### POSTER SESSION ON TUESDAY, 16 MAY 2017 AT 16:00 PM

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| P026 | Novel characterization method for beer haze using asymmetrical flow field-flow fractionation (AF4) | Wilbert, Heijne | DSM, Delft, Netherlands |
| P027 | Particle size characterization of precipitated non-spherical protein particles | Jesse, Ross-Jones | Mannheim University of Applied Sciences, Mannheim, Germany |
| P028 | Simulation of beer transport: impact of vibration on beer quality and stability | Barbara, Jaskula-Goiris | KU Leuven, Faculty of Engineering Technology, Technology Campus Ghent, Ghent, Belgium |

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| P030 | Spent hop material rich in xanthohumol: an overlooked foam stability enhancer | Lukáš, Jelínek | Institute of Chemical Technology, Prague, Czech Republic |
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| P034 | Application of projective mapping for hop aroma profiling in beers produced with different fermentation and hopping conditions | Torsten, Seewald | Technische Universität Berlin, Berlin, Germany |
| P035 | Aligning ESR technology with sensory panels to predict beer freshness | Heidi, Grimmer | FLAVORACTIV LIMITED, Oxfordshire, United Kingdom |
| P036 | Development of electronic beer nose | Amanda, Reitenbach | Federal University of Santa Catarina, Florianopolis, Brazil |
| P037 | Relevance of oxygen for the formation of Strecker aldehydes during beer production and storage | Philip, Wietstock | Technische Universität Berlin, Berlin, Germany |
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<td>BASF South East Asia Pte Ltd., Vice Director Regional Technical &amp; Application Management, Singapore, Singapore</td>
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Roland, Feilner
Krones AG, Neutraubling, Germany

### On the way to the “Smart Brewery” How to better profit from automation and IT technology.

Emilian, Axinia
COPA-DATA GmbH, Salzburg, Austria

### Monitoring the CO₂ purity level during fermentation as a parameter of quality monitoring and control

Martin, Jörg
Centec GmbH, Maintal, Germany

### “Asahi Super Dry” development strategies for beer dispensers challenging contributing to the increase in its brand value

Junichi, Kitano
Asahi Breweries, Ltd., Moriya-Shi, Ibaraki, Japan

### Hop citrus character – why are all the molecules floral?

Ray, Marriott
Totally Natural Solutions Ltd, East Peckham, United Kingdom

### Mini-oak chips: a promising tool for development of flavour enriched beer

Vojtěch, Hanko
University of Chemistry and Technology, Prague, Czech Republic

### Insight into the American IPA. A deconstruction of America’s popular beer style

Thomas, Shellhammer
Oregon State University, Corvallis, United States

#### Novel raw materials for beer production

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End of beer processing, including auxiliary and process aids

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Analysis and methodology (raw materials, product, research)

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**LO1**

**The PEF project at The Brewers of Europe, An Update**

Briijn P.

The Environmental Footprint (EF), launched by the European Commission, provides general guidance for comprehensive, scientifically sound and consistent environmental assessment of products. To make the general rules of the EF more relevant and applicable to specific product categories and sectors, the EF guides provide requirements for developing so-called Product Environmental Footprint Category Rules (PEFCRs), which are seen as cornerstones for consistent and robust assessments. A beer PEFCR is being developed for endorsement by the European Commission at the end of 2017 and will be instrumental, firstly, so that brewers can benchmark their environmental profile and, secondly, for business-to-business (B2B) and business-to-consumer (B2C) environmental communication. An IT-tool is equally being prepared to ensure that any brewer, whatever its size, can implement product environmental foot-printing, whilst a beer PEFCR declaration template will be made available for brewers to use in their supply chain. The objective of the beer PEFCR and the release of these tools is to enable the European brewing sector at large to improve its environmental performance through identifying the weak links in the production chain, whether at the brewery, downstream or upstream, so as they can be remedied.

**LO2**

**The continued craft brewing phenomena: industry competitive responses**

Nelson L.

Come time for the opening ceremony at Ljubljana it will have been four years since EBC Congress delegates looked closely at the continued global enthusiasm for all things craft beer. Remarkably, in all countries where craft was an established force in 2013 there has been continued expansion in both number of brewers and volumes brewed. There has been no regression. Which factors are driving the market for craft and are there variations between markets? Is there an end point, or a levelling off, in sight for the growth of craft? And what are the competitive responses from established industrial-scale brewers to these trends? It’s the last question that arguably deserves the greatest scrutiny. As has been a headline staple of late, many multinationals brewers have entered the craft market via acquisition – there are variations in approaches in this respect that can be fruitfully examined. More than this, it has also led to competitive responses in terms of brewing innovations, with brewers releasing short run products and augmenting brand extensions. This presentation will examine if an industrial scale brewer can be a ‘craft brewer’ at the same time, what constitutes best practice in this regard and what the implications are for consumer acceptance. And it will project current trends and developments, addressing the all-important question as to what will happen next.

**Mini-CV:**

Raised by wolves in the wilderness of Canada, by dint of discount airfare and then lax border enforcement Larry Nelson made his way to the shores of England at the beginning of the 1990s. Settled in the Home Counties outside London, he completed his MA legal training in 2008/2009 at the Chemical and Veterinary Investigation Office (CVUA) Münster to obtain the job title ‘state-certified food chemist’. In October 2009, he started to work as a research associate at the Research Institute for Raw Materials of the Research and Teaching Institute for Brewing in Berlin (VLB) where her scientific work mainly focuses on special analysis using mass spectrometric techniques.

**LO3**

**Development of an innovative analysis method to determine the gushing potential of malt**

Vorwerk H., Rath F.

VLB Berlin, Research Institute for Raw Materials, Berlin, Germany

The phenomenon of gushing, i.e. the spontaneous overfoaming of beer, is a serious quality failure of bottled beer. Despite strong efforts by various research groups the reasons for its occurrence are still not completely understood. The Joint EBC/Euromalt Gushing Project pursued an alternative approach to former research projects by conducting comparative analyses of gushing positive and gushing negative malts and belonging beers to reveal substantial differences between these samples. First results, presented at EBC Congress 2015 in Porto, showed MALDI-TOF MS combined with multivariate data analysis to provide a powerful tool for a clear discrimination of gushing positive and gushing negative samples. To establish a commercially applicable method, the analysis and data pre-processing procedures were optimized and validated. A statistical prediction model was calculated on the basis of a representative reference set of malts with clearly defined gushing behaviour. It allows an unequivocal identification of gushing negative malts as well as a reliable differentiation between categories of gushing positive malts. Furthermore, the interpretation of the model data provides valuable information on possibly gushing-relevant compounds which opens up new research opportunities to finally find a conclusive scientific explanation for the causes of primary gushing. Keywords: MALDI-TOF-MS, fingerprinting, multivariate data analysis

**Mini-CV:**

Henrike Vorwerk studied food chemistry at the University of Münster and graduated in 2007. She completed her academic education with a practical legal training in 2008/2009 at the Chemical and Veterinary Investigation Office (CVUA) Münster to obtain the job title ‘state-certified food chemist’. In October 2009, she started to work as a research associate at the Research Institute for Raw Materials of the Research and Teaching Institute for Brewing in Berlin (VLB) where her scientific work mainly focuses on special analysis using mass spectrometric techniques.
Identification of factors at the origin of the phenomenon of beer gushing and development of a premature detection technique of the gushing risk

Billard J.1,2, Kapel R.2, Boivin P.1, Schmitt M.1
1IFBM, Vandoeuvre Cedex, France, 2Université de Lorraine, LRGP, Nancy, France

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 factors 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. Different purification strategies were tested to separate the gushing factors from other compounds.

Once identified, the next step consisted in the development a premature method of detection directly on barley or on malt.

Mini-CV:
Julien Billard holds a Bsc in agricultural science and quality obtained in 2011 and an Msc in biotechnology and food industry specialized in food process obtained in 2013. Then he started a Phd in collaboration between IFBM (French Institute of brewing and malting) and LRGP (Laboratory of reaction and process engineering) at Nancy. He works on the gushing of beer to identify the compounds involved in this phenomenon and develop a premature technique of detection of these compounds on barley. His thesis focuses on: solid fermentation of barley, membrane and chromatographic separation, purification in reverse phase chromatography, protein analysis.

Development of novel hop-derived bitter acid oxides with body fat-reducing effect

Yamazaki T.1, Morimoto-Kobayashi Y.1, Taniguchi Y.2, Katayama M.1
1Kirin Company, Limited, Research Laboratories for Health Science & Food Technologies, Yokohama, Japan, 2Kirin Company, Limited, Central Laboratories for Key Technologies, Yokohama, Japan

Matured hop has less alpha acid and more bitter acid oxides than fresh hops, resulting in milder bitterness and a characteristic flavor in beer. However, little information exists on the chemical and health properties of bitter acid oxides. In this study, we elucidated the chemical properties of bitter acid oxides, termed matured hop bittering acids (MHBA). Having investigated the health properties of MHBAs, we discovered that MHBA reduced body fat in mammals. Moreover, we revealed for the first time that by ingesting MHBAs, humans could reduce their body fat without changing their lifestyles. And its physiological mechanism that MHBA induced body fat combustion by activating thermogenesis tissue was also revealed. In this study, we also established a method for producing MHBAs-rich extract: generating MHBAs through prolonged heat-treatment of hops. Although beer drinking is thought to be associated with obesity, we aim to break new ground with healthy beer-like beverages containing MHBA.

Mini-CV:
I entered Kirin Company in 2015. From then, I have been working on the development of novel hop-derived bitter acid oxides with body fat-reducing effect.

“A better future to beer market”

Kraemer P.

Disseminate beer passion is our role. We need to lead the way and bring to light positive facts about beer that many people don’t know. Beer is one of the world’s original social networks. For thousands of years, people have connected in real around a glass of beer. But this is just one of the things that makes beer great. Beer comes from nature. Its ingredients are natural: water, grains and hops. The alcohol is a result of a natural fermentation process. That’s why, like wine, when consumed in moderation, beer can be part of a balanced lifestyle. We need to show that beer in moderation can be part of a balanced lifestyle to highlight how beer can have a relevant role in the society and also guarantee a better future to beer market.

Mini-CV:
Construction of novel lager yeast strains through a fertile allotetraploid intermediate

Krogerus K.¹,², Arvas M.¹, De Chiara M.³, Magalhães F.¹,², Oja M.¹, Vidgren V.¹, Yue J.-X.¹, Liti G.², Gibson B.¹
¹VTT Technical Research Centre of Finland, Espoo, Finland, ²Aalto University, Espoo, Finland, ³University of Nice Sophia Antipolis, Nice, France

Interspecies hybridization has allowed the creation of new and unique lager yeast strains [S. cerevisiae x S. eubayanus]. New lager hybrids not only inherit beneficial properties from both parents, but may also outperform them in several respects. We’ve shown that fermentation properties, such as fermentation rate and aroma formation, may be influenced by ploidy level and the relative contribution of parental genomes. Allotetraploid strains seem to outperform their allotriploid counterparts. Allotetraploids have the added advantage of fertility and the properties of meiotic segregation may differ considerably from each other and the original hybrid. Furthermore, meiosis can be used to eliminate unwanted traits, such as 4-vinylguaiacol formation, from hybrids. Allotetraploids can also be mated further to produce complex hybrids with DNA from more than two parents. It is contended that breeding can considerably increase the diversity of strains available for lager brewing.

Mini-CV:
Kristoffer graduated from Aalto University as an MSc in Bioprocess Engineering and Food Engineering in 2013. He is currently working as a Research Scientist and PhD Student at the VTT Technical Research Centre of Finland. His research is focused on brewing yeast physiology and flavour production, with special attention to brewing yeast hybrids. Other areas of expertise include diacetyl formation and removal during brewery fermentations.

An energy self-sufficient brewery – the flagship project becomes a reality

Blomenhofer V.¹, Link A.², Gomer J.¹,³, Wasmuht K.¹
¹Ziemann Holvrieka GmbH, Ludwigsburg, Germany, ²Ingenieurbuero Link, Au/Id. Hallertau, Germany, ³University of Applied Sciences Rehensleben-Tresdorf, Freising, Germany

How to become primary energy independent? The way to a self-sufficient brewery is presented by means of a medium-sized brewery. The project is based on a convincing energy concept, which won an award in Bavaria/Germany and on funds granted by the German Federal Environment Agency (30 % of 3.6 million Euros) due the project’s high potential. The restructuring of the entire brewery is presented in three steps. 1. New machines and plant engineering 2. Optimization of peripheral equipment 3. Cross-linking of the implemented machines and engineering parts. New machines include all brewhouse equipment as well as a microturbine, a new heating vessel, an absorption cooling machine and a pilot plant called Ice Age®, producing snow for cooling purposes. In addition, different process changes are shown. The implementation of this concept leads to a reduction of approximately 280 tons of CO₂ and an annual saving of 1.4 million kWh of natural gas.

Mini-CV:
Verena Blomenhofer graduated as a diploma engineer of chemical and biological engineering at the University of Erlangen-Nuremberg in 2009. Between 2009 and 2014 she worked as a PhD student at the Chair of Fluid Mechanics / University of Erlangen-Nuremberg and Ziemann Holvrieka GmbH. Her main task was the development of a novel water quality management strategy in breweries by hybrid automation. Additionally, she completed a one-semester distance learning course in the field of Intellectual Property Rights. After successful completion of her PhD, she has been employed by Ziemann in the Process Technology Division including research & development and the patent system.
Reuse of second steeping water improves eco-efficiency of malting

Ritala A.1, Holopainen-Mantila U.1, Sarlin T.1, Honkapää K.1, Merta E.1, Jermakka J.1, Koljonen R.1, Huttunen T.2, Wilhelmson A.1
1 VTT Technical Research Centre of Finland Ltd, Espoo, Finland; 2 PBL Brewing Laboratory, Espoo, Finland

Malting is a water intensive process. Malthouse wastewater reuse in steeping has been mainly restricted by issues related to microbiological quality and germination inhibition. We set up an experiment to reuse second steeping water up to seven times and analysed the quality of steeping water and resulting malts. With increasing rate of water reuse: the conductivity and total suspended solids of water rose. However, conductivity stayed below the recommended limit (< 250 mS/m). The polysaccharides accumulated in the reused steeping water from both sources: barley and microbes. Reuse of second steeping water did not affect germination, enzyme activities, filterability or other Congress wort parameters or high gravity mashing properties of the resulting malts. Furthermore, the reuse of steeping water did not have a statistically significant effect on the sensory quality of the malts. Our results clearly indicate that there is no objection for recycling of steeping water in the malthouse.

Mini-CV:
Principal Scientist at VIT Ltd Industrial Biotechnology (Espoo, Finland), Adjunct Professor at the University of Helsinki, PhD in Pharmacy (University of Helsinki), Project Manager (IPMA C-certified), expertise in: malting, plant molecular farming and in the biotechnological production of plant-derived compounds and recombinant proteins; has been involved in interdisciplinary EU-projects either as a scientist or as a manager.

Shelf-life and consistency of active dry yeast for breweries

Gosselin Y.1, Van Nederveelde L.1, Boeykens A.3, Meurice R.2
1 Univ Liège, Department of Brewing Science and Fermentation Technology, Brussels, Belgium; 2 Odisee, Gent, Belgium; 3 Lesaffre, Fermentis, Mâcon en Barrois, France

Nowadays, active dry yeast (ADY) is an attractive and easy tool for beer production and/or diversification. Nevertheless, literature is poor in terms of information regarding consistency of ADY and its real shelf-life. Therefore, brewers have a limited visibility on the storage life of ADY without impacting its initial performances.

The purpose of this lecture is to present results from different independent studies on the consistency of ADY and its real shelf-life across different strains and batches. 10 commercials ADY were considered in forced ageing tests and 2 ADY were studied following a natural ageing (3 years). Yeast performance was evaluated by analysis of fermentation profile, attenuation level and volatiles production. For some yeasts, sensory analysis was performed after bottling. The results of this study show that after more than 3 years, there are no significant differences between aged and freshly produced ADY in terms of fermentation performances and beer quality.

Mini-CV:
Yves Gosselin is an Agricultural Engineer from the Université Libre de Bruxelles (ULB), Brussels, Belgium. He made a Complementary Master in Biotechnology at The Université de Liège, Gembloux Agro-Bio Tech and followed the “Complementary Master in Management,” at “Solvay Brussels School of Economics and Management”. Yves Gosselin joined the Lesaffre group in 1990 in the Research & Development pilot plant where he contributed to the development of specific processes for yeasts dedicated to alcohol applications such as wine, whisky, spirits, beer & fuel ethanol.

In 2007, Yves joined Fermentis – the business unit of Lesaffre dedicated to create & deliver innovative and dependable fermentations & derivatives offering sustainable technical solutions to the benefit of fermented beverage producers – as Technical Manager. Among his duties in the business unit, Yves is responsible for product innovation, quality management & technical support to Fermentis customers worldwide.

Spent grain to energy – biogas plant Göss

Offenbacher E.
BDI BioEnergy International AG, Grambach, Austria

“Brewing a better Future” is the slogan of the brewery Göss in Austria, reflecting the ambition for a CO2 neutral beer production. End of 2015 they reached 100 % independence from fossil fuels by starting up the world’s first biogas plant for turning spent grain into energy. Beside producing sustainable biogas, also valuable fertilizer, rich in nutrients, is generated. About 18.000 tons per year of brewery residues are turned into more than 15 GWh of biogas energy that is used in the steam boiler and for producing electricity in a CHP. A decent storage for both spent grain and biogas is balancing out the discontinuous operation of the brewery, ensuring a most optimised energy use. Plant operation is fully automated and coping with the high nitrogen content of the feedstock. Maximising the biogas production is another topic that will be presented in this paper, alongside with other information of one-year operation.

Mini-CV:
Elmar is Director Sales BioGas of BDI-BioEnergy International and has been working in the field of waste to energy for almost 20 years. He began his career as a process engineer with Austrian Energy & Environment for fluidised bed combustion technologies; from there he progressed to technical sales and was intensively working all over the world to introduce sustainable technologies for the thermal treatment of waste streams. Elmar is Master of Science and holds a degree in Chemical and Process Engineering of the Graz University of Technology in Austria.
Elucidation of the formation mechanism of 2-mercapto-3-methyl-1-butanol (2M3MB) in beer

Noba S.1, Yako N.2, Irie T.3, Kobayashi M.1, Watanabe T.1
1Asahi Breweries, Ltd., Research Laboratories for Alcohol Beverages, Moriya, Japan; 2Asahi Breweries, Ltd., Production Technology Centre, Moriya, Japan

2M3MB imparts an onion-like off-flavor in beer. Recently, we purified the precursor of 2M3MB from hops and identified the compound as 2,3-epoxy-3-methyl-butanal (EMB). Here, we attempted to elucidate the mechanism by which 2M3MB is formed in beer. EMB concentration increased during the hot aeration of wort and was directly related to the amount of 2M3MB formed during fermentation. Notably, the rate of precursor conversion was markedly influenced by the yeast strain, yeast condition, wort composition, and fermentation conditions. The wort concentration of threonine, which is known to affect the formation of hydrogen sulfide (H2S) during fermentation, strongly influenced 2M3MB concentration. In wort lacking threonine, H2S was not formed only in the early stage of fermentation and 2M3MB was also not formed, as EMB was rapidly reduced by yeast. These results indicate that the formation of H2S and yeast reduction of EMB are the key reactions leading to the formation of 2M3MB in beer.

Mini-CV:
Shigekuni Noba received a master’s degree in pharmaceutical sciences from the University of Tokyo, Japan, in 2006 and joined Asahi Breweries Ltd. He has been working on flavor analysis in Department of Brewing and Flavor Technology of Research Laboratories for Alcohol Beverages.

The role of a beer membrane filter in an environmental friendly brewery

Folz R.
Pentair Process Technologies, Venlo, Netherlands

Environmental stewardship is a top priority for modern breweries. Maintaining a healthy balance between sustainability goals and social enrichment has become as important to the future success of brewing, as economic viability and beer quality. In this presentation the author will explain the environmental aspects of the beer membrane filtration, especially in case the membrane filter replaces or is chosen instead of a cake filter in which diatomaceous earth, is used as a standard. A deep dive is taken into environmental aspects of the beer membrane filter, including the effect on solid waste stream, water consumption, beer loss, CO2 footprint and hygienic design to further reduce cleaning chemicals in use. This goes deeper than only looking locally at the filter itself – “first time right” becomes even more important, which means in the end a lower loss in the total brewing process stands as a result.

