FLAVAN-3-OLS

Carlos Silva Ferreira[1]; Cécile Chenot[1]; Sonia Collin[1]

1 - Université catholique de Louvain

Abstract

In dry-hopped beers, hop can be responsible for more than 30% of beer polyphenols. Flavan-3-ols can affect beer bitterness and astringency, and oxidation products of these compounds are responsible for the increase of color and haze in aged beers. Among them, (-)-epicatechin and its oxidized oligomers, which come exclusively from hops, are suspected to be involved in colloidal instability while quinones are responsible of polyfunctional thiol scavenging.

The aim of the present work was to investigate flavan-3-ols in fresh Belgian dry-hopped beers, according to the hop variety used, and to follow them through beer ageing. Polyphenols were analyzed by conventional global methods and by NP- and RP-HPLC-ESI(-)-MS/MS.

Total polyphenols showed strong variation among the samples (80 to 360 mg/L) while total flavanoids were always close to 50 mg/L. As for non-dry-hopped beers, (+)-catechin was identified as the main monomer (up to 6 mg/L), but hop (-)-epicatechin was also quantified at significant levels. Although procyanidin B3 emerged as the most abundant dimer (up to 7.7 mg/L), B2 and some derived procyanidins, issued from hop, were also evidenced. In the same way, procyanidin C2 emerged as the main trimer in all beers, but its isomer C1 revealed to be a hop variety-dependent constituent of dry-hopped beer. Our data allow for the first time to link colloidal stability, astringency and polyfunctional thiol stability of dry-hopped beers to the flavan-3-ol distribution of the hop cultivar.

Short biography

Carlos is an assistant at the Faculty of bioscience engineering of the UCL, where he teaches at the Advanced master in brewing engineering and does his PhD at the Brewing department of the same university under the promotion of the Professor Sonia Collin. He has been researching the dry hopping process and, more specifically its molecular impact on beer bitterness, aroma and polyphenols. He is a food engineer graduated at the Federal University of Viçosa (Brazil) and brewery science has been the focus of his studies since 2013.

P011 - MYCOBIOME IN MODERN BREWERIES

Riikka Juvonen[1]; Elina Sohlberg[1]; Laitila Arja[1]; Hovi Marjaana[2]; Riitta Saleva-Sjöblom[2]; Maija-Liina Vehviläinen[2]; Kaisa Tapani[2]; Tuija Sarlin[1]

1 - VTT Technical Research Centre of Finland Ltd; 2 - PBL Brewing Laboratory

Abstract

Fungi are major spoilage organisms in the beverage industry. However, recent studies about the composition of fungal communities in breweries are scarce despite of the recognized need to understand possible impacts of the increased product diversification on microbial ecology in this environment. This study explored fungal microbiome in four breweries producing various alcoholic and non-alcoholic products. In addition to culture-dependent identification, next generation sequencing (NGS) was applied for the first time for direct analysis of fungal communities in breweries. More than 100 fungi were identified from QC samples taken from air, raw materials, process surfaces and products. Sequencing revealed 39 yeast species among the isolates. The most common genera were *Wickerhamomyces*, *Saccharomyces*, *Candida* and *Pichia*. Differences in the species diversity between the products were found. *W. anomalus* was widely distributed in the samples, whereas *S. cerevisiae* was linked with alcoholic products and *Zygosaccharomyces* and *Dekkera* with soft drink production. Most of the yeast isolates grew in beer, indicating their potential as spoilers. A wide range of growth patterns was observed in soft drinks. NGS analysis of the key contamination sites in the filling lines revealed that fungal communities were largely composed of ascomycetes fungi. *Saccharomyces* and *Candida* dominated during the filling of alcoholic products. Higher species complexity was found on the surfaces when non-alcoholic products were filled. Overall NGS revealed higher fungal diversity in breweries than previously reported. However, the main microbial groups earlier found in the beverage industry were the same. Practical relevance of the results will be discussed.

Short biography

PhD, Senior Scientist. Microbiologist with more than 15 years of experience in characterization and management of microbiota in industrial and natural environments, especially in beer brewing. Her recent research activities also include utilization of lactic acid bacteria as cell factories for modifying texture, flavor and nutritional properties of plant materials and side streams. She has been a partner and a project leader in numerous publicly funded and industry driven projects. Supervisor of Master´s and PhD theses.

P012 - EFFECT OF HOP VARIETIES ON BEER AROMA DURING DRY HOPPING

Nathalie Brignier[1]; Damien Steyer[1]; Céline Clayeux[1]; Christophe Marcic[2]; Francis Heitz[3]; Antoine Wuchner[3]; Bernadette Laugel[3]

1 - TWISTAROMA; 2 - Faculté de Pharmacie de Strasbourg; 3 - Comptoir Agricole

Abstract

In recent years, the dry hopping technique was developed to produce unique beers by revealing all the aromatic potential of hops. The aim of this study was to investigate the impact of exposure time during dry hopping (4, 8 and 12 days) and hop varieties (Aramis, Barbe Rouge and Mistral) on the sensory properties and volatile compounds of dry-hopped lagers. Volatile

compounds were followed from the raw material (by SPME) to the final beer by SBSE-TD-GC-MS for 4, 8 and 12 days exposure time, then beers were tasted by sensorial analysis. All the data were statistically analysed and showed that exposure time has a minor influence whereas hop varieties modify the concentration and the chemical diversity of the volatile compounds in beer. Sensory ranking tests of beers revealed that these 3 hops are different and have unique aromatic signatures.

Short biography

Damien Steyer, engineer in Biotechnology (ESBS, Strasbourg, France), PhD in Biochemistry, CEO of TWISTAROMA. To complete his doctoral work at INRA (Colmar, France) on the influence of yeast strains on wine aroma, he developed a technique that assess flavour profiles of wine and beer. This technique combined with his expertise and knowledges of flavors, allowed him to create TWISTAROMA in 2011. This company offers innovative techniques for compounds analysis (antioxidants, volatiles, vitamins…) for food industry.

P014 - EVALUATION OF WATER AND ETHANOL EXTRACTS OF LEMON VERBENA, SAGE, CINNAMON AND HIBISCUS IN THE AROMATIC AND ORGANOLEPTIC PROFILE OF BEER

Avgoustinos Evripiotis[1]; Panagiotis Tataridis[1]

1 - Department of Wine, Vine & Beverage Sciences, University of West Attica, Ag. Spyridonos str., 12243 Egaleo, Greece

Abstract

The expansion of the craft beer market has led the brewers to continuously try to create new types of beers with special organoleptic characteristics. Herbs and spices were always used in the brewing process to enhance the flavors and the aromas of the final product. In this study, four different kinds of herbs and spices and their water and alcohol extracts were analyzed. These are: Aloysia citrodora, Salvia officinalis, Hibiscus sabdariffa and Cinnamomum cassia. Using a GC-MS SPME method, the aromatic compounds of the previous samples were identified and semi-quantified. The results were assorted into basic aromatic groups and compared to show the differences between the two extraction methods. A tasting panel graded and evaluated the previous samples based on their aroma and flavor intensity of each aromatic group as well as their addition to commercial beer at five different concentrations for each extract. The results from the sensory evaluation show the preferences of the tasting panel for each extraction method and the preferred concentration in the final product. For Aloysia citrodora, beer with alcohol extract with a concentration of 2g/L of herb in the final beer was rated higher. For Salvia officinalis, it was beer with water extract of 3.5g/L. For Cinnamomum cassia, both methods had similar ratings with the preferred concentrations of water extraction of 3.5g/L and alcohol extraction of 2g/L. For Hibiscus sabdariffa, both methods had similar ratings and the chosen concentration was 3.5g/L. This methodology is a useful tool for evaluating the addition of botanicals in beer.

Short biography

Avgoustinos Evripiotis graduated in 2015 with a B.sc. in Physics from National and Kapodistrian University of Athens. In 2017, he obtained his M. Sc. degree in Brewing Science from the department of Wine, Vine & Beverage Sciences of the University of West

Attica. During his master degree, he did an Erasmus internship in KU Leuven in the Faculty of Engineering Technology under the supervision of Prof. Filip Van Opstaele in “Aromatic compound analysis of different distillation methods with Juniper berries”. He is a passionate homebrewer since 2009 and a founding member of the Hellenic Homebrewer Association. In 2018 he is opening his own craft brewery in Athens, Greece.

P015 - BENEFITS OF BLEND-HOPPING WITH CASCADE, CENTENNIAL, AND CHINOOK DURING DRY-HOPPING

Scott Lafontaine[1]; Thomas Shellhammer[1]

1 - Oregon State University, Food Science and Technology

Abstract

Cascade, Chinook, and Centennial are hop varieties with distinct aromatic characteristics of American hops and they are used extensively for dry-hopping either singly and/or in blends to impart intense hoppy aroma to beer. A sensory directed dry-hopping mixture study was performed to understand the aroma contribution that each of these hop varieties make to beer aroma. Utilizing a 4th-degree simplex-lattice mixture-design sixteen beers were prepared(including an unhopped control) by dry-hopping a common unhopped base beer with a uniform mass of different blends of ground whole cone hops from the three cultivars. The treatments were evaluated by trained panelists using descriptive analysis, where the response variables encompassed the sensory attributes describing unique aromatic features of the three hops (i.e. citrus, tropical/fruity, tropical/catty, and herbal). Blends of hops created more intense aromatic impressions and had higher concentrations of hop volatiles than single hop treatments. Statistical groupings of blends were identified that had similar aromatic properties. The results can be used to select combinations or blends of the three hops for use during dry-hopping that provide similar or dissimilar overall aroma in dry-hopped beer.

Short biography

Dr. Shellhammer is the Nor'Wester Endowed Professor of Fermentation Science in the Department of Food Science and Technology at Oregon State University where he leads the brewing science education and research programs. His brewing research investigates hops, beer quality and the origins of hop aroma and flavor in beer. He is a former President of the American Society of Brewing Chemists, the former President of the District NW Master Brewers Association of the Americas, and currently serves on the Board of Examiners of the Institute of Brewing and Distilling. He is a Fellow of the Insitute of Brewing and Distilling and the Institute of Food Technologists. Dr. Shellhammer received his Ph.D. from the University of California, Davis in1996.

P016 - DRY HOPPING POTENTIAL OF EUREKA!, A NEW HOP VARIETY.

Christina Schmidt[1]; Martin Biendl[1]; Klaas Reglitz[2]; Martin Steinhaus[2]; Stefan Hanke[3]

1 - Hopsteiner - HHV; 2 - Leibniz-Institute for Food Systems Biology at the Technical University of Munich; 3 - Bitburger Braugruppe

Abstract
The new hop variety Eureka! offers resinous and fruity notes ranging all the way from tropical-citrus to dark stone fruit. Eureka! has a high total hop oil content with up to 4 ml/100 g, a high amount of black currant-like smelling hop odorant 4-mercapto-4-methylpentan-2-one (4-MMP) as well as a high content of bitter components. To evaluate the dry hopping potential, brewing trials were carried out in a 20 hl pilot plant. Dry hopping was performed for 1, 2, 4 and 8 days. Beers were analyzed using published methods to monitor the transfer of 4-MMP (GC×GC-TOFMS), selected hop aroma compounds (EBC 9.49) and hop derived bitter substances (EBC 9.47). Major transfer of 4-MMP and the aroma compounds myrcene, linalool, geraniol, and 2-methylbutyl isobutanoate happened during the first two days. Only slight further increase between days 2 and 8 was observed. The same behavior could be found for the bitter components alpha-acids and humulinones, whereas xanthohumol increased until day 4. In addition to analytics, sensory evaluations were carried out with help of quantitative descriptive analysis. The beers with 1 and 2 days of dry hopping were characterized as black currant-like, fruity and citrusy whereas the beers with 4 and 8 days were assessed more herbal and spicy and less citrusy and fruity. The received findings suggest a hop contact time of 2 days of dry hopping to achieve an efficient transfer especially with focus on black currant-like aroma in beer.

Short biography
Christina Schmidt studied food chemistry at the Technical University of Munich (2001-2006) and received then her government-recognized exam at the Bavarian Health and Food Safety Authority in 2007. After her doctoral studies at the Chair of Food Chemistry and Molecular Sensory Science (2007-2010) of the TUM, she served for the Bitburger Brewery in the research and development department. In May 2012 she started working for Hopsteiner as senior research scientist in special analytics and sensory science.

P017 - A NOVEL TECHNIQUE FOR ASSESSING ENERGY AND UTILITY CONSUMPTION IN BREWING

Sebastian Schmid[1]; Karl Glas[1]; Thomas Hofmann[1]

1 - Technical University of Munich, Chair of Food Chemistry and Molecular Sensory Science, 85354 Freising, Germany

Abstract
Energy (e.g. electricity, fossil fuels) and utilities (e.g. compressed air) have become important cost factors in the brewing industry. In Germany, breweries must reconcile with energy prices ranging amongst the highest in Europe within a shifting energy market (German Energy Transition). To benefit from subsidies that German authorities provide through initiatives to increase energy-efficiency in the industry, companies have to report on the performance of efficiency measures.

In order to meet the increasing burden of information required of this reporting, we propose an integrated approach to quantify energy and utility (E&U) consumption in a brewery at various levels (cf. ANSI/ISA-88). The concept is designed to be minimally invasive and highly flexible with a simple setup of distributed meters enabling recurring measurements (e.g. EN 16247-1).
Metering of thermal energy, electricity and compressed air is realized using clamp-on ultrasonic flowmeters, a multi-channel branch circuit monitoring device and inline thermal flowmeters, respectively. Meters are connected to a programmable logic controller (PLC), thus enabling measurement of E&U consumption in relation to equipment and recipe parameters. Linking metering and PLC data, integrated load profiles for each process action (e.g. heating) at the unit-level (e.g. mash tun) are derived. Thus, an E&U fingerprint can be assigned to each piece of equipment at varying operating modes. Results suggest that forecasting of E&U demand based on the integrated load profiles is feasible for the process cell-level (e.g. brewhouse) while the number of meters required may be significantly reduced. Moreover, in-house E&U distribution may be assessed using our approach.

Short biography
Sebastian Schmid is a research assistant (supervisors: Prof. Dr. Thomas Hofmann and Dr.-Ing. Karl Glas) at the Chair of Food Chemistry and Molecular Sensory Science, Technical University of Munich, Freising since 2013. He holds a university diploma of engineering in brewing science and beverage technology. His research interest is on energy supply and utility management in the food and beverage industry. Sebastian is experienced in managing research projects as well as proposal writing and enjoys teaching students. In 2012 he received the Barth-Haas Grant “Comparison of different dry hopping techniques” (Barth Haas Group, Nuremberg) for his thesis. From 2003–2006 he was an undergraduate student in economics at the Ludwig-Maximilians-University of Munich. When off-duty Sebastian enjoys yoga and, from time to time, working at a renowned craft beer store in Munich.

P018 - THE RAPID VISCO ANALYSER AS A RHEOLOGICAL TOOL TO DETERMINE THE POTENTIAL BREWING QUALITY OF BARLEY AND MALT

Bruno Godin[1]; De Smedt Corto[2]; Deneyer Valentine[1]; Pietercelie Anne[2]; Sinnaeve Georges[1]

1 - Walloon Agricultural Research Center - CRA-W. Chaussée de Namur, 24. B-5030 Gembloux, Belgium; 2 - Institut Meurice - HELDB. Avenue Emile Gryzon, 1. B-1070 Brussels, Belgium

Abstract

To meet expectations of brewer and microbrewers promoting local and craft production of barley and malt, it is necessary to have a fast and efficient tool to easily determine their potential brewing quality.

It was with this in mind that the application of the Rapid Visco Analyzer (RVA), a rheological tool which is commonly used to determine pre-harvest sprouting and pasting properties of starch in cereals (mostly wheat) was evaluated.

34 barleys were harvested in 2017 in Belgium. They were selected for their high degree of diversity: several varieties, various pedoclimates and different cropping methods. Samples were analyzed in terms of germination rates, screening, protein, Hagberg falling number and RVA. Their corresponding malts (malted under same standard conditions at VLB facilities) were evaluated for usual brewing parameters (extract yield, viscosity, etc…).

The RVA measurements were performed under both autolytic and enzyme-inhibited conditions on barley (Malting Barley Method from Perten) and adapted for malt to have higher degree of viscosity and clearer viscograms (Adapted Kilned Malt Method from Perten).

Results showed a strong multivariate relationship between RVA data and barley quality parameters like pre-germination of the grain. Concerning malts, friability, yield extract and wort viscosity also presented clear correlations with RVA values.

It could be very helpful for maltsters so as brewers to have rapid and reliable prediction of barley and/or malt quality and RVA analysis, already used in cereal industry, is a new way to meet these requirements. This would also be useful for craft malting plants and breweries.

Short biography

Bruno Godin is a researcher at the head of the cereal technology laboratory of the Walloon Agricultural Research Center (CRA-W). He graduated of his life sciences master from the University of Agricultural sciences of Gembloux. He has obtained his PhD degree of Agricultural sciences and biotechnology from the catholic University of Louvain (UCL). He is the author of several scientific articles about agro-resources characterization and their suitability to be converted.

P019 - INFLUENCE OF PASTEURIZATION ON DRY HOPPED BEERS

Frank Peifer[1]; Sandro Cocuzza[1]; Willi Mitter[1]

1 - Hopsteiner

Abstract

Dry hopping primarily imparts an intense hop aroma to beer, mainly due to highly volatile components which are usually lost during wort boiling. It is known, that such an aroma changes from the first hours after hop dosage to green beer until it is served to the customers. In order to investigate the influence of pasteurization on the hop aroma, several dry hopped beers were produced and analysed according to main bitter and aroma substances using HPLC, BU and GC-MS methods. It could be demonstrated, that pasteurization of dry hopped beer significantly lowers the concentration of certain aroma substances, such as Myrcene. On the other hand, aroma compounds like Linalool or Geraniol showed no change at all, Terpineol and Citronellol tended to a slight reduction. For all analysed bitter acids, no impact of a thermal treatment within pasteurization units of 40 to 60 was investigated.

As further changes in aroma will occur during storage of beer in the package, this “reduction” of hydrocarbons such as Myrcene in the bottle might help improve the flavour stability of the packaged beer. However, this loss of aroma must be considered when using pasteurization for dry hopped beers.

Short biography

Frank Peifer is the Technical Director for Europe at Simon H. Steiner, Hopfen, GmbH.

He is responsible for the technical support to breweries and brewing groups with national and international operations. Additionally, he works on hop-related F&E-projects and in the product development as well. The optimization of hop-processing is also a part of his duties.

Frank started his brewing career with an apprenticeship and practical experiences at the König-Brauerei in Duisburg in 1985. From 1989 to 1995 he studied brewing-science in Weihenstephan and finished with the graduation as a Dipl.- Ing.

During the following 19 years Frank was deeply involved in brewing traditional beers at the Bayerische Staatsbrauerei Weihenstephan. In his role as brewmaster and later as the Technical Director, he was in a tight contact with all brewing-institutions and brewing-specialists in Weihenstephan.

In 2015 Frank was looking for a new challenge and found his home at “Hopsteiner“, in Mainburg.

P020 - FACTORS AFFECTING HUMULINONE FORMATION IN HOPS

Philip Wietstock[1]; Keil Franziska[1]; Methner Frank-Jürgen[1]

1 - Technische Universität Berlin

Abstract

Humulinones are a constituent of hops which have a bitter value of 0.66 as compared to iso-α-acids. They are more soluble than α-acids, and are thus readily dissolving almost completely in beer during dry-hopping. The level of humulinones in hops and hop products therefore directly affects the bitterness perception of the beer produced thereof. Objective of this study was to study factors affecting humulinone formation in hops during hop processing and storage.

Eight hop varieties (HHA, HHE, HHT, HHS, HPE, HTU, HHM, HHS, crop 2017) from which two of them were from two different farms from the Hallertau region were used in this study. Hop acids, hop volatiles, and metal ion concentrations were quantified in unbaled raw hops by LC-UV/VIS, SAFE-GC/MS, or ICP-OES, respectively. Hops were ground in liquid nitrogen, then pressed into tablets, were vacuum-sealed, and stored for 4 weeks at 20 °C in the dark. All data were ultimately correlated using XLSTAT software.

Humulinone concentration ranged from 0.03 % to 0.16 % in unbaled raw hops and 0.14-0.46 % in pressed and stored hop samples. After pressing and 4-week storage, humulinone concentration increased by 182-507 %. While total humulinone concentration in raw and stored hops correlated positively with α-acid concentration, the % humulinone per % α-acid formed correlated negatively with α-acid concentration. Consequently, it appears that humulinones per % α-acid formed are higher the less α-acid is contained in the hops. Further results will also be presented, and a correlation of analytical parameters with humulinone formation will be discussed. This study features new insights into factors affecting humulinone formation in hops.

Short biography

Philip Wietstock is a post-doc at the Technische Universität Berlin, Germany. After graduating his biotechnology studies with qualification as a Dipl.-Ing. at the Technische Universität Berlin (2009), he was working for one year as a researcher at the Department of Food Science and Technology at the Oregon State University, Corvallis, USA. In 2011, he transferred to the Technische Universität Berlin where he finished his dissertation thesis in 02/2017.

P021 - ARABINOXYLAN AND B-GLUCAN IN BARLEY ENDOSPERM CELL WALLS: MICROSTRUCTURE ANALYSIS USING CLSM AND CRYO-SEM

Niels A. Langenaeken[1]; Pieter Ieven[1]; Erik G. Hedlund[2]; Clare Kyomugasho[3]; David De Schutter[4]; Davy Van De Walle[5]; Koen Dewettinck[5]; Ann Van Loey[3]; Maarten B.J. Roeffaers[2]; Christophe M. Courtin[6]

1 - Laboratory of Food Chemistry and Biochemistry and Leuven Food Science and Nutrition Research Centre (LFoRCe), KU Leuven, Kasteelpark Arenberg 20, 3001 Leuven, Belgium; 2 - Centre for Surface Chemistry and Catalysis, KU Leuven, Leuven, 3001 Belgium; 3 - Laboratory of Food Technology, Leuven Food Science and Nutrition Research Center (LFoRCe), Department of Microbial and Molecular Systems (M2S), KU Leuven, Kasteelpark Arenberg 22, 3001 Heverlee, Belgium; 4 - Fund Baillet-Latour, Brouwerijplein 1, 3000 Leuven, Belgium; 5 - Laboratory of Food Technology and Engineering, Department of Food Technology, Safety and Health, Ghent University, Coupure Links 653, 9000 Ghent, Belgium; 6 - Laboratory of Food Chemistry and Biochemistry and Leuven Food Science and Nutrition Research Centre (LFoRCe), KU Leuven, Kasteelpark Arenberg 20, 3001 Leuven, Belgium.

Abstract

The malting and brewing performance of barley depends largely on the degradation of the endosperm cell walls that separate amylolytic enzymes from their substrate. Because of the abundance of mixed linkage β-glucan (BG), the architecture of barley endosperm cell walls is remarkably different from other grass species. Cell walls had an average thickness of 0.59 ± 0.22 µm as estimated by cryo-SEM analysis of barley seeds. After malting, surprisingly, quite extensive cell wall remnants were observed with a thickness of 0.26 ± 0.13 µm. Sections of perpendicularly cut cell walls showed the presence of fibers with diameters ranging from 27 to 73 nm. After fluorescent staining of arabinoxylan (AX), BG and pectin within embedded samples, 3D confocal multiphoton microscopy imaging revealed the complex cell wall

architecture. AX is mostly present in the primary cell wall with perpendicular structures reaching into the secondary cell wall that is mainly composed of BG. Pectin are present at the interface of the middle lamella. During malting, AX and BG are degraded, but unlike BG, AX remains present in defined cell walls in malt. Integrating the results, a new model for the endosperm cell walls in barley is proposed. It emphasizes the close interactions of AX and BG on a nanometer scale.

Short biography

Niels Langenaeken is a third-year PhD candidate at the KU Leuven Laboratory of Food Chemistry and Biochemistry. After he graduated as a Bio-Science Engineer in 2015, he was awarded the 21st scholarship of the Baillet-Latour Fund to start his PhD. His research focusses on the mobilization of non-starch carbohydrates in beer making to improve brew-house yield on one hand and to assess the impact hereof on quality parameters on the other hand. He is co-founder of Brouwerij Polygoon, a small scale beer company with a yearly production of 50 hL.

P022 - BREWING YEAST STRAIN DIFFERENTIATION: PRACTICAL RESULTS AND COMPARISON OF GENOTYPE AND PHENOTYPE BASED TECHNIQUES

Marta Orive Camprubí[1]; Núria Feliu Besora[1]; Jaume Lluís Tartera[1]; Benet Fité Luís[1]

1 - Mahou-San Miguel

Abstract

Yeast strain provides beer with specific flavour notes. In our brewing yeast strain bank there is a need to ensure the supply of the proper yeast strain to the final users in the breweries that guaranty flavour consistency of the resulting beer.

For many decades, genotype analyses have been the preferred system by brewing microbiologists for strain differentiation and fingerprinting. Genotype was supposed to be independent from growing environmental conditions while phenotype techniques were not. Usually, results from phenotype analyses were not repetitive and therefore were considered not robust enough.

For the last years, the phenotype based technique MALDI-TOF provides a new opportunity for strain differentiation. Even though results may vary with the environmental conditions of growth, some brewery labs already prefer and/or offer this service for differentiation of brewing yeast species and strains.

Mahou-San Miguel, have both ale and lager yeasts strains in the yeast bank which are sent out to our breweries and licensees, most of them being lager, and therefore, very closely related strains. Analysis to differentiate them have been done by means of different techniques.

In the present poster, results for strains processed through several genotype based techniques such as microsatellites, karyotyping, Interdelta, … are shown. Additionally strains have been analysed by MALDI TOF and the results have been compared with genotype available data.

Discussions and conclusions on the application of the tested differentiation techniques are presented.

Short biography

Biology at Universidad de Barcelona, 1982, MSc. Brewing and Distilling at Heriot-Watt, Edingurgh, 2012.

Working in the brewing industry since 1984. Since October 2016 Head of Microbiology Central Lab, in charge of yeast strain improvement plans, of new method development for yeast evaluation, identification and of rapid microbiology methods for beer, water and soft drinks and plant hygiene.

From 1996 to 2012, member of EBC Subcommittee for Microbiology and since 2013, member of the Steering group of EBC Analysis Committee.

P023 - UNEXPECTED RESULTS IN ALE YEAST DNA FINGERPRINTING

Nuria Feliu-Besora[1]; Marta Orive-Camprubí[1]; Jaume Lluís Tartera[1]; Benet Fité Luis[1]

1 - Mahou S.A

Abstract

Ale yeasts strains tend to present significant differences in brewing properties.

In some breweries, as microbreweries, It is usual to use several different yeast strains in a very short time frame, and it is very important to have good manufacturing practices to prevent cross contamination between yeast strains in order to avoid non-expected end products.

Nevertheless, some accidental mixtures may occur and a question arouses of which strain has been pitched in fermentation and/or whether a cross contamination with the previous strain has happened. Having a tool to verify that the desired yeast is present in each beer could be very useful in troubleshooting studies.

DNA fingerprinting is a very well established tool for yeast strain differentiation and we consider that it could also be very useful tool to study such cases of accidental mixtures.

In this poster, several ale brewer's yeasts strains from different yeast collections and suppliers have been analysed by DNA fingerprinting in order to be characterized.

The first step is to characterize each strain by their band patterns and next, to compare and check if the different strains in the group can be clearly differentiated by their specific band patterns.

As expected, the studied ale yeast strains have shown clear differences in the DNA fingerprints between them. However, surprisingly, while some strains have shown a unique simple band pattern, other strains have shown multiple fingerprinting profiles, although they were considered to be pure.

Finally, potential applications for quality evaluation and troubleshooting are discussed.

Short biography

Food Technology and Technical Agricultural Engineer at University of Lleida (1998-2004). MSc in Brewing Science at University of Nottingham (2012-2015)

Working in the brewery industry in Mahou San Miguel from 2004. Firstly, as Applied Research Microbiologist in the R&D department and from October 2016 as specialist in microbiology central lab. Areas of expertise: yeast evaluation, management of the yeast storage bank of the company, validation of rapid microbiology methods for spoiler detection in beer, beer mixes and soft drinks, development of new products, quality control during process and end products, coordination of microbiology sampling plans of multiple brewery sites.

P024 - BEEROMICS FROM MALT AND MASHING TO BEER

Ida Kallehauge Nielsen[1]; Jørn Smedsgaard[1]; Timothy Hobley[1]

1 - Technical University of Denmark

Abstract

The different 'omes' of beer and brewing process steps have been studied to some extent. However, they are often screening type studies focusing on improving quality control in the beer. The different 'omes' are usually not combined to give a holistic overview of the whole process or to provide predictive power to control the process. In this presentation, we discuss our work to develop a robust package of 'omic' tools that are complementary and applicable to the brewing process from mashing to the final product. The origin and fate of desired and undesired compounds and relevant chemical processes is examined. The overall goal is to guide the brewmaster's decision-making during brewing.