Mini-CV:
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 RD&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. With his team of experienced engineers at the VLB-Berlin, Folz has worked on sustainable developments for the brewing industry, future brewing streams and on fermentation & applied microbiological concepts and control mechanisms. Under his leadership, the BBSA department became an internationally respected provider for mission-oriented research and solutions regarding technological topics, global consultancies and international training courses. Roland Folz started his career in the brewing industry with a technical apprenticeship as a Brewer & Malster at the Beck’s Brewery culminating with his doctorate degree with a thesis on the flavor stability of beer in PET bottles.

Genetic analysis of bottom-fermenting brewer’s yeast imparting good kire (crispness) to beer taste

Oomuro M., Motoyama Y., Watanabe T.
Asahi Breweries, Ltd., Research Laboratories for Alcohol Beverages, Moriya-shi, Japan

Selecting a brewer’s yeast with optimal fermentation performance is critical for producing a beer with the desired taste profile. We previously isolated the “SUPER DRY” yeast strain (SDY) from our wild-type stock brewer’s yeast strain (WTY) and used SDY to produce our leading product, “SUPER DRY.” The SDY has a rapid fermentation rate, resulting in lower residual sugar levels compared to WTY. In addition, the finished beer produced using SDY displays good kire, which is the Japanese word for crispness or smoothness of taste. To investigate which genes contribute to the formation of kire, we compared the genetic profiles of SDY and WTY. We identified several genes potentially involved in glucose sensing, protein biosynthesis, and the glycolytic pathway that had increased copy numbers and transcriptional levels in SDY. These findings suggest that changes in genetic profile in SDY influence wort fermentation and are responsible for the desired taste profile of “SUPER DRY” beer.

Mini-CV:
Mayu Oomuro joined Asahi Breweries Ltd. in 2012. Since then, she has been actively engaged in the breeding of new brewing yeast strains and the practical application of yeast technologies to fermentation processes. She was recently interviewed by Nikkei, the prestigious Japanese newspaper and cited as a “Brilliant Female Scientist of Brewing Yeast.” She is currently a leading researcher at the Department of Fermentation and Microbiology Technology Research Laboratories. Before joining Asahi Breweries Ltd., she received a master’s degree from the Department of Biological Information, Graduate School of Bioscience and Biotechnology, Tokyo Institute of Technology in 2012.
### L17

**Scaling & logistics rethought: multi-function mash-tun, kettle & whirlpool**

**Sparacio S.**
Simatec SRL, Sales, Vaie, Italy

**How big should my brewhouse be?**
An oversized brewhouse will output stagnant product, and in turn an inability to experiment with smaller batches. Too small of a brewhouse transforms your success into a burden- equipment wear & labor skyrocket-while this relatively young brewery must embark on the process upgrading the brewery.

SIMATEC Impiantibirra has patented two designs that allow for a pragmatic solution to this question. First, a whirlpool paddle that converts a kettle into a brewhouse. This paddle is unique in itself for its simple yet elegant design, and for reducing hot side aeration of the wort by eliminating an auxiliary pump.

But it also opens up possibilities for scaling. Our second patent is held over the modular brewhouse: because the kettle is multi-functional as a whirlpool and a mash-tun, we can exponentially expand the brewery with the existing tanks. Simatec can add 1, 2, or 3 multi-function tanks to the existing tank and lauter tun, stagger brews very closely together.

**Mini-CV:**
Business background with strong technical expertise in brewing Salvatore set up a micro-brewery in Turin in 2007 and in 2012 he sold this business. His background is based in manufacturing and planning environment, including IT issues, that makes him able to feel comfortable in every aspect of business. At the moment Salvatore has accepted the challenge to drive SIMATEC impiantibirra from having an Italian based market to a worldwide operating company.

### L18

**Understanding the impact hopping rate has on the aroma quality and intensity of dry hopped beers**

**Lafontaine S., Shellhammer T.**
Oregon State University, Food Science and Technology, Corvallis, United States

Dry hopping has been used by brewers to impart hoppy aroma character to beer for centuries and is becoming an increasingly popular method among US craft brewers. Many US craft brewers use extremely high dry hop dosing rates of up to 1000 g/hL and this is both unsustainable and wasteful. This study examined the impact of dry hopping rate on the sensorial and analytical characteristics of dry-hopped beers. A unhopped pale beer was dry-hopped with whole cone Cascade from the 2015 harvest over a broad range from 200 - 1600 g/hL in replicated, pilot scale (80 L) lots. Trained panelists using descriptive analysis scaled the overall and qualitative hop aroma intensity of these beers, as well as the unhopped base beer. Instrumental analysis was used to measure the levels of hop volatile extraction between the treatments. The relationship between dry-hopping rate and the sensorial and analytical characteristics of the finished beer was not linear but had an optimal range between 400-800 g/hL.

**Mini-CV:**
Scott Lafontaine is a Ph.D. student at Oregon State University and a member of Dr. Thomas Shellhammer’s laboratory. His research focuses on determining factors in hops that drive their dry-hop aroma performance in beer. He assists in the teaching of residential and continuing brewing analytical and quality education courses at OSU. Prior to joining the Shellhammer team at OSU, he received his Master of Science in Chemistry at OSU in 2015, during which his studies focused on analytical environmental chemistry.

### L19

**Improved dealcoholization process of beer and its market potential**

**Jörg M.1, Koukol R.2**

1 Centec GmbH, Sales and Project Management, Maintal, Germany, 2 Centec GmbH, General Manager, Maintal, Germany

In the last years more attention is given on the market segment of dealcoholized beverages especially of alcohol-free beers (AFB) by breweries as well as by consumers. This "malt-based soft drink” can be a substitute for soda-pops, which scores with less calories and several health benefits. Starting within the German beer market in the 1980’s, alcohol free wheat beer and alcohol free beer mix drinks currently increase the sale of alcohol free beer, while the beer sale itself is in decline. The improvements by usual technology of thermal dealcoholization as well as improvement of quality characteristics like flavour, foam, fullness of body and intensifying of the aroma by the modification of the original beer, blend with original beer and “aromawater” and dry-hopping addressing new consumer groups and potential markets by enormous flavour variation of AFB.

The dealcoholization technology, its improvements and market potential get presented under economic and science aspects.

**Mini-CV:**
After his education to brewer and malter, Mr. Jörg studied at the university of Weihenstephan/TUM by diploma brewmaster degree in 2002. During his first employment at ASIRAL GmbH sales department, he degrees by further education as Master Professional (CCI) of Technichal Management at the IHK Munich, as well as Quality Manager at the TFH Berlin. Working afterwards for several different breweries in Germany, Mr. Jörg joined finally the company Centec GmbH in 2010, where he is responsible for the Sale and Projectmanagement department in Europe.
### L20

**Alcolyzer beer ME - Results of alcohol analysis on beer samples with an alcohol content lower than 0.4% v/v**

**Peterherr M.**  
Anton Paar GmbH, Product Management, Graz, Austria

Alcohol determination by selective NIR absorption measurement was introduced to the market by Anton Paar more than 15 years ago. Since then, this technology was constantly improved ending up in a new method for alcohol analysis in alcohol free beers. This technology covers the increasing demand in analysis of this type of beers. In this presentation its advantages are demonstrated.

**Mini-CV:**  
Markus Peterherr Product Management Beverage Anton Paar GmbH Graz Austria  
Degree in electrical engineering 2004 - 2014  
Product Management for Beverage Analysis

### L21

**The use of hops in brewhouse and cold block**

**Michel R. ¹, Scheller L.², Vetterlein K.²**  
¹GEA Brewery Systems GmbH, Research & Development, Kitzingen, Germany; ²GEA Brewery Systems GmbH, Product Management, Kitzingen, Germany

The paper gives an overview on the available techniques for processing of hops in a brewhouse as well as in the cold block of a brewery including options for the craft brewers. A method is shown to reduce extract losses with pellet dosings above 200 g/hl.

In a brewhouse there are special skid mounted units for hop pre-isomerisation available besides the typical hop dosing units for pellets and extract. The working principle of the pre-isomerisation is explained with results from industrial trials in Europa and Asia. The isomerisation is done in parallel to the wort boiling operation, this allows to reduce boiling parameters to the needs of DMS transformation and the stripping process.

For dry hopping a new extraction unit was tested in an industrial environment. The process steps and the behaviour of hop oil fractions are explained. The overview includes also the use of centrifuges for the removal of a pellet suspension use for dry hopping in a fermenter.

**Mini-CV:**  
Rudolf Michel finalized an apprenticeship as brewer & maltster and studied at the Technical University of Munich at Weihenstephan. Here he graduated as engineer and did his PhD. He worked with Prof. Dr. Karl Sommer for several years on the mechanisms of hot break separation and on hygienic design of armatures and pipework systems. After different positions he joined Huppmann in June 2000 and was involved in major brewhouse projects. After a takeover by GEA in 2006 the new entity GEA Brewery Systems was built in 2009. Currently he is leading the research & development team focusing on brewing technology and environmental aspects. He is a member of DBMB and VeW and has published more than 100 papers.

### L22

**Towards a new comprehensive methodology for the evaluation of free and bound aldehydes in malt, wort and beer**

**De Clippeleer J.¹, Bustillo Trueba P.¹, Guevara Romero J.S.², De Cooman L.¹**  
¹KU Leuven, Department of Microbial and Molecular Systems (M2S), Ghent, Belgium; ²Wageningen University, Wageningen, Netherlands

With our current research, we aim at a more systematic investigation of the binding and release behaviour of aldehydes towards (i) amino acids (amine formation), (ii) bisulfite (bisulfite adduct formation) and (iii) cysteine (formation of 2-substituted 1,3-thiazolidine-4-carboxylic acids), in malt-, wort- and beer-related model systems. We perform measurements on the volatile fraction by HS SPME GC-MS, and analyse the different types of non-volatile aldehyde adducts using LC-MS. For identification and quantification of aldehyde adducts, authentic reference compounds were synthesized. Our approach provides a new comprehensive methodology for total aldehyde determination that covers both the volatile and the non-volatile (“bound-state”) aldehyde fraction in the matrix. The application potential of this comprehensive methodology is to obtain knowledge on the content of free and bound-state aldehydes in more complex matrices such as raw materials, wort and beer.

**Mini-CV:**  
Jessika De Clippeleer is currently Doctor Assistant at the Lab of Enzyme, Fermentation & Brewing Technology (EFBT) of KU Leuven. She is involved in fundamental and applied research, services and academic teaching. She participates in the collaborations of EFBT already since 2005. She is responsible for research project management, coordination, planning, and operation of the EFBT Analytical Centre (Flavour+). She delivers courses on biochemistry, enzymology and food science at the Faculty of Engineering Technology. She achieved a PhD in Bioscience Engineering at KU Leuven with her dissertation on beer flavour stability: chemical-analytical characterisation of critical factors related to wort production and hopping [2013]. She is a Master in Food Technology, Food Chemistry from Wageningen University [2003], and a Master in Engineering Technology, Biochemistry from KAHO Sint-Lieven [2000].
Perspectives of real-time carbohydrate profiling

Kunov-Kruse A.1, Bekkers A.2, Piltoft J.1, Nybo C.1, Geertman J.-M.2, Hoffmann-Petersen E.1.
1Specshell ApS, Valby, Denmark, 2Heineken BV, Zoeterwoude, Netherlands

SIBA (Specshell In-line Brew Analyzer) is a new mid-infrared based technology allowing for fully automated continuous inline monitoring of industrial mashing. The technology registers the amount of dissolved carbohydrates, average degree of polymerization, as well as individual carbohydrate profile, to be determined in real time with accuracy.

The presentation will discuss the potential of carbohydrate profiling as a tool to optimize mashing processes.

It will be demonstrated how the method can provide simultaneously insight in both gelatinization behavior and amylase activity during the mashing, by time-resolved analysis of the starch derived sugars and their degree of polymerization.

With the SIBA-technology, the brewer obtains a valuable set of completely new tools for data driven process optimization, e.g. raw material utilization and shortening of processing time, with potential for further product improvements.

Mini-CV:

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. Specshell is a Danish company specializing in in-line analysis of carbohydrates in industrial processes. Currently Andreas continues his research in spectroscopic investigations of carbohydrates, while maintaining an active role in the development of Specshell’s in-line technology.

Influence of variety, provenance, and processing on the concentrations of 4-mercapto-4-methyl-2-pentanone (4MMP) in hops

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German Research Center for Food Chemistry, Leibniz Institute, Freising, Germany

Among the compounds being transferred from hops into beer in aroma-active amounts, black currant-like smelling 4MMP is one of the most important. 4MMP vitally contributes to the characteristic flavor associated with some US hop varieties widely used by craft brewers. However, low concentrations and a high chemical reactivity make analysis of 4MMP challenging. We developed a sensitive and reliable analytical method for the quantitation of 4MMP in hops based on a stable isotope dilution assay in combination with the selective enrichment of thiols on mercurated agarose gel and GC×GC-TOFMS analysis. Application to ~80 samples of dried hops covering ~40 different varieties and the major growing regions worldwide revealed 4MMP concentrations ranging from 0 to 60 µg/kg.

Data allowed a first insight into the role of variety and provenance for 4MMP concentrations. Further experiments were focused on the influence of the harvest year and on changes in 4MMP concentrations during hop processing.

Mini-CV:

Martin heads a research group at the Deutsche Forschungszentrum für Lebensmittelchemie, Leibniz Institut (German Research Center for Food Chemistry, Leibniz Institute) in Freising-Weihenstephan, Germany. He studied Chemistry and Food Chemistry at the Ludwig-Maximilians-University, Munich and received a PhD in Food Chemistry from the Technische Universität München (Technical University of Munich) for a thesis on aroma-active compounds in hops. His research interests include the identification of the key aroma compounds in foods and beverages with a special focus on fruits, herbs and spices, the role of sulfur compounds as potent odorants and their analysis, and the influence of processing on the key aroma compounds. Currently he manages several projects dealing with the impact of hop compounds on beer aroma.

Development of a non-alcoholic beer with a novel idea undertaken by casting off preconceptions about beer

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1Asahi Breweries, LTD, Development Laboratories for Alcoholic Beverages, Moriya, Japan, 2Asahi Breweries, LTD, Research & Development Headquarters, Moriya, Japan

In Japan, the non-alcoholic beer (NAB) market has been dominated by products with < 0.5 % alcohol by volume (ABV) since the 1980s. The market for NAB rapidly expanded in 2009 due to the introduction of NAB labeled as 0.00 % ABV.

On the other hand, studies have revealed that many customers are not satisfied with the flavor of NAB as a beer substitute. Here we report the development of NAB with 0.00 % ABV with a new idea undertaken by casting off preconceptions about beer making.

Unfermented wort has been primarily used to produce 0.00 % ABV beer; however, we developed a new beer production method without wort through thorough analysis of core values toward beer, customer surveys, and chemically analyzing and using compounds that replicate the flavor of beer.

This production technology contributed to the expansion of the NAB market as customers could recognize a flavor similar to that of regular beer.

Our NAB market share in Japan increased to >30 % in the first year after launch.

Mini-CV:

Shinsuke Ito graduated from Department of Bioengineering in the Graduate School of Natural Science and Technology at Okayama University, Japan. He joined Asahi Breweries, Ltd. in 2003 as a brewing staff in Suita Brewery. After he had worked as a brewing staff in Fukushima Brewery, he has been engaged in research and development of beer and non-alcoholic beer in Development Laboratories for Alcoholic Beverages at Asahi Breweries Ltd. since 2007.
Approach for quantitative analysis of hordein peptides in gluten-free malt beers with High-Resolution-Orbitrap-MS

Hellen Watson 1, Decloedt A. 2, Vanderputten D. 1, Van Landschoot A. 1,2
1Ghent University, Faculty of Bioscience Engineering, Research Group Biochemistry and Brewing, Ghent, Belgium; 2University College Ghent, Faculty of Science and Technology, Research Group Biochemistry and Brewing, Ghent, Belgium

To comply with gluten-free labeling legislation (< 20 ppm) sensitive and reliable quantification methods are required. The R5-ELISA methods have some bottlenecks concerning the accurate quantification of hordeins (barley gluten) in malt beers. LC-MS techniques have opened a new chapter in today’s gluten analysis. An extensive literature search shows that immunogenic hordein epitopes are 9 amino acids long and contain 1-4 prolines and 2-6 glutamines. So far 115 hordein peptides in beer have been characterized of which 39 peptides persist a minimal of six residues to one or more of the known immunogenic epitopes. Untargeted High-Resolution-Orbitrap-MS has the possibility to complement and strengthen R5-ELISA results, by offering highly sensitive, accurate and unambiguous detection and quantification of immunogenic hordein peptides in beer. A better insight into the problematic hordein content of malt beers will help to evaluate their true potential as part of a gluten-free diet.

Mini-CV:
Hellen Watson graduated in 2014 as M. Sc. Biochemical Engineering, Ghent University. She started to work at the research group Biochemistry and Brewing of Ghent University where she performs a doctoral study on the occurrence and influence of processing on gluten and toxic gluten peptides in fermented beverages.

Polyols as natural sweeteners from lactic acid bacteria in oat wort-based beverages

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1UCD, Food and Nutritional Sciences, Cork, Ireland; 2Cork Institute of Technology, Department of Biological Sciences, Cork, Ireland; 3Technische Universität München, Lehrstuhl für Brau- und Getränke- technologie, Freising-Weihenstephan, Germany; 4Technische Universität München, Forschungszentrum Weihenstephan für Brau- und Lebensmittelqualität, Freising-Weihenstephan, Germany

The growth of the alternative beverage market and the increase in the consumers’ desire for healthier products has led to increased demand for naturally fermented beverages. To satisfy these markets, lactic acid bacteria fermentation for the production of polyols as natural sweeteners, is an attractive option for improving the palatability of these beverages while also reducing the caloric value without affecting the sweetness. In this study, 224 LAB strains were screened for their ability to produce polyols. Mannitol production was evident in 28 isolates. Two polyol-producing strains, Leuconostoc citreum TR116 and Lactobacillus brevis TR025, and a negative control strain were selected as starter strains for fermentation of barley, wheat and oat malt-based worts. In conclusion, oat is a suitable substitute for barley and wheat malt for the design of novel non-alcoholic fermented beverages. In addition, use of polyol-producing LAB can enable flavour modulation of wort-based beverages.

Mini-CV:
Eric Steffen studied Beverage Technology at Hochschule Geisenheim University (B.Sc) and Justus-Liebig-University Giessen in corporation with Hochschule Geisenheim University (M.Sc.). His research extended over wine fermentation with non-saccharomyces yeasts and polysaccharides of coffee colloids. After an industrial project, he is now doing his PhD in the group of Prof. Elke Arendt at University College Cork on the fermentation of cereal based beverages.

Journey into history – analysis of 100-year-old beer

Ošovská J., Matoulková D.
Research Institute of Brewing and Malting, Prague, Czech Republic

Three bottles of probably century-old beer were found in 2015 walled in a cellar of brewery in Záhlinice, Czech Republic. Good storage conditions enabled analysis of their original composition. Based on the results, the bottles contained most probably lager type beer. First one (bright, original extract 10.3 %) had sulfuric and fecal off-flavors. The second one (dark, original extract 7.6 %) was very acidic, resembling a Lambic. DNA analysis proved the presence of lager yeast Saccharomyces pastorianus and contaminant Dekkera bruxellensis. The third beer (light brown, original extract 10.4 %) contained small CO2 bubbles and was slightly bitter. As a consequence of natural aging process the extremely high concentration of 2-furfural and transformation products of iso-alpha acids was found. The relatively high degree of adjuncts addition could be assumed from high concentration of myristic acid and low concentration of silica. DNA of contaminating microorganisms in all samples was proved.

Mini-CV:
Jana Ošovská has worked 15 years as analytical chemist in biomedic field. She is an expert on modern separation techniques such as HPLC with UV, FL and MS detection. She has started to work in brewery research in 2010; from 2013 is she an expert of the Analytical Committee of EBC. Presently, she is a manager of the Analytical Testing Laboratory EN ISO/IEC 17025:2005, a manager of Sensory Laboratory and member of professional sensory panel of the Research Institute of Brewing and Malting, PLC.
Influence of yeast fermentation on dry hop aroma and flavour

Matsche B.1,2
1Barth Haas Group, Nuremberg, Germany, 2Nyseos, Montpellier, France

Dry hopping is done extensively by craft but also by big brewing companies. Within the different techniques of dry hopping, adding the hops for main fermentation becomes more popular. It is known that biotransformation reactions effect hop aroma components as Linalool, Geraniol, Citronellol and Terpineol. Still so far the impact of yeast is poorly understood in context with hop aroma. In our trials we tasted several yeast strains by maintaining a constant hopping regime to investigate the flavour impact of the yeast strain. With hop aroma analysis and sensory evaluation we look for correlations that bring light into the obvious flavour effects. We found that the yeast strain can have a considerable influence on the final hop flavour, depending very much on the relevant yeast strain but also the relevant hop variety.

Mini-CV:
Work Experience & Education
August 2016 – today:
Simply Hops (BARTH-HAAS UK), Paddock Wood
Sales Manager
February 2015 – July 2016:
Joh. Barth & Sohn GmbH & Co. KG, Nuremberg
Student trainee
September 2014 – January 2015:
Joh. Barth & Sohn GmbH & Co. KG, Nuremberg
Practical semester
August 2010 – June 2012:
Spitalbrauerei Regensburg
Apprenticeship as brewer and maltster
October 2012 – today:
University of Applied Sciences Weihenstephan-
Triesdorf
Brewing and Beverage Technology (B.Eng.)
September 2000 – July 2009:
Brewing and Beverage Technology (B.Eng.)
Triesdorf
University of Applied Sciences Weihenstephan-
October 2012 – today:
Apprenticeship as brewer and maltster
Spitalbrauerei Regensburg
August 2010 – June 2012:
Practical semester
Joh. Barth & Sohn GmbH & Co. KG, Nuremberg
September 2014 – January 2015:
Student trainee
Joh. Barth & Sohn GmbH & Co. KG, Nuremberg
February 2015 – July 2016:
Sales Manager
Simply Hops (BARTH-HAAS UK), Paddock Wood
August 2016 – today:

Off-flavours due to microbiological problems in speciality beers in Europe

Gadzov B.
FlavorActiV Limited, Chinnor, United Kingdom

Beer judging of specialty beers requires expert level of tasting skills; good knowledge of beer style aligned with internationally accepted flavour standard terminology, concentration and a fair assessment.

This study, describes common off-flavours due to microbiological problems, detected in sensory evaluation of 278 different beer brands and styles in Europe.

The findings can be used to advise the producers and beer judges how best sensory practices would help to detect, prevent and stop microbiological problems during and post-production.

Mini-CV:
Boris has been FlavorActiV Director of Global Sensory Management since 2009. Boris began as a Global Sensory Manager, professional trainer and adviser in brand equity, product quality, insight/innovation and taster management. Boris has visited over 200 breweries worldwide, his significant language skills have helped develop business overseas and provide global beverage and multi-language support to FlavorActiV’s customers. Before Boris joined FlavorActiV he gained a PhD in Food Molecular Microbiology gained from the University of Vienna.

Genetic and phenotypic characterization of different top-fermenting Saccharomyces cerevisiae ale yeast isolates

Meier-Dörnberg T.1, Michel M.1,2, Wagner R.S.1, Jacob F.1, Hutzler M.1
1Technical University Munich, Research Center Weihenstephan for Brewing and Food Quality, Freising, Germany, 2Central Washington University, Craft Brewing Program, Ellensburg, United States

Brewing yeast plays a pivotal role in determining the flavor and quality of beer. Different process techniques and fermentation conditions can interact with each yeast strain to create a wide variety of different flavor profiles. The five yeast strains Saccharomyces cerevisiae TUM 210, 211, 213, 506, 511 were characterized using a broad spectrum of genetic and phenotypic methods with a focus on brewing properties and sensorial performance. Sequencing ribosomal genes and spacer regions revealed that the strains belong to Saccharomyces cerevisiae and showed some polymorphisms. DNA fingerprinting techniques demonstrated that all strains were genetically different. Phenotypic characterization revealed that the brewing properties (e.g. fermentation performance, sugar utilization, etc.) and the sensorial characteristics of each strain were unique. The developed yeast characterization platform in a 21 is a broadly based, standardized tool to find the right yeast strain for distinct brewing aims.

Mini-CV:
Tim Meier-Dörnberg studied Brewing and Beverage Technology at the Technical University of Munich, Germany, and graduated with degree Dipl.-Ing. in 2014. Since July 2014 he is a scientific assistant and PhD student at the Research Center Weihenstephan for Brewing and Food Quality, Freising, Germany.
**LEcTure aBstraCtS**

**L32**

**Chemical-analytical characterization of potential prooxidative effects of malt and beer-derived antioxidants**

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Technische Universität Berlin, Department of Food Technology and Food Chemistry, Lab of Brewing Science, Berlin, Germany

It is well established that malt-derived antioxidants are of considerable importance for the prevention of oxidative processes in beer production and storage. In this study, the potential prooxidative character of gallic acid (GA), L-cysteine (CYS), sulfite (SO₂), and ascorbic acid (ASCO) was assessed by Fe²⁺ reduction kinetics, H₂O₂ formation, and DMS oxidation in model systems. All antioxidants reduced 18µM Fe²⁺ completely to Fe³⁺ in pseudo 1st order reaction (20 °C, 1 h) at significantly different rates (ASC0>GAS>CYS>SO₂). Consequently, H₂O₂ formation (>25 µM) was found for every antioxidant except for SO₂, as a result of chelative-/non-chelative Fe³⁺ formation and concomitant activation of oxygen. Each antioxidant showed significant DMS oxidation, when combined with Fe³⁺ or Cu²⁺ for 3h at 95 °C. Surprisingly, highest DMS oxidation was found for SO₂. Based on redox kinetics and technological considerations the scope of the described reaction mechanisms in beer production is discussed.

**Mini-CV:**
Matthias works as scientific assistant at the Technische Universität Berlin at the Chair of Brewing Science. He apprenticed as a brewer and maltster at a middle-sized brewery in Germany before he studied biotechnology and brewing technology. He graduated from his studies as a Diplom-Ingenieur. During this time he investigated grist fractionation methods to optimize the lautering process. Moreover, he evaluated thermal desorption processes to optimize volatilization of undesired aroma compounds. Matthias is currently working on his doctoral thesis, which is focused on sulfurous substances in the brewing process, especially on DMS and its precursors. In addition, he is working on optimization techniques for the brewhouse process and does fundamental research on oxidative reactions in food.

**L33**

**EBC wort turbidity: Nature and impact of brewing process**

Schmitt M., Schwebel S., Boivin P.
IFBM Vandoeuvre Cedex, France

Turbidity of EBC wort is a key point in malt specifications. It is known to be linked to barley variety, but the parameter is difficult to manage for the malster and the link between a high EBC wort turbidity and haze troubles in beer is not always confirmed.

The objective of this study is first to investigate the link between EBC wort turbidity and haze of beer. Other aims are to identify the compounds related to wort turbidity and to study their behavior during process from malt to beer. The influence of malting process and of mashing regime are studied as well. Regarding experiments, it appears that a lot of parameters can influence turbidity of EBC wort. Moreover, the compounds responsible for this turbidity can be different regarding the barley variety. Relation with wort recycling step at a laboratory scale or for pilot brews is also discussed for several barley varieties.

**Mini-CV:**
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 been lecturer in biochemistry and biosciences engineering at Nancy University from which 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. He is member of the Analysis Committee and of its Steering Committee of the EBC. He is member of EBC Brewing Science Group

**L34**

**New insights into bitterness perception of beer**

Cook D., Oladokun O., Cowley T., Dehrmann F., James S., Smart K., HORT J.
University of Nottingham, Division of Food Sciences, Loughborough, United Kingdom

Bitterness is a key sensory property of beers which balances their sweet, malty characters. However, it is a complex trait comprising different qualitative (e.g. ‘harsh’, ‘metallic’) and temporal aspects (e.g. ‘instant’, ‘lingering’). Much remains to be understood about how the design of beers, the hop products used and points at which they are added to the brewing process, determine perceived bitterness quality. Our group has developed a sensory lexicon to fully appraise the range of characteristics evoked by beer bitterness. Recent findings based on the application of this lexicon reveal the impacts of hop variety selection, hop product choice and the impact of taste-aroma interactions (mediated by addition of hop aroma oils) on the perceived bitterness of beers. Furthermore, some hop oils evoked trigeminal sensations in-mouth with the potential to impact on bitterness. With this breadth of sensory experience, the categorisation of bitterness in BU’s is no longer adequate.

**Mini-CV:**
David Cook is Associate Professor in Brewing Science at the University of Nottingham, UK and is Course Director for their innovative e-learning based Masters courses in Brewing Science. The Cook research group specialises in malting science and technology, flavour formation [in raw materials, beer or distilled spirits] and perception, beer flavour stability and the biorefining of raw materials or waste streams to add value.
Characterization of Kveik, traditional Saccharomyces yeasts domesticated by Norwegian homebrewers

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1University of Guelph, Molecular & Cellular Biology, Guelph, Canada, 2Escarpment Laboratories, Guelph, Canada

Human activity has resulted in the domestication of Saccharomyces cerevisiae yeasts specifically adapted to beer production. While there is convincing evidence beer yeast domestication was accelerated by industrialization of beer, there also exists a home-brewing culture in western Norway which has passed down yeasts referred to as Kveik for generations. This practice has resulted in yeasts which are typically highly flocculant, POF-, and exhibit a high rate of fermentation, similar to yeasts which are typically highly flocculant, POF-, Kveik into warm (>30 ºC) wort. Here, we characterize due to the traditional practice of pitching yeast ally, these yeasts are highly temperature tolerant other lineages of domesticated yeast. Additionally, these yeasts are highly temperature tolerant due to the traditional practice of pitching yeast into warm (>30 ºC) wort. Here, we characterize Kveik yeasts from 9 different Norwegian sources via PCR fingerprinting, lab-scale fermentations, and flavour metabolite analysis using HS-SPME- GC-MS. These data reveal potential use of Kveik yeasts for wider brewing applications, especially in craft brewing.

Mini-CV:
Richard Preiss is a graduate (BSc. Microbiology, MSc. Molecular Biology & Genetics) of the University of Guelph, where he conducted research on carbon metabolism in yeast, improvement of yeasts for sparkling wine production, and guided projects in beer yeast research, including investigation of Brettanomyces primary fermentation and characterization of novel Saccharomyces isolates (wild and domesticated). Since 2015 he is also co-founder of the Canadian yeast supplier Escarpment Laboratories, which supplies Canadian craft brewers with innovative yeast strains and blends.

A new analytical approach to malt aroma compounds

Voigt J.1, Fechir M.1, Mall V.2, Richter A.1, Kraus–Weyermann T.1
1University of Applied Sciences Trier, Food Technology, Trier, Germany, 2Deutsche Forschungsanstalt für Lebensmittelchemie, Leibniz Institute (German Research Center for Food Chemistry, Leibniz Institute), Freising, Germany, 1Weyermann Specialty Malts, Bamberg, Germany

New analytical methods of malt aroma compounds were established and the levels of key aroma compounds were quantified. This was done in standard malts and compared with specialty malts. The project comprises the modification malt production parameters leading to different levels and composition of such aroma compounds. The results were compared with sensorial effects in the malts. This leads to a correlation of analytical results with sensorial attributes. The findings will allow to formulate new recipes of the use of the final malt composition in the making of beer and other commodities such as bread and malt containing foods.

Mini-CV:
Dipl.-Ing. (MSc) in Brewing and Beverage Technology from TU München - Weihenstephan, Germany in 1985. 1985-1996 Steinecker, Freising as a technical engineer in brewery equipment. 1993 PhD in brewing technology on beer foam from Weihenstephan (Prof. Dr. NazriiB), Industrial experience. 1997 to 2003 Engineer for brewery equipment. 2004-2012 research associate with Prof. Sommer, Mechanical Engineering & Process Technology, at the Weihenstephan, TU München, working on brewing and beverage process technology issues. In 2012 he was appointed as a professor in beverage technology and hygienic design at the University Trier. Honorary professor at University of Nottingham. Memberships: MBAA regional chair, Fellow of the IBD, Editorial board in the Journal of the Institute of Brewing, London (JIB). Certified independent expert. Main research brewing technology and raw materials.

Meurastream – A global concept of wort production with reduced consumptions of energy and process water

Harmegnies F.1, Cantillon P.2
1Meura Technologies & Services, R&D, Louvain-La-Neuve, Belgium, 2Meura SA, Process, Péruwelz, Belgium

The "Meurastream" is a global concept of wort production using a de-intensified wort boiling process coupled with an innovative energy recovery system. This "open" energy recovery system produces very high temperature process water from wort cooling, at countflow of the brewing process. This process water is firstly used for wort pre-heating between mash filtration and wort boiling (78-99 ºC). After this first exchange the water at 80 ºC is collected in the hot water tank and it is normally used for mashing-in and sparging. The concept allows dramatical reductions of thermal energy and water consumptions, as well as a significant decreasing of surplus hot water. It can be integrated in a new or existing brewhouse, batch or continuous process. This lecture will present the concept and results from different industrial projects.

Mini-CV:
Frédérique Harmegnies graduated in 1993 as a Biochemical Engineer. After a 2 years research project on beer filtration, she joined Meura in 1995 as an engineer in the Research and Development department. In 1998, she was involved in the creation of the R&D pilot center of Meura on the site of the University of Louvain-La-Neuve. From 1998, she has taken part in varied projects developments such as milling under water, continuous brewing, direct steam injection, mash filtration, extract production, green malt processing, wort stripping... Since October 2006 she is holding the position of R&D Manager at Meura.
Lecture Abstracts

L38
The role of acetic acid bacteria (AAB) in lambic beer production processes is underestimated

De Roos J., Weckx S., De Vuyst L.
Vrije Universiteit Brussel, Research Group of Industrial Microbiology and Food Biotechnology, Brussels, Belgium

Lambic beers are spontaneously fermented and matured (wooden casks) for 3 years. Earlier studies reported a transient occurrence and limited role of AAB. Aseptic sampling at different heights, improved cultivation and MALDI-TOF MS identification of 2000 isolates, and metabolomic analysis allowed investigation of the spatial distribution of microflora and metabolites. Two casks filled with the same wort were studied. The temporal microbial and metabolitic composition in both casks was complex. Four phases were found: an Enterobacteriaceae and AAB phase, a yeast phase, a lactic acid bacteria and AAB phase, and a maturation phase. The AAB contributed to the production of acetic acid (both phases) and acetoin and ethyl acetate (third phase). Higher AAB counts and concentrations of acetic acid were present at the air/liquid interface at certain time points. These data indicate that the occurrence and functional role of AAB during the lambic beer production process were underestimated.

Mini-CV:
ir. Jonas De Roos obtained his Master of Science in Bioengineering Sciences, specialization Food Biotechnology, at the Faculty of Sciences and Bioengineering Sciences of the Vrije Universiteit Brussel, Brussels, Belgium, in 2014. In September 2014, he started a PhD on the spontaneous lambic beer fermentation and maturation process in the Research Group of Industrial Microbiology and Food Biotechnology (IMDO) of the Vrije Universiteit Brussel, under the supervision of Prof. Dr. ir. Luc De Vuyst. His research involves both microbial identification and metabolite target analyses besides fermentation and sensory studies. With his data on the identification of acetic acid bacteria, he contributed as selected speaker to the International Conference on Acetic Acid Bacteria held in China in 2015.

L39
The transformation of old tradition – a novel brewhouse concept

Becher T., Bastgen N., Ziller K.
Universität München (Technical University of Munich), Freising, Germany

Jointly with the Bavarian hops producer Ziemann Holvrieka GmbH in Ludwigsburg (Germany), Dr. Toby Becher has been working on a new brewhouse concept, which has been developed at the Technical University of Munich (Munich) and graduated in 2014. Silva is currently working on her PhD thesis with new German hop varieties in a project funded by the German Ministry of Economics and Energy (BMWi) via FEI and AiF. Using Molecular Sensory Science she studies the key aroma compounds in hops and their influence on the aroma of beer as a function of hopping technology.

Mini-CV:
Tobias Becher graduated as diploma engineer of brewing science and beverage technology in 2001 at the Technical University of Munich in Freising-Weihenstephan (Germany). He made an apprenticeship as a brewer and maltster before and worked afterwards as a process engineer for beer filtration systems. Later he worked as a technical consultant especially for environmental issues in the German brewing sector. Since 2005 he has been employed by Ziemann as an expert for process engineering and brewing technology. Today he is the head of research and development within the Process Technology Division at Ziemann Holvrieka GmbH in Ludwigsburg (Germany).

L40
Aroma-active compounds in novel German flavor hops

Nieens S., Steinhaus M.
German Research Center for Food Chemistry, Leibniz Institute, Freising, Germany

Pushed by the craft brewing industry, there was an increasing demand for hops with novel aroma characteristics in recent years. In Germany, new flavor varieties were developed, among which Huell Melon and Polaris have successfully been introduced to the market. Huell Melon is characterized by a strong fruity aroma, whereas Polaris exhibits minty and fruity notes. To clarify the molecular background, aroma extract dilution analyses (AEDA) were applied. Results revealed myrcene, linalool, 2-/3-methylbutanoic acid, and geraniol as most potent odorants. In Huell Melon, high FD factors were additionally determined for some fruity smelling esters, which corresponded to the intense fruitiness of this variety. The minty, fruity smell of Polaris was reflected by odor-active amounts of 3-methylbutyl acetate and 1,8-cineole. Quantitation experiments using stable isotope dilution assays confirmed the AEDA data. Further efforts will be focused on the effective transfer of these compounds into beer.

Mini-CV:
Silva is Research Scientist in the group of Martin Steinhaus at the Deutsche Forschungsanstalt für Lebensmittelchemie, Leibniz Institut (German Research Center for Food Chemistry, Leibniz Institute) in Freising-Weihenstephan, Germany. She studied Food Chemistry at the Technische Universität München (Technical University of Munich) and graduated in 2014. Silva is currently working on her PhD thesis with new German hop varieties in a project funded by the German Ministry of Economics and Energy (BMWi) via FEI and AiF. Using Molecular Sensory Science she studies the key aroma compounds in hops and their influence on the aroma of beer as a function of hopping technology.
Influence of the grist fractions on the final beer quality

Zarnkow M.¹, Frank A.², Biberger S.¹, Jacob F.¹
¹TU München, Freising, Germany; ²Bühler, Uzwil, Switzerland

Barley is a natural product. Its attributes with respect to brewing performance and final beer quality are strongly influenced by climate, growing region, growing year, varieties, agronomical techniques and so on. But the art of brewing is to produce reproducible products. We have to react on these changes. The idea of that study is to crush the malt and fractionate over sieving devices, and analyze the fractions due to the relevant malt attributes. With that knowledge there are now two possibilities. One is, to define the optimal malt and mix the fractions. The other way is to perform optimal brewing conditions due to the attributes of each fraction. And create different new beers or mix the final products to the wished one. We used eight different sieve qualities and analyzed nine different fractions. A broad range of attributes have been analyzed. Different type of beers resulted after optimal adjusted technology with regard to the fraction characteristic.

Mini-CV:

Solving the challenges of natural compressible filter aids for processing precoats on candle filters

Zacharias J.¹, Schneid R.²
¹Krones AG, CRD Process Technology, Neutraubling, Germany; ²Krones AG, Product Management Breweries, Freising, Germany

For the production of bright beer the precoat filtration is still a prevalent process. Alternative filter aids are still a considerable interest. The authors spread their efforts with viscose fibres in previous publications. But all these had in common that still some points had to be solved. Especially up scaling and stable production were difficult.

New is that beside structural properties an adjusted process engineering and control is of equal importance for the filtration result.

In this new publication the challenges and needs for handling compressible filter aids as the precoat for candle filter systems will be reported, as: - Working with the flow in the vessel and inside the candles for preventing the build-up of asymmetric precoat cake shapes - Solving the discrepancy of minimal pressure loss in correlation to a high cake flux - Control of turbidity in consideration of compression and porosity of the precoats

In the end, this yields a solution in avoiding instable filtration results.

Mini-CV:
Dr. Jörg Zacharias graduated in 1997 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 5 years he was an associate lecturer in food process technology. In 2005 he entered Krones AG in the research and development division where he was significantly involved in developing filtration technology for beer clarification and fresh water treatment. For it he is an expert for hygienic design, heat exchanger technology and the rheology of beverages.