P025 - NORWEGIAN PRODUCTION OF MALTING BARLEY AND HOPS

Mette Goul Thomsen[1]; Mauritz Aassveen[1]; Ragnar Eltun[1]

1 - NIBIO

Abstract

In Norway, there has been a rapid development in production of beer with special qualities, and the demand for Norwegian raw material – malt, hops and herbs – are increasing. In the present project, we found that we could produce malt and hops with good quality in Norway. However, two-row barley varieties can only be grown in South-eastern -and Mid-Norway. In areas with shorter growing season one depend on six-row varieties with grain size and size distribution, less favourable for malting. In old varieties, special challenges tied to long and

weak straw may lead to lodging and reduced grain quality. Our study also showed large yearly variation in yield and malt quality under Norwegian weather conditions.

Also for hops we found, large differences between both varieties as well as cropping methods and years in yield and quality. In plastic tunnels yield was two - three times higher than in traditional cropping systems. In a multiple analyses, we found that the factors length of longest primary shoot, clone and cropping method together explained 82% of the variation in cone yield. Increased yield in plastic tunnels may partly be due to increased degree-days as well as measures like irrigation from nozzles in the tunnel roof reducing infestation by powdery mildew. Content of α-acid, essential oils and aroma profile were analysed/described for the Norwegian hops in the project.

Short biography

Dr. Mette Goul Thomsen is a Researcher at Norwegian Institute of Bioeconomy Research. She has a PhD in plant biology and weed management in organic farming systems. For the last four years she has completed a number of studies on cultivation and quality of Norwegian hops. She has also worked with quality in malt and adaptation of the malting process to increase malt yield from barley produced in the Northern region.

P026 - ION MOBILITY SPECTROMETRY BASED HEADSPACE DETECTION OF VOLATILE ORGANIC COMPOUNDS PRODUCED BY MOLD FUNGI

Alexander Erler[1]; Daniel Riebe[1]; Toralf Beitz[1]; Hans-Gerd Löhmannsröben[1]; Thomas Kunz[2]; Daniela Grothusheitkamp[2]; Frank-Jürgen Methner[2]

1 - University of Potsdam; 2 - Technical University Berlin

Abstract

Mold fungi such as Fusarium, Alternaria, Aspergillus and Penicillium on malting barley cause major economic losses in malting and brewery facilities. Possible proxies for the detection are their (semi)volatile metabolites. For a confident detection in varying surroundings, characteristic marker compounds or patterns have to be found. The search for these substances was performed by headspace-gas chromatography (GC)-mass spectrometry (MS) investigations using two different ionization sources, a conventional electron ionization (EI) source and a new atmospheric pressure chemical ionization (APCI) source based on soft X-radiation. These results where than transferred to ion mobility (IM) spectrometry using the same APCI source. The aim of this work was the development of a mobile detection method for the on-site detection of mold fungi in grain stores.

Volatile metabolites of four mold fungi on different agars and barley grain were investigated. In total, 79 metabolites were found by the combination of EI/APCI-MS, 72 metabolites were detected by APCI-MS and 66 metabolites were found in APCI-IM spectrometry. These metabolites belong to different substance classes, such as substituted aromatics, terpenes and sesquiterpenes. In addition to metabolites unspecific to the individual fungus species, characteristic patterns allowing the confident discrimination of different fungi genera and even

different species of one fungus genus were found. Despite the lower resolution of IM spectrometry in comparison to MS, most of the specific metabolites could be separated and detected in GC-APCI-IM spectrometry. Thus, APCI-IM spectrometry can potentially be used as a mobile monitoring method for the on-site detection and classification of mold fungi.

P027 - NON-INVASIVE ON-LINE MONITORING OF THE SECONDARY BOTTLE FERMENTATION PROCESS USING NEAR INFRARED SPECTROSCOPY

Manuel Zimmer[1]; Florian Conradi[1]; Patrick Wefing[1]; Jan Schneider[1]

1 - Institute of Food Technology NRW

Abstract

The process of bottle secondary fermentation of young beer is a traditional and yet still trendy process to produce wheat beer that is characterized by an outstanding sprightliness and diversity of aromas. As glass is transparent for near infrared (NIR) radiation, this non-invasive method can be used to monitor the fermentation process during bottle fermentation without the need to open the bottle. Providing parameters like Extract (E), degradation of fermentable sugars (FS), and Ethanol (A) by an on-line system would imply a great advantage. Additionally, the quality control before shipping can be eased.

Due to the ability of NIR spectroscopy to determine many parameter relevant for food and beverages, like E, A, FS, pH, and biomass, it is possible to use this method to monitor the fermentation process of beer, on-line.

A contactless NIR sensor head is used to record NIR reflectance data through the bottom of the bottle. At different points in the fermentation process, samples are taken and analyzed for E, A, FS, and biomass concentration to create reference data. This is done by density measurement, high performance liquid chromatography (HPLC), and gravimetrical biomass analysis. Using the reference data and multivariate data analysis, calibration models are created, which can be used to predict the values of importance for future (unknown) samples. The presentation will show the experimental setup and results for the accuracy of the applied methods created with partial least squares (PLS) regression analysis.

Short biography

Manuel Zimmer studied chemistry at the University of Kaiserslautern, Germany from 2007 until 2012. His dipolma thesis comprised spectroscopic work on peptides in gas phase using infrared spectroscopy. A position as doctoral student at the University of Kaiserslautern followed, comprising various applications of molecular spectroscopy. He acquired his Ph D in 2017 and worked as post doctorate until he accepted a position at the Institute of Food Technology NRW in Lemgo, Germany, in November 2017. In the current project, food and beverages in closed containers are investigated using near infrared spectroscopy.

P028 - PORTUGUESE WILD HOPS GENOTYPING BY HRMA OF A MINIMAL SNP SET

Julio Machado Junior[1]; Miguel Faria[1]; Ana Maria Barata[2]; Andreja Cerenak[3]; Miguel Ferreira[1]

1 - LAQV/REQUIMTE, Laboratório de Bromatologia e Hidrologia, Departamento de Ciências Químicas, Faculdade de Farmácia, Universidade do Porto, 4051-401 Porto, Portugal; 2 - Banco Português de Germoplasma Vegetal, Instituto Nacional de Investigação Agrária e Veterinária, Quinta de S. José, S. Pedro de Merelim, 4700-859 Braga, Portugal; 3 - Slovenian Institute of Hop Research and Brewing, Cesta Zalskega Tabora 2, Zalec 3310, Slovenia

Abstract

The search for new hop varieties (*Humulus lupulus* L.) is being encouraged by brewers creativity based on the high intraspecific variability of the plant with much differentiated wild populations. To attain the request for new hops wild specimens have been collected worldwide, including Portugal, that need to be characterized at several levels to exploit their full potential as putative commercial varieties.

In the present work 90 Portuguese populations of *H. lupulus* (maintained in the Portuguese Vegetal Germplasm Bank), were genotyped as well as 37 well-known commercial varieties (Slovenian Institute of Hop Research and Brewing). Additionally, representatives of 20 wild populations, collected in the same locals of the original collection, were included. Genotyping was performed by High Resolution Melting Analysis of 7 highly-variable SNP (Henning et al. BMC Res Notes (2015) 8:542).

A NJ tree showed that most of the 147 genotypes analyzed (ca. 73%) could be discriminated. These were distributed in three main clusters, one composed almost exclusively of Portuguese wild populations, demonstrating the genetic uniqueness of the germplasm. The two other included genotypes from different origins and a few wild populations, which can indicate cross pollination of wild genotypes and commercial varieties in local hop farms. Overall genetic variation expressed as mean pairwise distances was of 0.34 (base differences/site) for the entire set, 0.29 within the Portuguese hops and 0.36 in commercial varieties. Results confirmed the high intraspecific variability of the Portuguese germplasm as well as the efficiency of the 7 proposed markers in the intraspecific discrimination of hops.

Short biography

Miguel Faria owns a PhD in Nutrition and Food Chemistry, University of Porto, 2005. Presently is a researcher at LAQV-REQUIMTE, expert in (i) molecular biology methods to evaluate food authenticity and safety (plants, animal and fungi) mainly throughout SSR and SNP markers with HRMA, and (ii) human cell-based assays in the evaluation of food nutrients, bioactives and contaminants in bioactivity, cytotoxicity and bioavailability (in vitro gastric and intestinal cell monolayer transport assays).

http://orcid.org/0000-0001-9366-0443

mfaria@ff.up.pt.

P029 - METABOLOMICS STRATEGY FOR MAPPING OF VOLATILE EXOMETABOLOME FROM SACCHAROMYCES SPP. WIDELY USED IN BREWING BASED ON COMPREHENSIVE TWO-DIMENSIONAL GAS CHROMATOGRAPHY

Silvia Rocha[1]; Cátia Martins[1]; Adelaide Almeida[2]; Tiago Brandão[3]

1 - Departamento de Química & QOPNA, Universidade de Aveiro, Campus Universitário Santiago, 3810-193 Aveiro, Portugal; 2 - Departamento de Biologia & CESAM, Universidade de Aveiro, Campus Universitário Santiago, 3810-193 Aveiro, Portugal; 3 - Super Bock Group, Via Norte, 4465-764 Leça do Balio, Portugal

Abstract

Saccharomyces spp. are widely used in brewing, and their cellular excreted metabolites are important for beer's general quality and can contribute for products' differentiation. This exploratory study presents a metabolomics strategy for the comprehensive mapping of cellular metabolites of *Saccharomyces pastorianus* (collected in industrial context), through a multidimensional chromatographic based platform [1]. Solid phase microextraction was used as a sample preparation method. The yeast viability and vitality, specific technological quality parameters, was also performed to unveil the performance. *S. pastorianus* registered good flocculation capacity (54%) and was considered highly active yeast with good fermentation potential, through the acidification power test. This untargeted analysis allowed the detection of 525 analytes, distributed over 14 chemical families, the origin of which may be explained through the pathways network associated to yeasts metabolism. This was the first in-depth approach that characterizes volatile fraction of *S. pastorianus* cultures. The combination of a sample preparation method capable of providing released volatile metabolites directly from yeast culture headspace with comprehensive two-dimensional gas chromatography was successful in uncovering a specific metabolomic pattern for this species.

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Short biography

Sílvia M. Rocha is Professor at the Chemistry Department of Aveiro University UA). She is the leader of the ***x-Chroma Lab*** (http://xchromatographylab.x10.mx). She is the Coordinator at UA of the Erasmus mobility Programs, in Biochemistry area. She is also the vice-director of the

Biochemistry Bachelor. She published over 120 SCI papers, 2 books, 16 book chapters, 1 interactive CD/book, more than 300 presentations in conferences, including and 3 patent applications, has received 19 national and international awards and distinctions and possesses *h*-index 32, with more than 2800 citations (http://www.scopus.com/authid/detail.url?authorId=7006653213). For the last 25 years, she has performed studies on the characterization of plant related materials, including the study of products and processes, and prospection of bioactive compounds, and metabolomics oriented to the comprehension of complex biological systems. She has a significant expertise on the study of alcoholic beverage, namely table and fortified wine and more recently on beer.

P030 - IN SITU IDENTIFICATION OF ANTIOXIDANT MOLECULES IN BEER BY HPTLC/BIOASSAY/MS

Pablo Murath[1]; Stephanie Hoffmann[1]; Karem Henriquez[1]; Mario Aranda[1]

1 - Universidad de Concepcion

Abstract

Beer is the most consumed alcoholic beverage in the world. Several published works have reported that beers present antioxidant properties, which are related with some level of protection against different kind of diseases like: cardiovascular, cancer, and neurodegenerative. Therefore, the identification of molecules responsible of antioxidant capacity (AOC) in beers is a key-point to understand the influence of this beverage on consumer's health.

A screening methodology was developed to detect and identify antioxidant molecules present in pale and dark beers commercially available in Chilean market. The detection was performed applying a novel high throughput technique named High Performance Thin Layer Chromatography (HPTLC)-Autography-Mass Spectrometry (MS). To assess the antioxidant capability from the different molecules in beer, DPPH autography assay was used. Thereafter, the identification of the molecules responsible for the AOC in the HPTLC plates were analyzed through mass spectrometry.

According to the mass/charge ratio obtained from MS analysis the molecules can be related with phenolic compounds coming from malt and hop, i.e. 4- hydroxybenzoic acid (*m/z* 137), humulones (*m/z* 361), cohumulones (*m/z* 341), among others. Moreover, the results suggest the possible antioxidant activity of two unknown compounds (*m/z* 164) and (*m/z* 239). Both compounds are related with the AOC in beer for first time and its molecular elucidation is in progress. In summary, these results contribute to the identification of molecules responsible of antioxidant activity in beers and, therefore, this could be useful when possible modifications in the brewery process are considered to increase the AOC of the final product.

Short biography

I obtained my bachelor degree in Biochemistry in 2014 and started my PhD studies in Analytical Science and Technology in 2017. My main motivation to course a PhD program is the possibility to increase my understanding in brewing science and contribute to the brewing research to generate novel knowledge useful to solve industrial challenges.

Since 2017 I have worked in two research works titled “Preliminary Identification of Antioxidant Molecules through HPTLC/Autography/MS” and “Preliminary Identification of Esters in Chilean Beers through HS-SPME/GC-MS”. The first work is already finished and will be published during this year. Finally, I have also been working on different projects funded by the Chilean government such as “Determination of the Principal Responsible Sources of Biogenic Amine Presence in Chilean Beers”.

During the last two years, I have been working as professor assistant in the department of Food Science and Technology and outreaching brewery science in Chile.

P031 - WINEBEER: A BEER WITH IMPROVED FUNCTIONAL PROPERTIES THROUGH GRAPE-SKIN EXTRACT ADDITION.

Stephanie Hoffmann[1]; Jonathan Carrasco[1]; Pablo Murath[1]; Karem Henriquez[1]; Mario Aranda[1]

1 - Universidad de Concepcion

Abstract

Beer is the most consumed alcoholic beverage in the world (42%) followed by wine with 15%. Their moderate consumptions are related with reduction of cardiovascular disease due to the presence of polyphenols, particularly wine, which presents a higher concentration of polyphenols with antioxidant capacity. Winemaking process produces several tons of grape skins, which still possess a high concentration of polyphenols. The objective of this work was to develop a novel beer with higher antioxidant capacity than regular beers through the addition of a grape skin extract. The methodology considered an extractive process optimization applying design of experiment, a purification step through semi-preparative chromatography and bioactivity evaluation via HPTLC/Bioassay/MS. Two brewing stages were chosen to incorporate the purified extract, i.e. fermentation and maturation, both evaluated by antioxidant capacity and sensorial assays. As a result, a beer with improved functional properties was obtained mixing the beneficial effect of beer and wine. 500 mL of beer showed the same antioxidant capacity, anthocyan and total polyphenols than 250 mL of wine. This product allows the reduction of environmental impact and contribute to improve consumer`s health.

Short biography

I am in the last year to obtain my bachelor degree in Biochemist. Currently I am finishing my thesis work related with brewery science in the Food Science and Technology department. In the meantime, I have been participated in the congress of the Chilean Chemistry Society in 2018 with my research called “Development and optimization of an industrial extractive process for the achievement of a functional ingredient from grape skins”. The main objective of this work is the development of a functional beer with a antioxidant capacity similar to wine. Due my personal interest I have also been collaborated in another research works related with brewery science in the laboratory where I work and participated in the 1st International Workshop on Brewing Yeasts. The opportunity to assist this congress is highly important to me to increase my knowledge in brewery science and develop novel research works in the future.

P032 - THE USE OF HIBISCUS SABDARIFFA FLOWERS IN BREWING

Panagiotis Tataridis[1]; Vasilis Ziovas[1]; Nektaria Christidi[1]; Eleni Vassiadi[1]; Evaggelia Tzouvara[1]; Adnan Sehandeh[1]; Arhontoula Chatzilazarou[1]

1 - Department of Wine, Vine & Beverage Sciences, University of West Attica, Athens, Greece

Abstract

Flowers of *Hibiscus sabdariffa* have been used in herbal tea preparations and beverages due to their red colour, sourness and flavor. There are also valued for their content in vitamin C and studied for their pharmacological and toxicological effects. Recently there have been more than 500 commercial beers using hibiscus at various concentrations in their production.

Six commercial samples of hibiscus, (2 Sudanese, 4 Egyptian) were studied for their effect on the composition of tea infusions, with contact times ranging from 2 to 20 min at controlled temperatures and analyzing the pH, acidity, colour, anthocyans, total phenols, as well as their sensory profile. Similarly the effect of concentrations ranging from 1 to 9 gr/L was also studied,. The sample with the best sensory profile and representative acidity and colour was used for beer production during the last minutes of wort boiling.

Depending on the concentration used the hibiscus leaves were able to lower slightly the pH without significant change in colour at lower concentrations, up to a significant drop below 3 in pH at concentrations of 7g/L. Higher concentration did not produce a significant drop in pH and resulted in less intense colour, as well as, a particular sourness and brackish sensation. All the above mentioned parameters were also evaluated. The same sample was also used instead of an organic acid for adjusting the pH during mashing and wort boiling.

H. sabdariffa can be used for red sour beer production of varying intensity without microbial acidification.

Short biography

Dr. Panagiotis TATARIDIS is an Assistant Professor at the Department of Wine, Vine & Beverage Sciences of the University of West Attica. He is the former President of the Pan-Hellenic Union of Registered Enologists. He is an Enologist and Brewer with a bachelor from the Department of Enology & Beverage Technology of the TEI of Athens, a D.E.A. in Enology-Ampelology from the University of Burgundy (IUVV) and a Ph.D. from the Institut Nationale Polytechique of Toulouse (ENSIACET). He is specialized in enology, malting and brewing science, fermentation technology, microbiology and microbial interactions, process engineering and sensory evaluation, as well as beverage law. He has 17 years of academic and 8 years of Quality Manager/Food Safety consultant experience, with 81 papers and communications, for which he has received 2 international awards. He has also participated in 12 funded research programs.

P033 - THE EFFECT OF MAGNESIUM AND ZINC IONS ON THE RATE OF LACTIC ACID FERMENTATION FOR SOUR BEER PRODUCTION.

Aneta Ciosek[1]; Katarzyna Fulara[1]; Aleksander Poreda[1]

1 - University of Agriculture in Krakow, Faculty of Food Technology

Abstract

The bioavailability of minerals, such as zinc and magnesium, which are co-factors of many fermentation enzymes and environmental stress regulators, has a significant impact on the course of the fermentation process. This metal ions are known for their influence on the growth and metabolic activity of yeast, but there are few reports on their effect on the functioning of lactic acid bacteria. The quantity and quality composition of the brewers wort, especially in relation to mineral components, is subject to considerable fluctuations, related to the variability of the composition of the main raw materials, barley malt and water. Therefore, there is a need to control the concentration of these ions and to investigate their impact on the lactic fermentation carried out by lactic acid bacteria.

We carried out lactic acid fermentation using 5 wort with various mineral composition: without supplementation (1); wort with addition of 50ppm (2) and 100ppm (3) of magnesium; wort with addition of 1ppm (4) and 2ppm (5) of zinc. Every 24 hours of fermentation wort parameters such as: pH, lactic acid concentration were determined. The aim of the study was to check how magnesium and zinc ions affect lactic fermentation, lactic acid production and the rate of wort souring.

For the fermentation we used wort made of powdered malt extract (to obtain extract 12°P), and sterilized (120°C/20 min). Fermentation was carried out by Lactobacillus brevis WLP672 which were inoculated into the wort to reached 6,5 x 10^6 cells/ml. Samples were collected for analysis every 24 hours to measure pH and lactic acid concentration. After the fermentation was completed (72 hours), we also analysed the concentration of magnesium and zinc in the wort, to assess the uptake of those ions by the lactic acid bacteria.

Short biography

In 2015 I graduated from the University of Agriculture in Krakow, Poland, obtaining a master's degree in food technology with the thesis "Magnesium hardness of technological water and the composition of wort ions". Since 2015, I have participated in 4 international conferences, presenting the results of my research in the form of posters. I am currently conducting research for the doctoral dissertation on the subject of "Microbiological and technological aspects of sour beer production", teaching students in the courses organized by the Krakow School of Brewing of The University of Agriculture in Krakow, and developing my passion for brewing.

P034 - OPTIMIZATION OF MASHING PROCESSES USING INLINE CARBOHYDRATE PROFILING

Andreas Kunov-Kruse[1]; Aitor Lekuona Amundarain[1]; Aitor Lekuona-Amundarain[1]; Jakob Grønborg[1]; Michael Svingel Jensen[1]; Jens Piltoft[1]; Christian Nybo[1]; Casper Ormstrup[1]; Lasse Svensson[1]; Peter Damm[1]; Michael Pohl[1]; Erik Hoffmann-Petersen[1]

1 - Specshell ApS

Abstract

Specshell has developed a fully automated Inline analyzer for the mashing process, the Specshell Inline brewing analyzer (SIBA). SIBA enables the brewer continuously to in-line monitor enzyme activity, starch gelatinization and development of the carbohydrate profile inline during the mashing process.

The SIBA technology has been developed in closed partnership with the brewing industry for several years, until 2018 that was brought to the market, being purchased and permanently installed at several industrial breweries around the world; where it has helped the brewers optimize the mashing process and recipes.

By acknowledging the exact time-points and temperatures for optimal gelatinization, amylolytic enzyme activity and development of the carbohydrate profile, SIBA has helped the brewers to optimize the mashing performance and recipes. With SIBA-technology, the brewer obtains a valuable set of completely new tools for data driven process optimization, allowing to cut down process time, save in enzymes and/or increase in adjunct use among others, while ensuring premium product quality and brewery specifications.

Several aspect and perspectives of these optimizations will be brought into light. The presentation will specially address how the SIBA technology has enabled the European brewers to introduce fast and rational counter actions, to maintain high wort quality when facing malt fluctuations. This will especially go into details on how these brewers tackle the unusual malt quality induced by the general climatic conditions in Europe during the summer in 2018.

Short biography

Andreas Kunov-Kruse holds a PhD degree from the Technical University of Denmark in spectroscopy and chemical engineering. Andreas co-founded the company Specshell while finishing his postdoctoral research at Massachusetts Institute of Technology. Trough the last years Andreas and the rest of the Specshell team comprising biochemists, brewing scientists, engineers, and software specialists has been devoted to developing, testing and commercializing the SIBA technology

P036 - A SIMPLE AND ACCURATE METHOD FOR THE DETERMINATION OF VERY LOW ALCOHOL CONCENTRATIONS IN 0.0 BEERS AND 0.0 BEER MIXED BEVERAGES USING NEAR INFRARED SPECTROSCOPY

Helmut Klein[1]; Fabian Webersinke[1]; Clemens Forster[1]

1 - Brau Union Österreich AG

Abstract

In the recent years, a growing variety of alcohol-free beers and beer mixed beverages with a very low alcohol content are being offered to consumers. These products claim an alcohol content of 0.0% by volume and by definition must meet the requirement of < 0.05% vol ethanol in the product.

Determination of such low ethanol concentrations in beer or beer mixed beverages can normally only be performed with gas chromatography or enzymatic analysis. Using the common near infrared (NIR) spectroscopic method (AP-Alcolyzer) is limited due to accuracy constraints and matrix effects caused by flavourings or carbohydrates in 0.0 products. With a simple and quick sample pre-treatment based on vapour steam distillation, these limitations could be overcome.

Validation with the reference methods, GC-FID and enzymatic analysis, proofed that the modified NIR ethanol method with sample pre-treatment is robust and accurate and can be applied for routine analysis in the brewery without the need of additional instruments.

Short biography

Helmut Klein is the laboratory manager of the centrallaboratory of

Brau Union Oesterreich AG.

He has been working for over 30 years on quality control of beverages primarily with chromatographic and spectrometric analytical systems.

Emphasis of his analytical activities are the development of automatic analysis systems, determination of off-flavours and investigation in taste stability.

TOPIC: BARLEY BREEDING AND AGRONOMY

P037 - SCREENING OF DROUGHT TOLERANCE IN SPRING BARLEY

Bram Marynissen[1]; Joos Latré[1]; Anita Van Landschoot[2]; Geert Haesaert[2]

1 - University College Ghent; 2 - Ghent University

Abstract

Drought is one of the major abiotic stress factors for barley as it severely limits plant development, yield and quality. Spring barley varieties that combine superior malting quality with a reasonable level of drought tolerance are presently not available. The aim of this work was to identify varieties that can be used for further breeding purposes based on their resilience to drought.

A diverse collection of barley germplasm was grown in a greenhouse under a normal moisture regime and drought stress was induced at ear emergence. Due to the complexity of drought adaptation, a comprehensive set of physiological parameters including (1) relative water content (RWC) and (2) gas exchange parameters were determined next to yield, plant and root growth. Roots were evaluated after harvest through a semi destructive approach followed by an image based analysis. For some varieties a significant increase was found in dry root weight, total root length and root surface area under the effect of drought stress. In between varieties, a large variation was found and wild barley varieties were out performing. A significant variation was found in different yield component traits. The grain weight/plant was significantly correlated positively with the ratio between number of grains/plant and the number of total spikelets/plant under all control and drought conditions.

Short biography

Bram Marynissen received a Master degree in Bioscience engineering at Ghent University. He worked for the Flemish research institute for agriculture, fisheries and food and is now lector at the University College Ghent. He's a third year Ph.D. student working on drought tolerance in spring barley, focusing mainly on root traits. Currently he's doing research on the symbiotic associations and the possible contribution of mycorrhiza to drought tolerance.

P038 - THE IMPACT OF A REDUCED INPUT GROWING REGIME ON MALTING CAPABILITY OF BARLEY AND WHEAT

Calum Holmes[1]; Jed Roy[1]; Derek Stewart[2]; Louise Shepherd[2]

1 - Heriot-Watt University; 2 - The James Hutton Institute

Abstract

Inorganic fertilisers are frequently used in modern agricultural practises to positively impact yield and crop quality. Many such fertilisers are produced through processes that require either a large input of energy (e.g. through use of fossil fuels) or use of non-renewable feedstock. Furthermore, the application of certain fertilisers and pesticides may result in detrimental environmental effects in growing regions (e.g. emission of nitrous oxides). Production of barley and wheat for the purposes of brewing and distilling represents a substantial proportion of the total agricultural output of the United Kingdom, a reduced application of fertiliser during their growth could aid sustainability the farming sector considerably. For a new process to be of economic viability, it is vital that crops display similar quality characteristics to those produced under conventional conditions typical for the region.

Spring and winter varieties of barley and wheat were grown under conventional and integrated (reduced fertiliser application and use of under-sowing) conditions. Barley produced using integrated conditions displayed similar thousand corn weight and germinative capacity to that produced under conventional conditions, although water sensitivity was increased.

The barley was malted at laboratory scale and standard malt quality characteristics were measured. Friability and homogeneity of low-input crops compared favourably to those grown under conventional conditions. The impact of integrated growing methods on yield, free amino nitrogen, and β-glucan content varied with variety, suggesting that some varieties may be more suitable for reduced fertiliser application.

Short biography

Calum holds an undergraduate degree in Microbiology from the University of Leeds, and an MRes and PhD in Brewing from the University of Nottingham. Following time in R&D at Molson Coors, he conducted post-doctoral research at Heriot-Watt University in the area of distillery co-product valorisation. Calum is currently an Assistant Professor in Brewing and Distilling in the International Centre for Brewing and Distilling at Heriot-Watt University. Research interests lie in the region of raw materials and brewhouse optimisation.

P039 - TR15245: A NEW TWO-ROW MALTING BARLEY COMBINES DESIRABLE AGRONOMICS, DISEASE RESISTANCE AND QUALITY INCLUDING REDUCED PHYTATE

Ana Badea[1]; William Legge[1]; James Tucker[1]; Adam Carter[1]; Marta Izydorczyk[2]

1 - Agriculture and Agri-Food Canada, Brandon Research and Development Centre; 2 - Canadian Grain Commission, Grain Research Laboratory

Abstract

TR15245, a new two-row hulled malting barley line with reduced phytate (carries the phytate reducing *lpa1-1* barley mutation), was recently developed at Agriculture and Agri-Food

Canada, Brandon Research and Development Centre. This line combines superior agronomic performance (13% higher yield than AC Metcalfe check, 8% higher than CDC Copeland check, similar to AAC Synergy check) and physical grain quality (high plumpness, low thins similar to AC Metcalfe check, fair test weight and high kernel weight) with moderate resistance to surface borne smuts, stem rust (carries the *Rpg1* gene) and spot-form net blotch, and intermediate resistance to Fusarium Head Blight (FHB) and spot blotch. It has an acceptable malting quality profile with fine extract and viscosity similar to the checks and alpha amylase slightly higher than CDC Copeland. It has lower peeled and broken grains, diastatic power, soluble protein, Kolbach index, and FAN levels than the checks; low beta-glucan levels and higher friability. The reduced phytate barley malt from TR15245 may improve yeast health and fermentation efficiency. Grains and brewer's spent grains with low phytate may also help reduce environmental pollution.