Industrial feasibility of the production of gluten-free barley malt beers on a day-to-day basis using different technologies

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¹University College Ghent, Faculty of Science and Technology, Department of Biosciences and Food Sciences, Research group Biochemistry and Brewing, Ghent, Belgium; ²Ghent University, Faculty of Bioscience Engineering, Department of Applied Biosciences, Research group Biochemistry and Brewing, Ghent, Belgium

The gluten-free food market is growing rapidly due to the rise in consumers suffering from a gluten sensitivity or allergy, but also by the assumption that a gluten-free diet is part of a healthy lifestyle. Therefore, commercially, it is very beneficial for brewers to be able to produce gluten-free barley malt beers on a day-to-day basis. Breweries that use different technologies and process aids (e.g. filtration types, filter aids, enzymes) were monitored with the Ridascreen Gliadin sandwich (R7001) and competitive ELISA (R7021), respectively quantifying gluten proteins and peptides. 92 % of the Belgian beers tested (n=153) had a gluten content below the gluten-free 20 ppm threshold (2009/41/EC). However, lowering the gluten peptide content turned out to be more challenging, but could still be achieved by combining technologies (32 % of the beers). Additionally, different issues related to the process adaptations have been addressed as well (e.g. foam stability and added costs).

Mini-CV:
Anneleen Decloedt graduated in 2011 as M. Sc. Biochemistry and Biotechnology from Ghent University. In 2014 she was the project manager of the Beer4Dreams team that won the first and public price at the Belgian Ecotrophelia competition and the fourth price at the European competition. She successfully defended her PhD in public health and food safety at the Laboratory of Chemical Analysis in 2015 (also at Ghent University). Since January 2015 she has been working as a research fellow at the Research group of Biochemistry and Brewing of Ghent University and University College Ghent, regularly presenting her work in scientific papers and at international congresses.
### Lecture Abstracts

#### L44

**Membrane separation technologies in brewing**

**Jastřembská K.**  
University of Pardubice, Institute of Environmental and Chemical Engineering, Faculty of Chemical Technology, Pardubice, Czech Republic

Membrane processes stand out as an alternative to conventional processes for the pharmaceutical, chemistry and food industries. The main advantages of using these processes are: product quality improvement, low energy consumption and reduction of processing steps. The purpose of this overview is to inform the audience about using membrane processes in brewing. Membrane processes can provide opportunities for technological progress in several areas of brewing. These areas can be divided into following topics: mash separation, clarification of rough beer, cold sterilisation. Significant attention will be given to alcohol-free beer production and beer aroma recovery.

**Mini-CV:**  
I am Ph.D. student at the Institute of Environmental and Chemical Engineering. I am focusing on membrane processes, especially on reverse osmosis and diafiltration. My master thesis aimed at producing of low-alcoholic drinks using membrane separation, especially beer. Nowadays, I am interested in membrane separation of organic solvents.

#### L45

**Behavior of plant protection substances during hop growing and beer production**

**Lagemann A., Kippenberger M., Hanke S. Stettner G.**  
Bitburger Braugruppe GmbH, Bitburg, Germany

Hop growers use plant protection products (PPP) very carefully to eliminate plant pests and diseases while keeping the residue levels as low as possible to obtain a product that is safe for the consumer. Maximum residue levels (MRL) in Europe are established for hop only and not for the final beer since a safe product is obtained if the MRL in hops are not exceeded. To elucidate the concentration of the plant protection substances boscalid and pyraclostrobin, brewing and pesticide spraying trials on a hop field were conducted. In a first series of experiments, the wort was spiked with two different concentrations. The levels of the PPP were subsequently monitored during beer production. We present the results in terms of transfer rates and processing factors with respect to the final product. In a second series of experiments a hop plant was treated with a PPP containing both pesticides. A sample of raw hop cones was taken every three days to monitor concentrations in the raw hops.

**Mini-CV:**  
After her study of food chemistry, she started working as PhD-student at the University of Münster. Following her supervisor Prof. Thomas Hofmann to Technische Universität München (TUM) she received her PhD in Food Chemistry in 2010. In 2008 she started working in the research and development section of the Bitburger Brewery. Since 2012 she has been the head of the central laboratory of the Bitburger Brewery Group.

#### L46

**Energy consumption of beverage bottling plants**

**Osterroth I., Voigt T.**  
Technical University of Munich / Chair of Food Packaging Technology, Freising, Germany

Sustainability is a megatrend in the food and beverage industry. The reduction of energy and media demand and the implementation of consumption-optimized systems are current targets for mechanical engineering and producers. In the presented research work the energy consumption behavior of beverage bottling plants was analyzed based on extensive empirical data. Generic energy consumption level related to the operational states of bottling machines were defined for future evaluation and specification. Based on this results a hybrid simulation model, mapping the operational behavior and the state based energy consumption of bottling plants was developed and successfully validated, enabling in-depth analysis and case studies for energy optimization of the bottling process.

**Mini-CV:**  
Isabel Anna Osterroth, born in 1986, is a research fellow at the Chair of Food Packaging of the Technical University Munich (TUM). She finished her studies in Food Technology at the TUM in 2012 with the degree of a Diplom-Ingenieur (Dipl.-Ing.). Her work is centered on analyzing, modelling, simulation and optimization of energy and process media consumption of food and beverage packaging machines. She developed a state based energy state model and is currently working on the validation of a hybrid simulation model for the operating behavior and the related energy consumption of bottling plants.
News insights on fermentation: Identification of key amino acids in lager fermentation

Boivin P.¹, Schmitt M.²
¹IFBM, R&D, Vandoeuvre Cedex, France, ²IFBM, Vandoeuvre Cedex, France

Free amino nitrogen (FAN) content of wort is measured as indicator of wort suitability for fermentation. FAN consists of individual amino acids, small peptides and ammonia. FAN is sometimes not related with fermentation performance. The concentration of individual amino acids in wort can affect both the rate of fermentation and the flavour production by yeast.

The purpose of this work is to study the impact of the different amino acids on fermentation of lager yeasts.

Data collection was made with a design of experiment built to study the influence of single amino acid supplementation to wort with interactions. The impact on yeast population, on fermentation duration, on diacetyle production was studied. The weight of each amino acid on FAN measurement according EBC 8.10 method was discussed.

For the amino acids of interest, the range of values observed malting barley varieties in discussed.

Mini-CV:
He is audit, training and technical manager at IFBM. He is Visiting Professor in malting and brewing at University of Lorraine and Harwich College. He received BSc in Biology and Biochemistry from Rouen University (1983), MSc in Biotechnology from Compiègne Technology University (1984) and PhD in Microbiology, Enzymology and Bioconversion from Compiègne University (1987). He was Post-Doctoral Fellow at Baylor University, Texas, U.S.A., 1987-1989. He received Master in Business and Administration in 1998 from French Institute of Management. Since 1989 he has been working at IFBM as scientific Director. He is a member of the EBC Brewing Science Group. He is lecturer of IFBM craft and industrial malting and brewing training program. He has been accredited a trainer by IBD and can conduct courses in French and English. He has published several papers, reviews and patents.

Using pulsatile target jets to clean spent grain loaded filter cloths

Werner R.A., Geier D.U., Becker T.
Technische Universität München, Lehrstuhl für Brau- und Getränkekettechnologie, Freising, Germany

Filter presses are utilized in breweries to separate wort and spent grain. These mash filters use large-scale filter cloths with defined mesh apertures. While tanks, pipes or other aggregates of breweries are constructed in terms of hygienic design to enhance cleanability, filter cloths are designed with focus on an appropriate filtration performance. However, they are often featuring complex structures, where spent grain has plenty possibilities to adhere. Thus, suitable cleaning concepts are demanded to avoid cross contamination and to guarantee product safety.

This work presents a method to remove spent grain efficiently from filter cloths via pulsatile target jets. The results show the suitability by reaching up to 15 % higher cleaning degrees as conventional methods. Furthermore, the method demands less detergents and shorter cleaning times, indicating economic and ecological advantages. The benefits are demonstrated by a parameter variation (e.g. process time, pulse length).

Mini-CV:
– Academic studies Brewing and Beverage Technology Bachelor of Science (2008–2012) – Academic studies Brewing and Beverage Technology Master of Science (2012–2014) – PhD-Candidate at the Technische Universität München (Chair of Brewing and Beverage Technology; 2014– now) – research field: cleaning of filter media – Academic consultant of the brewing study programs (Studienfakultät Brau- und Lebensmitteltechnologie)

Dry hopping and its effect on beer bitterness, the IBU test, foam, and pH

Maye J.
Hopsteiner, New York, United States

Dry hopping is very popular among craft brewers, however, many brewers are unaware that dry hopping can significantly alter the hop acid composition of beer which can effect a beer’s bitterness. This change in hop acid composition also effects the IBU test results causing these results to be inconsistent with the sensory results. Dry hopping can also effect beer foam and a beer’s pH. By performing comprehensive analysis utilizing High Performance Liquid Chromatography, UV Spectrophotometric Analysis (IBU Test), Nibem Foam Analyzer, and pH on beers before and after dry hopping this work will better explain why and how dry hopping effects bitterness, the IBU test, foam, and pH.

Mini-CV:
Dr. John Paul Maye is Technical Director at Hopsteiner with over 23 years of experience in the hop industry. Dr. Maye received his Ph.D. degree in Organic Chemistry at Purdue University in 1994, and started his work as a hop chemist in 1993, at Pfizer’s Brewing Ingredients Division located in Milwaukee, Wisconsin. He has published several papers on hops and received many hop related patents. He has developed many new products made from hops that are used inside and outside the brewing industry. He was a recipient of the ASBC’s Eric Kneen Memorial Award for his work on preparing stable HPLC calibration standards for isomerized and reduced alpha acids. He is also a founding member and the Secretary of the International Hop Standards Committee.
**Lecture Abstracts**

### L50

**Hop production in re-emerging U.S. growing regions: How craft beer is re-shaping the raw material supply sector**

**Sirrine J.R.**  
Michigan State University, Suttons Bay, United States

Although overall U.S. beer sales volume has been flat in recent years, tremendous growth in the craft beer sector belies this trend. The Brewers Association estimates that U.S. craft beer volume share will grow from 12% to 20% by 2020. Consumer preference for hop-heavy IPAs has increased the demand for hops, and aroma hops in particular. From 2015-2016, total U.S. hop acreage increased 18.5% (21,530 ha). While the majority of U.S. hop production occurs in the Pacific Northwest, additional acreage is being planted across the U.S.; Michigan alone will account for 300 ha in 2017. This paper explores recent hop production trends in “re-emerging” U.S. growing regions. A systems level analysis of the hop value-chain demonstrates the opportunities and challenges for new, smaller-scale U.S. hop producers. Consumer desire for quality, taste, flavor, variety, and local, will continue to drive demand for hops and require a more geographically diverse, local, and versatile hop supply sector.

**Mini-CV:**  
Dr. J Robert Sirrine is a Michigan State University Senior Extension Educator whose professional goal is to advance an ecologically sound, socially just, economically viable agrifood system. Dr. Sirrine’s scholarly interests lie in systems level inquiry of agrifood system value chains. In this context, he provides statewide leadership for hops research, education, and outreach. Efforts include on-farm research trials to determine best production practices, facilitation of Michigan’s farm to glass movement, and multi-state outreach efforts to improve growers’ production practices. Dr. Sirrine has received state and federal grants for multistate hop research, authored publications on hop production and given lectures on hops across North America. He is a co-founding member of the Great Lakes Hop Working Group and a member of the Hop Growers of America Best Practices Advisory Council.

### L51

**Advanced yeast hunting**

**Hutzler M., Meier-Dörnberg T., Jacob F.**  
Technical University of Munich, Research Center for Brewing and Food Quality, Freising, Germany

The development of diverse beer styles demands new Saccharomyces and Non-Saccharomyces strains that contribute significantly to individual beer flavor. This presentation discusses advanced methods and results for yeast discovery in environmental hot spots and old brewing cellars. Cultivation methods and PCR-based methods were optimized to get fast and reliable “yeast hunting” results. Phenotypic pre-characterization tools were developed to choose the appropriate strains for brewing trials. Selected strains were chosen and standardized pilot fermentations were carried out.

**Mini-CV:**  

### L52

**How to analyze dry hopped beer?**

**Biendl M.**  
Hopsteiner, Mainburg, Germany

Until some years ago analytical evaluation of beer mainly focused on iso-alpha-acids as most important bitter compounds. However, at least since the growing importance of dry hopping, many additional hop constituents have to be considered. In this presentation three methods are introduced which cover a wide range of substances typical for the flavor of “creative” beer. According measurements are based on HPLC-UV (humulones, humulones, prenylflavonoids), HPLC-MS (glycosidically bound polyphenols) and Headspace-Trap GC-MS (terpenes, terpene alcohols, esters, ketones). Because they are robust and easy to perform, all three methods can be considered for inclusion in Analytica-EBB. In each case, the beer samples are measured directly without any time consuming sample preparation. Moreover, a cold acidic water-ethanol extract of hops (or hop products) can be analyzed in the same way, allowing for straightforward differentiation of hop varieties with regard to their dry hopping potential.

**Mini-CV:**  
Martin Biendl is a chemist and R&D manager at the German site of the global Hopsteiner group, a hop trading and hop processing company. He is the representative of the International Hop Industry Cooperation (IHIC) on various analysis committees of the international hop and brewing industry and he is board member of the German Hop Trade Association. His research interest is in innovative application of hops in the brewing industry and beyond.
Development of a mycotoxin screening sensor system usable in industrial grain sorting – OptiScreen

Methner F.-J.1, Erler A.2, Kunz T.1, Klier D.1, Cappius H.J.1, Fröhling A.4, Karrasch A.4, Thoren P.1, Ungethüm B.1
1 Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Berlin, Germany
2 Universität Potsdam, Potsdam, Germany
3 Laser und Medizin-Technologie GmbH, Berlin, Germany
4 Leibniz-Institut für Agrartechnik Potsdam-Bornim e.V., Potsdam, Germany
5 LILA Instruments GmbH, Berlin, Germany

Aim of project “OptiScreen” is the development of a screening concept to improve elimination of mycotoxin contaminated grain during industrial sorting via optical sensor systems using fluorescence in combination with NIR-reflection spectroscopy. The concept is extended with an IMS-sensor for detection of fungal contamination in grain silos. The results reveal identification of spectral optical regions of tainted grains in relation to microbial analyses and quantitative mycotoxin determination via ELISA or HPLC. Further indicate the microbial load of grains including specific fungi contamination in grain silos. Based on this, an improved enzymatic kit based on ATP formation. In case of case-α-glucan determination the functional principle can also be used with a higher sensitivity to avoid unwanted distortions as observed using other methods like photometric iodine determination.

Mini-CV:
From 1975 to 1981 Studies in Brewing Science at Berlin Institut of Technology (TU). After the graduation (Diplom-Engineer) working as an operating supervisor at the Schlosser Brauerei Düsseldorf. From 1982 to 1986 Scientific Assistant with teaching duties at Research projects, and PhD-thesis in “Aroma Formation of Berliner Weissbier” with an enzymatic enzyme. Special focus on hops and Beers” were further tasks. For 18 years, starting 1987, he was holding a leading position as a Director at the Bitburger Brauerei, Bitburg, Germany, with responsibilities in fields such as technology and quality assurance.

An improved beer color independent enzymatic method for α- and β-glucan determination in beverages

Kunz T., Pereira F., Methner F.-J.
Technische Universität Berlin, Institute of Food Technology and Food Chemistry, Berlin, Germany

Studies have shown that some standardized analytical methods for α- and β-glucan determination like the MEBAK Calcofluor method, are significant influenced by beer color. Furthermore the usually used enzymatic methods e.g. based on glucose oxidation show insufficient results with a high standard derivation. Based on this, an improved color independent enzymatic method for α- and β-glucan determination was developed to avoid the color dependent distortion. Both methods allow a quick determination with high quality and sample quantity. The functional principle based on sample treatment with α- or β-glucan specific enzyme cocktails, which degrade the correleating polysaccharides into glucose units. The generated glucose units can be detected with an enzymatic kit based on ATP formation. In case of α-glucan determination the functional principle can also be used with a higher sensitivity to avoid unwanted distortions as observed using other methods like photometric iodine determination.

Mini-CV:
After qualifying as a certified technician (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 an engineer in the area of ESR spectroscopy at the Institute of Bio Physics at Saarland University (2002-2004). Since 2005 he has been employed as a Scientific Assistant and since 2009 as Head of Laboratory at the Institute of Food Technology Food Chemistry, Chair of Brewing Science, Technische Universität Berlin. His research focus lies in analyzing radical reaction mechanisms and oxidative processes in beer using ESR spectroscopy. A further research focus is given by the optimisation of filtration and stabilizing processes.

Improved HS Trap GC-MS analysis of hop aroma compounds in dry hopped beer

Lagemann A.1, Dixius D.2, Hanke S.1, Stettner G.1
1 Bitburger Braugruppe GmbH, Bitburg, Germany
2 Hochschule Trier, FB BLV Lebensmitteltechnik, Trier, Germany

To give beer its bitter taste and to prolong its shelf life, brewers have added hops for a long time. Lately, beer brewers have put more attention to the flavor potential. To analyze the hop flavor in dry hopped beer quantitatively, a recently published HS GC-MS method has been used and optimized within this study. Within this project, 54 volatile compounds with origin from hops could be identified in beer and determined in a single run method. First analyses of dry-hopped beers do not show correlations between quantitative amounts of singular hop oil components and the intensity and specification on the hop flavor in beer but rather point to the importance of the composition of hop oil and the interaction of those components. Following steps focussed on optimal conditions of dry hopping. In particular, differences of hop aroma compounds with varied contact time of hops were examined to accelerate beer processing.

Mini-CV:
After her study of food chemistry, she started working as PhD-student at the University of Münster. Following her supervisor Prof. Thomas Hofmann to Technische Universität München (TUM) she received her PhD in Food Chemistry on the subject ”Molecular Characterization of taste agents and ACE-Inhibitors in Spinach and other Leaf Vegetable" in 2010. In 2008 she started working in the research and development section of the Bitburger Brewery. Since 2012 she has been the head of the central laboratory of the Bitburger Brewery Group.
**Poster Abstracts**

**P004**

**Improved PCR detection of beer spoiling bacteria – optimized enrichment with NBB and innovative lateral flow detection**

Huber A.J.
Döhler GmbH, Darmstadt, Germany

PCR-based detection methods for beer spoiling bacteria have gained importance in quality control. However, cultural enrichment of samples is still a crucial step to detect trace contaminations. Therefore, we developed and evaluated a new culture medium based on NBB with an optimized nutrient composition especially for demanding bacteria (like L. lindeii) to induce fast microbial growth. The optimized broth is also compatible with all sample types arising in a brewery. Reliable PCR detection of samples spiked with 100 cfu was possible after 48 hours with four different commercially available real-time PCR systems. Visualization of PCR products can also be realized with a novel lateral flow system as easy as a pregnancy test. The sample analysis does not require a purification step. Beer spoilers enriched in the optimized NBB culture medium were reliably detected with the lateral flow system and no false positive results or PCR inhibition could be observed.

**Mini-CV:**
Agnes Huber studied biotechnology at the Technische Universität München – Weihenstephan from 2004 – 2009 with a focus on food biotechnology in her Master’s degree. After graduation she worked as a scientist in a research lab of the University Hospital Tübingen before she joined Döhler GmbH in Darmstadt in 2013 as R&D Developer for Döhler Microsafety Design products. Since 2015 she is team leader R&D Quality and Food Safety Solutions, responsible for the development and optimization of culture media and new detection solutions for beverage spoiling microorganisms.

**P005**

**Key-role of humulinones, polyfunctional thiols and terpenols in Belgian dry-hopped beers**

Silva Ferreira C., Bodart E., Thibault de Chanvalon E., Collin S.
Université catholique de Louvain, Unité de brasserie et des industries alimentaires, Louvain-la-Neuve, Belgium

The addition of hop during the late stages of the brewing process brings singular characteristics to the beer. Polyphenols and oxidation products of hop alpha acids like humulinones and hulupones can modify their bitterness and astringency. Terpenols, polyfunctional thiols and bound adducts (glucosides, cystein- and glutathionyl-thiol adducts) can impart new flavours. However, hop characteristics alone may not entirely predict the sensorial profile of dry-hopped beers. The aim of this work was to assess the level and bitterness impact of humulinones and hulupones in 21 Belgian dry-hopped beers. In addition, polyphenols, terpenols and polyfunctional thiols were quantified in these beers and the liberation of polyfunctional thiols from cystein- and glutathionyl-thiol adducts was investigated in model media. In order to understand why high levels of humulinones are only found in dry-hopped beers, its stability was further investigated throughout a pilot-scale brewing process.

**Mini-CV:**
Carlos Silva Ferreira received his engineering degree from the Federal University of Vçosã, Brazil in December 2014. Since 2012 he’s focusing his studies toward brewery research and technology. In 2013 he went to the Université catholique de Louvain as an exchange student and intern at the Unité de brasserie et des industries alimentaires. In June 2015 he started to work in same laboratory as a researcher, becoming an assistant in September 2015 and a Ph.D. student in March 2016, with a thesis project concerning dry-hopped beers flavour.

**P006**

**Volatile fingerprinting of coriander and orange peel in view of improved flavour-consistency of specialty beers and distilled spirits**

Van Opstaele F., De Rouck G., Winne V., Aerts G., De Cooman L.
KU Leuven, Faculty of Engineering Technology – Technology Campus Ghent - Laboratory of Enzyme, Fermentation and Brewing Technology, Ghent, Belgium

Particular flavouring herbs play a crucial role in the unique sensory properties of specialty beers. Variability in intrinsic aromatic quality of the herbs represents however a serious problem in view of consistent flavour quality of the end product. In this respect, a methodology based on HS-SPME GC-MS/O is used for fast and accurate quality control of botanicals used in brewing and distilling. The methodology allowed (1) to discriminate coriander samples as well as orange peel samples on the basis of their aroma characteristics, (2) to study the impact of storage conditions on the aromatic quality, and (3) to develop a protocol allowing brewers/distillers to anticipate on fluctuations in the aroma of botanicals in view of higher reproducibility of the herbs-derived aroma in the final product. The latter was demonstrated by taste panel evaluations of experimental top-fermented beers aromatised with coriander and orange peel alcohol extracts differing in origin and storage time.

**Mini-CV:**
Filip Van Opstaele obtained an academic degree in Industrial Engineering in Biochemistry in 1993 from KAHO Sint-Lieven (Ghent, Belgium) and started working at the same institute as scientific researcher. In 2001 he joined the Biochemistry Department at KAHO as assistant scientist at the Laboratory of Enzyme, Fermentation and Brewing Technology (EFBT). In 2011 he obtained the degree of Doctor in Bioscience Engineering (KU Leuven). He is currently principal investigator at EFBT and lectures chromatography, spectroscopic techniques and analytical chemistry at KU Leuven (Faculty of Engineering Technology, Technology Campus Ghent). Research experience: hopping technology, hop aroma analysis, flavour (bio)chemistry, (hyphenated) mass spectrometric techniques.
A new RT-PCR-based method for the direct monitoring of spoilage bacteria in beer samples

**Gerhardrs, Daniel**¹, **Burguière L.**¹, **Besson A.**¹, **Nahuet C.**¹, **Beau pied H.**², **Bonilla S.**², **Bouton S.**¹

¹/²Pall GeneDisc Technologies, Ridd, Bruz, France

The GeneDisc technology, based on real-time-polymerase chain reaction (RT-PCR) offers a highly flexible method to monitor beer spoilage bacteria all over the manufacturing process. Sample preparation includes bacterial concentration by centrifugation or filtration of large volume samples (50 - 500 mL) enabling to significantly increase the level of sensitivity. PCR analysis are run in less than 1 hour with an automated data management and allow detection/identification of the main beer spoilage bacteria species. Time to result, sensitivity and specificity are validated on a large range of beer samples and in-process samples (slurry). The results are available in 2 h with a sensitivity down to 1 and 5 bacteria per mL for filterable and unfilterable samples, respectively. The GeneDisc method for direct monitoring of beer spoilage bacteria provides a significant economic benefit for the brewing industry by dramatically reducing their storage cost and improving their logistic flow.

**Mini-CV:**
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 Technical University of Munich, 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.

**Schmidt C., Biendl M.**
Hopsteiner – HHV, Mainburg, Germany

As a major ingredient during beer brewing, hops give a characteristic bitter taste to the final product. The quantitative analysis as well as the knowledge of the contribution of hop bitter compounds to the overall bitter taste of beer is therefore essential. Whereas HPLC-UV analysis of selected bitter substances like alpha-acids or humulones (oxidized alpha-acids) in dry-hopped beers is feasible, the analysis of hop flavonoids like multifidol, kaempferol and quercetin glucosides requires the use of HPLC-MS/MS technique. New findings about key bitter compounds from hops [e.g. co-multifidol glucopyranoside] and their contribution to the bitter profile of beer were introduced and discussed in literature recently. To monitor selected hop flavonoids in dry-hopped beers an in-house HPLC-MS/MS method was developed. Dry-hopped beers produced with different hop varieties showed significant differences in their hop flavonoids pattern.

**Chemical studies on bitter acid oxides derived from stored hops (Humulus lupulus L.)**

**Taniguchi Y.**¹, **Matsukura Y.**¹, **Shindo K.**², **Yamazaki T.**³, **Katayama M.**²

¹Kirin Company Limited, Central Laboratories for Key Technologies, Kanazawa-ku, Yokohama-shi, Japan, ²Japan Women’s University, Department of Food and Nutrition, Bunkyo-ku, Tokyo, Japan, ³Kirin Company Limited, Research Laboratories for Health Science & Food Technologies, Kanazawa-ku, Yokohama-shi, Japan

Hop-derived bitter acids, such as α-, β- and iso-α-acids, affect beer quality and display various physiological effects. They readily oxidize; however, chemical information on bitter acid oxides has been limited and their effects on beer quality or potential health benefits are not well understood. In this study, we identified several α- and β-acid-derived oxides, such as humulones, hulupones, 4’-hydroxyisohumulones and tricyclooxyisohumulones, and their concentration changes during hop storage were revealed for the first time. By using model experiments of wort boiling and beer aging, some bitter acid oxides in hops were found to undergo chemical changes during these two processes and the structures of the transformation products were elucidated. Furthermore, we developed a simple method to prepare a fraction composed of bitter acid oxides without any other constituents from stored hops. Our results will promote the applied research of bitter acid oxides.

**Mini-CV:**
Yoshimasa Taniguchi received an M.A. degree in agriculture from Kyoto University in Japan in 2006. He began employment with Kirin Brewery Company, Ltd. in April 2006 as a researcher in analytical and natural products chemistry. He has been working at Central Laboratories for Key Technologies, Kirin Company, Ltd. since 2013. He will also receive a Ph.D. degree from Kyoto University in March 2017.
Hop, malt, yeast and water, the “classical four elements” in beer should be tested for characteristics, quality, and contamination to ensure the final product meets the highest expectations among European beer drinkers. In addition to the “classical” components, beer contains all major B vitamins, which are important for metabolism. Furthermore, bitter substances and essential oils are indisputably important for metabolism. Furthermore, bitter substances and essential oils are indisputably effective against loss of appetite, gastric disorders and states of anxiety. Undesired substances such as heavy metals (for instance Cd, Pb, Hg and As) and organic contaminants, the pesticides and mycotoxins such as ochratoxin A (OTA) can also be found in grains/brewers barley and thus represent a potential contamination risk. The determination of these substances is done using the inductively coupled plasma mass spectrometer ICPMS-2030 for the inorganic contaminants as well as the triple quadrupole mass spectrometer LCMS-8060 for the organic contaminants.

Mini-CV:
Uwe Oppermann, Shimadzu Europa GmbH, Duisburg, Germany. Shimadzu France SAS, Marne la Vallee, France

Analyst in the Analytical Business Unit of Shimadzu Europa and responsible for Food & Food Safety in the European market.

Development of a carbohydrate mass balance during malting and mashing

Langenaeken N.A.1, De Schepper C.1, De Schutter D.P.2, Courtin C.M.1
1KU Leuven, Laboratory of Food Chemistry and Biochemistry, Heverlee, Belgium, 2Fond Bailet Latour, Leuven, Belgium

From a carbohydrate point of view, the efficiency of barley-to-beer conversion can be assessed as the potential to convert most carbohydrates into alcohol and is mainly determined by the efficacy of enzymes during malting, mashing and fermenting. Research in this area requires the availability of thorough mass balance of a (lab scale) brewery from barley as starting material throughout the entire brewing process, with a focus on the conversions during malting and mashing, and the analytical tools to back this up. Efforts were invested in the fine-tuning of analytical procedures to ensure the availability of reliable methods for quantification of starch, β-glucan, arabinoxylan and fructan. Challenges that were addressed include the potential interference of enzymes or high sugar contents that are known to affect conventional measurements. Using these fine-tuned methods and a lab scale brewing experiment, carbohydrates in barley, malt, wort and spent grains were determined.

Mini-CV:

Application of a central composite design for optimization of an HS-SPME-GC-MS method for determination of volatiles in beer

Nešpor J., Karabin M., Hanko V., Dostálek P.
University of Chemistry and Technology, Department of Biotechnology, Prague, Czech Republic

Analytical method optimization, even though time-consuming, is an essential process for accurate compound determination. Currently, many different tools are used for this purpose, mostly based on complex response surface methodology models. One of them is CCD (Central Composite Design), which allows description of system behaviour while necessitating fewer analyses. An automated system based on HS-SPME extraction combined with GC-MS was optimized for the determination of 19 volatile compounds, which are responsible for important flavours and off-flavours of beer. The optimization process consisted of two steps. First, a SPME fiber was selected and subsequently four parameters of SPME extraction were optimized using a CCD model. After the optimization, parameters were validated and RSD (Relative Standard Deviations) for individual compounds did not exceed 15%. This indicates good accuracy and robustness of the optimized method.

Mini-CV:
Holds a MSc degree in Biotechnology from University of chemistry and technology Prague, Czech Republic. From 2016 he started doctoral study and as scientific researcher at the University of chemistry and technology Prague, department of Biotechnology. His research interests are in area of creating and forming volatiles compound during alcoholic beverages production process.
Comparative study of accelerated shelf-life tests on physical ageing of beverages containing weighted flavour emulsions

Rossmann S., Wolff V., Müller U., Schneider J.
Institute of Food Technology ILT.NRW, Lemgo, Germany

Beverage emulsions are an important product for the preparation of increasingly popular beer-based mixed drinks and soft drinks. They are used to incorporate water insoluble flavors and colors or to generate cloudiness. However, instability phenomena such as “ringing” or color and turbidity loss still occur. In difference to beer instabilty phenomena such as “ringing” or color and turbidity loss still occur. In difference to beer.

The effect of different shelf-life tests (Heat, Light, Agitation) were compared in regard to physical changes of emulsion-based beverages. The results reveal different effects on the rate and extent of deterioration of beverage emulsions. Elevated temperature storage and defined illumination accelerate the physical deterioration of beverage emulsions by a factor of up to 9.6. Periodic agitation enhances the deterioration even faster but with higher deviations in the extent of deterioration compared to real-time tests.

Mini-CV:
2011–2013: M.Sc. Life Science Technologies (Ostwestfalen-Lippe University of Applied Sciences Lemgo, Germany) since 2013: PhD student and research associate (Institute of Food Technology ILT.NRW, Lemgo, Germany)

Sensory and analytical changes in beer-mix beverages during shelf life

Klein H., Steingruber R., Forster C.
Brau Union Österreich AG, Linz, Austria

Beer-mix beverages, in particular Radlers have been increasingly successful in recent years. Due to the composition and specific ingredients of beer-mix beverages the known mechanisms and control strategies of beer staling have only limited relevance for these products. A broad range of Radlers in different pack types representing diverse flavours and alcohol levels has been investigated by physical-chemical methods, gas and liquid chromatography as well as descriptive sensory analysis over the course of the shelf life. Specific volatile substances like limonene, terpineols and linalool originating from fruit juice compounds could be identified as markers for the organoleptic deterioration of the product. Moreover, α-pinene and β-pinene very found to be highly thermo-sensitive and disappeared within a short period of time after a moderate heat load. Reaction rates of volatiles differed significantly in dependence of the pack type used, such as glass, PET or can.

Mini-CV:
Helmut Klein is the laboratory manager of the central laboratory of Brau Union Österreich 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.

The language of hops – How to implement and apply a common description of hop flavours

Wiesen E., Drexler G., Algazzali V., Kostelecky T., Zunkel M., Hinz S., Munoz A., Schönberger C.
Joh. Barth & Sohn, Nürnberg, Germany

Many new hop varieties emerging every year, and – strongly connected to the development in the craft brewing scene – significantly bigger hop dosages caused the need for a more detailed and comprehensive way of describing hop flavours in raw hops, in hop products, as well as in the final beer. This led to the introduction and design of a tasting form which can be an industry-wide approach to speaking the same language about hops. This poster shows more details about this new hop flavour tasting and description including a new flavour categorisation. It also explains how to best train, implement and apply this way of hop flavour description into your business – be it a hop grower, brewer, beer judge or simply an enthusiast about hops and beer.

Mini-CV:
Dr. Elisabeth Wiesen studied food and biotechnology at the Universität für Bodenkultur (BOKU), Wien, graduating as an engineer in 2005. After her studies she worked for the Brau Union Österreich AG as trainee. She pursued her doctoral thesis work at the Chair of Brewing Technology “Barley Proteins – Source and Factor of Haze Formation in Beer,” graduating in 2012. She joined the Barth Haas Group in 2011 as manager of technical Sales. Within this role she is also responsible for the guidance of research projects and authors hop-related professional articles.

36th EBC Congress · Ljubljana · 14 – 18 May 2017
First identification of cysteinylated and glutathionylated precursors of 3-mercaptohexan-1-ol in Barley. What is the influence of malting process?

**Roland A., Delpech S., Reillon F., Viel C., Dagan L.**

Nyseos, Montpellier, France

Thiol precursors of 3-mercaptohexan-1-ol (Cys3MH and G3MH) were recently identified in all barley samples (from 1-2 ppb for Cys3MH and 2-59 ppb for G3MH). After malting, the Cys3MH amounts did not change whereas the G3MH ones were impacted considerably. Decreased G3MH levels consolidating our previous findings concerning the enzymatic degradation of G3MH into Cys3MH. By contrast, G3MH concentrations could be 3 times higher in malts than in barley suggesting an in-situ formation since hexenal and free glutathione were present (until 128 ppm). Melting process could be a key operation to drive thiol precursor amounts in raw material.

**Mini-CV:**

Dr. Aurélie Roland was graduated from the National School of Chemistry of Montpellier (France) in 2007. She obtained her PhD degree in Food Sciences in 2010 focused on the influence of oxidation mechanisms occurring during must elaboration on the aroma quality of Sauvignon Blanc and Melon B. wines. Since 2011, she is working at Nyseos (Montpellier, France) as R&D manager. Her research focus (i) on analytical developments based on stable isotope dilution assay for aroma quantification in alcoholic beverages and food matrices and (ii) on organic synthesis to build innovative labelled molecules.

Investigation of mycotoxins in different beers with the Mycotoxin Screening System using several cleanup techniques

**Schultz C., Jochems P., Ludwig R., Schad G.**

Shimadzu Europa GmbH, Duisburg, Germany

Mycotoxins, especially aflatoxins, can be produced by fungal infestation during or after harvest of grain and can therefore end up in beer, brewed from malt. In addition to being acutely toxic, they are also known to be carcinogenic. To ensure food safety, manufacturers of food and beverages have to strictly manage risks from such contaminants and sensitive methods to assay mycotoxins in complex matrices are essential.

Different beer types were investigated with the Mycotoxin Screening System. The system offers an automated analysis including the ready-to-use results and reports. Furthermore, several sample cleanup columns were tried for the mycotoxin analyses in beer. The mycotoxins most commonly tested in malt products were extracted and analysed in several spiked and non-spiked beer samples. The combination of fluorescence and photodiode array (PDA) detection provided detection limits for all compounds of interest ≤ the EU maximum residue limits.

**Mini-CV:**

Carola Schultz graduated with a M.Sc. in chemistry at the University of Münster (Germany) in 2013. Her PhD subject work was completed (title award to follow) at MEET Battery Research Center of the Institute of Physical Chemistry (University of Münster) and focused on analytical chemistry and mainly high performance liquid chromatography (HPLC). Since 2016, she has worked as a product specialist for consumables in the Center of Innovation and Product Support at Shimadzu Europa in Duisburg, Germany.

Evaluation of a rapid haze stability measurement for beer

**van Koerten K., de Jong C.**

NIZO, Ede, Netherlands

Haze stability is an important factor in special beers which are characterized by their turbid appearance [1]. Main contributors to haze formation are proteins and polyphenols, which interact and form colloidal particles. Haze formation and stability strongly depends on ingredients and the various processing steps, where most of the determining compounds are formed. Though research has been done to predict haze stability over time based on initial properties [2], haze stability is still quantified by long-term storage. In this research we investigate use of increased gravitation to simulate long-term storage effects on haze stability. This will be done using a LUMiFuge, which allows transmission measurement of a sample over time under increased gravitation.

Results will be compared with results from long-term storage for validation.

**References:**


**Mini-CV:**

Kevin van Koerten is a researcher at NIZO Food Research, focusing on modelling the varying aspects of food processing, both on the product and the process scale. He specializes in heat and mass transfer phenomena, but also has fundamental knowledge of reaction kinetics and the chemical properties of food products. As such, his interest is in how a process works but also in how it affects the final product quality product. This has also led to varied collaborations. For example, he is involved with Martijn Fox, in modeling spray dryer behavior and powder properties. But also with Catrienus de Jong, in beverage pasteurization and flavor aspects.
Open your eyes: In microbiological results some important information may be hidden

Orive Camprubi M., Feliu Besora N., Lluís Tartera J., Fité Luís B.
Mahou S.A, Quality/R+D+i, Lleida, Spain

It is well known that microbiology analyses are no maths. Results from media or methodology used in analyses (membrane filtration, broth incubation, forcing test, RT-PCR, etc) may only give partial information of the real spectrum of microorganisms present in the sample. Bias may exist because media and/or methodology could favour one group of microorganisms while hindering others. This bias is clearly shown in this poster. Brewery spoiled samples produced in a pilot plant where hygiene conditions were forced to be understood, are evaluated. Samples are analysed using different media and methodologies. RT-PCR is used both to identify microorganisms grown in media and also for detection and identification directly from spoiled samples. It is shown that no method gives a complete picture of the microorganisms present in the sample.

Microbiologists and brewers must be aware of the complexity of microbiology results and take decisions accordingly.

Mini-CV:
- Biology at Universidad de Barcelona, 1982, MSc. Brewing and Distilling at Heriot-Watt, Edingburgh, 2012.
- Working in the brewing industry since 1984. Since October 2016 Head of Microbiology Central Lab, in charge of new method development for yeast evaluation, identification and yeast strain improvement, and in rapid microbiology methods for spoiler detection in water, beer mixes and soft drinks. Other experience in R&D projects on barley tissue culture, barley identification, brewery hygiene, bioluminometry techniques (ATP) and rapid detection of Legionella sp.
- 1996-2012, member of EBC Subcommission for Microbiology and since 2013, member of the Steering group of EBC Analysis Committee.

Comparison of rapid methods for detection of spoilers in low alcohol beer mixes

Feliu Besora N., Orive Camprubi M., Lluís Tartera J., Fité Luís B.
Mahou S.A, Quality/R+D+i, Lleida, Spain

Rapid detection of spoilage microorganisms is needed in the brewery industry for low and non-alcoholic beer mixes in PET bottles, because a shortened time to result would mean a reduction in quarantine time.

In our company, different rapid microbiological methods for detection of spoilage organisms have been studied. The best available technique (BAT) has been selected according to the following criteria: capacity to detect a range of microorganisms, detection level, compatibility of the technique with our products, time to results, and number of samples to process in parallel. Furthermore, user-friendliness and equipment and analysis costs have been also considered.

First selected method is based on flow cytometry and the second one is based on microcolony detection. Both techniques have been evaluated by using samples spiked with spoilage microorganisms isolated from our breweries. Detailed information and valuable data are given for each technique.