Short biography

Dr. Ana Badea is a research scientist – barley breeding and genetics with Agriculture and Agri-Food Canada Brandon Research Centre (AAFC-BRDC) based in Brandon, Manitoba, Canada since 2012. As leader of a multi-disciplinary program, she integrates principles of plant breeding, agronomy, pathology, physiology, cereal chemistry, molecular genetics, and genomics to develop cultivars for two spring barley classes, two-row hulless for food and two-row covered malting, with improved agronomic performance, disease resistance and quality profiles to serve traditional and emerging markets. She is also an adjunct professor within the Department of Plant Science, Faculty of Agricultural and Food Sciences at University of Manitoba in Winnipeg, Manitoba, Canada and an Associate Editor with the Canadian Journal of Plant Science (CJPS).

P040 - EFFECTS OF PLANT GROWTH REGULATOR APPLICATION ON THE MALTING QUALITY OF BARLEY

Tricia Mcmillan[1]; John O'donnovan[2]; Breanne Tidemann[3]; Marta Izydorczyk[4]

1 - Grain Research Laboratory, Canadian Grain Commission; 2 - AAFC Lacombe AB; 3 - AAFC, Lacombe AB; 4 - Grain Research Laboratory, Canadian Grain Commission, Winnipeg MB Canada

Abstract

Barley can be cultivated in a wide range of environments; however, adverse climatic conditions and abiotic stresses may negatively affect the yield and quality. Heavy rainfalls and strong winds are known to cause lodging in barley, which can negatively affect kernel weight and plumpness, result in a higher susceptibility of grain to fungal attack, and lower its potential for being selected for malting. Plant growth regulators (PGRs) are synthetic compounds that can modify plant growth and reduce lodging. The objective of this study was to assess the effect of PGR application on the malting quality of barley grown in western Canada. The effect of three PGRs (Ethephon, Chlormequat, and Trinexapac) on CDC Copeland was assessed using a

factorial randomized complete block design. The results showed that application of any of the three investigated PGRs reduced the kernel weight of barley. The kernel weight in PGR-treated barley was reduced by 1.7 to 6.5% compared to the non-treated grain with ethephon instigating the greatest effect. Application of PGRs did not negatively affect other quality parameters of barley grain. The smaller kernels of specifically ethephon- and trinexapac-treated barley showed good hydration during steeping, good germination vigour, and good grain modification during malting as indicated by high levels of starch converting enzymes, high Kolbach indices, and low levels of wort β-glucans. The chlormequat-treated barley, however, produced malt with somewhat reduced levels of enzymes and poorer endosperm modification indicating possibly a different mode of action of chlormequat chloride compared to other two PGRs tested in this study.

Short biography

Marta S. Izydorczyk is currently a research scientist and program manager of Milling and Malting and Research on Barley and other Grains at the Grain Research Laboratory, Canadian Grain Commission, and an adjunct professor at the Department of Food Science, University of Manitoba in Winnipeg, Canada. Her research program focuses on identifying and characterizing constituents and molecular mechanisms, which are responsible for functionality, quality, and performance of barley and other grains in food products. She is responsible for assessment of malting quality of Canadian barley. Her research program aims at developing effective strategies for improving the quality of barley and for better adapting it to current and future needs. Marta also has responsibilities in representing the Canadian Grain Commission in domestic and international forums, establishing liaisons and technology transfer activities with producers, industry, and marketers, providing advice and responding to queries from clients and public.

TOPIC: BEER QUALITY - FOAM

P041 - RELATIONSHIP BETWEEN BEER FOAM AND SURFACE MOLECULES INVESTIGATED USING SUM-FREQUENCY GENERATION SPECTROSCOPY

Takayuki Miyamae[1]; Haruhito Kato[2]; Masaru Kato[2]

1 - National Institute of Advanced Industrial Science and Technology; 2 - Kirin Co. Ltd.

Abstract

We investigated the molecular composition of the surface of beer and the orientations of these molecules on the beer surface using sum-frequency generation (SFG) vibrational spectroscopy. By measuring the representative substances contained in beer, we identified the SFG peak derived from hop-derived iso-α-acids. Furthermore, it was found that, on the surface of beer, hop-derived iso-α-acids molecules aligned such that their hydrophobic groups pointed toward the air. Considering that iso-α-acids impart a strong bitter taste, the bitterness of beer foam could be caused by the segregation of iso-α-acids on the beer surface. Furthermore, increasing the amounts of hop-derived molecules enhanced beer foam stability, indicating that

the hop-derived molecules interacted with the hydrophobic proteins appearing at the beer surface to form more surface-active complexes. Because the formation of bubbles on the surface of liquids is a usual phenomenon observed not only in carbonated beverages but also in a variety of other materials, studies of foam are very important for elucidating the mechanism of bubble and foam formation on material surfaces and interfaces. Furthermore, these hop-derived molecules significantly contribute to the stability of beer foam by forming surface-active species with hydrophobic proteins on the beer surface.

Short biography

Takayuki Miyamae currently works at the National Institute of Advanced Industrial Science and Technology (AIST), Japan. TM does research in the surface science using nonlinear spectroscopy, organic electronics and physical chemistry of Interfaces. On the area of organic electronics, he is interested in using doubly-resonant sum frequency generation & electric-field induced technique to probe charge accumulation in organic devices. On the area of physical chemistry of interfaces, he uses sum-frequency generation spectroscopy to investigate the molecular arrangement in many types of interfaces, including liquids and polymer interfaces.

P042 - TOWARDS A BIOMIMETIC SENSOR FOR HYDROPHOBIN DETECTION IN BEER

Fatemeh Bajoul Kakahi[1,2]; Mehran Khorshid[1]; Derick Yongabi[1]; Guy Derdelinckx[2]; Patrick Wagner[1]

1 - Soft-Matter Physics and Biophysics Section, Department of Physics and Astronomy, KULeuven; 2 - Department of Microbial and Molecular Systems (M2S)

Abstract

Hydrophobins (HFBs) are a group of small proteins (≤ 20 kDa), which are well known as the main cause of the gushing phenomenon in beer. These proteins are produced by filamentous fungi in beer raw materials, especially in barley. Gushing is a highly undesirable condition which affects a high percentage of breweries all over the world. This phenomenon does not only lead to a huge economic loss of breweries, but also leads to considerable loss in the reputation of brands and malthouses. In the present research, we aim to develop a novel biosensor for specific detection of HFB class II (*e.g.* HFBI, HFBII, HFB2a-2) using surface imprinting polymers (SIPs). A quartz crystal microbalance with energy dissipation monitoring (QCM-D) was used as the transducer platform. To prepare the SIP sensors for HFBI, an ultra-thin prepolymerized polyurethane layer (PU) was spin coated on gold-coated quartz chips. Afterwards, a PDMS stamp spin coated with 500 µl of HFBI solution (2.036 µg/mL) was pressed onto the PU layer. The stamped PU coated sensors were cured overnight at 60°C followed by protein extraction. Different HFBI concentrations ranging from 5 µg/mL to 100 µg/mL were introduced on SIPs as well as non-imprinted polymer (NIP) sensor surfaces. The results show a sharper and higher shift in the frequency/dissipation (Df/DD) over time for SIPs in comparison with NIPs. This suggests that HFBI molecules have a higher binding affinity to SIPs than NIPs layers. Therefore, SIPs can be potentially used as biomimetic sensor surfaces for HFB detection.

Short biography

Science has always been one of my greatest interests! I moved to Belgium in May 2010 and did my Pre-doc research in Bioscience engineering at KULeuven, gaining a good experience and knowledge during my studies. In 2015, I started to work as a research associate in the department of Microbial, Molecular Systems and Malt Beer Science on production of Hydrophobin. In 2016, a new project started in collaboration with the Gembloux Agro –Biotech Lab that focuses on Bioreactor design and implementation strategies for enhanced production of hydrophobin from Trichoderma species. Today I am a Researcher in the field of Bio-Engineering (Beer Foaming and gushing processes) and the proud mother of 2. I've learned that science too is like a child needing nourishment, time and effort. It helps us understand and learn more about ourselves and the beautiful nature gifted to us.

P043 - INVESTIGATION OF FACTORS AFFECTING BEER FOAM COLOR APPLYING A NOVEL TECHNIQUE USING TWO-DIMENSIONAL COLORIMETER

Azusa Asai[1]; Atsushi Tanigawa[2]; Kiyoshi Takoi[2]; Ryouta Aritomo[2]; Takashi Iimure[1]; Yoichi Kozaki[1]; Fumito Ishida[1]; Masahiro Nomura[2]

1 - SAPPORO BREWERIES LTD., Research and Development Institute for Alcoholic Beverages, Yaizu, Japan; 2 - SAPPORO BREWERIES LTD., Product & Technology Innovation Department, Yaizu, Japan

Abstract

Foam quality is one of the most essential characteristics of beer, and beer foam color is an important factor that contributes to consumer appeal. However, there is no known method for evaluating beer foam color. In this study, we used a "two-dimensional (2D) colorimeter" which can identify all the colors that are recognized by human eyes. We have established a novel method for evaluating beer foam color and whiteness using L*a*b* values measured by the 2D colorimeter. We revealed that significant correlation was observed between the beer liquid color (°EBC) and the beer foam whiteness. Additionally, we investigated the influence of various types of malts on beer foam color and several physical factors on beer foam whiteness. Our results indicated that bubble size affected beer foam whiteness, while CO_2 gas pressure had no impact on the beer foam whiteness. These findings would contribute to improve the quality of beer foam.

Short biography

Azusa Asai received a master's degree from the Department of Applied Life Sciences, Kyoto University, Japan. She began her career as a biochemist in 2015 at the Research and Development Institute for Alcoholic Beverages, SAPPORO BREWERIES LTD. Her main research topic is improvement of beer foam quality.

TOPIC: BEER QUALITY - SENSORY

P044 - INFLUENCE OF POST-FERMENTATION PROCESSES ON HOP AROMA IN BEER

Ray Marriott[1]; Liridona Ferizi[1]

1 - Totally Natural Solutions Ltd

Abstract

Maximising hop aroma and flavour in beer has been key to the development of the craft beer sector and there has been many developments to improve the efficiency of hop aroma transfer from hops to beer. However there has been little attention paid to the preservation of the hop aroma in post fermentation processes and this study looks at the influence of centrifugation, stabilisation, filtration and pasteurisation on the retention of key aroma molecules in beer.

We have investigated the changes in hop aroma molecules using headspace SPME-GC-MS with model beer systems in the laboratory and also in commercial breweries where individual batches have been tracked from post-fermentation to final pack. Bright beer and cloudy beer styles such as New England IPA have both been investigated as the “cloud” particles have a particular influence on hop aroma stability.

This work has shown that filter aids and filter materials selectively absorb certain groups of hop molecules resulting in significant changes in the hop aroma and flavour profile but centrifugation and stabilisation has much less impact.

This work has led to a better understanding of hop aroma stability post fermentation and the development of new products that exhibit better shelf-life stability.

Short biography

Ray is Innovation Director of Totally Natural Solutions Ltd a company specialising in the development of hop aroma and flavour products. Ray Marriott spent 35 years in industry working on the extraction and application of natural products and the development of hop products before moving to academia in 2008. Ray then spent time at York University and Bangor University developing “green” processing techniques before returning to the hop industry. Ray has a biochemistry degree from Cambridge and a PhD in terpene chemistry from Bath University.

P045 - HIDDEN SECRETES OF THE NEW ENGLAND IPA

John Paul Maye[1]

1 - Hopsteiner

Abstract

New England IPA, also known as Hazy IPA, is gaining popularity across the United States with almost every craft brewer making one. What makes these beers desirable is their massive hop flavor and low bitterness. This means hop heads and people who don't like bitter IPA's enjoy them. Many of these beers also taste fruity or juicy and they're incredibly hazy. The process for brewing a New England IPA will be discussed and dozens of tests were conducted on these beers and the haze to better understand the bitterness, aroma and the secretes properties behind the haze.

Short biography

Dr. John Paul Maye is Technical Director at Hopsteiner with over 25 years of experience in the hop industry. He received his Ph.D. degree in Organic Chemistry at Purdue University in 1994, and started work as a hop chemist in 1993. He has developed many new products and applications for hops both inside and outside the brewing industry and has many publications and patents. Over the last few years his research has focused on dry hopping and it effects on bitterness, the IBU test, pH and foam. Today he will talk about his research into New England IPAs.

P046 - THE CONTRIBUTION OF STALING ALDEHYDES TO THE FLAVOR (IN)STABILITY OF TOP FERMENTED, HOPPY BEERS

Christian Schubert[1]; Sarah Thörner[1]; Jörg Maxminer[1]; Nils Rettberg[1]

1 - VLB Berlin - Research Institute for Beer and Beverage

Abstract

Many consumers highly appreciate hoppy beer styles such as Pale Ales, India Pale Ales (IPA), or Double IPAs. These beers are now distributed and consumed country- or even worldwide, making consistent quality and flavor stability a growing concern for their producers. To date, various studies have investigated flavor stability in Lager beer, whereas very little research has been carried out in order to understand flavor changes in hoppy top fermented beer.

In order to investigate the flavor chemistry of hoppy beer, eleven German craft beers were selected by a Design of Experiment (DoE) approach using basic beer parameters (ABV, IBU, and

Color) as input variables. The beers were subjected to a six month storage trial at 4 °C and 20 °C. Chemical changes were tracked by application of multiple targeted and non-targeted instrumental assays on eight separate occasions and complemented with sensory evaluation.

The current paper discusses the contribution of staling aldehydes to flavor changes in hoppy top fermented beer. It is commonly known that trace amounts of staling aldehydes negatively contribute to the overall flavor impression of aged lagers and our work reveals that some of the fresh tested beers already contained high aldehyde levels. The aldehyde distribution differed from those typically observed in lagers and these demonstrated a remarkable increase throughout storage. However, these findings did not necessarily correlate well with sensory, suggesting the high importance of known or unknown yeast and/or hop derived volatiles in flavor (in)stability of some top fermented, hoppy beers.

Short biography

Christian Schubert is a trained brewer and maltster, graduated from Technical University Berlin (Germany) with a Master of Science (brewing and beverage technology) in 2016. He is now a research associate at the Department for Special Analysis at the Research and Teaching Institute for Brewing in Berlin (VLB). Christian's scientific work is focused on the ageing stability of beer especially top fermented, hoppy beers.

P047 - DISENTANGLING SENSORY EXPERIENCES OF BEER WITH ARTIFICIAL INTELLIGENCE

Supinya Piampongsant[1,2,3]; Miguel Roncoroni[1,2,3]; Beatriz Herrera[1,2,3]; Ruben Wauters[1,2,3]; Tom Wenseleers[4]; Jan Steensels[1,2,3]; Kevin Verstrepen[1,2,3]

1 - VIB – KU Leuven Center for Microbiology, Gaston Geenslaan 1, B-3001 Leuven, Belgium; 2 - CMPG Laboratory of Genetics and Genomics, KU Leuven, Gaston Geenslaan 1, Leuven, Belgium; 3 - Leuven Institute for Beer Research (LIBR), Gaston Geenslaan 1, B-3001 Leuven, Belgium; 4 - Laboratory of Socioecology and Social Evolution, KU Leuven, Leuven, Belgium

Abstract

After thousands of years of beer brewing, we now have a significant grasp on the science of brewing and the chemical composition of beers. However, despite this wealth of information, we are still unable to accurately connect a beer's chemical profile to its sensory perception and overall appreciation by consumers. While sensorial properties of single beer constituents are often known, complex interactions between them (masking, temporal effects, synergistic effects, and physical interactions) make accurate predictions of overall beer perception a longstanding challenge.
Over the past five years, we have undertaken a large research project that integrated advanced chemical analyses, sensory science, and artificial intelligence techniques to link the chemical profile of a beer to its flavor, aroma, and appreciation. We have elaborately characterized the chemical profiles of 250 beers, yielding over 65.000 measurements. These data were supplemented with publicly available consumer data on sensory perception and appreciation of

these beers, as well as sensory data from blind tasting sessions with trained experts. Using this extensive data set, we employed state-of-the-art machine learning algorithms to predict perceived tastes, aromas and appreciation, solely based on chemical properties of the beer. Our models provide unique insights into the chemical and sensory profiles of current market offerings and could complement tasting panels during quality control and product development. Moreover, it can be employed to identify market gaps and opportunities, and increase the cost-effectiveness of production by suggesting cheaper raw materials. Ultimately, it could be used to reverse-engineering beers based on desired characteristics of specific consumer markets and will enhance the way beers are designed and evaluated before reaching consumers.

Short biography

Supinya Piampongsant is a PhD student in the Verstrepen Lab at Leuven University and the VIB Center for Microbiology. The lab specializes in yeast fermentation research and investigates a variety of both fundamental and applied projects. It regularly publishes high-profile breakthrough papers, including in high-impact journals such as Science, Cell, PLoS Biology, PNAS, Nature Genetics, and Nature Communications. It has productive collaborative relationships with other academic labs all over the world as well as industrial partners, and has recently opened its own pilot brewery. http://www.kuleuven.be/verstrepen/en

P048 - A NEW METHODOLOGY FOR DYNAMIC "EASINESS TO DRINK" WITH TEMPORAL DOMINANCE OF SENSATIONS (TDS) - GOOD KIRE (CRISPNESS) OF BEER LEADING TO EASINESS OF DRINKING

Seiko Miyashita[1]; Takahiro Wakihira[1]; Minoru Kobayashi[1]; Kazuhiko Uemura[1]

1 - Asahi Breweries, Ltd., Research Laboratories for Alcohol Beverages, Moriya, Japan

Abstract

Kire, the Japanese word for crispness or smoothness, is an important attribute of good beer in Japan. Previously, we performed sensory and instrumental analyses of 14 beers, and revealed that both taste and aroma compounds affect *kire*. We also confirmed that ethyl esters, acetates, and linalool aroma significantly suppressed sensory evaluations of *kire*. The objective of the present study was to elucidate whether these aromas also affect the ease of drinking of beer continuously. A new methodology for continuously evaluating the ease of drinking has been developed based on Temporal Drivers of Liking, which was proposed as an extension of Temporal Dominance of Sensations (TDS). Beer with the highest *kire* score and beer with significantly weaker *kire* score by sensory evaluation in advance were used in the present study. A trained panel performed sensory evaluations of each sample using TDS to monitor changes of dominant sensations during consumption of a sip of beer and scored easiness to drink throughout the tasting immediately after TDS; these parameters then were evaluated repeatedly over 5 consecutive sips. The results confirmed that beer with strong *kire* had significantly higher easiness-to-drink scores than did beer with weaker *kire*, and differences in drivers of easiness to drink were observed between the samples. Additionally, using sensory evaluations, we assessed the effect of the aroma compounds noted above on the ease of drinking beer. At the end of this presentation, we also discuss whether the ease of drinking beer could be a good predictor of beer drinkability.

Short biography

Seiko Miyashita is an analyst at the Department of Brewing and Flavor Technology Research Laboratories for Alcohol Beverages at Asahi Breweries Ltd. She graduated from the Department of Material and Life Science in the Graduate School of Engineering at Osaka University before joining Asahi Breweries Ltd. in 2009. She has been engaged in the research and development of analytical technology since 2011, with a particular focus in the area of brewing science.

P049 - THE IMPACT OF BREWING WITH UNMALTED CEREAL ADJUNCTS ON THE SENSORY AND ANALYTICAL PROFILE OF BEER

Joanna Yorke[1]; David Cook[1]; Megan Weaser[2]; Rebecca Ford[1]

1 - University of Nottingham; 2 - Molson Coors

Abstract

Unmalted cereal adjuncts provide a source of extract and nutrients with which to substitute a proportion of malted barley in the grist bill, potentially lowering costs and improving the overall sustainability of the brewing chain. Brewing with adjuncts at high concentrations can be challenging, and the processability of the grist must not negatively impact the product quality. Consequently, the sensory characteristics of beers produced using high rates of adjuncts are still not fully understood.

The objective of this study was to investigate how brewing with five different unmalted cereal adjuncts (rice, maize, wheat and two grades of barley) at relatively high adjunct concentrations (0, 30%, 60% of grist) impacted the sensory and analytical properties of the beers produced. Adjunct based beers and a 100% malt control were brewed on a 25L scale in the University nanobrewery. A trained sensory panel (n=8) were used to establish a lexicon for the adjunct beers. Each attribute was rated for the samples using a modified Quantitative Descriptive Analysis method in triplicate.

Results demonstrated that brewing with 30% adjunct produced insignificant variation in the expected beer flavour profile. Distinct sensory properties for each adjunct material were observed at 60% concentration. High maize inclusion produced a significantly more sour beer relative to the 100% malt control ($p<0.01$). Chemical analyses associated with the noted sensory impacts of each adjunct will be presented.

This study will develop understanding of the characteristics of unmalted cereal adjuncts and accentuate the mitigating strategies that need to be considered to retain flavour quality.

Short biography

Joanna Yorke is currently a second year PhD student researching Brewing and Sensory Science at the University of Nottingham. Her project is funded by Molson Coors. After completing a four-year Master's degree in Chemistry at the University of Birmingham in 2015, she decided

to pursue her interest in Analytical Chemistry. Joanna worked for Mondelez in a Pharmaceutical Chemistry laboratory before deciding to develop her chemistry knowledge with her brewing and sensory science interests by returning to research.

P050 - INFLUENCE ON BEER BITTER QUALITY BY USING DIFFERENT HOP PRODUCTS

Dominique Dixius[1]; Stefan Hanke[1]; Georg Stettner[1]; Annika Lagemann[1]

1 - Bitburger Braugruppe GmbH

Abstract

Beer is the only beverage which provides a hop derived bitterness. The hop bitterness is also a quality attribute because the bitterness should be harmonic and not lingering or astringent. The use of conventional hop extracts, like CO2- and ethanol extract, are widely common and provide some technical and technological advantages to the brewer. It is well known that the composition of conventional hop extracts differs depending on the extraction conditions in terms of polarity and solubility during the extraction process. Brewing with extracts can result in a different sensation of the bitterness in comparison to cone hop or pellets. We brewed different beers in our pilot plant comparing ethanol extract with CO2 extract and also mixtures of extracts and pellets with the focus on bitter quality and bitter sensation of the final beers. Also, we analysed hop derived components from the soft and hard resin fraction by HPLC and LC-MS/MS and show differences in the composition of the final beers. The beers were sensory evaluated and the generated bitter profiles will be presented.

Short biography

Dominique Dixius joined Bitburger Braugruppe GmbH in 03/17 as food chemist with responsibilities in LC-MS/MS method development and other R&D projects. She holds a Master Degree in food economy from University of Apllied Sciences Trier. The topic of the master thesis was "Quantification of Hop Aroma Compounds in Beer by Headspace Trap GC-MS and Sensory"

P051 - WOOD AGED IMPACTS: COMPARISON BETWEEN BRAZILIAN SPECIES AND AMERICAN OAK CHIPS

Ana Carolina Corrêa[1]; Giovanni Casagrande Silvello[1]; Aline Marques Bortoletto[1]; Mariana Costa De Castro[1]; André Ricardo Alcarde[1]

1 - University of São Paulo - College of Agriculture "Luiz de Queiroz"

Abstract

The use of wood has been a trend in the brewing industry. The application of wood chips in the aging beers is advantageous because of the low cost, ease of use and availability. Studies about

the potential of Brazilian woods for aging beverages has grown in the recent years. Sensory analyses are fundamental in the evaluation of characteristics provided by the interaction between beverages and wood. The objective of this study was to evaluate beers aged with chips from different woods. A Russian Imperial Stout beer underwent forced aging with the addition of chips (5 g/L) from three different wood species: American Oak (*Quercus alba*), Amburana (*Amburana cearenses*) and Cabreúva (*Myrocarpus frondosus*). The samples were kept under controlled temperature at 40 °C for 72h to accelerate the extraction of the wood compounds. The beers were evaluated by two different panelists groups: 9 beer specialists and 5 aging beverages specialists. The methodologies used were CATA (Check-All-That-Apply) and *Napping* (projective mapping). The groups presented similar criteria for characterization of the samples. The "full-bodied" sensation and “spices” aroma were descriptors more used to Cabreúva. The "coconut" and "woody" aromas characterize beer aged with Amburana. "Woody flavor" and "astringency" characterize samples aged with both Brazilian wood chips. The use of oak may have resulted in greater harmony and complexity for some descriptors.

Short biography

Ana Carolina Corrêa is a PhD student in Food Science and Technology, with emphasis on Technology and Quality of Alcoholic Beverages, at University of São Paulo – College of Agriculture “Luiz de Queiroz” (USP/ESALQ). She is a biologist and a Master in Food Science and Technology from University of São Paulo (USP/ESALQ). She has experience in chemical and sensory quality of alcoholic beverages.

P052 - EUROPEAN HOPS VARIETIES ANALYSED WITH SENSORY AND ANALYTICAL BEST PRACTICES

Boris Gadzov[1]; Katia Jorge[1]; Evelyne Canterranne[1]; Tina Tian[1]; Dale Smith[1]

1 - FLAVORACTIV LIMITED

Abstract

The predominant source of bitterness in beer is formed by the iso-a acids, derived from acids which are naturally present in the flowers of the female hop plant. With a huge variation in bitterness compounds and perceived differences in bitterness taste (pleasant to harsh), beer bitterness tests have become an essential part of quality control in commercial beer production.

Good knowledge and understanding of different varieties of hops and unique flavour profiles can be beneficial for any brewery, professional judges or beer sommeliers.

This work describes hops varieties produced in 7 countries in Europe, their flavour profiles in 84 beer brands analysed with sensory and analytical best practices.

The Descriptive profiles determined through sensory analysis have been aligned with internationally accepted flavour standard terminology.

We have used a new instrument for determination of Beer Bitterness. The results showed excellent accuracy and repeatability with tight control over the IBU/EBU values. This can be used as an alternative to current manual extraction or expensive chromatography methods to analyse in-process (at-line) for adjusting the brewing process or as final QC/QA in the lab.

Short biography

Boris has been FlavorActiV Director of Global Sensory Management since 2009. Boris began as a Global Sensory Manger, professional trainer and adviser in brand equity, product quality, insight/innovation and taster management. Boris has travelled extensively and has trained tasters in over 300 beverage companies in Europe, Africa, Asia and North America. His significant language skills have helped develop business overseas and provide global beverage and multi-language support to FlavorActiV's customers. He is the author of many scientific papers published in the international journals. Before Boris joined FlavorActiV he gained a PhD in Food Molecular Microbiology gained from the University of Vienna.

P053 - DETERMINATION OF POTENTIAL FLAVOUR DEFICIENCIES OF COMMERCIAL NON-ALCOHOLIC BEERS

Jeroen Bauwens[1]; Lore Eggermont[1]; Barbara Jaskula-Goiris[1]; Gert De Rouck[1]; Filip Van Opstaele[1]; Jos De Brabanter[2]; Luc De Cooman[1]

1 - KU Leuven, Department of Microbial and Molecular Systems (M²S), Cluster for Bioengineering Technology (CBeT), Laboratory of Enzyme, Fermentation and Brewing Technology (EFBT), Technology Campus Ghent, GebroedersDe Smetstraat1, 9000 Ghent, Belgium.; 2 - KU Leuven, Department of Electrical Engineering (ESAT), member of the division STADIUS, StadiusCentre for Dynamical Systems, Signal Processing and Data Analytics, KasteelparkArenberg10 –box 2446, 3001 Leuven, Belgium

Abstract

Non-alcoholic beer (NAB) is a beer type that has gained a lot of interest over recent years. NABs can be a desired alternative to alcoholic beers mainly due to drinking/driving regulations, as well as medical and religious reasons. However, the flavour of these beers is generally not as desired, they are often characterised by a pronounced worty off-flavour, a lack of fullness, an excessive sweetness and/or a low aromatic profile.

To gain more insight in potential flavour deficiencies of NABs, a comprehensive 'flavour mapping' of commercial NABs in comparison to their alcoholic counterparts was carried out by detailed chemical-analytical and sensory profiling. Beers were analysed by state of the art HS-SPME GC-MS (esters, higher alcohols and aldehydes), HPLC-RI (sugars) and UPLC-PDA (amino acids and bitter acids) techniques, as well as standard brewery analyses. Furthermore, the beers were sensorially evaluated by duo-tests and detailed descriptive analysis. Aiming at finding correlations between analytical and sensory data on the one hand, and determination of potential flavour deficiencies in NABs on the other hand, the results collected were subjected to

suitable multivariate data analysis techniques (including principal component analysis, partial least square regression and canonical correlation analysis).

Based on the analytical parameters, a clear separation was obtained in the PCA between the alcoholic and non-alcoholic beers. Generally, the non-alcoholic beers contain more sugars and carbonyl compounds, whereas the alcoholic beers are characterised by a higher aroma compound concentration (esters and higher alcohols).

Short biography

Jeroen Bauwens holds a M.Sc. in Chemical Engineering Technology. After graduating in 2017 from KU Leuven he started a PhD program focussing on technology development for producing flavourful non-alcoholic and low-alcoholic beers.