Mini-CV:

Development of new method for classification of non-volatile nitroso compounds in beer using GC with chemiluminescence detection

Vržal T., Matoulková D., Olšovská J.
1Research Institute of Brewing and Malting, Inc., Prague, Czech Republic; 2Department of Analytical Chemistry, Faculty of Science, Charles University, Prague, Czech Republic

Based on our previous study, about 1% of ATNC is formed by volatile N-nitrosamines, non-volatile ones represent the vast majority of total ATNC in beer. Hence, a routine and reliable analytical method for determination of non-volatile N-nitrosamines doesn’t currently exist, the structure of these compounds has not been elucidated either.

Therefore, we developed a new method for classification of nitroso compounds in beer by GC with chemiluminescence detection. Before the analysis, the sample was precipitated with acetonitrile, cleaned up with SPE and derivatized by BSTFA. The method is based on different pyrolysis profiles of various groups of TEA positive compounds and classification of the resulting signals by linear discrimination analysis. For this purpose, the pyrolysis profiles of training set samples were collected, and the validation of the method was performed. The method was demonstrated on beer samples, which were artificially contaminated by coliform bacteria.

Mini-CV:
Tomáš Vrzal finished MSc degree at Faculty of Science, Charles University in Prague in 2014. Currently, he is a PhD student, topic of his thesis is Analysis of sensory and toxicologically important compounds in beer. Simultaneously, he works as a researcher in Research Institute of Brewing and Malting. He is an expert of Gas Chromatography with FID, ECD and MS detection and he is a member of profesional sensory panel of RIBM. Finally, he is interested in modern statistical methods. ana Olšovská has worked nearly 15 years as analytical chemist in biomedical field. She is an expert of modern separation technique as HPLC with UV, MS detection. She has started to work brewery research in 2011; from 2013 is she an expert of Analytical committee of EBC. Presently, she is a manager of Analytical testing laboratory EN ISO/ IEC 17025:2005 of the Research Institute of Brewing and Malting, PLC.
Poster Abstracts

P022

Pesticide residue analysis in hops: Analysts’ nightmare or a unique opportunity to advance

Dusek M., Olšovská J.
Research Institute of Brewing and Malting, Prague, Czech Republic

Hops is considered the green gold among the brewery raw materials and the cost of this key ingredient is related to the yield per plant. The range of problems that can arise in growing the hop plant includes bacterial diseases, fungus and mildew, virus diseases, as well as pests and parasitic invasion. In fact the hop plant belongs to crops with intensive chemical protection.

The method of sample preparation that is widely used for pesticide residue analysis in matrices such as fruits and vegetables and well known as “QuEChERS” is hardly applicable to hops without further modification due to co-extraction of matrix components (chlorophyll, resins, low molecular bitter acids) together with compounds of interests.

In our initial set of experiments we focused on developing a QuEChERS based method in combination with a new generation of dSPE sorbents. Our attention then focused on comparing the matrix effects of this method with previously described sample preparation procedures.

Mini-CV:

Martin Dusek graduated at the Institute of Chemical Technology (ICT) in Prague in 2004, having obtained MSc in Meat Technology and a Ph.D. in Food Technology and Biotechnology. After graduation, he has been working as a specialist in LCMS for Czech Agriculture and Food Inspection Authority in Prague for 8 years; there he was responsible mainly for pesticide residue analysis in various food matrices. Currently, he works as a researcher for Research Institute of Brewing and Malting (RIBM) in Prague. His main research focus is on application of high-resolution mass spectrometry in the fields of brewing and food science.

P023

Comparison of different dosage criteria when using aroma hops

Schuell F., Forster A.
HVG eG., Technical Management, Wolnzach, Germany

There are various reasons for using aroma hops for middle and late hop additions. In particular, the question arises as to which dosage criterion is best suited, if the aim is to obtain a hop aroma in the beer through dosing at end of boil, in the whirlpool or by dry hopping.

For comparing hops of different crop years of one variety hop oil can be a practical reference value. But hop varieties differ significantly in their oil composition, for example in the ratio of monoterpenes and sesquiterpenes (poor solubility) to the oxygen fraction (better solubility).

Therefore different varieties which are dosed based on the hop oil content produce unsatisfactory results when comparing the intensity of the hop aroma. In a new approach two different hop varieties are dosed in late additions according to their oxygen fraction. Analysis and sensory assessment show whether the oxygen fraction is a more suitable parameter for achieving a comparably intensive hop aroma than other.

Mini-CV:

Dr.-Ing. Florian Andreas Schüll 09. März 1979, Ludwigsburg Married with one child
Since 05/2015: Technical Manager for Hops at HVG, Hopfenverwertungsgesellschaft, Wolnzach
07/2010 – 05/2015 Head of research brewery at TU-München / Weihenstephan, Lehrstuhl für Brau- und Getränktechnologie Since 05/2008 Assistant laboratory manager of the raw material lab at TU-München / Weihenstephan, Lehrstuhl für Brau- und Getränktechnologie

P024

Improving extract yield and wort viscosity: automated measurement of hydrolytic enzymes in malt

Cornaggia C., Mangan D., McKie V., Liadova A., Ivory R., Rooney E., McCormack N., Mc Cleary B.
Megazyme, Bray, Ireland

The combined action of a range of carbohydrate hydrolyses is responsible for starch mobilisation and production of fermentable sugars during mashing. endo- (1,3;1,4)-β-Glucanase and endo-xylanase are responsible for cell wall breakdown which greatly affects wort viscosity and filterability while the amylolytic enzymes α-amylase, β-amylase and limit-dextrinase hydrolyse starch into dextrins and fermentable sugars the balance of which is crucial to wort fermentability and beer mouthfeel. Novel assays have been developed for the direct and specific measurement of endo- (1,3;1,4)-β-glucanase, endo-xylanase, α-amylase, β-amylase and limit-dextrinase. An optimised extraction protocol and a fully automated assay format were devised and used to analyse a series of malt samples and EBC malt standards. These assays are a powerful and revolutionary solution for high-throughput malt analysis and allow for accurate malt blending, more predictable brews and consistent fermentability expectations.

Mini-CV:

Dr. Claudio Cornaggia attended the University of Pavia, Italy where he earned his BSc and MSc in Chemistry following a research period at the Technical University of Munich, Germany. After a short spell as a Research Assistant at his Alma Mater, he moved to Trinity College, Dublin, Ireland where he earned a PhD degree in Organic Chemistry. He is the author of a number of publications in the areas of polymer chemistry, organocatalysis and carbohydrate chemistry and is currently involved in the development of novel colorimetric substrates for the assay of carbohydrate hydrolyses. He is currently employed as Senior R&D Organic Chemist with Megazyme International under CEO Professor Barry McCleary who developed the Cerealpha method along with a wide range of assays and CODEX approved methods for the measurement of resistant starch, total starch and β-glucan.
FTIR characterisation of sorbent-polyphenol interactions involved in beer stabilization

Karabin M., Jelínek L., Nešpor J., Dostálek P.
University of Chemistry and Technology, Department of Biotechnology, Prague, Czech Republic

Methods for colloidal stabilization of beer by sorptive stabilizers are relatively well-studied. Less is known about the physicochemical characteristics of specific bonds which are involved in removal of polyphenols.

In this work the ability of both traditional (PVPP) and newly developed (BEERPAP) sorbents to bind selected polyphenolic substances was tested. Types of bonds were described using FTIR method for the obtained polyphenol-sorbent complexes and importance of the individual functional groups in polyphenolic molecules was defined.

We found that, in addition to the expectable interactions of the hydroxyl groups, also carboxyl group of phenolic acids and, by so far unidentified interaction, also methoxy- moieties participates in the stabilization effect. Lower absolute efficiency of polyamide sorbent could be compensated by its ability to preferentially bind larger flavonoid structures and thus increase the colloidal stability of beer without losing antioxidant activity.

Mini-CV:
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 in connection with the determination of sensorily and colloidally active constituents of malt, hops and beer; hop varieties authentication; basic methods of brewing analytics.

Novel characterization method for beer haze using asymmetrical flow field-flow fractionation (AF4)

Heijne W., Stam P., Mutsaers J., de Bruijn A., Kaal E.
DSM Biotechnology Center Glad, Analytics, Delft, Netherlands, DSM Biotechnology Center Glad, Applied Biochemistry, Delft, Netherlands, DSM, Food Specialties, Enzyme Solutions, Delft, Netherlands

Haze occurring in packaged beer is in most cases unwanted and brewers spend a lot of effort to prevent it. Many compounds from the raw materials and most steps in the brewing process influence formation of haze in final beer. Better understanding of the nature of the beer haze is essential to prevent or resolve it. We describe a novel characterization method for beer haze, using Asymmetrical Flow Field-Flow Fractionation (AF4).

This approach allows to disentangle substances in complex product samples such as beer. After separation, the fractions are analyzed using several detection methods with ultraviolet, fluorescence, differential refraction index and angle laser light scattering (UV, FJR, MALLS- dRI). AF4 requires only limited sample preparation and these preliminary results of several randomly chosen beers from the market show that the obtained profiles contain valuable information on beer haze composition.

Mini-CV:
Wilbert Heijne is global coordinator of the brewing enzymes application at DSM. In this role he combines his bio-technology background with the knowledge of the DSM enzyme solutions to meet the needs of the brewing industry. He is responsible for the global technical customer support and works with a team of highly experienced DSM brew masters that enable the world’s major brewers to efficiently produce, and stabilize their beers.

Particle size characterization of precipitated non-spherical protein particles

Ross-Jones J., Teumer T., Garcia F., Krause M., Rädie M., Nirschl H.
1 Mannheim University of Applied Sciences, Institute for Process Control and Innovative Energy Conversion, Mannheim, Germany, 2 Karlsruhe Institute of Technology, Institute for Mechanical Process Engineering and Mechanics, Karlsruhe, Germany

In most beers, producers strive to minimize haze to maximize visual appeal. To detect the formation of particulates, a measurement system for sub-micron particles is required. To facilitate the construction of a characterization system for non-spherical protein particles, a simulation software was written. The software simulates a monochromatic light source and subsequent light scattering from particles 50 to 200 nm in diameter. A fragmented virtual sensor is designed to record the scattered rays. This program describes the scattering of non-spherical particles based on the physical phenomena of light interference, reflection and diffraction.

The simulation results of spherical and non-spherical particles are presented alongside the expected changes as a result of varying the angle of the incident light beam to the particle. The presented theory and simulations show how non-spherical sub-micrometer particles scatter light and how a sensor probe measuring this light should be designed.

Mini-CV:
The author, Jesse Ross-Jones, received a BASc in Systems Design Engineering from the University of Waterloo. He also received a MEng in Electrical Engineering from Memorial University of Newfoundland. Since then, he is writing his PhD thesis in the field of rarefied gas dynamics at the Karlsruhe Institute of Technology and is working at the Institute for Process Control and Innovative Energy Conversion where his focus lies in data analysis and simulation.
Beer transport often occurs under suboptimal conditions. Especially in the case transporting overseas the beer is stored for a prolonged period before actual beer consumption. During this time, the fresh beer flavour deteriorates, resulting in the occurrence of off-flavours and a significant decrease in drinkability of the beer. Therefore, in this study we investigated the influence of temperature and vibrations on beer quality and stability under lab conditions. Fresh beers (stored at 0 °C), beers after transport simulation (30 days at 30 °C with or without vibrations), and forced aged samples (60 days at 30 °C) were analyzed using advanced analytical tools for aldehydes content, colour and decrease in bitterness. Moreover, combination of high temperature and vibration showed pronounced negative effect in beer colloidal stability.

Mini-CV:
Barbara Jaskula-Goiris obtained her PhD in Biotechnology from Wroclaw University of Technology, Poland. Since 2008 she is working as scientist at the Laboratory of Enzyme, Fermentation and Brewing Technology of KU Leuven Technology Campus Gent, Belgium. The main fields of the research are beer flavour stability, hop alpha-acids isomerisation, hop chemistry, and analytical liquid chromatographic techniques.

**Potential effect of “chit” malt on beer foam stability**

**Buiatti S., Bertoli S., Passaghe P.**
University of Udine, Department of Agricultural, Food, Animal and Environmental Sciences, Udine, Italy

Aims:
The tightness of the foam depends on the presence of some polypeptides, derived from barley and α-acids coming from hops. The goal of this work is to find a direct interaction between foam stability and “positive foam” proteins and to investigate the possibility to increase their content using different raw materials in the formulation.

Methods:
Five craft beers were brewed with different percentage of Chit malt which has a content of protein fractions potentially higher than a normal base malt. The protein content of the five beers was determined with the test BCA, the CE analysis and the stability of the foam of each beer sample was measured with the NIBEM instrument.

Results and Conclusions:
The data obtained confirm a direct relationship between the content of “positive” protein fractions and the persistence of foam and that the use in the formulation of under modified malt could be a viable alternative to traditional techniques adopted to improve the foam stability of beer.

**Mini-CV:**
Stefano Buiatti has been working at the Department of Agricultural, Food, Animal and Environmental Sciences of University of Udine as researcher since 1990. He is in charge of an experimental microbrewery 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 and 1999. Expert as project evaluator for EU since 1999.

**Spent hop material rich in xanthohumol: an overlooked foam stability enhancer**

**Jelínek L., Hanko V., Úspor J., Karabin M., Dostálek P.**
Institute of Chemical Technology, Department of Biotechnology, Prague, Czech Republic

Spent hop material (residue after CO₂ extraction or production of hop pellets T45) is a rich, but so far underused, source of polyphenols. It can be assumed, that xanthohumol contained in some of these materials can, after isomerisation to isoxanthohumol, contribute significantly to the stability of beer foam similarly like iso-α-bitter acids. In this work, the spent hop material (residue after CO₂ extraction of hop variety Taurus) in combination with iso-α-extract was used for preparation of wort, which was further analysed. This wort was characterised by high concentration of isoxanthohumol and up to 50 % rel. higher stability of foam than control wort (without spent hop material). It was proved, that the concentration of isoxanthohumol strongly correlates with beer foam stability. Due to this fact, the spent hop can be regarded as a promising material for increasing the beer foam stability.

**Mini-CV:**
There have been published several recipes for foam standards, mostly based on protein and bitter acids as a foaming material. This foam standard was meant to be used in control laboratories for validation of analytical methods of in research laboratories for beer foam studies. Such foam standards usually create foam with unnaturally long stability, or have unnaturally coarse structure when diluted to achieve stability similar to real beer foam. These disadvantages can be solved by the addition of fatty acid to the recipe for foam standard. Foam properties of model solution containing protein, bitter acid and fatty acid in buffer solution will be presented.

Mini-CV:
Petr Kosin received an engineering (MSc equivalent, 2006) and doctor (Ph.D., 2012) degree in brewing and malting at the Institute of Chemical Technology Prague, Faculty of Food and Biotechnology, Department of Fermentation Chemistry and Bioengineering, Prague, Czech Republic. He worked on both of his theses “Application of Modern Methods for Yeast Activity Control in Brewery” and “Consumer perception of beer qualitative characteristics” at Budweiser Budvar, N.C. in Ceske Budejovice. He has been working in research and development at Budweiser Budvar, N.C. since his graduation. He has been a member of EBC Brewing Science Group since 2011.

Hanke S., Stettner G.
Bittburger Braugruppe GmbH, Bitburg, Germany

In the last years many new aroma hops with special flavors were released. 2012 released multi-purpose hop variety Polaris is getting into focus for many hop growers because of the agronomical properties, yield potential in dry years and due to its very good tolerance against verticillium wilt. In beer, hop derived bitterness is a unique property of this beverage compared to other bitter beverages. In last years the research and also practical applications were focused on hop flavor to create intense and unique flavors for craft beers but bitter quality was not in focus by brewers. For the evaluation of Polaris as bittering hop pilot brewing trials with 4 different hop varieties (Herkules, Magnum, Taurus and Polaris) were carried out and the bitter quality was evaluated in German Pilsner-style Beers. Analytical and Sensory evaluation was done over a period of ageing. The results show that the variety Polaris is suitable to substitute established varieties for bitter quality.

Mini-CV:
Stefan Hanke (37) 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 Brewing Group, Bitburg. Since 2013 he is also responsible for the craft subdivision Craftwerk Brewing. He is a member of several scientific committees.

Gonzalez Viejo C., Fuentes S., Howell K., Torrico D., Dunshea F.
The University of Melbourne, School of Agriculture and Food, Faculty of Veterinary and Agricultural Sciences, Parkville, Australia

Aroma, taste and mouthfeel are quality traits directly related to the beer main components such as hops, barley and yeast. These have a direct influence over beer foamaibility and color parameters. In this study, a quantitative descriptive analysis was conducted using a trained panel to acquire intensities detected from each descriptor for 22 different beer samples. Furthermore, a robotic pourer, RoboBEER, was used to assess foamaibility and color parameters automatically from the same samples used for sensory analysis. A regression model with high determination coefficient ($R = 0.91$) was developed using artificial neural networks to predict the intensity levels of ten different sensory attributes such as yeast, grains and hops aromas, bitter, sour and sweet tastes, hops flavor, and viscosity, astringency and carbonation mouthfeel. RoboBEER showed to be less time consuming, more cost effective and an objective tool to predict foam related sensory descriptors compared to a trained panel.

Mini-CV:
PhD student at The University of Melbourne with Food Science and Engineering background with six years of experience in food products development, quality assurance and sensory science. Currently working on research related with beer and carbonated soft drinks foamaibility and bubbles dynamics, this involves the development and implementation of new technologies using robotics and remote sensing on food quality and sensory science.
Application of projective mapping for hop aroma profiling in beers produced with different fermentation and hopping conditions

Seewald T., Methner F.-J.
Technische Universität Berlin, Chair of Brewing Science, Berlin, Germany

The creation of new beer styles with exclusive hop aroma impressions is becoming increasingly important. The aim of this study was to test the influence of different flavour hop treatments (start of boiling, whirlpool, dry hopping) to the final hop aroma profile of top- and bottom-fermented beers brewed with the new German flavour hop varieties Polaris and Hüll Melon using projective mapping with ultra-flash profiling (PM-UFP). Significant differences in analytical data (e.g. polyphenol content, foam stability, hop acids, oxidative stability, etc.) as well as significant changes in the hop aroma intensity can be observed. The data obtained from PM-UFP show the differences and similarities between the samples and give an overview of potential descriptors that may contribute to the characterisation or differentiation of beers produced with mentioned flavour hops. PM-UFP offers a fast method for hop aroma profiling as well as a parallel monitoring of relationships between a set of samples.

Mini-CV:
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 fields of reaction mechanisms of carbohydrates, oxidative processes and hop aroma profiling in beer.

Aligning ESR technology with sensory panels to predict beer freshness

Grimmer H., Jorge K., Gadzov B., Guzhiev A., Nixdorf R.
FLAVORACTIV LIMITED, Oxfordshire, United Kingdom

Fresh beer is the prized output of every brewer, requiring meticulous attention to the brewing process and packaging to ensure a consistent consumer experience. Beer freshness is therefore dependent on producing a flavour stable product. This requires constant monitoring by a calibrated panel trained on specific off-notes and oxidation flavours. However, trained panels can only assess the packaged beer. This limits the ability of the brewer to identify where in the brewing process beer freshness and hence flavour stability has been impacted both negatively and positively. By adding an analytical method such as ESR which can measure beer freshness throughout the brewing process, more information is available to optimize the flavour stability of the beer. This becomes even more powerful when the ESR analytical outputs are correlated against a calibrated sensory panel, providing a rapid predictive beer freshness measure throughout the process.

Mini-CV:
Dr Grimmer is a biochemist by training, with experience in sensory science, flavours and beer flavour stability. She currently heads up Flavour Stability at FlavorActiv.

Development of electronic beer nose

Reitenbach A., Pinto L.T.
1 Universidad Federal de Santa Catarina, ESA, Florianópolis, Brazil; 2 Versuchs- und Lehranstalt für Brauerei Berlin e. V., Berlin, Germany; 3 Federal University of Santa Catarina, ESA, Florianópolis, Brazil

Beer’s flavor and aroma vary due to a wide range of influences which can occur at every single stage of its production and storage. Beer is made of over one thousand components which can contribute to the product’s flavor, providing it with pleasant or, in several cases, unpleasant aromas, due to the presence of what is called off-flavor compounds. This project aims at developing an electronic nose which is able to evaluate and detect undesirable compounds in beer samples, as a new proposal to the aroma’s quality control. For the processing of the information acquired by the e-nose, it is necessary that the equipment is connected to a multi-varied interface which has to be able to recognize aromatic patterns - the artificial neural networks. The combination of the electronic nose with the artificial neural networks presents itself as a promising alternative for the development of new products.