P054 - FLAVOR COMPOSITION OF BEER AGED IN BARRELS OF OAK AND BRAZILIAN WOODS - A PROPOSED SENSORY WHEEL

Aline Marques Bortoletto[1]; Giovanni Casagrande Silvello[1]; Ana Carolina Corrêa[1]; Mariana Costa De Castro[1]; André Ricardo Alcarde[1]

1 - University of São Paulo

Abstract

The production of barrel aged beer implies an ageing period in wooden barrels, in which numerous physicochemical reactions occur between the wood and the beer. The oak is the principal wood used in the aging process of alcoholic beverages worldwide. However, in Brazil, use of tropical wood species can be a viable option, allowing the innovation of the beer characteristics. The use of several Brazilian woods has been increasingly widespread and contributes to sensorial complexity. Further studies concerning the sensory quality can promote a considered benefit to the sector and increase its exportation. The development and standardization of sensory descriptors are important to enlarge the beer qualification techniques and boost greater investment in quality from the producers, associations and the government. The aim of this study is to develop a sensory wheel as a tool for determining Flash Profile in aged beer in different wood barrels. General terms were taken from descriptive analysis. A panel of 7 experts assisted in the discussion, selection and grouping of similar terms. Frequent terms were related to beer which had not been mentioned in literature yet. Sensory Wheel was constructed containing final descriptors for the aspects: visual, smells, tastes and sensations. The use of the wheel is intended to be a tool to form new tasters and beer quality evaluators but also for experienced tasters in sensory analysis. The Aged Beer Wheel aims to activate the sensory memory and provide standardized and organized descriptive terms to assessors.

Short biography

Aline Marques Bortoletto is currently in a Post-Doctoral Program at the College of Agriculture "Luiz de Queiroz" of the University of São Paulo (USP), Brazil. Majored in Food Science, Master and PhD in Food Science and Technology by USP. The main research area is chemical and sensorial quality of alcoholic beverages and spirits, with focus on Cachaça (Brazilian sugar cane spirit) and brazilian woods.

P055 - ASSESSMENT OF QUALITY CONTROL METRICES FOR MEASURING BEER FRESHNESS IN THE LAB USING THE MICROESR TECHNOLOGY

Mangethe Zwane[1]; Dr Boris Gadzov[1]; Evelyne Canterranne[1]; James Jugg[1]

1 - FlavorActiV

Abstract

Beer freshness is mainly measured using three metrices in the laboratory; Lagtime, T150 and Area. This study will assess the stability of the QC method and propose an improved alternative to these metrices namely Freshness index, Oxidation index and Oxidation capacity. A better-quality method for measuring beer freshness will also be presented and seeks to improve sensitivity and robustness of the assessment of beer freshness in a quality control laboratory. Furthermore, all the quality control metrices will be assessed on their correlation to beer oxidation levels when tested by a sensory panel.

Short biography

FlavorActiV produces Pharmaceutical Quality GMP Flavour Standards for training and maintaining the abilities of professional tasters, combined with FlavorActiV's proprietary taster proficiency software, in use by 50,000+ tasters globally, a trained, monitored panel brings validation to analytical instruments. The combination of both human and instrument sensory is where FlavorActiV adds value and mitigates risk for brand owners.

P056 - INTRODUCTION OF A STANDARD BEER FOR QUALITY CONTROL ASSESSMENT OF BEER FRESHNESS IN THE LABORATORY USING THE MICROESR TECHNOLOGY

Mangethe Zwane[1]; Dr Boris Gadzov[1]; Evelyne Canterranne[1]; James Jugg[1]

1 - FlavorActiV

Abstract

The study will introduce a reference beer standard that will be able to assess quality control laboratories that measure beer freshness using the microESR. The reference beer is a stable reference standard which can be used to compare laboratory performance. The results will show the assessment of the stability of the reference beer over a period of three months. Also,

a comparative study will be presented to assess the robustness of the quality control metrices across 4 laboratories using the reference beer standard.

Short biography

FlavorActiV produces flavour standards to Pharmaceutical Quality GMP Standards for training and maintaining the abilities of professional tasters. FlavorActiV's multi-lingual trainers deliver sensory training globally and monitor tasters with FlavorActiV's proprietary taster proficiency software, in use by 50,000+ tasters globally. Trained, monitored panels bring validation to analytical outputs of sensory instruments. The combination of both human and instrument sensory is where FlavorActiV adds value and mitigates risk.

P057 - SENSORY IMPACT OF ESTER-RICH SPECIAL BEER VIA RETRONASAL AROMA ANALYSIS

Kazuki Maruyama[1]; Atsushi Tanigawa[2]; Shigeki Araki[1]; Takashi Inoue[1]

1 - SAPPORO HOLDINGS LTD.; 2 - SAPPORO BREWERIES LTD.

Abstract

SAPPORO BREWERIES LTD. has collected more than 1000 yeast strains from around the world. The special bottom fermentation yeast amongst these has a particularly strong aroma. The beer brewed using this yeast has a characteristic full-bodied flavour that balances fruitiness and malt. Previously reported selectable 1D/2D GC-MS-olfactometry and sensory tests revealed the characteristic flavour components in such beers to be various esters, alcohols, terpenes, lactones, and phenols. Esters were a particularly important component of this beer. Because our previous research covered only orthonasal aroma, we herein focused on retronasal aroma. Orthonasal aroma is the scent smelled directly by the nose, whereas retronasal aroma is the scent perceived by the nose from the back of the throat when food is chewed and swallowed. Retronasal aroma is considered more important than orthonasal aroma for experiencing the taste of beer. Thus, we attempted to analyse retronasal aroma in real time while drinking beer, by identifying the main flavour components using a proton transfer reaction-time-of-flight (PTR-TOF) mass spectrometer. As a result, flavour components such as ethyl acetate lingered in the exhaled air after drinking, which is considered to affect the beer taste. The beer brewed with our special yeast showed prolonged lingering of ethyl acetate, which was supported by the sensory tests. Therefore, a real-time analysis of the retronasal aroma of beer can be conducted by using PTR-TOF, which offers the possibility of evaluating the beer quality by using this system.

Short biography

Kazuki Maruyama graduated from Tokyo University of Fisheries with a master's degree in ocean sciences in 2000. In 2006, he joined Frontier Laboratories of Value Creation of SAPPORO BREWERIES LTD. Since 2017 he has been working at Foodtechnology Laboratories for Value Creation of SAPPORO HOLDINGS.LTD. He has been engaged in chemical analyses and sensory testing of flavour components.

TOPIC: BEER, SOCIETY, HEALTH AND NUTRITION

P058 - DEVELOPMENT OF NOVEL, MATURED, HOP-DERIVED MILD BITTER ACIDS THAT IMPROVE COGNITIVE FUNCTION

Takafumi Fukuda[1]; Tatsuhiro Ayabe[1]; Kuniaki Obara[1]; Satoshi Umeda[2]; Yasuhisa Ano[1]

1 - Kirin Company, Limited, Research Laboratories for Health Science and Food Technologies, Yokohama, Japan; 2 - Department of Psychology, Keio University, Tokyo, Japan

Abstract

Epidemiological studies indicate that moderate consumption of alcoholic beverages prevents dementia. Several studies have reported the preventive effects of polyphenols in red wine on cognitive decline, but there are no reports pertaining to beer. We previously demonstrated that iso-□-acids, the hop-derived bitter components in beer, prevent cognitive decline and Alzheimer's disease pathology in a model mouse (J. Biol. Chem., 2017). On the contrary, because iso-□-acids are limited in their application to various foods and beverages owing to their instability and potent bitterness, we developed matured hop mild bitter acids (MHMBA) by heating hop pellets, which comprise oxidized decomposition of □ and □-acids such as 4'-hydroxyallohumulinone (HAH) and 4'-hydroxy-cis-alloisohumulone (HAIH) as representative components. To elucidate the effects of MHMBA on cognitive function, via preclinical studies, we demonstrated that consumption of MHMBA, HAH, or HAIH improves memory and attention via the vagal nerve. We also demonstrated that providing MHMBA supplements for 12 weeks improved cognitive function in a clinical trial with a randomized, double-blind, placebo-controlled design; the scores of a verbal fluency test evaluating long-term memory and the Stroop test evaluating attention were significantly improved in the MHMBA group compared with the placebo group. These preclinical and clinical studies indicate that MHMBA improves cognitive function, ultimately leading to the prevention of dementia. Improvements in cognitive function via the consumption of MHMBA support the findings of previous epidemiological studies and may indicate a novel approach for the prevention of cognitive decline and dementia.

Short biography

Takafumi Fukuda received a Master's degree in Engineering from Tokyo Institute of Technology, Japan, in 2013 and joined Kirin Company Ltd. Since then, he has been researching the health benefits of hops.

P059 - SHOULD WE WORRY ABOUT NICKEL CONTENT IN BEERS ON THE BELGIAN MARKET?

Anita Van Landschoot[1]; Anneleen Decloedt[2]; Mehrnoosh Babaahmadifooladi[3]; Gijs Du Laing[3]; Liesbeth Jacxsens[4]

1 - Ghent University, Faculty of Bioscience Engineering, Department of Biotechnology, Valentin Vaerwyckweg 1, B-9000 Ghent, Belgium; 2 - Ghent University, Department of Veterinary Public Health and Food Safety, Laboratory of Chemical Analysis, Salisburylaan 133, B-9820

Merelbeke, Belgium; 3 - Ghent University, Faculty of Bioscience Engineering, Department of Green Chemistry and Technology, Coupure Links 653, B-9000 Ghent, Belgium; 4 - Ghent University, Faculty of Bioscience Engineering, Department of Food Technology, Safety and Health, Coupure Links 653, B-9000 Ghent, Belgium

Abstract

In 2015 in the EFSA Journal 13,2,4002, EFSA (European Food Safety Authority) formulated a scientific opinion on the risk to human health from the presence of nickel (Ni) in food. In 2015 and also in 2018 (doi:10.2903/j.efsa.2015.4002) EFSA addressed concerns about Ni in beer because beer outliers contained more than 5000 µg Ni/L.

Ni in beer can originate from water, raw materials and contact materials such as brew kettles, keggs and cans.

In the frame of the FOD-RT-16/4-INNIBEL project, beers were analysed for Ni content and for content of Fe and Cr (the two other main metals in stainless steel) using ICP-MS or ICP-AES.

148 beers on the Belgian market, in cans or bottles, revealed a Ni content of 1.5-33.8 µg/kg and a Cr and Fe content of respectively 0.05-45.3 µg/kg and 9-6300 µg/kg. 6 of these beers analysed (4%) had a Ni concentration >20 µg/kg or the drinking water standard (2003/40/EC). The Ni, Cr and Fe concentrations in 44 beers from kegs were respectively 0.52-70.4 µg/kg, 2.2-16.9 µg/kg and <LOD-1119 µg/kg. Two (= 2 sour beers) of these beers (4.5%) had a Ni concentration >20 µg/kg. The Ni content was found unrelated to alcohol percentage, original extract, real extract, type of beer and package (bottle, can or keg).

The Ni, Cr and Fe concentrations in 31 selected potential 'Ni-risk'-beers were respectively 2.3-42 µg/kg, 2.1-7.0 µg/kg and <LOD-380 µg/kg and could be considered as comparable to the other beers analysed (in bottles, cans or kegs).

Short biography

Anneleen Decloedt graduated in 2011 as M. Sc. Biochemistry and Biotechnology, Ghent University, Belgium. She has been a PhD student at the Laboratory of Chemical Analysis, Food Safety and Public Health Department (Ghent University) for three years where after she successfully defended her PhD in 2015. From January 2015 up to December 2017 she has been working as a research fellow and assistant at the Laboratory of Biochemistry and Brewing of Ghent University and University College Ghent. She regularly presents her work in scientific papers and at international congresses as WBC, EBC and ASBC. In 2017 she completed a two month research internship about beer at the Proteomics and Metabolomics Facility, Colorado State University (USA). Now Anneleen is postdoctoral researcher at Ghent University and scientific coordinator in the private sector (quality control for the food industry).

P060 - CAN BEER CONSUMPTION CONTRIBUTE TO THE DAILY INTAKE OF ESSENTIAL MINERALS ELEMENTS?

Edgar Pinto[1]; Isabel Ferreira[1]; Agostinho Almeida[1]

1 - University of Porto -Faculty of Pharmacy

Abstract

Minerals deficiencies are a major public health problem in many developed and developing countries. The micronutrient deficiencies of major public health concern are the Fe and Zn deficiencies, which cause several health problems such as impairment in cognitive performance, lowered immunity to infections, poor learning capacity, among others. However, Se and I deficiencies are also of great relevance due to their high prevalence in developed countries nowadays [1].

Beer is an extremely rich product, containing a wide variety of compounds. Beer usually has a well-balanced amount of minerals [2]. However, it is known that the mineral composition of beer can greatly varies depending on factors such as the quality of raw products (including water), brewing process, type of beer, among others. Nowadays, much is known about the concentration of major minerals, like Ca, Mg, Na and K, in beer. Yet, little information exists on the concentration of microminerals such as Fe, Zn, Se and I. As beer can be an important source of these minerals for the human diet, more information is needed about the general mineral composition of beer.

This study aimed to determine the concentration of minerals in beers from the European market. Using the powerful analytical technique inductively coupled plasma – mass spectrometry (ICP-MS), the concentration of several macro and micro minerals is being determined in several hundred beer samples. The results of this comprehensive study will be presented in the present communication.

[1] WHO, 2014. Vitamin and Mineral Deficiency, A Global Progress Report - Unicef.

[2] Powl, P, 2009. Metals in beer. In: *Beer in Health and Disease Prevention*. ISBN: 978-0-12-373891-2

Short biography

Edgar Pinto (EP) has a PhD degree in Sustainable Chemistry from University of Porto (2014). He has a vast experience in the fields of analytical, food and environmental chemistry, namely in the analysis of both organic and inorganic compounds in food and environmental matrices using liquid chromatography tandem mass spectrometry (LC-MS/MS) and inductively coupled plasma-mass spectrometry (ICP-MS). His scientific path has been focused on the study of minerals transfer in the water-soil-plant system under normal and stress conditions. In last few years, he has been focused on the subjects of mineral malnutrition, biofortification, and food composition analysis.

TOPIC: CONSUMER STUDIES

P062- REVEALING PATTERNS OF CONSUMER INTEREST IN GLUTEN-FREE BEERS

Gianluca Donadini[2]; Terenzio Bertuzzi[2]; Edyta Kordialik-Bogacka[1]; Filippo Rossi[2]; Giorgia Spigno[3]; Sebastiano Porretta[4]

1 - Institute of Fermentation Technology and Microbiology, Lodz University of Technology, Wólczańska 171/173, 90-530, Łódź, Poland.; 2 - Department of Animal, Food and Nutrition Science, Faculty of Agriculture, Food and Environmental Sciences, Università Cattolica del Sacro Cuore, Via Emilia Parmense 84, I-29122 Piacenza, Italy.; 3 - Department for Sustainable Food Process, Faculty of Agriculture, Food and Environmental Sciences, Università Cattolica del Sacro Cuore, Via Emilia Parmense 84, I-29122 Piacenza, Italy.; 4 - Experimental Station for the Food Preserving Industry, Department of Consumer Science, Viale Tanara 31/a, I-43121 Parma, Italy

Abstract

This study explored the quality perception of gluten-free beer with a panel of beer drinkers in Italy and Poland. A conjoint rating technique was used. The respondents were given sixty-four beer concepts to evaluate and were asked to score each concept on a 9-point scale of interest. For each concept there were eleven attributes (alcohol content, colour, type of malt, price, drinking location, drinking occasion, bottle size, label claims, type of farming, type of brewer and bottle closure). When evaluating GF-beer, Italian consumers rated alcohol content as the most important factor (30.8%) followed by beer colour (18.3%). Price (13.8%) was ranked third. The type of brewer and the drinking occasion were both ranked as less important than price. The other factors were regarded as being scarcely important. The average interest was moderate (5.42) and oriented towards a blond craft beer with a %ABV > 7.0 and sold at a price in the 1.51-2.50 Euro range. This beer was suitable for drinking in the evening after dining. Polish consumers rated price (38.7%) and alcohol content (28.8%) as the two most important factors and had little interest in the other factors. The average interest was moderate (5.44) and oriented towards a vitamin-rich black craft beer brewed from barley with a %ABV in the 5.51-7.00 range and sold at < 5.00 PLN. The bottle was of 0.50L with a flip-off cap and the beer was suitable for drinking in the afternoon and at a casual restaurant. Results by gender and age class were reported and discussed. The research was supported by the European Foundation For Alcohol Research (Project EA 1542).

Short biography

He published over 30 papers in the field of Sensory Analysis, Consumer Science and Food Security in peer-reviewed journals. His research aims at investigating the complex interaction between food, consumers, the marketplace and the industry and focuses on the understanding of what influences food choice and preference. This complex interaction is explored through

different disciplines (economics, food science, nutrition, psychology, sociology, marketing and anthropology) by means of qualitative and quantitative methods. Lecturer and poster presenters at several editions of the EBC Congress. Invited as a guest to the 8th and 10th Brewing Science Group technical meeting. Teaching experience in Sensory Analysis of food (Università Cattolica del Sacro Cuore, Piacenza, Italy). He is member of the SISS (Italian Sensory Science Society).

P063 - PATHS FOR SMART TOURISM OPPORTUNITIES TOWARDS BEER CONSUMERS

Jan Lichota[1]

1 - UNED - Universidad Nacional de Educación a Distancia

Abstract

Beer tourism is experiencing a rapid evolution. Information channels have widely developed in recent years and powerful communication and interaction tools are in place to further accelerate the process.

The extensive range of mobile based channels that enable travelers to discover the breweries offer, destinations and cities' on-trade scene creates a competitive panorama across the globe. The offer has also been expanding and various new opportunities for visits have been created on their own or as part of thematic trails.

The research outlines the key aspects of smart tourism that may be applicable to beer consumers in search of a visitor's experience. The results aim to leverage from tourist characteristics and technology framework towards setting paths for future development of smart tourism experiences for confirmed beer consumers or those that may become them.

Short biography

Jan Lichota is a researcher at the UNED – Universidad Nacional de Educación a Distancia – in Madrid in European studies. His research themes are related to law, smart tourism, beer and economy, and EU affairs. He has completed law studies in Madrid (Universidad Complutense), International Relations and Cultural studies in Liège (University of Liège), as well as Business Management (ICHEC) and International Association Management (Solvay Business School) in Brussels. He is a visiting lecturer at the postgraduate course of brewing technology at the Wrocław University of Environmental and Life Sciences. His professional activities involved him as legal advisor at The Brewers of Europe and Executive Board member of the European Beer Consumers Union. He currently works at visit.brussels, the Brussels Capital Region tourism agency.

TOPIC: END OF BEER PROCESSING, INCLUDING AUXILIARY AND PROCESS AIDS

P064 - YEAST PROTEIN EXTRACT (YPE), A NATURAL INNOVATIVE AND SUSTAINABLE SOLUTION FOR WHITE BEER HAZE STABILITY

Olivier Caille[1]; Dominique Gallo[2]; Laurence Van Nedervelde[2]; Stéphane Meulemans[1]; Philippe Janssens[1]; Yves Gosselin[1]

1 - FERMENTIS Lesaffre for beverage; 2 - Meurice Institute

Abstract

Yeast derivatives are yeast cellular fractions obtained by inactivation or autolyzation of living yeast cells, and subsequently fractionated and purified the components thereof. Multiple applications of yeast derivatives have been explored in food and wine. In white beer, sensitive proteins and polyphenols form complexes responsible of haze. Could yeast provide sensitive proteins as a clean label solution for stable haze ?

Fermentis is dedicated to the development of fermentation and characterization solutions for beverages. It has developed a yeast derivative rich in protein (Yeast Protein Extraction) able to provide a stable homogeneous haze in white beers.

The haze has been investigated systematically for a range of YPE dosing rates, in various types of beer matrixes chosen based on specificities of the brewing process (stabilization protocol, filtration/centrifugation system, bottle conditioning) and the beer composition (cereals, proteins and polyphenols). In parallel, YPE has been fractionated according to the protein molecular weight to characterize haze active fraction.

The YPE product increase the haze in White beer and create a haze in Blond beers. Surprisingly, a stable haze could be created in PVPP-treated beers. Haze induced by YPE is strictly related to the total polyphenol. Alcohol and yeast content show no influence. Beers made with a specific enzyme treatment generates unstable haze over time. This YPE should be added during the bottling process.

The work presented reveals that 100% yeast derived protein extract as a clean label product is an innovative and sustainable solution for maintaining or creating stable haze in white beer.

Short biography

I get two different degrees: An Industrial engineer degree in brewing and fermentation technologies at Meurice Institute (Belgium) and a Master at Université Libre de Bruxelles, Belgium (1996-2002).

My first professional experience concerned a work of eight years on antibiotic resistance mechanisms in pathogenic bacteria (PhD thesis in Geneva 2002-2007 and three years post-doctoral fellowship at Harvard Medical School in Boston 2007-2010).

Afterwards, as a second post-doctoral, I developed molecular tools for improving bacterial bioethanol production at CNRS (Centre National de la Recherche Scientifique) in collaboration with Deinove.

My last professional experience before I join Fermentis pointed out the biotransformation, by the gut microbiota, of ellagitanins contained in pomegranate peel into polyphenol molecules active against inflammatory mechanisms and muscular mass loss, (2013-2016).

I joined Fermentis' team in September 2016 as the technical manager of yeast derivatives uses in fermented beverages.

P065 - STUDY OF BEER-SPOILAGE LACTOBACILLUS NAGELII HARBORING HOP RESISTANCE GENE HORA

Minami Umegatani[1]; Nobuchika Takesue[1]; Shizuka Asano[1]; Hideyo Tadami[1]; Kazuhiko Uemura[1]

1 - Asahi Breweries, Ltd., Research Laboratories for Alcohol Beverages, Moriya, Japan

Abstract

Lactic acid bacteria (LAB) cause the majority of beer spoilage incidents in the brewing industry. Previous studies revealed that the hop-resistance genes, *horA* and *horC*, are applicable to the species-independent determination of beer-spoilage ability of LAB. However, new beer-spoilage LAB species are constantly emerging and their insights should be shared in the industry to prevent the spoilage incidents by unknown species. In this study, *Lactobacillus nagelii* ABBC668 strain, isolated from spoiled pilsner-type beer, was investigated, because *L. nagelii* has been poorly characterized as a beer spoiler. We examined three *L. nagelii* strains from different origins, and only ABBC668 caused spoilage in hopped beer and harbored *horA* gene. The nucleotide sequence of *horA* gene obtained from ABBC668 showed 99% similarity with the corresponding sequences of *L. brevis* ABBC44 and ABBC45 strains. In addition, the *horA* gene retention rate of ABBC668 decreased after 15 times of subculturing in MRS (de Man, Rogosa and Sharpe) broth, while ABBC44 and ABBC45 showed no deletion of *horA* gene under the same conditions. The decrease in beer-spoilage ability was observed with the loss of *horA* in *L. nagelii* ABBC668.

Taken collectively, these results suggest that *L. nagelii* acquire *horA* by horizontal gene transfer and also indicate the unstable nature of hop-resistance genes in *L. nagelii*, as compared with those of *L. brevis.* This may account for the less frequent encounter of beer-spoilage *L. nagelii* strains in the brewing industry. To our knowledge, this is the first report of *L. nagelii* as a beer-spoilage species.

Short biography

Minami Umegatani received a MS degree in Nutrition Chemistry from Kyushu University, Japan, in 2016. She joined Asahi Breweries, Ltd. in April 2016 and worked in Hakata Brewery. Since September 2017, she has been researching spoilage microorganism of beer and RTD (Ready-To-Drink) in Research Laboratories for Alcohol Beverages in Ibaraki..

P066 - IMPACT OF HIGH PRESSURE PROCESSING ON THE FOAM STABILITY OF UNFILTERED BEER

Katerina Stulikova[1]; Tomáš Bulíř[1]; Jakub Nešpor[1]; Lukas Jelinek[1]

1 - University of Chemistry and Technology, Prague

Abstract

High pressure processing (HPP) has expanded as an innovative preservation method throughout the food and beverage industry. Since HPP retains original flavour and sensory qualities of products, it serves as an alternative technological approach for shelf-life extension of vegetable and fruit juices, concentrates and purees, where thermal pasteurisation was formerly employed. The use of HPP for beer stabilisation is a matter of current investigation. We examined the influence of HPP on the foam stability (FS) of unfiltered beer, since foam stability is a critical beer quality control parameter. Also, the activity of proteinase A (pro-A), an yeast enzyme connected with degradation of foam-active proteins, was monitored. Unfiltered lager beer samples were subjected to high pressure treatment. Samples were analysed weekly for the period of 8 weeks. Compared to the untreated samples, the samples processed by high pressure treatment had more than twice higher FS, which suggests that HPP had a beneficial impact on beer foam properties. As well, the activity of pro-A was significantly lower in the pressure processed samples. Our results indicate that HPP contributes to higher FS in unfiltered beer due to the denaturation of pro-A.

Short biography

Katerina Stulikova graduated from Charles University in Prague where she obtained her master degree from Pharmacy. She worked as a Quality and Innovation Specialist in Heineken brewery in Krusovice, Czech Republic. Nowadays she is a PhD student of Biotechnology at University of Chemistry and Technology in Prague and works as a Research Associate in the department of Microbiology at Research Institute of Brewing and Malting in Prague. Her research is focused at new approaches for the shelf-life extension of unfiltered beer.

TOPIC: ENVIRONMENTAL ISSUES AND SUSTAINABILITY

P067- RENEWABLE ENERGIES IN BREWERY MICRO GRIDS

Holger Schmidt[1]

1 - ABB Automation Products GmBH

Abstract

Figures have revealed that nearly 90 per cent of wasted food is lost before products even reach supermarket shelves. In many developing countries, power supplied by the public grid can be unstable, often resulting in blackouts and power surges, which can be devastating to food manufacturers.

Manufacturers are now looking to Industrial Internet of Things (IIoT) technologies, including microgrids, to solve the problem.

Microgrids, or small-scale power networks, which often incorporate on-site renewable energy sources like wind and solar, as well as customized battery storage systems, are providing plants with sustainable energy that is not only more efficient, but also has a lower carbon footprint.

In this presentation XXX will explore how microgrids can ensure a stable and reliable power supply for breweries and how this can increase automation efficiency and extend the lifetime of electronic components.

As the world grows more aware of the environmental impact of fossil fuels, manufacturers are increasingly turning to renewable energy as a power supply. We will discuss how renewable energy can be integrated into existing plant infrastructure with minimal disruption for maximum benefit.

Short biography

Mr. Schmidt completed his training as a Brewer and Malter at the Beck Brewery in 1989. Graduating as a Brewmaster in Weihenstephan, Mr. Shmidt began working as a sales and project engineer for KHS. He held similar positions with APV (now SPX) and Huppmann (now GEA). He was responsible for the global food and beverage marketing at Endress+Hauser and became involved with the European Hygienic Engineering and Design Group (EHEDG), and currently leads the Subgroupo 37 “Hygienic Sensors” and has been part of the advisory board since 2015. Mr. Schmidt joined ABB in 2017 as a Global Key Account Manager working with German machine builders.

P068 - UNLOCKING PRODUCTION EFFICIENCY

Holger Schmidt[1]

1 - ABB Automation Products GmBH

Abstract

Overall equipment effectiveness (OEE) is a powerful tool for measuring manufacturing productivity and improving the performance of machines and industrial assets. While measuring OEE is best practice, where do you begin when collating and analyzing data?

This presentation will explore the concept of holistic plant assessments (HPA) and the vital role they play in establishing a starting point for understanding and unlocking production efficiency as well as improving sustainability and overall plant efficiency.

Using the example of an international brewery, we will explore how a HPA is conducted, focusing on six key areas; power, heat, compressed air, refrigeration, motor controls and automation. We will show how plant managers can develop and implement their own action plans and how this can affect OEE by improving plant efficiency, productivity and profit margins.

Short biography

Mr. Schmidt completed his training as a Brewer and Malter at the Beck Brewery in 1989. Graduating as a Brewmaster in Weihenstephan, Mr. Shmidt began working as a sales and project engineer for KHS. He held similar positions with APV (now SPX) and Huppmann (now GEA). He was responsible for the global food and beverage marketing at Endress+Hauser and became involved with the European Hygienic Engineering and Design Group (EHEDG), and currently leads the Subgroupo 37 “Hygienic Sensors” and has been part of the advisory board since 2015. Mr. Schmidt joined ABB in 2017 as a Global Key Account Manager working with German machine builders.

P069 - THE RE-USE OF PVPP-REGENERATION-CAUSTIC FOR CIP-CLEANING

Deniz Bilge[1]

1 - VLB Berlin

Abstract

PVPP-caustic is used in order to regenerate PVPP for beer stabilization. By elevating the pH with caustic polyphenols are removed from the stabilizer. After regeneration the caustic looks dark and wasted wherefore it is usally dumped into the drain. Its dark appearance makes it look unusable but that is not representing its real cleaning power, since the main components carried in this caustic are polyphenols and their concentration is rather low. Furthermore it is free of microorganisms since it is processed hot. So why not use it in CIP operations? The idea

came up to re-use this caustic for cleaning purposes. Doubts against this idea were possible dangers of discolorations, deposits or foaming and therefore a harm to the cleaning result or the brewing equipment. A research project was carried out in order to evaluate the properties and the processability of this former waste product as cleaning medium in CIP-operations in the cold block and Brewhouse. The results were positively surprising. The PVPP-caustic showed the same cleaning properties like new caustic solutions. Stains were easily removable from plastic material and stainless steel. Tiles just needed a simple detergent treatment when stained with this caustic. Even breweries working with lost cleaning media could cover their caustic needs with PVPP-caustic.

Short biography

After an apprenticeship at Beck Co. with subsequent work as crafter in the filtration cellar a two year occupation followed in a craft brewery in Montreal/Canada. After returning to Germany and work in the fermentation cellar at Beck Co. again studies in fermentation technology followed at the Technical University in Berlin. In a five year contract at the Technical University´s chair of brewing Deniz Bilge worked as assistent to the professor. In this time he worked as head of the malt and beer laboratory and later as chief of the pilot plant. He furthermore accomplished a PhD-thesis on ultrafiltration in this time. Jobs in the technical support of breweries at Sopura and as plant manager in industrial brewery operations in Greece followed before returning to the VLB in Berlin.

P070 - HEATING WITH BEER - DISTRICT HEATING BY HEAT RECOVERY FROM THE COOLING PROCESS OF THE BREWERY PUNTIGAM

Gerald Zanker[1]; Gabriela Maria Straka[1]

1 - Brau Union Österreich - Heineken

Abstract

In the past, beer could be brewed only in the cold months, and only by the Linde process it was possible all year round to brew.

Puntigamer brewery, part of Heineken is one of the largest breweries in Austria with a beer output of more than 1 million hectoliters per year. The fermentation of beer wort and other cooling processes creates exhaust heat, cooled down by ammonia evaporation. About 12. 000 MWh waste heat arise per year!

New: Heatpumps, which installed after the compressor, detract the latent heat of the ammonia. This heat loss is delivered directly to the new heating supply via heat exchanger in an intermediate pressure stage with 55°C for the heating and in a high pressure stage with 75°C for the hot water. Optimal use of the physical specifications of the Carnot process realize extremely economical and sustainable results.

Since December 2017, the brewery together with the KELAG Wärme GmbH already supplies 65,000 square meters of the neighboring estate with district heat. This development project

includes around 800 apartments. The estate is designed for operation with a low-temperature heating system. In the final phase, around 3.8 million kWh of heat will be supplied to the customers per year; almost CO_2 neutral and 100% sustainable. Currently are the CO2 savings are approximately 500 000 kg and further use, for example for brewing processes, there is a potential of 1 500 000 kg a year.

This is worldwide the first utilization of this loss energy of this dimension.

Short biography

Chemistry at Graz-University, Doctor. rer.nat.,chemistry

Brewerymanager in Puntigam, Heineken

Extra activities:

1996 to 2012; Member of MEBAK; Member of EBC Analysis Committee until 2013.

Seven patents worldwide in beer production.

Comparative Investigation of Oligomeric- and Polymeric-Components in Beer Foams

27th-EBC-Cannes 1999

Use of spent grains

28th-EBC-Budapest 2001

Analytical Device for Measuring of Ethanol Concentration in Beer, based on NIR-Absorption

28th-EBC-Budapest 2001

Sterile Filtration of Beer by Membranes-

Characterization of the membrane fouling process in the microfiltration of beer

Analysis of the reasons for blockage

29th-EBC-Dublin 2003

Continuous In-line COD Alerting System for Waste- Water Supervising

INEX 2005

Realized Cost savings by the Implementation of a Spent Grain Combustion

30th-EBC-Prag 2005-08-04

Novel optochemical method for the non destructive determination of oxygen in encapsulated beer bottles

30th-EBC-Prag 2005-08-04

Product Quality, Product Safety and Product Integrity through Consistent Process Monitoring

31st-EBC-Venice: 6.-10. May 2007

Efficient beer recovery from Surplus yeast

32st-EBC-Glasgow, 22.-26. May,

P071- BREWING WITH GREEN MALT FOR AN ENERGY AND WATER EFFICIENT FUTURE

Celina Dugulin[2]; Gert De Rouck[1]; Luc De Cooman[1]; David Cook[2]

1 - KU Leuven, Bioengineering Technology, Ghent Technology Campus, Gebroeders De Smetstraat 1, 9000 Gent; 2 - International Centre for Brewing Science, Bioenergy and Brewing Science Building, University of Nottingham, School of Biosciences, Sutton Bonington Campus, Loughborough, LE12 5RD, UK

Abstract

In the UK alone, emissions of more than 300,000 tonnes CO_2 per year are produced through the manufacturing of more than 1.6 million t of malt annually (CarbonTrust 2011, Euromalt 2016). In malting, kilning is one of the most dominant users of energy and has become the main target in reducing the carbon footprint of malting operations. In omitting the kilning process, the brewer must brew with freshly germinated (green) malt, which introduces new technical challenges, but offers the reward of significantly lower energy and water usage.

Our research group has previously focused on laboratory scale development to enable this alternative to conventional brewing processes, investigating key quality concerns associated with green malt: Lipoxygenase (LOX) activity, S-methyl methionine levels, oxidation compound development and rootlet removal.

Subsequent brewing trials are underway utilising the innovative 5 hL pilot brewing plant at KU Leuven. The milling of green malt utilises a wet disc mill (Meura) in conjunction with lipoxygenase hostile mashing parameters: Mashing in at > 63 °C, pH: 5.2, under oxygen-limited conditions. The resulting wort is then filtered using a membrane assisted thin bed filter. Samples were collected throughout the brewing process, and compared with wort and beer samples produced using conventional pale lager malt, brewed under the same brewing conditions (besides the amount of brewing water). Findings from these trials will demonstrate the feasibility of a more energy and water efficient alternative to the malting/brewing paradigm.

Short biography

Celina Dugulin finished her bachelor's and master's degree in Nutritional Science specialising in Molecular Nutrition at the University of Vienna. In 2013 she completed an internship in Montreal, Canada at Lallemand, within the R&D department, investigating brewing yeast. Upon return to Austria she continued to work for Lallemand, Vienna working part time as quality control assistant for baking and wine yeast. Since 2017 she is part of the European Joint Doctorate in Food Science funded by the Marie Sklodowska-Curie grant, Horizon 2020 and pursues her doctorate in brewing science at the University of Nottingham and KU Leuven.

P072- BULIDING A PILOT REACTOR - VALORIZING CO2 THROUGH POWER-TO-GAS AND BIOCATALYTIC METHANISATION

Timo Broeker[1]; Marc Hoffarth[1]; Klaus Heikrodt[2]; Jan Schneider[1]

1 - Institute of Food Technology ILT.NRW; 2 - University of Applied Sciences OWL

Abstract

Germany as a country with a high amount of renewable electricity had to shut off 5,5 TWh of wind power in 2017, since no storage capacities are available yet. Power-to-gas/liquid is considered as the technology with the highest energy storage potential. In order to become economic, cheap and pure CO2 sources are significantly important.

Is alcoholic fermentation are going to play the most important role of Power-to-X and the transition of the energy system?

After lab scale studies on biocatalytic methanisation with CO_2 from brewing (presented on a poster in Ljubliana 2017), now we move to building a sophisticated pilot reactor at container size, to prove feasibility and model business cases in hardware-in-the-loop simulation. The innovative reactor is equipped with the entire process chain, from a PEM Hydrogen Electrolysis, the specialised bioreactor with all necessary process control, to a product gas tank and flare.

Results of experiments show high methane purity (larger 94 %), quick process run-up and shut down response and increased production rates (14 $Nm^3/L*d$) due to an optimised stirring process. The performance characteristics have to fulfil the requirements given by models of electricity grid market in order to move towards a business case.

Project partners are Südzucker AG and Viessmann.

Short biography

Timo Broeker is a biotech engineer and holds a master degree from the University of Applied Sciences OWL in Lemgo, where he has been working at the Department of beverage technology on research projects for almost 10 years. He deals with issues of side-stream

valorisation and cascade processes. He also is a member of the managing board of the Institute of Food Technology ILT.NRW.

TOPIC: FILTRATION

P073 - REDUCED IRON ENTRY DURING KIESELGUHR FILTRATION VIA PRE-TREATED FUNCTIONAL VISCOSE FIBERS TO IMPROVE OXIDATIVE AND COLLOIDAL BEER STABILITY

Thomas Kunz[1]; Ole Schneidereit[1]; Frank Jürgen Methner[1]

1 - Technical University Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Seestraße 13, 13353 Berlin, Germany

Abstract

The most widely used beer filtration technology is pre-coat filtration with kieselguhr as filter aid. Kieselguhr causes a well-known prooxidative acting iron entry during filtration with corresponding influences on oxidative and colloidal beer stability. Viscose fibers are regenerated cellulose fibers with variable cross-section shapes and fiber properties. The specific created surface structure of so-called "Poseidon" viscose fibers is characterized by an ion exchange functionality which can be enhanced by a pre-treatment procedure. The viscose fibers can be used to remove iron ions from the kieselguhr dosage tank during filtration.
The baseline investigations using standard beer analyses and ICP-OES demonstrate the ion-specific bonding affinity of functional viscose fibers in buffer solutions. The pre-treated "Poseidon" fibers show a very strong affinity against iron ions followed by copper with a wide gap whereas the concentrations of other metal Ions (e.g. Zn, Ca, Mg, Mn) are just slightly or not influenced. The application in Kieselguhr dosage tanks binds a significant amount of accessible free iron ions as demonstrated via lab-scale and pilot pre-coat filtration trials. In this connection, it is to point that the direct application of "Poseidon-fibers" as filter aid is inefficient and inadvisable because of their specific ion-exchange properties in a beer matrix.
All together the application of pre-treated functional viscose fibers results in an improved oxidative and colloidal beer stability as indicated by analyses using ESR-spectroscopy as well as a lower turbidity development during forced ageing conditions.

Short biography

After qualifying as a certified technician in preservation engineering (1991-1993), Thomas Kunz completed his basic studies in chemistry at University of Applied Sciences, Isny (1994-1995) and his basic studies in food chemistry at Wuppertal University (1995-1998), before starting to study food technology at University of Applied Sciences, Trier (1998-2002). After graduating, he worked as a chartered engineer in the area of ESR spectroscopy at Institute of Bio Physics at Saarland University (2002-2004).
Since 2005 he has been employed as a Scientific Assistant, PhD student. As head of laboratory since 2009 he is responsible for official and industrial research projects. His main focus lies in analyzing the influences of brewing process stages, filter aids, stabilizing or fining agents and specific beer ingredients on radical reaction mechanisms and oxidative stability of beer or

other beverages using ESR spectroscopy and GC-MS. Since 2015 he is a supervisor in EJD-European Joint Docotrate Food Science Program.

P074 - BEECH WOOD SAWDUST AND GALLOTANNIN COMBINATION AS A SUSTAINABLE FILTER AID

Thomas Kunz[1]; Max Panglisch[1]; Frank Jürgen Methner[1]

1 - Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Seestraße 13, 13353 Berlin, Germany

Abstract

Based on previous studies the combined usage of beech wood sawdust and gallotannins as a sustainable filter aid for beer filtration was investigated in filtration trials at a pre-coating filtration pilot plant. Beech wood sawdust contains a variety of water-soluble substances being turbidity active and having a wooden astringent aroma profile which can be prevented with a pre-treatment. Pre-treated beech wood sawdust filtrated beers do not differ in technological matter from the reference beer filtrated with kieselguhr.

After pre-coating and filtration performance optimization, samples of unfiltered and filtrated beers were analyzed via standard beer analysis, ICP-OES (Fe), ESR-spectroscopy (EAP-/T-value) and sensorial analysis. Beside an improved oxidative stability mainly caused by an significantly lower iron entry, other important beer parameters are not influenced. In sensory analyses the pre-treated beach wood filtrated beer cannot be distinguished from kieselguhr filtrated beer. The analysed turbidity of 4 EBC is not efficient enough for standard pilsner beer types due to the sensing threshold of 2 EBC. This fact makes the sole application of beech wood sawdust just suitable for dark beers, juices, extracts or preliminary filtration of bright beers. Otherwise experiments in combination with gallotannins as a stabilization aid showed that there is an adequate potential left reduce the turbidity.
The sustainable raw material beech wood sawdust in combination with gallotannins is an attractive filter aid, due to good technological characteristics and low prizes regarding acquisition and disposal. The researches have shown that the combination can be used in existing filtration plants instead of kieselguhr.

Short biography

After qualifying as a certified technician in preservation engineering (1991-1993), Thomas Kunz completed his basic studies in chemistry at University of Applied Sciences, Isny (1994-1995) and his basic studies in food chemistry at Wuppertal University (1995-1998), before starting to study food technology at University of Applied Sciences, Trier (1998-2002). After graduating, he worked as a chartered engineer in the area of ESR spectroscopy at Institute of Bio Physics at Saarland University (2002-2004).
Since 2005 he has been employed as a Scientific Assistant, PhD student. As head of laboratory since 2009 he is responsible for official and industrial research projects. His main focus lies in analyzing the influences of brewing process stages, filter aids, stabilizing or fining agents and specific beer ingredients on radical reaction mechanisms and oxidative stability of beer or other beverages using ESR spectroscopy and GC-MS. Since 2015 he is a supervisor in EJD-European Joint Docotrate Food Science Program.

P075 - FIRST EXPERIENCE OF THE 'BREWERY 4.0' – THE INTERNET OF THINGS CONCEPT APPLIED IN AN OPERATIONAL BEER FILTRATION UNIT

Dr. Roland Folz[1]; Mark Mol[1]

1 – Pentair, Netherlands

Abstract

First experience of the 'Brewery 4.0' – The Internet of Things concept applied in an operational beer filtration unit

Process manufacturers, like the brewer of today, face constant pressure to improve operational performance. Boosting efficiency and productivity is commercially interesting to do thereby outperforming market rivals, while manufacturing processes are complex so this objective is not easily accomplished. "Internet of Things" technology enables connected operations, giving process manufacturers the ability to collect data from connected equipment, sensors and devices that can be combined with data and intelligence from business systems, leading to benefits in maintenance, operational costs and product quality.

The use of IoT technology:
1. enables maintenance alerts when the equipment deviates from its prescribed parameters which will conserve energy, reduce costs and eliminate machine downtime.
2. enables the monitoring of production lines starting from the malting process down to the packaging of final products leading to a better control of operational costs.
3. aggregates product- and quality data from various stages of a product cycle. All of these inputs can be analyzed to identify and correct quality issues.

In this presentation it will be shown how IoT works in the typical manufacturing process of a brewery. Questions and challenges are popping up which must be answered and tackled, like which data are needed from the process, is it possible to measure these data on a real time basis and how to present these data to involved personal like operators, supervisors and managers. The Beer Membrane Filter system is shown as a worked out example and experiences from first commercial systems are evaluated.

Short biography

Dr. Roland Folz is the Director of Technology & Innovation for Pentair's Food & Beverage division. Since February 1, 2014, Folz is responsible for innovation, product design, solutions development, and the global R&D function.

Folz has 17 years of experience in the brewing and beverage industries. Prior to joining Pentair, he headed the VLB department Brewing & Beverage Science and Applications (BBSA), located in Berlin, Germany.

Folz holds a Ph.D. in Engineering Technology and a Diploma for Brewing Technology from the Technical University Berlin, Germany.

P076 - A NEW APPROACH TO ASSESS THE CROSSFLOW MEMBRANE FILTRATION OF BEER

Michael Kupetz[1]; Martina Gastl[1]; Thomas Becker[1]

1 - Lehrstuhl für Brau- und Getränketechnologie, TU München

Abstract

Filterability of beer is influenced by the applied filtration technology, the use of stabilizers as well as beer composition. Due to this, it is difficult to predict the filterability of beer, especially in connection with stabilizers, at a laboratory scale. Over the years, various approaches for the measurement of filterability have been proposed, which are neither informative nor practical for the assessment of crossflow membrane filtration. Therefore, the aim of this study was the development of a test to determine filter efficiency and performance of beer and the influence of various stabilizers during crossflow membrane filtration (CFMF). In this context, filter efficiency describes the ratio of filtered beer volume between two filter periods, which are interrupted by an intermediate cleaning step of the polyether sulfone membranes. The comparison of different beer samples and their filter efficiency resulted in a good comparability between industrial and laboratory scale (Δ<10%). Furthermore, evaluation of filter performance was performed on the basis of industrial CFMF data. Three categories of filter performance at industrial scale – 'bad' (0–1.5 hL/m^2), 'acceptable' (1.5–3 hL/m^2) and 'good' (>3 hL/m^2) – were identified and compared to a corresponding flux. The use of stabilizers had a major impact on filter life and backwashing of the membranes.Thus, the developed membrane filter test allows the prediction of filter efficiency and performance for CFMF based on one method. Due to the good comparability, this filter test can not only be used for the prediction of filterability, but for optimisation of membrane cleaning processes.

Short biography

Michael Kupetz graduated in 2011 as a graduate engineer for brewing and beverage technology at the Technical University of Munich. In July 2017 he received his doctorate at the Chair of Brewing and Beverage Technology in Weihenstephan on the topic "Comparative identification of filtration-inhibiting substances in the membrane and kieselguhr filtration of beer". In addition, he is head of the Analytical Laboratory for malt, wort and beer quality since July 2016. His research topics are in the fields of method development with a focus on polysaccharides and method automation as well as filterability of beer.

P077- PRACTICAL EXPERIENCE WITH THE KRONES MEMBRANE FILTER PHOEBUS

Joerg Zacharias[1]

1 - Krones AG

Abstract

In the last years membrane filtration became a more and more accepted way for the clarification of beer. As there are advantages and disadvantages in this process, membrane filtration captured a respectable market share. Nevertheless, there are obvious potentials in hygienic design and the cleaning processes. Their influence on the filtration process itself can be shown. Consistent energy reduction and CIP media consumption should be achieved, while membrane life is still prolonged.

Based on the Development „Krones Phoebus - Hygienic Membrane Filtration for Beer“, this paper presents first practical results of the production in a Bavarian brewery. The role played by the new design of Phoebus for an improvement in the CIP capability of the membrane filter is shown by the prove in keeping the beer quality and reasonable duration of the operation time.

Thereby the previously described functionality of membrane modules switched in series were installed, which allow direction changes on the unfiltrate side and specifically individually backwashes for the CIP process. The plant was equipped with two independent membrane units each with six membrane modules. Operation was carried out for the filtration of Original, Dark, Oktoberfest and Bock beer. This paper reports on the performance of the membrane filter in terms of operation, filtrate quality and cleaning. Selected results will be presented. In addition, the importance of hygienic design and process aspects for this membrane filter will be discussed and substantiated with examples.

The Krones Phoebus for beer shows particularly advantages in cleaning and energy consumption.

Short biography

Dr. Jörg Zacharias graduated in 1997 at the Technical University of Munich in Weihenstephan as an engineer in Food Science. 2003 he finished his post-graduate studies with a doctoral degree at the affiliated department of fluid-mechanics and process-automation. Over the last years he was and still is active as associate lecturer in various fields as mechanical and food process technology as well as for plant design and control. In 2005 he entered Krones AG in the research and development division where he is significantly responsible in developing future alternatives in filtration technology for beer clarification and fresh water treatment. For it he is an expert for hygienic design, heat exchanger technology and the matters of rheology of all kinds of beverages. Further, with his expertise, he is involved in the development of several manuals and guidelines in the soft drink and brewing sector as for the EBC, ISBT and MEBAK.

P078 - NOVEL CERAMIC MEMBRANE FOR CROSSFLOW FILTRATION OF BEER

Kohei Watanabe[1]

1 - Asahi Breweries, Ltd., Production Technology Center, Moriya, Japan

Abstract

Conventional ceramic crossflow membranes are more durable than polymer hollow fiber membranes, but their permeability is inferior. Here we report trials with a new ceramic membrane manufactured by NGK INSULATORS, LTD. The membranes have improved permeability due to the presence of water collecting slits on the permeate side after through skin layer. This has been shown to produce a high pure-water flux, and the same can be expected for beer. Filtration trials were carried out on Pilsner type beer in a crossflow filtration system with four ceramic rods with a filtration area of 2.3 m^2/rod and dimensions of □60 □ 1100 mm. We measured the transmembrane pressure during filtration under different conditions (Pore size: 0.5, 0.7, 1.0 □m; Silica gel: hydrogel, xerogel; Flux: 50, 75 100 L/m^2/h).

The results showed that both a high flux and a slow increase of transmembrane pressure can be achieved under optimal conditions. The flux was more than twice that for a conventional ceramic membrane, indicating a filtering performance comparable to that for polymer membranes. We also report the results of microbial tests using this new membrane.

Short biography

Kohei Watanabe received an M.S. degree in Agriculture from the University of Tohoku in 2008, and then began working for Asahi Breweries, Ltd. After a few years as a technical staff member for brewing, he became involved in new product development at the Development Laboratories for Alcoholic Beverages. Since September 2015, he has been working at the Ibaraki R&D Promotion Office, Production Technology Center in Asahi Breweries. He is now in charge of the development and introduction of crossflow filtration systems for wine and beer.

TOPIC: HOP BREEDING, AGRONOMY AND PROCESSING

P079 - HOP OIL PROFILING TO MITIGATE CLIMATE CHANGE IMPACT ON TRADITIONAL HOP VARIETIES

Ray Marriott[1]; Colin Wilson[1]

1 - Totally Natural Solutions Ltd

Abstract

In recent years many traditional hop varieties such as Saaz, Hallertau Hersbrucker, Cascade and Styrian Golding have exhibited declining oil content which has resulted in decreased aroma

impact and lower yields of hop oils. It is not clear that this is entirely a result of climatic change [1,2], although these growing areas have seen hotter and drier summers, or whether it is a combination of hop age, climate and other factors.

This decrease in oil content has an impact on both end product quality and economics and to mitigate this the essential oil of each affected hop variety has been profiled to identify key components and to help create similar aroma and flavour profiles from higher yielding hop varieties from areas less exposed to climate change.

This work has been carried out using both analytical and sensory assessment and oil profiles recreated using hop oils, fractions and individual impact molecules.

Short biography

Ray is Innovation Director of Totally Natural Solutions Ltd a company specialising in the development of hop aroma and flavour products. Ray Marriott spent 35 years in industry working on the extraction and application of natural products and the development of hop products before moving to academia in 2008. Ray then spent time at York University and Bangor University developing “green” processing techniques before returning to the hop industry. Ray has a biochemistry degree from Cambridge and a PhD in terpene chemistry from Bath University.

P080 - BREWING QUALITY ATTRIBUTES OF UMBRIAN WILD HOPS

Valeria Sileoni[1]; Ombretta Marconi[2]; Giovanni De Francesco[1]; Claudia Riccioni[3]; Beatrice Belfiori[3]; Andrea Rubini[3]; Michele Bellucci[3]; Giuseppe Perretti[1]

1 - Italian Brewing Research Centre, University of Perugia; 2 - Department of Agriculture, Food and Environmental Science, University of Perugia; 3 - Institute of Biosciences and Bioresources (IBBR), Research division of Perugia, National Research Council of Italy (CNR)

Abstract

The hop plant is known, and was used, since ancient times for medicinal purposes. Nowadays hop has become one of most important ingredients in beer, in fact brewers are continuously searching hops varieties that can characterize their beer in a unique way. Brewing trend in Italy is constantly expanding and numerous farm breweries have sprung up thanks to the Ministerial Decree 212/2010which compares beer to an agricultural product, experimenting the hops cultivation in addition to their own malt, obtaining beer from wholly local product. Hops cultivation in Italy has never overstep the experimental phase, but nowadays it has regained a new interest and has been included by MIPAAF (Ministry ofAgricultural, Food and Forestry Policies) among innovative crops. In this context, this work aimed to evaluating the main brewing parameters in spontaneous hops in Umbria and observing their characteristics.16 samples was collected and analyzed for: α and β acids, α / β ratio, cohumulone content and the qualitative and quantitative content of the essential oils of each sample. The results of the analysis shown that Umbria hops can be used as dual purpose or finishing hops due to their low content of essential oils, volatile compounds and alpha and beta acids. The study revealed a

good potential of some Umbria hops genotypes for brewing use, particularly for HLVEL2 sample which resulted the most interesting. Further studies should be done cultivating the samples in the field to eliminate the pedoclimatic variable for the evaluation of effective differences between Umbria hops genotypes.

Short biography

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P081 - THE APPLICATION OF METABOLOMICS AND GENOMICS IN HOP BREEDING

Alexander Feiner[1]; Paul Matthews[5]; Klaus Pillen[3]; Ludger Wessjohann[4]; David Riewe[2]

1 - Simon H. Steiner, Hopfen, GmbH; 2 - Julius Kuehn-Institute; 3 - Martin-Luther-University Halle-Wittenberg; 4 - Leibiz-Institute for Plant Biochemistry; 5 - S.S. Steiner, Inc.

Abstract

The major goal of hop breeding is to develop new competitive varieties for an efficient and resource-saving hop industry. Resistance to diseases, pests and changing climatic conditions as well as consistency in yield and quality are specific breeding targets. An important tool to master these requirements is the implementation of molecular genetics and metabolomics. Studying the relationship between metabolite content levels and trait expression enables the identification of molecular processes involved in resistance against abiotic and biotic stress.

For example, downy mildew caused by *Pseudoperonospora humuli* generates significant losses in hop cone yield and quality as well as potential crown death. Therefore, in the present study, a F1 hop population was inoculated with the fungus *P. humuli* under *ex situ* conditions. The inoculation led to both variation in specialized metabolites and downy mildew resistance. Following an untargeted metabolomics approach and using correlation analysis, a small number of metabolites with potential protective function against downy mildew were identified. These metabolites were even correlated in the mock plant set suggesting that downy mildew resistance is established prior contact with the pathogen. The genome-wide association study detected a co-localization of the major downy mildew resistance locus and

the correlated metabolite markers, providing evidence that the main contribution to resistance is mediated by these metabolites, in a heritable way.

This kind of novel metabolic and genetic markers provide a better understanding of the underlying resistance mechanism for a precise selection of crossing partners and progeny in hop breeding in the future.

Short biography

Grown up on a hop farm in Germany, Alexander Feiner started his studies of Agricultural Management at the University of Applied Science Weihenstephan, Germany, in 2005. Followed by a six months internship at the Hopsteiner Research Station in Yakima, USA, in 2010, he started his MSc. in Agricultural Management at the Technical University Munich/Weihenstephan. After finishing his studies in 2012, Alexander Feiner became Head of Hopsteiner Breeding in Europe. In 2014 he started his PhD as an external student at Martin-Luther-University Halle (Saale) and Leibniz-Institute for Plant Biochemistry working on metabolomics and genetics in hops.

P082 - IMPACT OF KILN TEMPERATURES ON THE AROMA AND ENZYMATIC POTENTIAL OF HOPS

Scott Lafontaine[1]; Lindsey Rubottom[1]; Thomas Shellhammer[1]

1 - Oregon State University, Department of Food Science and Technology

Abstract

This study evaluated the impact of kiln temperature on dry-hop aroma potential of Amarillo® and Simcoe® hops across 2 different harvest years. Hops were dried over a range of temperatures (47°C, 60°C, 77°C and 82°C) on pilot scale and commercial scale kilns. The hop storage index increased with kiln temperature, however the concentration of humulones were not significantly impacted by kiln temperature. Furthermore, kiln temperature had only a minimal impact on total oil content of dried hops. In terms of aroma potential in beer, hops dried at high and low temperatures attributed similar aroma intensities and qualities which were more intense compared to intermediate temperatures. Drying higher temperatures significantly reduced the dextrin degrading enzymatic activity of hops relative to lower temperature treatments. These results suggest that higher drying temperatures and shorting drying times can produce hops with similar aroma potential and lower enzymatic activity compared to hops kilned at lower temperatures.

Short biography

Scott Lafontaine is a Ph.D. candidate in Dr. Tom Shellhammer's Laboratory in the Department of Food Science at Oregon State University. His research focuses on understanding the

molecular constituents that drive hop flavor and aroma in dry-hopped beer. He assists in the teaching of residential and continuing brewing analytical and quality education courses at OSU. Prior to joining the Shellhammer Laboratory at OSU, he received his Master of Science in Chemistry at OSU in 2015, during which his studies focused on analytical environmental chemistry.

P083 - "VAKUPACK" – WHOLE HOPS PACKAGED UNDER AN INERT ATMOSPHERE

Scott Lafontaine[1]; Adrian Forster[1]; Andreas Gahr[2]; Florian Schüll[1]

1 - HVG Hopfenverwertungsgenossenschaft e.G.; 2 - Hopfenveredlung St. Johann GmbH

Abstract

Whole hops cannot be stored for long without protection from oxidation. Depending on the variety, even cold storage for one year at 0 °C can result in alpha acid losses of 25–40 %. Aroma compounds and polyphenols are also susceptible to oxidation. To avoid severe losses in quality, whole hops are usually pelletized and packaged in multi-layer film bags. The milling and pelletizing process destroys the structure of the hop cones.

At present, some breweries deliberately utilize whole hops to distinguish themselves from large industrial breweries and accept the difficulties inherent to using whole hops and their subsequent separation. Some view the pelletization temperatures of 50–55 °C as problematic. Whole hops are therefore packaged under oxygenfree atmosphere to overcome storage problems using a proprietary production and packaging process. Bulk whole hops with a specific weight of 100 kg/m³ are compressed to 500 kg/m³ in special presses. The 5 kg rectangular block product is packed, evacuated and sealed in a film bag. The hops are gently conveyed to preserve the cone structure; the shelf life is comparable to pellets. This packaging is known as "Vakupacks".