Mini-CV:
The researcher Amanda Felipe Reitenbach, from Brazil, resides in Florianópolis (SC) and, since her graduation she is dedicated to the study of beer and related topics. The object of her master degree was the development of a probiotic beer which may raise numerous health benefits; in doctoral studies, she developed an electronic nose for beers the line of sensory analysis in VLB-Berlin. Recent activities of her research group deserve mention: – develops new products and technologies for beer in partnership with several breweries and in the R & D from Senai (Vassouras, RJ).
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<tr>
<th>Mini-CV:</th>
<th>Contribution of compositional profile of iso-alpha acid to the quality of bitterness</th>
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<tr>
<td>Boris has been FlavorActiV Director of Global Sensory Management since 2009. Boris began as a Global Sensory Manager, professional trainer and adviser in brand equity, product quality, insight/innovation and taster management. Boris has visited over 200 breweries worldwide, his significant language skills have helped develop business overseas and provide global beverage and multilingual support to FlavorActiV’s customers. Before Boris joined FlavorActiV he gained a PhD in Food Molecular Microbiology gained from the University of Vienna.</td>
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<td>Kishimoto T., Miyashita S., Onagawa Y., Kobayashi M., Watanabe T.</td>
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<td>Asahi Breweries, Ltd., Research Laboratories for Alcohol Beverages, Moriya-shi, Ibaraki, Japan</td>
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<td>The crispness, sharpness and smoothness, the KIRE in Japanese, is an important attribute for beer taste. In this study, we investigated the contribution of compositional profile of iso-alpha acid to the crispness of bitterness. Iso-co-, normal-, ad-humulones were fractionated from the isomerized hop extract, and each fraction was added to unhopped beer to obtain beer with equivalent bitter units. Moreover, the beer with iso-alpha acids comprising higher or lower iso-co-humulone ratios was prepared by pilot brewing. These beers were assessed by a taste sensor and a trained panelist. It was supposed that the iso-alpha acids with a higher ratio of iso-co-humulone contribute to the crispiness of the bitter quality, as the highest polarity of iso-co-humulone resulted in poor binding to bitter taste receptors. The results revealed that the bitterness with higher ratio of iso-co-humulone contribute to the crisp, sharp and smooth bitterness of beer.</td>
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<th>Mini-CV:</th>
<th>Aligning In-process sensory &amp; beer flavour stability</th>
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<td>This study describes the sensory evaluation of 7 brands in 3 seasons, represented with 9 batches sensory analysed at critical control points in the production (Incoming Water, Brewhouse Water, Fermenting Beer, Conditioned Beer, Filtered Beer, Beer in bright tank, Deaerated Water, CO₂, O₂, N₂ and Filters). In total 2765 samples have been tasted by a professional in-process panel. The results will highlight the range and intensity of dominate off-flavours in the production of each brand. The findings will then be used to advise the producer about prevention steps needed in earlier stage of production and maximise freshness, drinkability and product stability. The project aims to improve understanding of beer ageing non-conformances origin in different stages of production, comparing tasting with instrumental data, monitoring and preventing faults and recalls. The study results are considered to be suitable to monitor beer flavour stability.</td>
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<td>Gadzov B.</td>
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<td>FlavorActiV Limited, Chinnor, United Kingdom</td>
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<td>This study describes the sensory evaluation of 7 brands in 3 seasons, represented with 9 batches sensory analysed at critical control points in the production (Incoming Water, Brewhouse Water, Fermenting Beer, Conditioned Beer, Filtered Beer, Beer in bright tank, Deaerated Water, CO₂, O₂, N₂ and Filters). In total 2765 samples have been tasted by a professional in-process panel. The results will highlight the range and intensity of dominate off-flavours in the production of each brand. The findings will then be used to advise the producer about prevention steps needed in earlier stage of production and maximise freshness, drinkability and product stability. The project aims to improve understanding of beer ageing non-conformances origin in different stages of production, comparing tasting with instrumental data, monitoring and preventing faults and recalls. The study results are considered to be suitable to monitor beer flavour stability.</td>
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<th>Mini-CV:</th>
<th>Relevance of oxygen for the formation of Strecker aldehydes during beer production and storage</th>
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<td>Philip Wietstock is a scientific assistant 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 an intern at the Oregon State University, Corvallis, USA. In 2011, he transferred to his present profession where he is working on his degree dissertation at which he investigates parameters influencing oxidative beer stability.</td>
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<tr>
<td>Wietstock P., Kunz T., Methner F.-J.</td>
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<tr>
<td>Technische Universität Berlin, Berlin, Germany</td>
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<td>Factors affecting carbonyl formation during beer storage were investigated using response surface methodology and SAFE-GC/MS. During storage experiments at 28 °C, glucose/xylose and Fe²⁺ concentration were found insignificant for Strecker aldehyde formation while amino acids were significant. Though, glucose/xylose played a significant role for 2-furfural formation. De novo formation of phenylacetaldehyde and benzaldehyde from phenylalanine during beer storage was observed using labeling experiments and a linear relationship between total packaged oxygen and aldehyde levels was found. Oxygen barrier crown corks and addition of excess EDTA effectively diminished Strecker aldehyde formation during storage. O₂ was additionally shown to promote Strecker aldehyde formation during lab-scale sweet wort production such as mashing and heating to start of boil. A pathway is proposed and the insignificant role of Fe²⁺ is discussed.</td>
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| P037 | P038 | P039 |
Effect of retronasal aroma on kire of beer

Miyashita S., Kobayashi M., Haruna K., Kikuchi K., Kishimoto T., Watanabe T.
Asahi Breweries, Ltd., Research Laboratories for Alcohol Beverages, Moriya, Japan

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 retronasal aroma (RA) compounds affect kire. It is well known that RA has a strong influence on the quality of food. Therefore, to elucidate the effect of RA on kire of beer, the Retronasal Flavor Impression Screening System was used to compare the RA of a beer with strong kire to other beers with significantly weaker kire. The results confirmed that beers with weaker kire had significantly higher levels of ethyl esters, acetates, and linalool RA, and that these compounds significantly suppressed sensory evaluations of kire. Interestingly, the drinking temperature of the beer had a small effect on RA as fusel alcohols, whereas RA of the esters noted above decreased with lower temperatures. These results suggest that RA affects kire, and that lowering the temperature improves kire.

Mini-CV:
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.

Occurrence of biogenic amines in craft corn beers and commercial barley beers

Metropolitan Autonomous University, Biotechnology, Mexico, Mexico

Tyramine (TYR) and putrescine (PUT) are two of the most important biogenic amines (BA) found in fermented beverages and foods. Large amounts ingested of this compounds might produce toxicological effects and sensory disturbances. There are no reports about the occurrence of BA in beers made 100% corn malt. Thus, TYR and PUT was evaluated in two commercial barley beers and six craft beers made with red and blue pigmented-corn, and barley as raw material. Measurement was carried out by RP-HPLC separation and UV-vis detection of the aminonitrores formed by the reaction with the derivatization reagent (diethylthiooxymethylene-malonate). Results suggest that red and blue corn do not influence the TYR occurrence. Otherwise, barley beers (craft and commercial) showed the highest concentration of TYR. The highest amount of PUT was found in blue corn beer followed by barley beer. Within the commercial beers, PUT was not detected in American-Pilsner beer but it was in the Münchner-Dunkel one.

Mini-CV:
Bachelor Degree in Food Engineering / Master Degree in Biotechnology / PhD candidate (Biotechnology) Three years experience in Quality Control and R&D in food and beverages industry Three years experience as assistant professor Interested in fermented beverages quality, health and nutrition Recent participation at international congresses: 1st Food Chemistry Conference 18th IUFoST World Congress of Food Science and Technology

Impact of dry hopping techniques on xanthohumol content of beer

Melo A., Machado Jr. J.C., Faria M.A., Mansilha C., Ferreira I.M.P.L.V.O.
1Pharmacy Faculty of University of Porto, Department of Chemical Sciences, Laboratory of Chromatography and Hydrology, Porto, Portugal, 2National Institute of Health Doutor Ricardo Jorge, Department of Environmental Health, Porto, Portugal

Dry hopping techniques are being widely used by breweries to highlight aroma characteristic of hops in beers. Besides the volatiles fraction the dry hopping techniques also increase the extraction of other compounds like xanthohumol. Xanthohumol is a prenylchalcone which occurs almost exclusively in hops and have a multiple bioactive properties; however, studies about yours extraction are scarce. In this study the aim was evaluated the extraction of xanthohumol in dry hopping techniques using three varieties of hops in beer with different conditions. Beer samples were analysed with hops concentrations of 0.7 g/L, 1.4 g/L, and 2.8 g/L of American hops Chinook (CHI), English hops East Kent Golding (EKG) and German hops Tettnanger (TET), added during 21 days, 10 days and 5 days of maturation time. In general the lower value of xanthohumol was 0.18 (±0.14) mg/L in beer matured 5 days with Tettnanger and the higher value of 1.33 (±0.03) mg/L in beer matured 10 days with 2.8 g/L of Chinook.

Mini-CV:
The main activity of Armindo Melo over the last years the main activity area it has been focused on areas of environmental science and technology of food chemistry, quality and safety. More specifically, in determination of different compounds from chemical pollution of conventional pollutants to so-called “emerging contaminants”, for that propose the analysis of these contaminants it is achieved through development and validation of new methodologies taking into account the last innovative and environmental friendly sample preparation techniques. Always with the ultimate goal to improve the knowledge about their occurrence, persistence, and bioaccumulation and to lay down defensive and precautionary regulations in food and natural ecosystem and is also a marker of human impact on the environment and human health.
Hop α-acids are lost during beer production due to isomerization to iso-α-acids after wort boiling. Enhancement of α-acids occur by the addition of hop to cold stage of brewing process, a technique called dry hopping that increases the hoppy aroma. The impact of dry hopping techniques on α-acids content of beer was evaluated. American Pale Ale beers were prepared using a bitter high α-acids hop variety, Chinook (CHI); a hop with dual purpose, East Kent Golding (EKG); and an aroma variety hop with low content of α-acids, Tettnanger (TET). Three different hop concentrations (0.7; 1.4 and 2.8 g/L) were added at 3 different points during 21 days maturation. Total α-acids after wort boiling. α-acids are lost during beer production due to the exquisite aroma imprinting in beers as well as its bioactive potential. The main bioactive hop-derived compounds xanthohumol (XN), isoxanthohumol (IXN), αβ acids (ABA) and iso-α acids (IAA) were tested for their in vitro antiproliferative activity on Caco-2 cells. Additionally, lyophilized beer without hop (NHB) reconstituted in culture medium was also assayed to test the effect of the base matrix. ABA and IAA showed ca. 70% cell growth inhibition after 48 h exposure at the high concentrations tested, 100 and 80 µg/ml, and IC50 values of 18.9 and 33.0 µg/ml, respectively. XN had no effect on cell growth from 0.31 to 20.0 µg/ml. Serial dilutions of NHB resulted in a dose dependent response inhibition to ca. 60%. NHB fortified with the active compounds ABB and IAA showed an increased inhibition of cell growth to a maximum of 80%, suggesting an antiproliferative synergistic effect.

Mini-CV:
Miguel Faria owns a degree in Pharmaceutical Sciences (University of Porto/1997) and received his PhD in Nutrition and Food Chemistry in 2005. He held postdoctoral positions at the department of Food and Water Science – UP from 2006-2012 and at CIBIO (https://cibio.up.pt/) during 2012/2013. He has over 5 years of teaching experience in organic and food chemistry. Currently he’s a researcher at LAQV-REQUIMTE (http://www.requimte.pt/laqv/). His main research focuses are the development of fast DNA-based methods for the identification of species/varieties in foodstuffs authentication and human cell based assays for testing the effects of food bioactive/toxic compounds as well as their bioaccessibility/bioavailability.
**P046**

**Brewing yeasts secrete trophic, anti-inflammatory and antioxidant biomolecules in their surrounding medium: why not in beer?**

**Dillemans M.**¹, Vlayen V.¹, Gallo D.¹, Van Nedervelde L.²

¹Meurice R&D - Institut Meurice, Biotechnologies & Biopharmaceuticals, Brussels, Belgium, ²Meurice R&D - Institut Meurice, Brewing Sciences & Fermentation Technologies, Brussels, Belgium

An increasing number of potential health benefits are attributed to probiotic treatments. The beneficial effects of the probiotic reference *Saccharomyces boulardii* in gastrointestinal inflammatory conditions are mediated through modulation of host proinflammatory responses not only by the whole yeast, but also by secreted factors. Our results show that some brewing yeasts are also able to produce in the surrounding medium trophic substances that are active in the regulation of immune response and in the promotion of mucosal anti-inflammatory signalling effects. Moreover, brewing strain supernatants regulate intestinal mucosa homeostasis via mitogenic factors. These molecules enhance cell restitution that stabilizes gastrointestinal barrier function and decreases intestinal permeability. Interestingly, compared to *boulardii*, brewing yeast activities are significantly of greater efficiency, mainly for ale strains. The aforementioned biomolecules can contribute to health benefits of beer.

**Mini-CV:**


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**P048**

**Beer taxation in Europe – A consumer friendly framework?**

**Lichota J.**

Universidad Nacional de Educación a Distancia, Political Sciences and Administration, Madrid, Spain

The taxation framework for beer and other alcoholic beverages is about to change. After years of failed attempts a proposal should be released aimed at modernising the fiscal scheme established in 1992 as a result of compromise between European Union countries. While structure has been rather stable, taxation rates fluctuation has been high and various changes in consumer habits and beverages availability provide the ground for analysis for the brewing industry evolution trends. The research provides an overview of the evolution of tax systems and consumer related patterns in relation to beer. Emphasis will be put on the most recent and foreseen trends arising from the discussions in Europe that could impact the shaping of the beer taxation system structure for the future with direct impact on the consumer.

**Mini-CV:**

Jan Lichota has been working at The Brewers of Europe between 2004 and 2014. For several years he dealt with taxation, legal issues, trade, beer statistics, as well as with industry, education and SME policies. He joined the association after studying Law at the Complutense University (Spain) and International Relations in Liège (Belgium). He continued his education with Cultural Studies at the University of Liège, Management at Ichté in Brussels and Political Sciences at UNED in Spain. Jan is a Board member of the Polish beer consumers’ association and writer for beer magazines. End 2016 he became the manager of the Association Bureau within visit.brussels.

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**P049**

**Uncovering patterns of consumers’ preference for beer: a case study with craft beer (CB).**

**Donadini G.**, Porretta S.

¹Università Cattolica del Sacro Cuore, Institute of Entomology and Plant Pathology, Piacenza, Italy, ²Experimental Station for the Food Preserving Industry, Department of Consumer Science, Parma, Italy

This study explored patterns of consumers’ preference for craft beer (CB) by means of Conjoint Analysis. The consumers were given 49 CB profiles to score on a 9-point scale of interest. Each profile was described on 11 CB attributes (i.e. type of brewery, brewing technology, raw materials, brewhouse equipment, location of the brewery, type of container, retail price, where to buy) varied at different levels. Results showed that consumers placed greatest importance on type of container and on brewing technology and placed least importance on brewhouse equipment and location of the brewery. Glass bottle + crown cap, microfiltration, local grains, stainless steel keg and brewed by monks were the utilities that most increased consumers’ interest. PET keg, can and large scale corporate brewery were the lowest utilities. Men and women shared similar patterns of interest. These findings are relevant to understanding consumers’ behaviour in the beer market and to product development.

**Mini-CV:**

Further use of PVPP regeneration caustic for CIP applications – A significant step to enhance an environmental friendly beer production

Zeuschner P., Bilge D., Pahl R.
VLB Berlin, Research Institute for Beer and Beverage Production (FIBGP), Berlin, Germany

During the PVPP regeneration process the used caustic soda turns to a deep brown to black color and is regularly discarded directly after the process. Some breweries already apply a nanofiltration to the spent caustic to separate the diluted polyphenolic substances. This can be seen as a useful but comparatively complex and cumbersome matter. However, the discoloration originating from the dissolved polyphenols should theoretically not affect the dirt dispensing capacity of the caustic soda. Hence, VLB Berlin investigated the possibilities of a direct re-use of the discolored spent caustic for CIP purposes with very promising results. The project includes the first evaluation of chemical-physical and general cleaning properties in the laboratory, trials in the institute’s pilot brewery and the application of this new approach in an industrial brewery in Germany, resulting in considerable savings in NaOH, fresh water and waste water.

Mini-CV:

Directly after studying Brewing Technology at the University of Technology in Berlin, Philipp Zeuschner began his profession as research associate in the Research Institute for Engineering and Packaging at the VLB Berlin in 2013. Within the new establishment of VLB Research Institute for Beer and Beverage Production shortly after, Philipp Zeuschner is responsible for the planning and execution of scientific research projects thematically covering the whole value chain from the delivery of raw materials via all production stages up to filling and packaging. Additionally, Philipp is engaged as brewery consultant and as lecturer in diverse international VLB training courses.

Valorization of brewer’s spent yeast

Ferreira I., Martins Z., Pinho O.
REQUIMTE, University of Porto, Faculty of Pharmacy, Porto, Portugal, REQUIMTE, University of Porto, Faculty of Nutrition and Food Science, Porto, Portugal

Brewer’s spent yeast (BSY) is the second major brewing by-product, mostly used for animal feed. However, it can be a valuable source of dietary fibre, especially β-glucans. The production of a functional food ingredient from BSY that can contribute to indirect income generation and circle economy is described. Therefore, fibre enriched extracts recovered from BSY were characterized and used to produce wheat bread with increased fibre content, while maintaining high sensory acceptability. The fibre composition of BSY extracts was as follows: 72.33 g / 100 g of Total Dietary Fibre; 52.25 g / 100 g of Insoluble Dietary Fibre; 20.09 g / 100 g Soluble Dietary Fibre and 37.98 g / 100 g of 1,3;1,6 β-glucans. Furthermore, the impact of adding 2.5% of BSY extracts to bread on sensory, colour, and crumb structure properties was studied. This fortification level was selected according to EFSA upper threshold set at 200 mg yeast β-glucan per serving. Data from image analysis complemented sensory profile information.

Mini-CV:

Isabel M.P.L.V.O. Ferreira is Associate Professor at University of Porto – Faculty of Pharmacy and coordinator of Food Quality and Safety research line at LAQV/REQUIMTE. Specialization: Food quality and safety, development and validation of GC and HPLC methods for analyses of nutrients and contaminants. Find new applications for brewing by-products, barley spent grain and yeast. H-Index 28, published 148 indexed articles and 8 chapters. Supervised 8 PhD thesis, 24 MsD thesis and 5 Post-Doc.

Study on the implementation of a biocatalytic power-to-gas reactor in a brewery

Broeker T., Hoffarth M., Heikrodt K., Schneider J.
1Institute of Food Technology ILTARW, Lemgo, Germany
2University of Applied Sciences Ostwestfalen-Lippe, Future Energy, Lemgo, Germany

Environmental concerns drive industrial development towards efficiency. Not seldom this leads to advanced fields of activity, e.g. through adding value to a side stream. Beside spent grains, breweries produce a major side stream: CO₂. Present utilization like liquefaction consumes further energy and offers a solution only for a small percentage of the overall emissions. On the other hand, power-to-gas and methanisation of the electrolytic produced hydrogen with CO₂ are an intensively discussed technology to contribute to the transformation of the energy system. For economic reasons, there is a demand for cheap and pure CO₂ sources, which makes breweries interesting for implementation. An innovative lab scale reactor for the biocatalytic methanisation has been build up and coupled to fermentation. The implementation into a brewery has been investigated. Experimental and published results have been used to study several possibilities to realise a biocatalytic P2G concept in a brewery.

Mini-CV:

Mr. Broeker finished his Bachelor in Biotechnology and the Master in Life Science Technologies at the University of Applied Sciences OWL in Lemgo. He worked as an assistant of Prof. Schneider at the department of beverage technology since 2010. He leads the working group of bioethanol and bio-refinery within the Institute of Food Technology ILTARW and is member of the board of directors. In one of his other activities, he is vice chairman of the supervisory board of the municipal utility company.
### Poster Abstracts

#### P053

**Wet oxidation of spent grains from breweries for the production of fermentable sugars**

Schneider J., Hoffarth M., Broeker T.