The production process as well as brewing trials with bulk whole hops, Vakupacks and pellets from identical lots are described in this poster including sensory tests. Systematic differences can be observed in the yields of some compounds due to lupulin gland condition. Pellets and Vakupacks exhibited better extraction because the lupulin membranes were crushed during the production process.

Short biography

Adrian Forster (born in1942) attended the Tecnical University of Munich/Weihenstephan (1966 brewing engineer) and obtained a PhD in brewing science in 1972.

1969-1973 scientist in Weihenstephan at the chair of Prof. Narziss.

1973-2003 managing director of the world´s leading hop extraction and hop pellet plant with responsibility in research.

Forster has published hop-related topics extensively and is current a hop consultant, mainly for the hop growers cooperative in Germany (HVG).

P084 - EVALUATION OF CASCADE HOPS QUALITY CULTIVATED IN NORTH OF ITALY

Paolo Passaghe[1]; Manfredi Guglielmotti[1]; Stefano Bertoli[2]; Stefano Buiatti[1]

1 - University of Udine, Italy, Dept. of Agricultural, Food, Animal and Environmental Sciences; 2 - Theresianer Brewery, Nervesa della Battaglia (TV), Italy

Abstract

Aims. Compared with the large quantities of malt required in beer production, the amount of hops needed is significantly smaller. This minor ingredient has, however, a crucial impact on beer quality and, thus, hops are of great importance for beer brewing. The brewing value of hops is primarily attributed to the precursors of the flavour- and bitter-active compounds found in the resins (α- and β-acids) secreted by the lupulin glands. The hop essential oils are also important to the brewer as they provide flavour and aroma characteristics to the beer. Although hop aromatic character is variety dependent, differences are present within the same variety according to cultivation areas and crop years. This project started in 2015; 21 different hop varieties were cultivated in 3 different experimental fields and the results were presented in the 35th EBC Congress. From these varieties Cascade was chosen (best agronomic and compositional performances) and pilot scale fields were grown in different Italian pedoclimatic environments in 2017 and 2018 (in Piemonte region, north-west of Italy).

Methods. The hop cones, soon after harvest, have been dried at the final humidity of 10%. Pressed and under vacuum packaged samples have been stored at 4 °C in the dark. The alpha-, beta-acids concentrations and the essential oil compounds have been analysed according to EBC methods.

Results and Conclusions. The data obtained are useful information on the possibility to grow hops in different Italian pedoclimatic environments. Cultivation trials provided good results in terms of resin and oil composition.

Short biography

After his study of Food Science, he started working as PhD-student at the University of Udine. Following his supervisor Prof. Stefano Buiatti; he is in charge of experimental microbrewery at the University and deliveries course on Brewing Technology, Cleaning and Disinfection of Food Plants'. In 2016 he started working in the research and development section (Brewing Science Group) at the Department of Agricultural, Food, Animal and Environmental Sciences of University of Udine.

P085 - WHAT CAN CRYO HOPSR AND AMERICAN NOBLE HOPS™ DO FOR YOUR BEER?

Cynthia Almaguer1, Patrick Jensen1, Missy Raver1, Emily Breneman1, Jacqueline Hite1, Brenda Padilla1, Aidee Padilla1, Nick Ziegler1

1 - Yakima Chief, Louvain-la-Neuve

Abstract

The Cryo HopsR process is an innovative cryogenic hop processing technology, proprietary of Yakima Chief Hops, used to separate whole cone hops into two different hop products for brewing purposes. Cryo HopsR and American Noble Hops™ are produced simultaneously when hop cones are separated into purified lupulin and bract fractions, respectively. The separation process occurs at very low temperatures and in a nitrogen-rich atmosphere avoiding the rupture of the lupulin glands. If these glands are damaged, this would consequently cause the oxidation of hop resins and oils. It is in the lupulin glands that the main brewing principles of hops, resins and essential oils, are synthesized and accumulated. It is the purpose of this work to characterize and profile these innovative brewing hop products. Further, the functionality of Cryo HopsR and American Noble Hops™ as brewing products is examined. To achieve this, brewing trials were conducted using Cryo HopsR, American Noble Hops™, and traditional hop products (e.g. whole cone hops) to dry hop beers. These beers were chemically analyzed and compared. The hop oil profiles of these beers were determined by stir bar sorptive extraction coupled with GC-MS. These experiments showed that adding the same amount of Cryo HopsR will yield almost twice the amount of hop constituents and lower vegetal notes compared to traditional hop products. In contrast, American Noble Hops™ could be used as an alternative to traditional hop varieties used in mildly hopped beer styles. Both products offer the brewer new options to deliver desirable aromas and flavors.

TOPIC: MALTING: MALT PRODUCTION AND QUALITY

P086 - CHARACTERIZATION OF MALTS BY SENSORY ANALYSIS AND ANALYSIS OF VOLATILES

Michael Féchir[1,2]; Veronika Mall[2]; Klaas Reglitz[2]; Jens Voigt[1]; Martin Steinhaus[2]

1 - Trier University of Applied Sciences; 2 - Leibniz-Institute for Food Systems Biology at Technical University of Munich

Abstract

Besides water, malt is quantitatively the most important raw material for beer production and the main source of fermentable extract and colour. Malt may also have an impact on the overall olfactory and retronasal profile of the final product beer. A trained sensory panel was used to characterize the aroma of trial malt types produced in a pilot plant model system by varying technological malting parameters. In parallel, malt volatiles were analyzed by applying a semiquantitative HS-trap-GC-MS method. Results were compared to industrially produced

reference malts. Volatiles that varied most significantly between malt types were selected as marker substances to be exactly quantified. Varied malting parameters led to significant differences in the sensory properties as well as in the volatile composition according to statistical evaluation by ANOVA and Bonferroni Multiple Comparison. PLSR modeling with sensory and analytical malt data showed, that several quantified marker substances may serve as promising indicators for malt aroma properties, although it was not assessed whether these compounds causally contributed to the aroma or not. Ongoing research will apply the approach also to beer and brewing intermediates to assess and predict the influence of malt type and malting parameters on the overall aroma properties of beer.

Short biography

Michael Féchir is a researcher in Food Technology at Trier University of Applied Sciences and PhD candidate at the Technical University of Munich. His research focusses on the characterization of malts by sensory analysis and analysis of their volatiles. He is a certified expert for sensory evaluation of beer and mixed beer drinks (DLG) and successfully completed his M. Eng. in Food Economy (graduation as 2nd best of year 2015, Master Thesis at Mich. Weyermann Specialty Malts, Bamberg) and his B. Eng. in Food Technology (2014, Bachelor Thesis at Merck, Darmstadt) at Trier University of Applied Sciences.

P087 - AN EXAMINATION OF CHANGES IN PASTING BEHAVIOR OF IN-PROCESS MALT USING RAPID VISCO ANALYZER (RVA)

Xiang S Yin[1]; John Andrews[1]; Pattie Aron[1]; Paul Kramer[1]

1 - Rahr Corporation, USA

Abstract

Starch liquefying characteristics directly impact the brew house efficiency and the fermentation performance of malt. While regular analytical parameters of malt provide certain indication on these properties, RVA has been shown to have more detailed insights to the pasting profile of the starch components in malt when undergoing a programmed temperature treatment. The present research explored the pasting behaviors of malt through RVA of selected varieties of barley, and of varying process intensities in the stages of saccharification and curing during kilning. Data indicated that when the green malt kernels were undergoing in-kernel mashing in the saccharafication phase, the pasting temperature increased significantly by about 5 ˚C, accompanied by changes in viscosity. However, during the curing hours, while the high heat inactivated the enzymes, the onset of the pasting temperature did

not show noticeable change. Results reflected the physical and biochemical modifications of starch components inside the malt kernels in the malthouse setting. The study demonstrated a practical technique in acquiring valuable gelatinization and viscosity information of malt, that is significantly beneficial for process optimization by both maltsters and brewers.

Short biography

Xiang S Yin is the Director of Brewing Research and Innovation at Rahr Corporation, USA. He worked as the Global Director of Brewing Raw Materials at SABMiller based in UK, and prior to that as Global Technical and Innovation Director with Cargill Malt based in USA. Xiang is a fellow of IBD, and served the ASBC as president and chairman of the Foundation Board and is a recipient of ASBC Award of Distinction 2015. Xiang also serves the ASBC on the Editorial Board for the JASBC and as Asia Liaison Officer. He is currently the Technical Committee Chairman for the Brewing and Malting Barley Research Institute, Canada. He is the author or coauthor of over 60 papers and patents. Xiang obtained his first degree in fermentation technology from China, and received his Ph.D. from Heriot-Watt University, Edinburgh in 1986, with postdoctoral training in Edinburgh University and Gran Research Laboratory, Canada.

P088 - UNDERSTANDING THE COMPONENTS OF SPECIFIC WEIGHT IN MALTING BARLEY

Aaron Hoyle[1,2]; Maree Brennan[3]; Gail Jackson[2]; Steve Hoad[1]

1 - Scotland's Rural College; 2 - University of Edinburgh; 3 - Faculté des Sciences et Technologies

Abstract

Specific weight is one of the longest standing measures of grain quality for cereals because it is a measure of the weight of grain per unit volume, and is therefore of economic importance for transport and batch processes such as malting and brewing. A high specific weight is thought to be indicative of high starch content and benefit maltsters. Accordingly, specific weight influences the value of barley grain and high specific weight is an important breeding target. However, the reliability of specific weight as a malt quality indicator is disputed. Understanding components of specific weight is an essential step towards linking this measure to efficiency/productivity of the malting process. Initial work has shown that specific weight is the product of grain packing efficiency and grain density. The determinants of these two components are being investigated to determine whether they are beneficial for malt production. The grain density component was further dissected by stratifying samples from five spring barley malting cultivars into different density classes. Elemental analyses, enzymatic starch assays and starch granule analyses were carried out to determine if composition correlates with density. Nitrogen content (r^2=0.34, p<0.01) and volume of starch B granules (r^2=0.28, p<0.01) have significant positive correlations with grain density. However, grain starch content does not correlate with density. This could have wide implications for the use of specific weight as a quality measure in the malting supply chain, especially since density (a component of specific weight) carries detrimental characteristics like nitrogen content and increased B granule volume.

Short biography

Aaron Hoyle is a PhD student entering his 3rd year at Scotland's Rural College (SRUC) and the University of Edinburgh (UoE). Aaron's project is on the grain quality measure specific weight, an important quality measure for malting barley.

P089 - ECONOMIC CONSIDERATIONS ON A SMALL SIZE DRUM MALTING PLANT

Stefano Buiatti[1]; Manfredi Guglielmotti[1]; Daniele Rossi[1]; Stefano Bertoli[3]; Giovanni Cortella[2]; Paolo Passaghe[1]

1 - University of Udine, Italy, Dept. of Agricultural, Food, Animal and Environmental Sciences; 2 - University of Udine, Italy, Polytechnic Dept. of Engineering and Architecture; 3 - Theresianer Brewery, Nervesa della Battaglia (TV), Italy

Abstract

Aims. The number of craft breweries using their own barley is growing, consequently interest on small scale malting plants and on their economic sustainability has highly increased. Data about energy and water used by a small size malting plant (500 kg) were collected and elaborated to validate a predictive model.

Methods. The energy and water consumptions of every steps of malt chain production were measured and recorded. These data were elaborated to validate a predictive model. The model was used to evaluate consumptions depending on some parameters variations (e.g. temperature and humidity of utilized air). Moreover, a water recycle system has been evaluated in order to decrease its consumptions. The malt quality was assessed through different analysis: humidity, β-glucan content, diastatic power, Kolbach index and extract yield. The malt was also used to produce a craft beer.

Results and Conclusions. From the collected data the energy consumption is, as confirmed by literature data, mostly represented by kilning step. The water usage, which is rather high caused by the barley transfer from the steeping vessel to germination drum, can be considerably reduced thanks to a recycling system. Nonetheless, the small malting plant consumptions were higher than large malting plants, but it can allow to have beers with an added value coming from the possibility to use local raw materials.

Short biography

Degree in Agricultural Science, University of Bologna, 1984

Lecturer/Researcher University of Udine 1985 – present

Quality Control Technician – Moretti Brewery, 1985

Research secondment to Brewing Research International, Nutfield (UK) September 1997 to March 1998 and July 1999 to October 1999

Expert as project evaluator for EU since 1999 (in FP 5,6, 7 and Horizon 2020)

In charge of the experimental microbrewery at the University of Udine

Preparation and delivery of lecture course at University of Udine on “Brewing science” and “Cleaning and Disinfection of Food Plants”

Optimization of analytical methods, chemical and microbiological quality assessment of craft beers. Stefano Buiatti has been working at the Department of Food Science of University of Udine as researcher since 1990. He is in charge of a pilot brewery and an experimental malting plant at the University and deliveries courses on “Brewing Technology” (since 1994), “Cleaning and Disinfection of Food Plants” (since 1999) and “History and culture of Food” (since 2007). Research secondment to Brewing Research International, Nutfield (UK) in 1997, 1998 e 1999. Expert as project evaluator for EU since 1999.

P090 - EVALUATION OF GERMINATION PARAMETERS DURING MALTING REGARDING PHENOLIC ACID RELEASE DURING WORT PRODUCTION USING RESPONSE SURFACE METHODOLOGY

Torsten Seewald[1]; Max Biermann[1]; Frank-Jürgen Methner[1]

1 - Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science

Abstract

The release of phenolic acids during wort production has a considerable influence on the formation of key aroma compounds during the production of beers, which are fermented with POF^+ yeasts. The most common phenolic acids are ferulic acid and p-coumaric acid, as precursors of 4-vinylguaiacol and 4-vinylphenol, respectively. However, in parallel to these desired precursors, undesired precursors such as cinnamic acid, which can be enzymatically decarboxylated to vinylbenzene (styrene), are also released. Since vinylbenzene has a carcinogenic potential, it is essential to minimize the release of cinnamic acid. The aim of the study was to evaluate the influence of the germination process during malting on the release of desired and undesired phenolic acids.

Therefore, small scale malting trials with two barley varieties (*Solist* and *Quench)* and one wheat variety (*Dacanto*) were performed using response surface methodology. Within the scope of this experimental design the germination temperature and the aeration rate were varied. Congress worts were produced and malt quality was evaluated according to MEBAK®. Ferulic acid, p-coumaric acid and cinnamic acid were quantified using HPLC-DAD.

The results indicate that the varied germination parameters lead to a significant change of the phenolic acid release. Especially, the modification of the malts from the barley varieties *Solist* and *Quench* contribute to an optimized ratio between the desired and undesired phenolic

acids.These results can contribute to achieve a targeted malt modification for an increased release of the desired ferulic acid and p-coumaric acid, while simultaneously minimizing the cinnamic acid.

Short biography

Torsten Seewald is a scientific assistant at the Technische Universität Berlin, Germany, where he studied food technology and graduated as Diplom-Ingenieur. During his studies, he was working on several research projects at the Chair of Brewing Science and completed industrial placements at WILD Dairy Ingredients GmbH and Herbstreith & Fox KG. Currently, he is working in the field of malting and oxidative processes in wort and beer.

Keyword's : Malting, Germination, Phenolic Acid Release

TOPIC: NEW PROCESS DEVELOPMENT

P091- LABORATORY PLANT FOR A CONTINUOUS CLOSED LOOP CONTROLLED MASHING AIDED BY DIGITAL TECHNOLOGIES

Patrick Wefing[1]; Florian Conradi[1]; Johannes Rämisch[1]; Jan Wilhelm Schoppmeier[1]; Kevin Pinkal[2]; Fan Zhang[2]; Oliver Niggemann[2]; Jan Schneider[1]

1 - Institute of Food Technology ILT.NRW; 2 - Institute Industrial IT - inIT

Abstract

Mashing has not been realized as a closed loop-controlled process yet. Therefore, an inline sensor system is needed for providing pysico-chemical information in real-time. By the implementation of machine learning algorithms, an automated adaption on varying raw material properties, a closed loop-controlled (CLC) process, can be achieved. Furthermore, application of the CLC technology on continuous processes advances such a process from inflexible to highly flexible in regard to raw materials. A flexible continuous process advantages a standard batch process due to product assortment, smaller equipment and energy saving options.

A pilot plant (flow rates from 0.3 L/h to 6.0 L/h) as a semi-heterogeneous reactor cascade was designed and set up. The plant consists of a mashing-in vessel and one or two reactors (1 L) per rest. The system is equipped with NIR-transflectance and temperature sensors. Temperatures and residence time are the major adjustments screws and thus the actors in the continuous CLC set-up. The mean residence time is conducted by variation of flow rate and reactor volume. Process control and data acquisition is realized with CodeSys on a Raspberry Pi.

Process control parameters as maltose and FAN concentrations are gained from in-line NIR spectra and conductivity measurements. Further development of the sensor system shall also

include the gelatinization point and pH value. The submitted work presents the realized plant in the current state of progress (mashing-in and maltose rest (ß-amylase rest)) as described above, technical measurements as residence time distributions and first approaches with the inline NIR-systems.

Short biography

born: 28.08.1988 in Bielefeld, Germany

Master of Science

Bachelor of Science in the field of Biotechnology - 2009 - 2012

- OWL University of Applied Sciences, Germany

Master of Science in the field of Molecular and Applied Biotechnology - 2012 - 2015

- RWTH Aachen University, Germany

Research Assistent at the Chair of Bioprocess Engineering - 2016 - 2017

- University of Bayreuth, Germany

Research Assistent at the Institute of Food Technology ILT.NRW - 2017 - now

- OWL University of Applied Science, Germany

Doctoral Candidate at the Chair of Bioprocess Engineering - **2018 - now**

- TU Berlin, Germany

P092 - PRE-TREATMENT OF BARREL: CONTROL TOOL FOR AGING OF BEERS

Mariana Costa De Castro[1]; Giovanni Casagrande Silvello[1]; Ana Carolina Corrêa[1]; Aline Marques Bortoletto[1]; André Ricardo Alcarde[1]

1 - University of São Paulo, USP-ESALQ, Piracicaba, São Paulo, Brazil

Abstract

Aging in wood barrels is a frequently used practice aiming to increase the complexity of the product and obtain high quality beverages. The reactions between beer and wood allow degradation and extraction of compounds that modify the sensory profile of beer. Along this process, the beverage interacts with wood and incorporates color and flavor. However, wood can supply a range of varieties of yeast and bacteria, which causes transformations during maturation, such as the increase of beer acidity. The objective of this study was to evaluate the

effect of thermic and chemical treatments on microbiological contamination of English Barleywine beers aged during 180 days under controlled temperature (17 ± 0,3 ºC) and humidity (81 ± 3%) conditions in barrels made of different wood species: American oak (*Quercus alba*), Amburana (*Amburana cearensis*) and Cabreúva (*Myrocarpus frondosus*). The treatments employed water steam and peracetic acid. Microbiological monitoring analyzes were carried out by plating in selective medium for lactic acid bacteria (MRS-agar), acetic acid bacteria (Manitol-agar) and yeasts (WL Nutrient Medium) at 0, 90 and 180 days of aging. The treatment used to sanitize the barrel was efficient to eliminate acetic and lactic bacteria. On the other hand, an increase in the number of CFUs was observed for yeasts. Besides the termic and chemical treatments, conditions in the aging chamber may have favored the selection of yeast during the aging process for beer.

Short biography

Mariana Castro is an agroindustrial biotechnologist at the Federal University of São Carlos (UFSCar). Currently is a master's student in Food Science and Technology, with emphasis on alcoholic beverages at the University of São Paulo - College of Agriculture “Luiz de Queiroz” (USP/ESALQ). She has experience in the area of fermentation, barrel-aging and beverage technology.

P094 - ADJUNCT CUM MASH TUN FIRST OF ITS KIND IN COMMERCIAL SCALE BREWING IN ASIA.

Gopal Krishnan[1]

1 - Carlsberg India

Abstract

In Asia Breweries, to reduce the overall cost of beer more adjuncts are used with the objective of lower beer production cost mainly contributing with the lower extract cost in brewing.

Traditionally in the brew house(BH), adjunct like maize and rice grits are cooked in a adjunct cooker. The cooked adjunct will be transferred to the mash tun for mashing with Malt. This requires two vessels of adjunct cooker and Mash tun. Also the conveyors from adjunct grist case to adjunct premasher and Malt grist case to Malt premasher is required . With the new installation instead of an adjunct cooker(AC) and a mash tun(MT) ,two vessels of adjunct cum mash tun (ACM) installed with a single premasher (MM, Meura Mechamasher) for both malt and adjuncts installed. With the traditional brewing method of adjunct transferred to mash tun will give raise to maximum 8 brews a day, with the new installation the number of brews per day increased to 14 resulting in substantial increase in brew house capacity with less capital expenditure compared to the traditional design of adjunct cooker(AC) and mash tun(MT) vessel operation.

With the new ACM kettle operation of mashing, mash is transferred via the Meura Mechamasher (MM) which is the most ideal of gentle transfer to the vessel with out any

oxygen pick up with very low grist to Liquor ratio of Max 1.9. Due to the low lipoxygenase activity , the beer quality obtained with this novel method improved compared to the traditional mashing with top premashing.

In India a new green field brewery installed by Carlsberg India at Mysore, Karnataka has successfully running this brewhouse for the last one year. The brew length is 325 hl with brewhouse configuration of Meura mechamasher)1 no, ACM -2 No, Mash filter(Meura), Pre run vessel(PRV), Wortkettle with vapor recovery, Hop dosing system, Whirlpool, Essau Huber Turbojet wort aerator,Wort cooling with complete automation. With this configuration comparing with traditional operations of a separate adjunct cooker and Mash tun , a capex cost of 1.8 Euros/HL is saved for a 1.8 million HL brewery capacity. (4.12 Euro per HL capex cost for traditional Vs 2.3 Euro per HL for ACM). Thus a saving of 3.3 Million Euros for a 1.8 Million HL brewery.

Also there is a small saving of operating cost in CIP costs with the new ACM mashing operations.

Now to reduce the operating cost and investment cost adjunct cum mash kettle is proposed instead of separate adjunct kettle and mash kettle. The total process with process flow diagram is discussed in this poster to get overall idea on the same.

P095 - MICROBIAL EXOPOLYSACCHARIDES AS AN ALTERNATIVE FOR DECLARABLE STABILIZERS AND OPACIFIERS

Julian Huchtmann[1]; Sören Rossmann[1]; Verena Kindsvater[1]; Viktor Eckel[2]; Frank Jakob[2]; Jan Schneider[1]

1 - ILT.NRW; 2 - Lehrstuhl für Technische Mikrobiologie, Technische Universität München

Abstract

Microbial exopolysaccharides (EPS) are alternative hydrocolloids and can be produced by fermentation in situ in food. EPS formed by fermentation could thus fill an important gap as non-declarable stabilizers ("clean labelling"), which may even be superior to conventional stabilizers in their techno-functional properties because they can be specifically adapted in terms of structure and properties by selecting the strains and by knowledge-based fermentation management. A targeted use as a functional ingredient has not yet been pursued because EPS were generally regarded as undesirable thickening substances. Current studies, however, show that homopolysaccharides (HoPS), which are formed from sucrose by lactic acid and acetic acid bacteria, cause only slight viscosity increases even in high concentrations. Rather, these EPS types have the ability to form and stabilize turbidity in aqueous solutions and at the same time can have emulsifying properties. A targeted, knowledge-based application of such HoPS in beverages is currently hampered by a lack of basic knowledge of the properties of EPS.

In the present study, two strains each of Lactobacillus (L.) hilgardii and L. hordei were fermented in apple juice, grape juice and beer wort. The resulting EPS were investigated for

their ability to adapt the properties of real beverages. Studies on viscosity increase and turbidity formation showed promising results. Clear differences were observed depending on the fermentation medium and the strain used.

The poster gives an overview of the beverage influencing properties of the EPS obtained in different growing media and shows the applicability for cloudy non-alcoholic beverages and mixed beer beverages.

Short biography

After his apprenticeship as chemical-technical assistant Julian Huchtmann started his study in 2011 in Beverage technology at OWL University of Applied Sciences. In 2014 he was working for a half year at LägereBräu AG in Wettingen in Switzerland. After his job at LägereBräu AG he finished his bachelor and started the master in Life Science Technologies also at OWL University of Applied Sciences. During the masters he developed functional beverages, for example: "Yourdaily". After his master thesis in June 2018 he started working an ILT.NRW – Institute of Food Technology NRW in the research project "Innovative beverage ingredients". Also he is working as teamleader from the "Junge DLG Lemgo" since 2016.

P096 - SIMULATION OF DRY HOPPING IN LABORATORY-SCALE HOP EXTRACTOR

Lukáš Jelínek[1]; Jana Müllerová[1]; Jakub Nešpor[1]; Kateřina Štulíková[1]; Marcel Karabín[1]

1 - University of Chemistry and Technology Prague, Department of Biotechnology

Abstract

Dry hopping is a very popular brewing technology which allows the production of beers with an intensive hop flavor. Nowadays, commonly used maceration of hop material is replaced by techniques using hop extractors where the beer is circulating through the layer of hop material. This technology can make the process more effective and is significantly contributing to the standardization of the final beer. In our research we simulated production of dry hopped beers using a laboratory-scale hop extractor equipped with a candle filter and flow control. This extractor was used to prepare 16 samples of dry hopped lagers (under defined conditions), which were analyzed for the concentration of essential oils. Influence of hop dose, processing time and flow rate on the content of essential oils was assessed based on the obtained results. Statistical analysis (Central Composite Design and Pareto distribution) proved the significant influence of the hop dose, however the effect of flow rate was also interesting, inasmuch as the best results of dry hopping were achieved for extremely low and extremely high flow rates. The final beers were further compared with samples made by static dry hopping (maceration). It has been shown that two-hour hop extraction can easily replace 14-day maceration. It has also been shown that beers produced in extractor contain more terpenes hydrocarbons than static dry hopping samples, where the oxygen fraction was dominant.

Short biography

Born in 1984. 1999 – 2003: Technical graduation as a brewer and maltster; 2004 – 2009: MSc degree at the Institute of Chemical Technology, Prague, Czech Republic; 2009 – 2014: Postgraduate (PhD) in biochemistry and biotechnology at ICT, Prague. PhD thesis: New ways to improve the colloidal stability of beer; 2014 – present: Assistant Professor at department of Biotechnology, University of Chemistry and Technology, Prague; Research topics: Colloidal stability of beer, sensory analysis, high tech hopping and waste management.

TOPIC: NEW PRODUCT DEVELOPMENT

P097 - FASTER AND SAFE TANK CLEANING USING CONTROLLED JET MOTION

Thomas Weyrauch[1]; Max Hesse[2]

1 - Hohe Tanne GmbH; 2 - Fraunhofer IVV Dresden

Abstract

Efficient cleaning is crucial in the food industry due to increasing safety needs, cost pressure and diminishing size of production batches. Motor-driven jet cleaners are traditionally often used to clean large tanks having stubborn contamination. The downside of these cleaners is that their path of movement is set by the fixed gear ratio. This means that a need-based or adaptive cleaning within the scope of Industry 4.0 is not possible.

To make the cleaning process more effective and efficient, an adaptive jet cleaning system with two independently driven axes has been developed. The adaptive jet cleaner is able to perform customized, heavy-duty cleaning tasks. Especially critical points like tank connectors, manholes, agitators and dried deposit due to the liquid level are effectively cleaned by user defined cleaning motion.

To demonstrate the advantages of the novel tank cleaning solution an investigation has been carried out using a test tank. The result shows the influence of free programmable cleaning motions compared to forcibly guided cleaners, which follow a predetermined path. It was pointed out that an optimized cleaning motion has a major impact regarding cleaning time and consumption (power, detergent, wastewater). At the end a reduction of 65 % cleaning time could be reached in the tests.

Short biography

Mr Weyrauch studied mechanical engineering with focus on processing machinery and packaging technology at the Technische Universität Dresden. Since 2012 he works at the Fraunhofer IVV in the working group Industrial Cleaning Technologies where he leads the team of system and component development. Research and development activities of this group focusing on issues related to Hygienic Design of food processing machinery and making industrial cleaning processes more effective as well as efficient.

In addition, since 2016 he is consultant of the company Hohe Tanne GmbH, where he is responsible for the development and design of hygienic equipment for food handling and cleaning systems.

P098 - USE OF WOOD CHIPS IN BREWING : IMPACT OF PROCESS AND MATERIALS

Brabant Pierre[1]; Schmit Marc[1]

1 - IFBM

Abstract

More and more beers are made with wood chips. La Tonnellerie Radoux (French for Radoux copperage) and IFBM collaborated together to understand in beer what is already known with wine and wood.

(The aim of this study is to understand the impact of process, dosage and wood species on the final result.)

Different timings were also tested from Brewhouse to ageing tanks. Two types of wood were tested, French oak and American oak with different dosages.

Analysis part was approach from the perspective of beer, performing standard analysis but also looking for molecules of interest brought from wood, molecules which are already well-known in wine.

The goal was to control the taste from the process control monitored with analytical data.

Short biography

Pierre Brabant is the pilot plan manager at IFBM. He studied brewing and malting at ENSAIA engineer school in Nancy, France. After working in production of soft drinks he joined IFBM in 2016. He is in charge of the malting plant, the brewery plant and the beverages studies. He is a trainer in the IFBM craft brewing training program.

P099 - TRANSFER OF CHARACTERISTIC MARKERS DURING AGING OF BEER WITH DIFFERENT OAK CHIPS

Marcel Karabín[1]; Monika Lazarová[1]; Jakub Nešpor[1]; Lukáš Jelínek[1]; Pavel Dostálek[1]

1 - University of Chemistry and Technology Prague, Department of Biotechnology, Prague, Czech Republic

Abstract

Maturation in wood, traditionally used for production of other alcoholic beverages (wine, spirits), has also become an interesting alternative for brewing. Nowadays, this technique is almost exclusively used by microbreweries to produce special "barrel/wood aged" beers. However, the traditional process based on maturation in wooden casks is very expensive, and also is associated with the risk of oxidation triggered by oxygen diffusion through the wood pores. Therefore, alternative ways of beer maturation with small wood fragments are currently being studied, which should provide beer with similar sensory properties as those produced using wood barrels. This study focuses on the determination of significant markers of aging with toasted wood chips (whisky lactones, guaiacol, eugenol, vanillin, syringaldehyde, furfural) and their transfer to beer under both model and pilot-scale conditions. The influence of the type of wood (American and French oak) and the level of toasting were assessed. It has been found that samples prepared from different types of wood differ particularly in the content of guaiacol (smoked), *cis*-whisky lactone (coconut) and furfural (roasted almonds). The use of heavily toasted wood chips leads to an increase in the content of guaiacol derivatives, so this material could be used, for example, to imitate the sensory properties of “smoked” beers.

Short biography

Holds a PhD degree in Brewing and Malting from the University of Chemistry and technology Prague, Czech Republic. Appointments: 2000-2008 - Research Scientist, Department of Biotechnology, UCT Prague. Since 2008 - Assistant Professor, Department of Biotechnology, UCT Prague. Current Research Topics: Chromatographic methods (HPLC, GC-MS); isolation techniques and preparation of samples related to the determination of sensorially and colloidally active constituents of malt, hops and beer; health-promoting properties of hops; hop varieties authentication; methods of brewing analytics.

P100 - HIGH PROLYL-ENDOPEPTIDASE ENZYME DOSAGES FOR THE PRODUCTION OF GLUTEN-FREE WHEAT BEER: A LAB-SCALE CASE STUDY

Hellen Watson[1]; Anneleen Decloedt[2]; Dana Vanderputten[3]; Jessika De Clippeleer[1,3]; Anita Van Landschoot[1], Filip Van Opstaele[4]

1 - Ghent University, Faculty of Bioscience Engineering, Department of Biotechnology, Brewing Science and Technology Research group, Ghent, Belgium; 2 - Ghent University, Faculty of Veterinary Medicine, Laboratory of Chemical Analysis, Ghent, Belgium; 3 - University College Ghent, Faculty of Science and Technology, Department of Biosciences and Food Sciences, Brewing Science and Technology Research group, Ghent, Belgium; 4 - KU Leuven, Department of Microbial and Molecular Systems (M2S), Cluster for Bioengineering Technology (CBeT), Laboratory of Enzyme, Fermentation and Brewing Technology (EFBT), Technology Campus Ghent, Gebroeders De Smetstraat 1, B-9000 Ghent, Belgium

Abstract

Gluten-free is one of the fastest growing markets. Also in the beer-market today's consumers have a thirst for gluten-free beer. The enzyme prolyl-endopeptidase from *Aspergillus niger* (AN-PEP) has showed to be effective in the reduction of gluten and gluten peptide levels in barley malt beers to below the gluten-free (< 20 ppm) threshold. AN-PEP enables the production of gluten-free malt beers in a controlled and reproducible manner [1]. This creates new opportunities for breweries in the gluten-free beer-market and it also drives the need for a range of different gluten-free beer styles.

In this study the effect of the AN-PEP enzyme (1- to 16-times the recommended standard dose) on an industrial wheat beer wort (13°P) with high gluten concentrations (i.e. > 2700 ppm) was studied. The addition of a high AN-PEP dosage successfully lowered the gluten and gluten peptide concentration to < 20 ppm and made the final wheat beer gluten-free. Characteristic for wheat beers are a pleasant fruity aroma, a whitish-yellow colour, intense beer foam and high turbidity due to the lack of a beer clarifying step. Therefore, the impact of elevated AN-PEP enzyme dosages on latter quality and sensory attributes of the final wheat beer was evaluated in comparison to the untreated reference.

[1] Watson H.G., Vanderputten D., Van Landschoot A., Decloedt A.I. (2019) Applicability of different brewhouse technologies and gluten-minimization treatments for the production of gluten-free (barley) malt beers: pilot- to industrial-scale, *J. Food Eng.* 245, 33-42

Short biography

Hellen Watson graduated in 2014 as M. Sc. Biochemical Engineering, Ghent University, Belgium. After graduating she started to work at the Brewing Science & Technology Research Group of Ghent University as a PhD student. Her doctoral study focusses on the occurrence and influence of processing on gluten and toxic gluten peptides in fermented beverages. The technological aspect of her work has successfully led to the implementation of gluten-minimization treatments in industrial brewhouses for the production of gluten-free malt beers. Her work also gives more insight into the gluten proteome of non-gluten-free and gluten-free malt beers.

P101 - WHY BREWER'S YEASTS ARE THE BEST "HEALTH BENEFIT" PARTNERS OF KOMBUCHA MICROORGANISMS CONSORTIUM?

Dillemans Monique[1]; Rochefort Lauranne[2]; Van Nedervelde Laurence[1]

1 - Labiris; 2 - ULB

Abstract

Kombucha is a beverage traditionally obtained by fermenting tea with a symbiotic culture of bacteria and yeast (SCOBY). It is generally associated with health-promoting effects which derive from the tea and/or the beneficial microorganisms of the kombucha's consortium.

The aim of this work was to develop a “health beverage” using a “microorganism matrix” where probiotic bacteria and brewer’s yeasts are combined with gluconobacter, kombucha’s essential element.

After fermentation, a better understanding of the yeast’s role on health criteria will be performed. This will be assessed by evaluation tests on approved *in vitro* models of some physiological parameters involved in many diseases.

Knowing that multiple mechanisms and synergistic effects underlie the potential biological activities of a functional food or beverage, studies have focused on a multicenter approach.

Indeed, the following “health markers” were considered: cell apoptosis regulation, epithelial permeability, intracellular junctions integrity and redox homeostasis. Moreover, antioxidant parameters and NF-κB inflammatory markers were quantified.

The results show that the addition of brewer's yeast to a commercial kombucha or even a “consortium-defined” kombucha positively and significantly influences the value of the studied “health scores”, specifically those concerning the level of antioxidant and anti-inflammatory properties.

Short biography

Studies : 1978 : Brewing Engineer from the Meurice Institute in Brussels.

1981 : MSc in Natural Science from the Catholic University of Louvain

1990: European Certificate in dermo-cosmetology at the University of Brussels.

Current position : Since 1978 Research Manager at the department of Brewing Sciences of Meurice Institute.

Her main research activity is concentrated on yeast metabolism and yeast derivatives and cosmetics (antioxidant, yeast activators...).

TOPIC: NOVEL RAW MATERIALS FOR BEER PRODUCTION

P102 - BREWING WITH 10/20 % LENTIL MALT ADDITION IN A MICROBREW SCALE

Jonas Trummer[1]; Hellen Watson[2]; Jessika de Clippeleer[2]; Aleksander Poreda[1]

1 - University of Agriculture in Krakow, Faculty of Food Technology, Department of Fermentation Technology and Technical Microbiology, Krakow, Poland; 2 - Ghent University, Faculty of Bioscience Engineering, Department of Biotechnology, Laboratory of Brewing Science and Technology, Ghent, Belgium

Abstract

Lentils are a common source of food throughout the whole world. It has been proven, that commercial green lentils can be germinated and kilned in order to get a malt which is suitable for wort production. In this research, the addtion of 10 and 20 % lentil malt, in order to produce a beer, was done in a microbrew scale of 80 l. Analysis that have been performed were: Chemical-technical analysis; sugar composition; gluten content; amino acid composition and sensory analysis. The analysis showed sufficient results compared to the reference brews (100 % barley malt). Overall, the use of lentil malt in beer production has been determined as possible, for usage of 10 and 20 % addition.

Short biography

Jonas Trummer is a Phd student at the University of Agriculture in Krakow within the European Joint Doctorate in Food Science (PhD School in malting and brewing).
Graduated from the TU Munich-Weihenstephan where he accomplished the B.Sc. and the M.Sc. in Brewery Science and Beverage Technology. He did exchange programs at Corvinus University Budapest and University College Cork, where he wrote his master thesis about the influence of LAB on malt quality. Before starting the PhD in 2017, he was working for two years for a medium sized brewery in Germany in the position of a quality controller.

P103 - HOW RESEARCH ON ALTERNATIVE GRAINS CAN BOOST THE BREWING INDUSTRY

Jessika De Clippeleer[1,2] Julie Demeulenaere[1], Dana Vanderputten[2]
1 - Ghent University, Faculty of Bioscience Engineering, Department of Biotechnology, Laboratory for Brewing and Fermentation Science & Technology, Valentin Vaerwyckweg 1, B-9000 Ghent, Belgium; 2 - University College Ghent, Faculty of Science and Technology, Department of Biosciences and Food Sciences, Laboratory for Brewing and Fermentation Science & Technology, Valentin Vaerwyckweg 1, B-9000 Ghent, Belgium

Abstract

Worldwide, beer lovers increasingly appreciate the creativity and authenticity of the brewer through sustainable innovations. The use of raw alternative grains in the brewing process offers a possible answer to this increasing market demand for natural, authentic and innovative products. Mixing of unmalted grains such as barley, wheat, rice and corn is already common practice. In contrast to these traditional crops, little attention is paid to the use of unprocessed alternative grains such as kamut, unicorn, bucket, amaranth, teff, etc. It is therefore not self-evident for a brewer to integrate these raw materials into the brewing process when not knowing which technological problems will arise and what influence these grains have on the visual characteristics and organoleptic quality of the final beer. The aim of our research is to provide the brewer with hands-on knowledge for the processing of raw

alternative grains into beer, related to their availability and brewing technological relevant characteristics, through analytical characterization of different selected alternative grains and their corresponding worts and beers.

Short biography

Starting from October 1st, 2017, Jessika De Clippeleer was appointed a full-time position as Professor (tenure track) in brewing and technology of fermentation processes at the Biotechnology Department of Ghent University, Belgium. She is Head of the Research Group Brewing Science and Technology of Ghent University and University College Ghent, involved in research and industrial services. She is Lecturer in biochemistry, brewing technology, industrial microbiology, and biomolecules' analysis and separation.

Jessika graduated in Biochemical Engineering Technology (KAHO Sint-Lieven, Ghent) in 2000, and received her MSc degree in Food Technology specialisation Food Chemistry (Wageningen University) in 2003. Subsequently, she was working at the Enzyme, Fermentation and Brewing Technology (EFBT) lab of KU Leuven, Technology Campus Ghent, as lecturer and researcher. In 2013, she received her PhD in Bioscience Engineering from KU Leuven on Flavour stability of pale lager beer - Chemical-analytical characterisation of critical factors related to wort production and hopping.

P104- RAW MATERIALS INCLUDING ANTHOCYANINS COULD CHANGE THE CONCENTRATION OF DIACETYL IN BREWING.

Atsushi Tanigawa[1]; Kei Asada[1]; Takahiro Takase[2]; Ayako Sanekata[2]; Ichiro Matsumoto[1]; Masahiro Nomura[1]

1 - SAPPORO BREWERIES LTD.; 2 - SAPPORO HOLDINGS LTD.

Abstract

Presence of diacetyl (DA) is one of the major causes of off-flavours in beers. Otherwise, DA concentrations in red wines are higher than that in beer and white wines. In red wines, DA is mainly produced by lactic acid bacteria during malolactic fermentation. However, several types of white wines prepared via malolactic fermentation contain DA at low levels. In a previous study, we revealed that the high DA concentrations in red wines could be caused by the metabolism of yeast, which was affected by anthocyanins derived from grape juice, as well as that of lactic acid bacteria. We performed fermentation trials using white grape juice and standard anthocyanin reagents, including malvidin-3-glucoside, and found that DA could be generated at higher levels in the test-wines including anthocyanin than that in the control wine containing no anthocyanins.

In recent years, craft beer has been booming all over the world. Various botanical raw materials, such as fruits, flowers, and herbs, including anthocyanins have been used in beer brewing. In this study, we attempted to brew various test-beers with different raw materials including anthocyanins and compared the corresponding changes in the DA concentrations. As

a result, the amount of DA in the finished beers including anthocyanins was found to be higher than that in the control beer. However, DA concentrations in the end of primary fermentation was not higher than that in the control beer. These data suggested that anthocyanins would affect to the yeast metabolism during secondary fermentation.

Short biography

Atsushi Tanigawa graduated from Tokyo University with a Master's degree in Bioresource and Bioenvironmental Sciences in 2005 and joined SAPPORO BREWERIES LTD., as a biochemist. From 2005 to 2011, he mainly investigated yeast metabolism. As present, he develops the new products as a research brewer. In 2017, he received the best poster award at 36th Congress of EBC in Ljubjana, Slovenia.

P105 - TASTE PROPERTIES AFFECTING BEER OF POLYPHENOLS DERIVED FROM HERBS AND SPICES

Shunji Fujioka[1]; Takako Inui[1]

1 - Suntory Beer Ltd., Beer Development Department, Osaka, Japan

Abstract

In recent years, craft beers using herbs and spices become more popular in the world, because of their distinct flavors. However, not only aroma but also taste properties in herbs and spices are expected to give beer the various distinct characteristics. Thus, we evaluated the taste impacts on beer without strong distinct aroma characteristics or undesirable aroma by addition of small amount of hot water extracts of sixteen herbs and spices on beer. As results, in-company sensory panel perceived the various taste properties derived from 16 herbs and spices. Among them, it was confirmed that a very small amount of coriander seed give beer the crispness, distinctively. Subsequently, to explore the key components of the crispness derived from coriander seed, polyphenols in coriander seed were extracted and fractionated by polar character. Then, each polyphenol fraction was added to beer and its crispness was compared between fractions. Finally, some key compounds of crispness were estimated from the fraction that indicated the strongest crispness in beer using LC-orbitrap-MS. Furthermore, to give beer the crispness more effectively or efficiently, we are searching other raw materials which include more key compounds. This study could provide brewers with the new worth and the secret of how to use of herbs and spices.

Short biography

Shunji Fujioka received a master's degree from the Graduate School of Informatics, Kyoto University, Japan. He joined Suntory Beer, LTD. in 2013 and started his career at Kyoto Brewery. Since 2016, he has been working in Beer Development Department. Now his main research is focused on the relation between yeast and flavor of beer.

P106 - TRITORDEUM A NOVEL INGREDIENT FOR BREWING

Jose Luis Olmedo[1]

1 - Hijos de Rivera Inversiones Corporativas, S.L.

Abstract

Brewers all over the world are looking for new alternatives of raw materials for brewing.

AGRASYS a CSIC spin off has developed by traditional breeding techniques and not by genetic modification a new cereal crossing wheat (*Triticum durum*) and a wild barley (*Hordeum chilense*). The result is called Tritordeum and it is registered at the Community Plant Variety Office (CPVO) of the European Union. It has beneficial aspects from three points of view:

- Sustainability: higher resistance to pathogens and lower demand of irrigation with high resistance to drought and heat stress.
- Health: higher contents of fiber, lutein and oleic acid than wheat. Less content of indigestible gluten.
- Sensorial experience: with interesting aspect, special aroma and different taste.

We produced in a 10 hl brewing plant a high quality lager beer with 100% Tritordeum malt with an O.G. 12ºP and 4,7% ABV. We obtained analytical results for the new beer.

We studied its behavior during the brewing process, trying to get the maximum potential to this new cereal without interference of nuances contributed by the yeast and hops used.

We studied in a trained sensorial panel the descriptive parameters of its sensorial profile.

We made a consumer test in a trendy bar in Madrid in order to have the impressions of the new beer with the statistical treatment of the collected data.

Short biography

Born in Madrid in 1971.

Studied engineering in agronomy at the University of León (Spain) until 1998.

Study a Master's Degree in malting and brewing technology at the Politechnic University of Madrid in 1999.

From 1999 working at Hijos de Rivera, S.A. (Galicia – Spain) as brewmaster, market quality management and nowadays at the R&D department of Hijos de Rivera Inversiones Corporativas, S.L. Project Manager of several projects such us: raw materials (including cereals, hops and fruits), new formats, new products (beer recipes and novel products) and development of technology.

P107 - OLIVE LEAVES AS NUTRACEUTICAL INGREDIENT IN CRAFT BEER PRODUCTION

Manfredi Guglielmotti[1]; Paolo Passaghe[1]; Stefano Buiatti[1]

1 - University of Udine, Italy, Dept. of Agricultural, Food, Animal and Environmental Sciences

Abstract

Aims. Olive leaves, as by-product of olive oil production, are known for high polyphenols content and beneficial effects to human health. The most important phenolic compounds in olive leaves are oleuropein, with a bitter taste, and 3-hydroxytyrosol, with a high antioxidant activity. The use of olive leaves as beer ingredient could contribute to bitterness, antioxidant activity and nutraceutical properties of beer. Twelve beers were produced adding olive leaves during boiling. Three forms of olive leaves were tested, to investigate the most suitable for brewing purposes: dry crumbled leaves, infuse and atomized extract. Alcohol content, original gravity and IBU were analysed; moreover, total polyphenol content was monitored during 120 days of storage.

Methods. Beer samples were produced with small pilot scale brewing system. IBU, and total polyphenols content were analysed according to EBC methods. Alcohol content and original gravity were measured with Anton-Paar Alcolyzer System®. Beer samples were also compared to reference beers by sensory analysis with a two-way paired test.

Results and Conclusions. Total polyphenol content analysis confirmed that the use of olive leaves significantly increases (2 to 5 times the average polyphenol content of beer) polyphenol content of beer. Sensory analysis demonstrated that 1% of olive leaves added to beer imparts a sour/astringent taste and herbal aroma. A lower quantity (less than 1%) can improve the sensory profile of beers. Also perceived bitterness is comparable to the one of reference beers. The atomized extract was the most suitable form for brewing purposes, since it can be used in small quantities and without difficulties.

Short biography

Manfredi Guglielmotti (born 1992) graduated from University of Udine with a Master's degree in Food Science and Technology in 2018. At present he is working at the Brewing Science group of University of Udine.

TOPIC: WORT PRODUCTION

P108 - SPECIAL MALT ADAPTED HOP DOSAGE TO IMPROVE OXIDATIVE BEER STABILITY

Thomas Kunz[1]; Sebastian Orlowski[1]; Giovanni Antonio Cervantes Negrete[1]; Frank Jürgen Methner[1]

1 - Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science, Seestraße 13, 13353 Berlin, Germany

Abstract
Special malt types (caramel / roasted) cause a significant prooxidative acting iron entry. Additionally there is an increase of specific Maillard reaction intermediate products with reductone/enediol structures detectable which can reduce Fe-ions rapidly resulting in an accelerated formation of prooxidative acting radicals decreasing oxidative wort and beer stability. Based on this fact it is an advantage to reduce that amount of Fe ions by an individual matched hoping scheme since α- and β- hop acids are able to precipitate Fe ions. Thereby the induced iron removal is greatly dependent on the used malt or special malt types in the grist and resulting mash or wort matrix. In this connection several studies were carried out in small batches using a standard mashing scheme (90% pilsner, 10% special malt). Those wort matrices were boiled with different amount of hop extract, calculated to 0-50 IBUs. The iron entries were detected via ICP-OES. It was observed that the hop regime results in an individual remove of iron ions out of the wort and beer matrices. Consequently, a lower generation of prooxidative acting radicals can be detected via ESR-Spectroscopy (Tmin-value), which derives in improved oxidative beer stability. There is a malt type specific saddle point when it is reached an increased hop regime does not lead to a further decrease in radical generation and iron content in wort. This point of individual hop dosage can be used as a tool for adapted hop regimes to minimize the negative influences of special malt on oxidative beer stability.

Short biography
After qualifying as certified technician in preservation engineering (1991-1993), Thomas Kunz completed his basic studies in chemistry at University of Applied Sciences, Isny (1994-1995) and his basic studies in food chemistry at Wuppertal University (1995-1998), before starting to study food technology at University of Applied Sciences, Trier (1998-2002). After graduating, he worked as a chartered engineer in the area of ESR spectroscopy at Institute of Bio Physics at Saarland University (2002-2004).
Since 2005 he has been employed as a Scientific Assistant, PhD student. As head of laboratory since 2009 he is responsible for official and industrial research projects. His main focus lies in analyzing the influences of brewing process stages, filter aids, stabilizing or fining agents and specific beer ingredients on radical reaction mechanisms and oxidative stability of beer or other beverages using ESR spectroscopy and GC-MS. Since 2015 he is a supervisor in EJD-European Joint Docotrate Food Science Program.

P109 - AND IN THE END, IT'S ALWAYS BEER - A COMPARISON OF THREE LAUTERING SYSTEMS

Nele Bastgen[1,2]; Jean Titze[3]; Tobias Becher[1]

1 - Ziemann Holvrieka GmbH; 2 - Technical University of Berlin; 3 - Anhalt University of Applied Sciences

Abstract

Customers expect beer to be a tasty, digestible beverage with a shiny, attractive color, and a perfect head. There are various ways of producing beer. Three different lautering systems can be used for the separation of wort and spent grains: lauter tun, mash filter, and a continuous mash filtration system. The novel brewhouse with the continuous mash filtration system, as

introduced at the EBC Congress in Ljubljana, is further equipped with separate hop isomerization and special malt extract dosing. This raises the question whether there are any differences in the wort or beer composition. For this purpose, a series of experiments on a scale of 10 hL was carried out, in which the wort constituents as well as the final beer composition were investigated.

There are mainly differences in the protein composition in the wort used for isomerization of hops, since only the low concentrated wort is used in the novel brewhouse. Furthermore, the wort samples of middle of cooling of the lauter tun and the mash filter show a doubled amount of polyphenols and a ten times higher amount of tannoids in comparison to the worts of the novel mash filtration system. This leads to the expectation of a higher chemical stability of the beer in the novel brewhouse.
The presentation will focus on further comparative data to give an overall impression of the three lautering systems and their effects on wort and beer production. Recent results from a commercial brewery will complete this overview.

Short biography

Nele Bastgen graduated from Trier University of Applied Sciences in 2015 with a bachelor's degree (B.Eng.) in Food Technology and in 2016 with a master's degree (M.Eng.) in Food Economy. She joined the Technology / R&D department at Ziemann Holvrieka GmbH, Ludwigsburg as PhD candidate in 2017 in cooperation with the Technical University of Berlin and the Anhalt University of Applied Sciences. Her ongoing research is about the application of a rotary disc filter system in the brewing industry with the technological effects on the final product.

P110 - INVESTIGATING THE EVOLUTION OF STALING ALDEHYDES DURING THE BREWING PROCESS AND BEER AGING

Maciej Ditrych[1]; Weronika Filipowska[1]; Gert De Rouck[1]; Barbara Jaskula-Goiris[1]; Mogens Larsen Andersen[2]; Luc De Cooman[1]

1 - KU Leuven, Faculty of Engineering Technology, Technology Campus Ghent, Laboratory of Enzyme, Fermentation and Brewing Technology, Ghent, Belgium; 2 - University of Copenhagen, Faculty of Science, Department of Food Science, Copenhagen, Denmark

Abstract

During aging, beer undergoes a myriad of unfavourable chemical reactions, which lead to unavoidable flavour deterioration. Many of the off-flavours are associated with the presence of the so-called staling aldehydes, however, formation of these compounds is yet not fully understood. Aldehydes may arise from *e.g.* fatty acids oxidation, Strecker degradation of amino acids, Maillard reactions, *etc.* Moreover, aldehydes may also be released from non-volatile precursor forms, so-called bound state aldehydes. Therefore, to unravel another puzzle piece of beer flavour instability, we monitored the staling aldehydes throughout the process of wort and beer production, as well as during beer aging. Levels of 2-methylpropanal, 2-methylbutanal, 3-

methylbutanal, hexanal, furfural, methional, phenylacetaldehyde and *trans*-2-nonenal were quantified. High levels of aldehydes determined in malt and mashing-in samples point to malt as the major source of staling aldehydes. In general, concentrations of aldehydes decreased over the entire wort production process, with exception of furfural. The highest decrease was observed during boiling. On the other hand, furfural increased not only during boiling, but also during wort clarification. Additionally, levels of fatty acids oxidation products elevated during wort clarification. Furthermore, relative increase in aldehydes was observed during sparging. With regard to fermentation and maturation processes – although aldehydes levels elevated during the initial stage of fermentation – the overall aldehyde levels were strongly reduced by the yeast. During beer aging, levels of aldehydes increased remarkably. This study illustrates for the first time the status of staling aldehydes and identifies critical steps of the brewing process for improved beer flavour stability.

Short biography

Maciej Ditrych graduated BSc and MSc studies in Fermentation Technology and Technical Microbiology at Lodz University of Technology in Poland in 2011. In 2013 he graduated a double MSc programme in International Management at Lodz University of Technology and Grande Ecole de Commerce INSEEC Chambery in France.

Maciej is currently in the second year of his PhD research – related to flavour instability and staling aldehydes – which is carried out jointly at KU Leuven, Technology Campus Ghent in Belgium and at University of Copenhagen in Denmark. The PhD is part of European Joint Doctorate in Food Science founded by Marie Sklodowska-Curie grant.

P111 - A FRESH LOOK AT SMALL AND LARGE STARCH GRANULES IN BARLEY MALT

Charlotte De Schepper[1]; Niels Langenaeken[1]; Christophe Courtin[1]

1 - Laboratory of Food Chemistry and Biochemistry (KU Leuven)

Abstract

The brewing industry relies predominantly on the starch in barley malt for the production of fermentable sugars and dextrins during mashing. Barley starch shows complex behavior, not only because of its general composition and structural arrangement but also because it consists of both large, lenticular A-type (20-50 µm) and small, spherical B-type granules (ca. 2 µm). These granule types have different gelatinization temperatures and thus behave differently during mashing. In spite of this, the granule ratio is not taken into account when selecting barley or setting up the mashing process. The impact of the granular composition of starch on the brewing process is deemed to be minimal because it is generally believed that the small granules are substantially degraded during the malting process. In this study we show that barley malt does contain a substantial amount of small granules. By using microscopic imaging and image analysis techniques the volume percentage of small and large granules was quantified for starch that was quantitatively isolated from different malt samples. Our results show that on a volume percentage basis up to 35% of the starch consists of small starch granules. This percentage varies

between the different samples. Because the small granules gelatinize at a higher temperature compared to the large granules, suboptimal conversion of starch into fermentable sugars can occur. These results thus indicate that the small to large granule ratio should be taken into account when selecting barley cultivars or designing mashing schemes.

Short biography

Charlotte De Schepper is a PhD researcher at the Laboratory of Food Chemistry and Biochemistry (LFCB). Before starting her PhD, she first obtained a BSc and MSc in Engineering Technology. It was during these studies, and more specifically during her thesis work at the brewery of Haacht that she found her passion for both research and the brewing process. Afterwards she obtained an MSc in Bioscience Engineering – Food Technology during which she performed master thesis research on the optimal use of barley carbohydrates in the beer brewing process to increase resource efficiency.

P112 - INFLUENCE OF COMPOSITION OF WORT ON THE QUALITY OF LAGERS

Pavel Dostálek[1]

1 - Department of Biotechnology, University of Chemistry and Technology, Prague

Abstract

The first Czech pale bottom fermented lager, which was brewed in Pilsen in 1842, quickly became the world's standard for one of the most produced beer types around the globe, nowadays known as Pils or Pilsner beer. Pilsner beer was very successful and technology of its production was quickly adapted by other breweries. Since then, this type of beer has evolved, and while production in the Czech Republic is still based on traditional procedures and recipes, production in other countries has undergone many changes. Therefore, Czech Republic in 2004 has registered in EU protected geographical indication (PGI) “Czech beer”, which is standard for Czech lagers. This legislation include requirements for raw materials – Czech pale malts, Czech hops and very soft water – as well as specific requirements for technology procedures such as decoction mashing process and two-phase fermentation consisting from primary fermentation and cold maturation. Key to the quality of lagers is mainly specific constitution of wort. It is known that decoction brewing has principal effect to composition of wort (higher content of amino acids, higher content of silicon, and lower content of short fatty acids). High impact to final quality of lagers has also degree of used malt substitution and HGB technology. High degree of HGB and surrogates leads to low concentration of esters and high concentration of higher alcohols especially 2,3-butandiol. Czech lagers brewed by classical technology are thus different in volatiles profile from lagers brewed by intensified technology.

Short biography

1985 - Graduated from the Institute of Chemical Technology, Prague (Department of Fermentation Chemistry and Bioengineering, Faculty of Food and Biochemical Technology). 1991 - Ph.D. degree in biotechnology (Institute of Chemical Technology, Prague). 1993 - Teaching stay at Dublin City University, Dublin, Ireland. 1996 - Course of Food Technology at Hebrew University, Faculty of Agriculture, Rehovot, Israel. 2004 - Member of Editorial Board of the journal ‚Kvasny Prumysl'. 2007 - Assoc. Prof. degree in biotechnology (Institute of Chemical Technology, Prague). 2012 - Professor of Biotechnology (Institute of Chemical Technology, Prague). 2013 - Visiting professor possition at Department of Agraria, Sassari University, Sardinia, Italy. 2015 - F.O.Poupe award for a lifetime contribution to Czech brewing from Czech Brewing and Malting Association. 2016 - Editor of Czech Journal of Food Sciences. 2017 - F.O.Poupe award for textbook "Malting - theory and practice of malt production" as a member of author´s team from Czech Brewing and Malting Association.

P113 - ASSESSMENT OF METAL CHELATION DURING THE MASHING STAGE OF BREWING

Tuur Mertens[1]; Thomas Kunz[1]; Frank-Jürgen Methner[1]

1 - Technical University of Berlin, Institute of Food Technology and Food Chemistry, Department of Brewing Science, Berlin (Germany)

Abstract

Beer tends to inevitable change over time, which makes flavour stability one of the most challenging quality aspects of brewing. Staling is a very complex issue, but it is evident that transition metals (iron, copper, and manganese) play a key role herein. Acting as catalysers, they drive the formation of reactive oxygen species (ROS) through the Fenton and Haber-Weiss reaction mechanism. Oxidative deterioration of beer freshness could potentially be reduced by chelating these transition metals whilst brewing, thus prolonging the shelf-life. In this study, five chelators (EDTA, citric acid, tannic acid, gallic acid, and phytic acid) are assessed for their chelating abilities during mashing on lab scale. The high temperatures and intricate (wort) matrix could prove challenging for metal complex formation. To see whether transition metals are effectively removed after lautering (by way of spent grains on filter paper), the wort is examined for metal content by inductively coupled plasma optical emission spectrometry (ICP-OES) and for oxidative stability by electron spin resonance (ESR) spectroscopy. The aim is to screen for the most suitable chelating agent and its optimal working parameters in mashing. Future research will explore if beer flavour stability can ultimately be enhanced by applying the findings in (pilot scale) brewing trials.

Short biography

Tuur Mertens graduated in 2016 as Master of Science in Bioscience Engineering Technology (Food Industry) at Ghent University (Belgium). He did his thesis at the Faculty of Pharmaceutical Sciences, where he optimized the analysis of mycotoxins in diverse samples of the brewing process. After graduating, he worked at the pharmaceutical fine chemicals industry Ajinomoto OmniChem as a Lab Technician Analytical Development. Tuur is currently pursuing his PhD at the Technische Universität Berlin (Germany) as one of the eight early stage researchers of the European Joint Doctorate Food Science project.

P114 - PREDICTION MODEL FOR EXTRACT AND FERMENTABLE SUGARS

Héctor Hugo Rivera Yerena[1]

1 - Tecnológico Nacional de México en Celaya

Abstract

It is well known that temperature, pH, mash thickness and enzymic content are important factors in mashing process for extract levels and fermentability of wort. There are several studies showing the importance of this factors, however no quantitative relationships between them are shown to make numerical predictions about the performance of mashing process. In this study a series of experiments were carried out to manipulate the main variables of the mashing process like of temperature, pH and mash thickness in a range of typical values for the brewer in order to obtain a regression equation for the prediction of extract in the mash and percentage of fermentable sugars in the extract. Both regression equations involve the main variables in the mashing process and the diastatic power of malts used. The extract was determined by refractive index and density while fermentable sugars were determined by HPLC. The model was adjusted from a series of laboratory-level experiments using commercial Pale and Pilsen malt.
The models show, numerically, which are the best conditions to achieve the characteristics of the wort established by the brewer. From a highly fermentable extract to one of low fermentability, always trying to make the most of the malt.

Short biography

Héctor Rivera is a Ph.D. student at Chemical Engineering Faculty in Tecnológico Nacional de México en Celaya, México. He is owner of a craft brewing company in México. He was working in the Mexican energy sector and has been collaborating in projects of different technical nature with the food, energy and materials industry. His main interests are the modelling of biological systems, neural networks, statistical tools and ceramic materials. The title of his master‘s thesis was: Determination of significant factors in mashing for beer production and it´s neural network modelling

P115 - NEAR INFRARED SPECTROSCOPY AND MASHING – A PROMISING APPROACH FOR REAL TIME INLINE QUALITY CONTROL?

Florian Conradi[1]; Wefing Patrick[1]; Schneider Jan[1]

1 - ILT.NRW - Institute of Food Technology.NRW

Abstract

Modern analytical technologies have the potential to replace common quality control strategies, where samples are analysed atline or in the laboratory. Using a real time quality control strategy, data is aquired within the process and product quality parameters are avaliavle immediately and in significant smaller intervals with less effort. Mashing represents

an interesting application since brewers have to deal with varying malt qualities and product quality requirements. Near infrared spectroscopy is a promising process analytical technology and already described for laboratory analysis of mash. In contrast to laboratory analysis, inline aqusition of spectra provides several challenges such as high and varying temperatures, particles, turbidity and agitation.

The aim of this study is to obtain a reliable regression model for mash´s extract based on near infrared spectra regarding the influence of temperature, malt water ratio and probe path length. Experiments are performed with fine milled pilsener malt and preheated water. Spectra are aquired with a NIR-DAD-Spectrometer (1100 nm – 2100 nm; Polytec, Germany) equipped with a transflectance probe (Polytec, Netherlands) immersed in the mash. Samples are taken during maltose rest and analysed for extract with a flexual resonator.

A regression model for extract content, using inline aquired spectra and reference values, was generated and sucessfully validated with high R2 of 0.99 and RMSECV (root mean square error of cross validation) of 0.13 °Plato or 0.82 % based on the average of the reference values. Results indicate a great potential for real time quality control of the mashing process using near infrared spectroscopy.

Short biography

Florian Conradi studied Food Chemistry in Halle (Saale), Germany and wrote his diploma thesis (authenticity verification of oregano with infrared spectroscopy and chemometrics) at the German Federal Institute for Risk Assessment. In 2017 he joined the Institute of Food Technology ILT.NRW as PhD-Student and is member of the partnership SmartFoodTechnology.NRW. He works on real-time quality control strategies in the food production and is currently challenging the mashing process during beer production.

P116 - HYDROGEN PEROXIDE FORMATION AND -INACTIVATION BY MALT-DERIVED THIOLS DURING MASHING

Matthias Baldus[1]; Sarah Majetschak[1]; Frank-Jürgen Methner[1]

1 - Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Chair of Brewing Science

Abstract

Nowadays, malt-derived thiols are well established antioxidants in beer. In mash, thiols may inactivate hydrogen peroxide (H_2O_2) and thereby diminish oxidative reactions responsible for beer quality deterioration. However, in the presence of transition metal ions and molecular oxygen, thiols may also form hydrogen peroxide via reductive chelation. The present work aimed to assess the involvement of thiols and the transition metal copper (Cu^{2+}) on oxygen consumption and hydrogen peroxide formation in mash. In model solutions, the addition of 250 µM of thiols (cysteine (Cys), glutathione (GSH)) together with Cu^{2+} was followed by significant O_2 consumption within 15 minutes at 60 °C. At this stage H_2O_2 formation was observed, which correlated to the respective oxygen consumption. O_2 consumption and H_2O_2 formation was significantly higher in the Cys treatments as compared to GSH. In the further course of

incubation the H_2O_2 concentration was degraded to ~70% in the Cys treatment while for the GSH treatment the H_2O_2 concentration remained constant. During mashing (Pilsner malt, grist-water ratio: 1:4) O_2 was completely degraded within 5 minutes. The addition of maleimide (thiol-blocking agent) significantly decreased O_2 consumption demonstrating the potential involvement of thiols in O_2 reduction and H_2O_2 formation in mash. As O_2 consumption could not be diminished completely it is proposed that further malt-derived substances are involved in these mechanisms. The data of this work contribute to the understanding of the behavior of thiols in oxidative processes during mashing and can be used for further approaches to increase wort and beer quality.

Short biography

Prof. Dr. Frank-Jürgen Methner was graduating with a Diploma in Engineering at Technical University of Berlin in 1881. From 1982 to 1986 he was PhD-Student at TU Berlin graduating 1987. From 1987 til 2004 he was working as a Director at Bitburger Brauerei, Bitburg, Germany, with responsibilities in Brewing Technology, Development and Quality Management. Since winter-semester 2004/2005 he is leading the Department of Brewing Science at the TU Berlin.

P117 - VARIETAL DEPENDENCE OF FE, MN AND CU CONTENT AND CONTRIBUTION INTO BREWERS WORT IN POLISH AND AMERICAN HOPS

Olga Szczepanik[1]; Marek Zdaniewicz[1]; Aleksander Poreda[1]

1 - University of Agriculture in Krakow

Abstract

The sensory stability of beer is a growing issue in the brewing sector. The oxidation reactions are largely responsible for changes in stability during the distribution and storage of beer. These reactions occur, among others with the participation of metal ions such as iron (Fe), manganese (Mn), copper (Cu). Hops, although rich in minerals, are not a significant source of metal ions in beer, because most of the them are removed during the wort boiling And clarification bound to the hot trub. It is known, however, that even traces of Fe, Mn and Cu ions affect the aging process of beer.

In the experiment the content of Fe, Mn, Cu ions was analyzed in pellet of six hop varieties: three Polish (Sybilla, Puławski and Magnat) and three American (Citra, Cascade, Crystal). The granules of each variety were then boiled in distilled water and in the 12ºP wort (to check how the compounds present in the wort affect the release of ions into the aqueous solution). The concentrations of the studied ions in individual varieties differ from each other even several

times. The aim of the research was to determine the extent to which Fe, Mn and Cu ions pass into a solution of water and wort in the cooking process.

This work was financially supported by Grant LIDER 46/0185/L-9/17/NCBR/2018.

Short biography

Olga Szczepanik was awarded the degree of engineer (2015) and MSc. in food science at the Faculty of Food Technology of the University of Agriculture in Krakow, specialization: Fermentation and Beverage Technology. In 2017, she started her PhD studies at the Department of Fermentation Technology and Technical Microbiology at the University of Agriculture in Krakow. Her work is devoted to the hopping process, with particular emphasis on the Polish hop varieties. In 2018 she completed an industrial internship at the largest hop products manufacturer in Poland.

P118 - MASH HOPPING - A PERFECT SOLUTION FOR A HOPPY SOUR BEER

Aleksander Poreda[1]; Marek Zdaniewicz[1]; Aneta Ciosek[1]; Olga Szczepanik[1]; Aneta Pater[1]; Katarzyna Fulara[1]

1 - University of Agriculture in Krakow, Faculty of Food Technology

Abstract

Sour beers are getting on popularity within the beer consumers around Europe. It is produced with the use of low hop dosage due to the sensitivity of lactic acid bacteria to the iso-alpha-acids. On the other hand, the well-hopped beers (either for the bitterness or hoppy aroma) are also facing increasing demand. Consequently, there is a gap in the market, that can be filled with the sour beers with a characteristic hoppy aroma. Hops are added to the boiling wort in order to allow for the maximum conversion of alpha acids into the iso-alpha-acids, responsible for the bitterness of the beer, which does not allow for an efficient LA fermentation.

Therefore we evaluated the suitability to produce a sour beer with a distinctive hop aroma with the use of the method of mash-hopping (a technique that has not been given much attention with respect to the production of sour beers till now). The idea behind the novel approach is that the hops are added to the mash and allowed to release the aroma compounds, with a limited rate of alpha-acids isomerization (temperatures below 80ºC). Following, boiling of the wort was performed with a minimal evaporation degree (1-1,5%) with subsequent inoculation of wort with lactic acid bacteria (at the temperature around 30ºC. On the completion of lactic acid fermentation top-fermenting yeast is added to produce the low alcoholic sour beer, with pleasant hoppy aroma with very low bitterness. In the study, we compared beers produced with various: mashing techniques (infusion and decoction), hops varieties (fine aroma hops and aroma hops), hop dosage (3 levels of alpha-acid input). The analysis performed included: extract yield, wort pH, bitterness and extract, hot trub amount,

pH of beer and the content of lactic acid, fermentation rate, final attenuation and aroma profile of the beer. Based on the results obtained we propose a suitable set of conditions when applying mash hopping in sour beer production.

Short biography

Aleksander Poreda obtained his PhD in food science at the University of Agriculture in Krakow in 2006 ("Influence of metal ions on the brewers' wort fermentation"). Since 2016 he's been the leader of the Krakow School of Brewing, providing research and education for the Polish brewers. He has established the European Joint Doctorate in Food Science, an international network of European universities that offer the joint doctorate programme in malting and brewing (ejdfoodsci.eu).

TOPIC: YEAST AND FERMENTATION

P119 - A NEW METHOD FOR SCREENING INDUSTRIAL YEASTS WITH FERULIC ACID DECARBOXYLATION ACTIVITY BASED ON SNP MARKERS

Chen Lu[1]; Hua Yin[1]; Jianjun Dong[1]

1 - State Key Laboratory of Biological Fermentation Engineering of Beer

Abstract

The compound 4-vinylguaiacol, which is produced by the decarboxylation of ferulic acid in certain yeasts, is an important flavour compound in the brewing industry. This decarboxylation ability varies significantly in different beer yeasts and most strains possessing this ability are classified as ale yeasts. In this study, both lager and ale strains were used for fermentation tests and the decarboxylation ability was quantified. Two lager and three ale strains were identified with high ferulic acid decarboxylation activity. Single nucleotide polymorphism(SNP) analysis of PAD1 and FDC1 was conducted by gene sequencing and alignment. In addition, transcription analysis of the two genes was also performed with a GeXP genetic analysis system. A positive relationship between SNPs and ferulic acid decarboxylation activity was determined, and the premature termination codon introduced by base substitution and insertion resulted in the loss of this ability in beer yeasts, whereas other SNPs had a relatively limited influence on it. The GeXP results revealed that genes containing nonsense mutations exhibited low transcription levels, which could be explained by nonsense-mediated mRNA decay. These findings will further the understanding of the relationship between SNPs and biological traits, and will hopefully provide a promising strain selection method for industrial yeasts based on SNP markers.

Short biography

Lu Chen studied Food Science at Ocean University of China. From 2008-2013 she completed her PhD thesis on the influencing mechanism and detection method of PYF of barley malt. In 2010 she began employment as a senior project manager at Tsingtao Brewery Corporation and

from 2012 she was responsible for the organisation and implement of research direction in yeast and fermentation at the state key State Key Laboratory of Biological Fermentation Engineering of Beer and focused on the research on yeast metabolism, strain screening, brewing technology and microbiological control.

P120 - INFLUENCE OF LATE HOPPING ON FERMENTATIONPPERFORMANCE OF YEAST

Stefan Hanke[1]; Georg Stettner[1]

1 - Bitburger Braugruppe GmbH

Abstract

Late hopping is a traditional hopping technique which is used since hundreds of years to create beers with a pleasant hoppy flavour. With the up rise of the New England IPA high hop loads only at late production stages came into focus to create very flavourful beers at a moderate bitterness. In pilot trials we investigated the influence of late hop additions on the fermentation performance of the yeast, because of occasional occurrence of longer fermentations with late hopped beers. We conducted several brewing trials with hop loadings only into the whirlpool from 0- 250 g pellets/hl with two hop varieties (3 and 10 % alpha) so that the alpha addition was between 0 and 26 g alpha/hl. In these trials we could show that the hop addition into whirlpool delayed the fermentation process compared to an unhopped beer up to 48 hrs in an extreme. These findings can have effect to production and capacity planning of breweries or should be considered in recipe development. As side effect, utilization rates of alpha-acids from these whirlpool additions were calculated and presented. This paper presents that high late hop additions can show negative effects on production times and that there can also be an substantial intake of iso-alpha-acids to the beer which has to be considered.

Short biography

Stefan Hanke studied Brewing Science in Weihenstephan. In 2010 he received a Ph.D. degree for his research on the influence of hopping technology on harmony of beer. 2004-2010 he has been a scientific employee at the Lehrstuhl fuer Technologie der Brauerei I, Freising-Weihenstephan. 2006- 2007 he headed the institute's Pilot Brewery Department. 2007-2010 he was responsible for the Chromatography Laboratory of the Weihenstephan Institute for Brewing and Beverage Technology. Since 2010 he is head of the pilot plant of the Bitburg Braugruppe, Bitburg. Since 2013 he is also responsible for the craft subdivision Craftwerk Brewing. He is a member of several scientific committees and brewing organizations.

P121 - IDENTIFICATION AND EXPLOITATION OF MANNITOL-PRODUCING LEUCONOSTOC CITREUM STRAIN TO PRODUCE NATURALLY-SWEETENED, REDUCED-SUGAR, FERMENTED OAT AND BARLEY BASED FUNCTIONAL BEVERAGES

Kieran Lynch[1]; Tom Rice[2]; Emanuele Zannini[1]; Aylin Sahin[1]; Mareille Heitmann[1]; Aidan Coffey[2]; Elke Arendt[1]

1 - School of Food and Nutritional Sciences, University College Cork, Cork, Ireland; 2 - Department of Biological Sciences, Cork Institute of Technology, Bishopstown, Cork, Ireland

Abstract

Sucrose is the most common ingredient used by the food industry to sweeten goods, especially in beverages such as soft drinks. Due to their significant contribution to the sugar intake of consumers, reducing the sugar content of such products has become an important objective for the beverage industry. Lactic acid bacteria were isolated from different (pseudo)cereal and legumes flours with the aim of identifying strains that naturally produce the low-calorie sweetening agent mannitol (from fructose) during the fermentation. Following screening of 224 isolates, 52 were observed using HPLC to produce mannitol. One isolate, *Leuconostoc citreum* TR116, which originated in a yellow pea derived sourdough, was identified as a particularly strong producer, generating 350 mM mannitol from 568 mM fructose. This strain and two other mannitol-producing strains (*Leuconostoc mesenteroides* and *Lactobacillus brevis*) were applied in the fermentation oat and wheat wort substrates. A novel enzymatic procedure to generate fructose in the worts was designed. In both substrates, all strains were able to grow and ferment, reaching levels of >8 log CFU/mL after 24 h. However, TR116 appeared to be more metabolically active, particularly in oat, producing higher levels of acids. In addition, this strain produced the highest amounts of mannitol in both substrates (up to 3.4 g/L in oat). This study also investigated *Leuc. citreum* TR116 at a genomic level to characterise its superior mannitol-producing capacity. The process developed herein, for the production of mannitol in wort using specifically selected LAB strains, represents a novel approach for the production of sugar-reduced, natural and clean-label functional beverages.

P122 - ISOLATION, IDENTIFICATION AND CHARACTERIZATION OF WILD YEAST, SACCHAROMYCES CEREVISIAE AFY-5 FROM SOUTH KOREA FOR THE BEER BREWING

Ha Yeon Lee[1]; Jae Gil Lee[1]; Da Hye Choi[1]; Da Hye Kwon[1]; Soon Bae Kwon[1]

1 - Agro-food Research Institute, Gangwon Agricultural Research and Extension Services (GARES)

Abstract

The craft beer industry in South Korea has recently increased as a result of attracting a lot of interest to the South Korean consumer. Beer brewing yeast is an important part of making good beer because it affects various characteristics of the beer. However, most beer breweries in South Korea have used similar yeast purchased from foreign countries such as USA, France,

and etc. In this study, we evaluated the various test of 273 strains isolated from fermented food in South Korea for selecting suitable strains for beer brewing. The AFY-5 strains showed tolerance to glucose and maltose at 40% concentration, the ability of growth at a pH 3, and high enzyme activity of β-glucosidase, glucanase, and protease. AFY-5 strain was identified to *Saccharomyces cerevisiae* by sequencing ITS (internal transcribed spacer) region. Aroma of beer fermented by *Saccharomyces cerevisiae* AFY-5 was analyzed by GC-TOF/MS. Ethyl laurate, isoamyl decanoate, and isopentyl decanoate increased compared to a beer fermented by commercial yeast. Alcohol contents and foam sustainability of beers by the two strains were similar. Further study, we will study fermentation and aging characteristics of beer using AFY-5 strains for industrial use.

Short biography

Ha Yeon Lee is a researcher who studies fermentation microbiology in Agro-food Research Institute, Gangwon Agricultural Research and Extension Services (GARES) in South Korea since 2015. She has completed course for Ph.D. program in 2018 and got a grant for a Master's degree in 2012 from Kangwon national university in South Korea majoring food biotechnology. Ha Yeon's available for researching projects are fermentation (beer, wine, vinegar, and soybean paste).

P123 - REDUCTION OF DIACETYL FORMATION DURING BREWING USING CRISPR/CAS9 GENETICALLY MODIFIED YEAST

Konstantina Giannakou[1]; Ida Kallehauge Nielsen[1]; Christopher Workman[1]; Tomas Strucko[1]; Mikael A. Petersen[2]; Timothy Hobley[1]; Jakob B. Hoof[1]; José L. Martinez[1]

1 - Technical University of Denmark; 2 - University of Copenhagen

Abstract

The formation of diacetyl in beer causes a buttery off-taste. Silencing the genes ILV2 and ILV6, which are responsible for the synthesis of the diacetyl precursor, α-acetolacetate, has previously been shown to have great potential in reducing the diacetyl content. Breeding or mutating yeast with silenced genes is a rather time consuming process. In this work, we have tested the gene editing potential of the CRISPR/Cas9 system for this purpose. Single and double knock-out mutants were created. Results show that two base pairs were successfully removed, which also caused a frameshift mutation. No extra DNA residues remained after the manipulations resulting in a strain, which appears to have suffered a "natural" mutation. . The time frame for this was approximately 3 months, which is much reduced compared to classical strain improvement. The yeast strains were tested for beer fermentation in small scale conditions. GC-MS analysis indicated an up to 50 % reduction in diacetyl in beer produced with mutant strains compared to wild type. This study provides a novel way of constructing yeast strains with reduced off-flavor production during fermentation.

P124 - VOLATILE ORGANIC COMPOUNDS MONITORING DURING LAGER BEER FERMENTATION: EFFECTS OF YEAST RE-PITCHING AND PROCESS VARIABILITY

Ana C. Vieira[1]; Maria J. Carvalho[1]; Ana C. Pereira[1,2,3]; Sofia Freitas[4]; Tomé Mendes[4]; Nuno Branco[4]; José C. Marques[1,3]

1 - Faculdade de Ciências Exatas e da Engenharia, Universidade da Madeira, Campus Universitário da Penteada, 9020-105 Funchal, Portugal; 2 - CIEPQPF, Department of Chemical Engineering, University of Coimbra, Rua Sílvio Lima, 3030-790, Coimbra, Portugal; 3 - Instituto de Nanoestruturas, Nanomodelação e Nanofabricação (I3N), Universidade de Aveiro, 3810-193 Aveiro, Portugal; 4 - Empresa de Cervejas da Madeira, PEZO, 9304-003 Câmara de Lobos, Portugal

Abstract

During alcoholic fermentation, secondary metabolites are produced by the brewing yeast. While some of these substances have great relevance in beer colloidal and organoleptic stability, others induce off-flavours formation and contribute to beer degradation. Studying the influence of fermentation parameters in beer flavour is crucial for modern industrial breweries. Alcohols, esters, aldehydes, fatty acids and vicinal diketones (VDKs) are important volatile organic compounds (VOCs) and their concentration in beer changes according to yeast physiological state as well as pitching rate, wort composition and fermentation parameters.

Identical wort batches were inoculated with a 1st, 2nd and 4th generation yeast. The samples were obtained from a local brewery (Madeira, Portugal), *Empresa de Cervejas da Madeira* (ECM) and the batches were monitored during primary fermentation. Ten samples were collected during this period. VOCs were determined by GC-MS, following a 20-minute extraction at 40°C, by exposing a Car-PDMS fibre in a 20 mL vial containing 10 mL of sample and 3.3 g of NaCl. Additionally, FAN (free amino nitrogen), fermentation temperature and extract were also monitored.

Results show that VDKs formation/reduction occurs earlier in 1st generation fermentations when compared with those from 2nd and 4th generations. Differences in fermentation rates were also noticeable in extract and FAN consumption. Also, acetaldehyde and other VOCs profiles along fermentation showed a different behavior in the 2nd generation. Results indicate that other factors whose effects prevail on the number of re-pitching cycles, namely re-pitching conditions and other variables of the brewing process may be affecting beer organoleptic properties.

Short biography

Ana Carolina Vieira graduated from University of Madeira (Funchal, Portugal) as a MSc in Applied Biochemistry in 2017. At that point, she monitored several volatile organic compounds and amino acids in lager fermentations. She is currently working as a Research Scientist at the same institution in cooperation with a local brewery, *Empresa de Cervejas da Madeira* (ECM). Her recent research is focused on lager beer fermentation and flavour production, with special attention to vicinal diketones formation and reduction. Also, she has been studying preservation

techniques of fermented wort samples, oxidation-related compounds in beer storage and the influence of temperature during oversea transportation in the quality of exported beer. Analytical areas of expertise include gas-chromatography, mass spectrometry and methodology implementation and validation.

P125 - SYNERGIES BETWEEN LACTIC ACID BACTERIA AND BREWING YEASTS ON FLAVOUR PROFILE OF SOUR BEERS

Van Nedervelde Laurence[1]; Bernaerdt Maxime[1]; Grichoux Valentine[2]; Caille Olivier[3], Gabriela Montandon[3]

1 - Labiris; 2 - Université de Bourgogne; 3 - Fermentis SI Lesaffre

Abstract

Sour beers are becoming more popular in the market today and brewers are looking for an easy way to produce this beer style in a convenient and controlled manner. This study was conducted to evaluate the effects of acidification on qualitative attributes of the wort and beers.

Biological souring was performed using different lactic acid bacteria (LAB) strains, selected for their high sensitivity to hops, in the preboiling wort at different temperatures and pitching rates. The wort was then hopped and boiled to stop the souring, contribute bitterness and provide microbial protective effects to the beer. The impact of acidification was evaluated on hop isomerisation yield and hot trub elimination. Following the boiling process, alcoholic fermentation was carried out using different *Saccharomyces* yeast strains (neutral, fruity, POF-, POF+) in order to set up the synergies between LAB and yeasts. Fermentation kinetics were monitored and several parameters such as organic acids, bitterness, haze, flavour profile… were quantified in the final products.

The beers are mostly bright, with a fresh character, a smoother bitterness and an absence of organoleptic failures. Furthermore, they possess a better colloidal stability associated with a low level of protein haze.

Short biography

Researcher at the LABIRIS (SPFB), she is coordinator of the Agro-Food Pole including the Department of Brewing Sciences. In 1991, she received her diploma as engineer in chemistry and agro-food technology from the University of Brussels. Her main research areas include selection of industrial yeasts (brewing purpose, bioethanol production...), improvement of brewing yeasts (ester production, carbonyl compound reduction…) and development of new fermentation technologies (immobilisation technique, fed batch propagation, on-line measurements, new renewable filter aid)

P126 - THE IMPACT OF TEMPERATURE ON KVEIK FERMENTATION KINETICS AND FLAVOUR COMPOUND PRODUCTION

Barret Foster[1]; Jordan Hofstra[1]; Richard Preiss[2]; George Van Der Merwe[1]

1 - University of Guelph; 2 - Escarpment Laboratories

Abstract

We recently used PCR fingerprinting, whole genome sequencing and phylogenetic analyses to characterize traditional Norwegian farmhouse ale yeasts (aka kveik) as a distinct group among beer yeasts. WGS analysis, phenotypic screens and lab-scale fermentations confirmed domestication markers in maltose metabolism, flocculation and a novel POF- loss-of-function mutation. In addition, SNPs and CNVs analyses suggested thermotolerance, high ethanol tolerance, and high fermentation rate phenotypes of kveik strains. Here we analysed the impact for fermentation temperature on the fermentation kinetics of six previously sequenced kveik strains in comparison to commonly used ale yeast strains. We report on the differences in sugar consumption rates and ethanol and glycerol production during wort fermentation. In addition, we monitored the flavour compounds produced at the end of the fermentation.

Short biography

Dr. George van der Merwe received his Ph.D. in Molecular Microbiology from the Stellenbosch University in South Africa. His Ph.D. research layed the foundation for his expertise in the adaptation of yeast to available nutrients. As a Research Associate in the Wine Research Centre he developed an interest in the responses of industrial yeasts to fermentation-related stresses. In 2002 he accepted a faculty position in the Department of Molecular and Cellular Biology at the University of Guelph where he is currently an Associate Professor. He uses a combination of genomic, genetic, metabolomic, and molecular and cellular biology approaches to under understand the molecular responses of yeast to its environment using commercial fermentations as a model system.