Institute of Food Technology ILT NRW, Lemgo, Germany

The renewable but limited resource biomass is the source of carbon for an upcoming bio economy. In order to provide a sustainable and non-competitive feedstock it is necessary to find solutions to access carbohydrates in lignocellulose. Spent grains are often used as feed or for the production of biogas due to the high protein content. However, a significant content is the remaining cellulose. Other methods, like the steam-explosion, to access the cellulose are carried out under harsh conditions and make further use as feed impossible.

The electrolytic production of active chlorine from sodium leach by using platinum electrodes results in a concentration of about 6000 ppm. Afterwards, enzymatic hydrolysis was used to produce glucose. The process has been optimised and carried out for spent grains and wheat straw as a reference. The consumption ratio of active chlorine per g biomass was observed, also lignin degradation and the glucose yield.

**Mini-CV:**

Jan Schneider studied in Weihenstephan (1991-1996), PhD-student and assistant at the chair of brewery plants at TU Munich (1997-2001). He joined as key account manager the Pall corporation (2001-2002) and moved as technical project manager to Novartis Kundl, Austria (2002-2003). In September 2003 he became the head of a research institute at the VLB, Berlin. He held lectureships at Technical Universities of Munich (Weihenstephan) and Berlin. He was appointed professor for beverage technology at the University of Applied Sciences OWL in 2006. In 2011 he was founder member of the Institute of Food Technology ILT NRW and became deputy director in 2014.

#### P054

**Effect of wort filtration type on final blond beer: industrial case study**

Van Landschoot A.1, Decloedt A.1, Vandoorne S.1,2, Vanderputten D.2

1Ghent University, Research Group Biochemistry and Brewing, Ghent, Belgium, 2University College Ghent, Research Group Biochemistry and Brewing, Ghent, Belgium

Many brewers are shifting from the traditional lauter tun for mash filtration to membrane filtration because some advantages have been assigned to the latter technique. In 2016 a Belgian craft brewer replaced the lauter tun by a wort filter Meura 2001 Junior. Due to this change an increase in the colour of the blond beers of 2-11 EBC was observed. Analysis of wort and beer samples revealed that filtration with the Meura filter resulted in a higher Free Amino Nitrogen (FAN) content in the wort. The higher amount of amino acids and peptides in the wort were responsible for an increase in Maillard reaction during cooking and thus for higher colour intensity in the final beer. The problem was solved by directly mashing in at 62 °C, eliminating the protease rest at 55 °C. Changing the mashing process had no relevant effect on the sugar profile of the wort, final beer pH, the fermentation attenuation and the taste of the blond beers. Even a better foam stability of the beers was noted.

**Mini-CV:**

Anita Van Landschoot holds a PhD in biochemistry at Ghent University (Belgium) and Max Planck Institute (Germany). She was a postdoctoral researcher (6 years) in microbial genetics and protein engineering at Ghent University and Plant Genetic Systems, a biotech company since 2002 part of Bayer CropScience. Anita is now professor in biochemistry and brewing at Ghent University and head of the brewery group. The brewing lab of Ghent University Association represents the oldest Belgium brewing institute (anno 1887). The brewing research is in strong collaboration with industry and Fermentatio (former student association, anno 1894).

#### P055

**Faster wort and beer filtration, from lab to large brewery scale**

Heijne W.1, Pinheiro A.B.2, Freitas T.3, Teixeira C.1, Jansen H.1, Jansen M.1, Mutsaers J.1

1Unicer Bebidas, S.A., Porto, Portugal, 2DSM Food Specialties, Enzyme Solutions, Delft, Netherlands, 3DSM Biotechnology Center Kiel, Applied Biochemistry, Delft, Netherlands

Efficient beer production requires maximum starch yield. Also, the brewing process including mashing, separation, wort and beer filtration should be as fast and smooth as possible. Enzymes play an essential role, from the malt as well as solutions added to match the brewers’ needs. Besides Beta glucanases, proteases and amylases, it was recently shown that xylanases contribute to efficient filtration of wort and beer.

We developed a solution with classical enzymes for the maximization of starch, as well as for the fastest mash and beer filtration. On lab scale, filtration time, yield, beta glucan levels and wort viscosity were found to be outstanding with the solution Filtrase NL Fast.

The relevance for large industrial scale brewing is shown here with wort and beer production at the brewery of Unicer. Mash and beer filtration and yield demonstrated a strong performance correlating to the lab work. This solution enables brewers to optimize wort and beer filtration maximize the output.

**Mini-CV:**

Wilbert Heijne joined DSM more than 10 years ago, and worked on several scientific biotechnological developments and innovations covering yeasts, enzymes and food industrial processes, before joining the Brewing Enzymes team. He is now responsible for Global Application of Brewing Enzyme Solutions for DSM, including world wide technical service and linking the innovation power of DSM to the actual needs in the brewing industry. Major expertise fields are in beer stabilization, filtration and brewing with wide variety of adjuncts, to produce beer in a more sustainable way, valuing the traditions of the brewer whilst meeting the demands of the beer consumers.
The clarification of rough beer is important, because of improving product quality, efficiency, environmental regulations and sustainability. Crossflow microfiltration is an alternative process instead of applying conventional filtration with kieselguhr. The scope of the present research is to investigate the effect of static mixer on crossflow microfiltration for the clarification of rough beer. Thus a standardized lager beer was brewed for the filtration investigations. 2P type full factorial experimental design was used, the three factors were the following: static mixer, transmembrane pressure and recirculation flow rate. Flux was considered as a response. A membrane cleaning method was developed and analytical measurements, technical calculations and statistical analysis were performed. It has been proven that application of static mixer has immense effect on decrease of initial fouling resistance (e.g. 73% decrease) and steady state fouling resistance (e.g. 67% decrease) values.

Mini-CV:
Mr. Áron Varga is a Ph.D. student at Faculty of Food Science, Szent István University, Hungary. He has finished his B.Sc. in Food Engineering (specialization in Brewing and Distilling) and M.Sc. in Food Engineering (specialization in Food Process Design) at Corvinus University of Budapest, Hungary. He received his practical experience in brewing technology from several reputable organizations in United Kingdom and Hungary. He has keen interest in the different fields of brewing industry, especially application of membrane technology, computer-aided simulation, product development and so on. Mr. Varga already has published some of his research findings in international conferences and symposiums and developed beers that are commercially available.

Szent István University, Department of Food Engineering, Budapest, Hungary
**POSTER ABSTRACTS**

**P059**

**Are different hop pellet properties for dry hopping and hop dosing in the brewhouse justified?**

**Forster A., Schuell F.**

HVG eG, Wolnzach, Germany

The aim of pelleting hop powder is to achieve a free-flowing product. Powder is compressed in a die under pressure during which heat is generated. Generally the more stable and harder a pellet, the more it was compressed and the higher the product temperature after pelleting was. Relating the product temperature after pelleting was to the product temperature after pelleting was. Generally the more stable and harder a pellet, the more it was compressed and the higher the product temperature after pelleting was. Relevant parameters for the hop pelletization process are discussed in this poster. There are evident reasons for stable pellets in the brewhouse like easier handling in dosing units and less dust in the vapor stack. For dry hopping a higher content of hop powder in the pellet foil is usually not a big concern. Softer, less stable pellets would have two major benefits: They are produced at lower temperatures, which has a positive impact for the sensitive hop aroma of dry hopped beers and they dissolve faster in the cold beer. Brewers should avoid unnecessarily strict specifications regarding pellet stability and especially for dry hopping accept higher ratios of fine particles.

**Mini-CV:**

Adrian Forster (born in 1942) graduated from the Technical University of Munich /Weihenstephan as a brewing engineer in 1966 and after that took his doctorate under Prof. Ludwig Narziss. 1969 - 1973 Scientific assistant at the chair of Brewing Technology 1973 - 2000 Head of the world's largest hop extract and pelletization plant in Wolnzach and St. Johann with responsibility for research and development. Forster has written numerous publications on hop topics and is currently working as a consultant, mainly for HVG.

**P060**

**Identification of geranic acid contributing to varietal aroma in SORACHI ACE and synergy with other hop-derived flavor compounds**

**Tanigawa A.¹, Sanekata A.², Takoi K.¹, Takasumi K.², Matsumoto I.², Nakayama Y.¹**

¹SAPPORO BREWERIES LTD, Product & Technology Innovation Department, Yatsu Shizuoka, Japan; ²SAPPORO BREWERIES LTD, Frontier Laboratories for Value Creation, Yatsu Shizuoka, Japan

SORACHI ACE hop was originally bred in Japan by SAPPORO BREWERIES LTD. Recently, this hop is used as ‘flavor hop’ to give beer a unique characteristic aroma. We previously showed that one of the unique volatile compounds comprising SORACHI ACE is geranic acid and the highest level of geranic acid was found in this hop. In addition, geranic acid itself had little flavor, but that geranic acid could enhance the flavor intensities of linalool and geraniol. In this report, we studied the synergy of geranic acid and other hop-derived compounds in more detail. As a result, it was found that various hop-derived flavor compounds such as terpenoids are essential in contributing to the unique flavor of SORACHI ACE beer, especially its lemon-like flavor. These data suggested that geranic acid might affect not only the flavor intensities of terpenoids comprising SORACHI ACE, but also those of various flavor compounds, including volatile thiols, derived from other ‘flavor hop’ varieties.

**Mini-CV:**

ATSUSHI TANIGAWA graduated from Tokyo University with a Master’s degree in Agricultural and Life Sciences in 2005 and joined Sapporo Breweries, Ltd., as a biochemist. From 2005 to 2011, he mainly investigated yeast metabolism. At present, he develops the new products as a research brewer.

**P061**

**Recent hop varieties from Slovenian breeding program**

**Černek A.¹, Košir I.², Radišek S.³, Oset Luskar M.¹**

¹Slovenian Institute of Hop Research and Brewing, Department for Plants, Soil and Environment, Žalec, Slovenia; ²Slovenian Institute of Hop Research and Brewing, Department for Agronomy and Brewing, Žalec, Slovenia; ³Slovenian Institute of Hop Research and Brewing, Department for Plant Protection, Žalec, Slovenia

The Slovenian hop industry relies on own varieties, mainly Celeia, Aurora, Savinjski golding and Bobek, which cover together with new varieties 99 % of crop production. Selection methods are concentrated on improved quantity and quality of the yield and resistance against diseases and pests. Without neglecting the classical breeding objectives, new hop varieties with fruity, citrusy and floral aroma compositions have been bred for a strong, differentiating hop-derived aroma and flavor notes. In various brewing trials using both traditional and dry hopping techniques, various top and bottom fermented beers revealed unique aroma and flavor impressions imparted by new Styrian varieties. In recent years, 5 hop varieties (Styrian Gold, Styrian Eureka, Styrian Eagle, Styrian Cardinal and Styrian Wolf) have been released, while Styrian Kolibri as a new flavour variety is just before release. New varieties are increasing hop acreage in recent years.

**Mini-CV:**

Dr. Andreja Černek finished the interdisciplinary study of biotechnology in 2004 with a doctoral thesis Genetic mapping of hop (Humulus lupulus L) with AFLP markers. From 2006 - 2010 she was Head of the Department for Plants, Soil and the Environment. From 2012 she was awarded on the Faculty of Agriculture and Life Sciences, University of Maribor in the field of genetics and plant breeding (including plant biotechnology). From 2010 - 2016 she was editor in chief of the periodic scientific publication with an international editorial board Hop Bulletin ISSN 0350-0756, and since 2011 the head of the research group on IHPS, and since 2016 she is president of the Scientific Board on IHPS. Since 2010, she is the EU technical expert at the Community Plant Variety Office (CPVO - Community Plant Variety Office). As a main author, she released 7 new hop varieties in last 10 years.
To keep innovative the craft beer sector, it is necessary to deepen knowledge on existing hop biodiversity, but also to renew the varietal panorama. Traditional hop breeding techniques are time consuming, due to the seasonality of seed germination and the impossibility of precocious sex plant discrimination. Biotechnologies are a valid tool to overcome these problems.

In this research, in order to accelerate the hop breeding process, seed germination was stimulated using different GA concentrations to imbibition seeds before the in vitro culture and added to the culture medium; moreover, markers linked with plant sex were used to precociously discriminate male and female seedlings.

Results obtained after two months of culture demonstrated that hop seeds germinate in higher percentage and in less time, when GA is used.

A higher percentage of female than male plants were recovered and transferred to open field conditions.

Mini-CV:
Dr. C. Liberatore graduated summa cum laude in Biotechnology at the University of Perugia, discussing a thesis on “Hayward synthetic seed conversion.” Since November 2016, Dr. Liberatore is frequenting a Ph.D. course in “Food science.” The main core of her research activity is “Hop selection through biotechnological methods.”

Dry hopping has seen a rapid revival as the craft beer sector has grown and the consumer looks for beers with more diverse flavor and aroma. Traditionally dry hopping with cones, plugs or pellets has provided an adequate method of flavour introduction but higher raw material prices and beer losses through absorption onto hops has led to a re-evaluation of the options that are available to deliver dry hop character. There have been very few studies on the use of alternative techniques and products to improve aroma utilisation partly due to the difficulty in obtaining robust analytical data for aroma molecules present at ppb levels. This paper will review the available options for dry hopping and present the results of trials using a full range of products from hops to hop oil products from a single hop variety showing the relative utilisation as measured by transfer of key aroma molecules into beer, beer losses through the dry hopping process and the relative economics.

Mini-CV:
Ray Marriott spent 35 years in industry working on the extraction and application of natural products and in particular hops before moving to academia in 2008. Ray is Innovation Director at Totally Natural Solutions Ltd, East Peckham, United Kingdom.

Two existing promising breeding lines with Spalt and Tettnang as mother have been compared with the classic aroma hop varieties Tettnang, Spalt, Saaz, Hallertau Mittelfrüh and Saphir. They differ essentially through a lower polyphenol content and a greater aroma potential. In particular one is significantly richer in hop esters and linalool. These characteristics can also be found in the beers. The ester content varies from 18 to 220 µg/l. The linalool values range from 62 µg/l to 215 µg/l. Sensorily the beer of one breeding line scored particularly well and is a convincing alternative to established varieties with regard to quality. Its significantly higher potential makes it an interesting alternative also economically.

Mini-CV:
Andreas Gahr was trained for two years on the job of a brewer and maltster at the Augustiner Brewery, Munich, Germany. He 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, which belongs to the hop processing company Hopfenveredlung St. Johann GmbH 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. Together with other authors he received the MBAA Inge Russel Best Paper Award 2010 and the Ludwig Narziss Preis for Brewing Science in 2015.
Selective steering of roasting processes to reduce prooxidative effects of roasted malt products

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The acceleration of prooxidative processes caused by roasted malt mainly arises from strong reduction properties of Maillard reaction intermediates with reductone structure like \( \alpha \)-dicarbonyls which can rapidly reduce oxidized metal ions. In a reaction chain an acceleration of oxygen activation by electron transfer and radical generation (\( \text{OH}^· \)) can be observed. In correlation to raw materials and roasting conditions distinct increases of \( \alpha \)-dicarbonyls can be detected using HPLC-DAD. Following reaction products show lower or no prooxidative properties. Consequently two different reversal points in oxidative properties of roasted malt appear during roasting using EPR-Spectroscopy. The first describes the highest prooxidative effects. The second lays temporary in time period of maximum color yield and can be used to produce roasted malt with lower prooxidative properties. As shown these facts open innovative possibilities to influence oxidative properties by selective steering of roasting.

Mini-CV:
After qualifying as a certified technician (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 an engineer in the area of ESR spectroscopy at the Institute of Biophysics at Saarland University (2002-2004). Since 2005 he has been employed as a Scientific Assistant and since 2009 as Head of Laboratory at the Institute of Biotechnology, Freising, Germany. His research focus lies in analyzing radical reaction mechanisms and oxidative processes in beer using ESR spectroscopy. A further research focus is given by the optimisation of filtration and stabilizing processes.

Varietal comparison of cytolysis of barley during malting

Yin X.S., Aron P., Jennings R., Kramer P.
Rahr Malting Co., Shakopee, United States

The present study examined the varietal differences in cytolysis during germination of selected North American malting barleys. Malt samples germinated for 1-4 days under commercial production conditions were tested for progressive changes in molecular weight (detected by MALDI) of beta-glucan, wort viscosity, and enzyme development including beta-glucanase and xylanase, followed by kernel modification and bench-top filtration studies. Results indicated while some varieties like CDC Copeland followed conventional pattern of cytolysis in the kernels over time, others such as Pinnacle responded to the germination conditions very differently, where the cytolysis activities initiate much earlier as reflected by a 2/3 reduction in wort beta-glucan during the first two days of germination. The observation was supported by other indicators like friability and viscosity. Trends in diastatic power and other enzyme development were found to be in alignment with the cytolysis pattern.

Mini-CV:
Xiang S Yin is the Director of Brewing Research and Innovation at the Rahr Corporation in USA. He recently worked as the Global Director of Brewing Raw Materials at SABMiller based in UK. And prior to that he was with Cargill Malt as Global Technical and Innovation Director based in the USA. Yin is a fellow of the Institute of Brewing and Distilling (IBD). He served the ASBC as president and chairman of the Foundation Board. Yin is a member of the Editorial Board for the ASBC Journal, ASBC Asia Liaison Officer and a recipient of the ASBC Award of Distinction 2015. He currently serves as the Technical Committee Chairperson for the Brewing and Malting Barley Research Institute, Canada. He is the author or co-author of over 50 papers and patents. Yin obtained his first degree from Wuxi (now Jiangnan University) in China, and received his Ph.D. from Herriot-Watt University, Edinburgh in 1986.

A study on advanced DON reduction technologies in malting

Aron P.1, Yin X.S.1, Jennings R.2, Kramer P.3
1Rahr Malting Co., Brewing Research and Innovation, Shakopee, United States; 2Rahr Malting Co., Quality Assurance, Shakopee, United States; 3Rahr Malting Co., Rahr Technical Center, Shakopee, United States

Fungal load of Fusarium spp. on barley kernels is a major cause of deoxynivalenol (DON) production on malt. In this study, an exploration of Fusarium reduction on barley was conducted via application of state-of-the-art clean technologies: ozone, plasma, cold plasma and pulsed light. The work was conducted in comparison with conventional approaches: acidic, alkaline, acid, ClO2 and sodium bisulphite. Natural hop beta-acids were also included in the tests. While some treatments, e.g. acid/alkaline combination, resulted in increased production of DON possibly due to the suppression of microbial competitors during malting, others led to significant DON reduction without impacting malt quality. The study was extended to examine the effect of reduction in total Fusarium spp. and F. graminearum on the barley and DON congeners produced during malting. Results provide options for developing commercially feasible solutions to manage quality and supply assurance in the malting barley supply chain.

Mini-CV:
Dr. Patricia Aron currently works as a Senior Research Scientist for Rahr Corporation. Prior to this position Dr. Aron was the Senior Hop Chemist for MillerCoors. Dr. Aron completed a degree in Biochemistry from Elmira College. She later obtained an MS in Food Science and Technology focusing on Oenology and a PhD in Food Science and Technology, focusing on hops and lager beer flavor, from Oregon State University. Dr. Aron has over 13 years experience working in raw materials and fermentation science and has conducted research pertaining to wine grapes, red wine fermentation, hopping technology, beer flavor chemistry, sensory science and malting and barley quality.
Malt is one of the most important ingredients for the beer production, bringing in sugars, enzymes and aroma. With the uprising trend of craft brewing the varieties in beer flavours and the therefore used malts with special aroma characteristics are increasing steadily. In order to rate the aroma potential of two special malts, a roasted malt and a Belgian type, key aroma compounds were characterised by means of aroma extract dilution analysis. Identification experiments (comparing chromatographic, mass spectrometric and odour characteristics) elucidated 2-methoxyphenol and vanillin next to 4-hydroxy-2,5-dimethyl-3(2H)-furanone with the highest flavour dilution (FD) factor in the roasted malt, while the Belgian style malt evoked other key aroma compounds such as 3-(methylthio)propanal, maltol or sotolon. The study underlined how varying malting regimes can result in products with very different aroma profiles evoked by qualitatively and quantitatively different patterns of odorants.

Mini-CV:
Veronika works as a Senior Research Scientist at the Deutsche Forschungsanstalt für Lebensmittelchemie, Leibniz Institut (German Research Centre for Food Chemistry, Leibniz Institute, Freising, Germany, University of Applied Sciences Triel, Triel, Germany, Heyerwagen Specialty Malts, Bamberg, Germany, Technical University Munich, Freising, Germany).
Bär R., Voigt T.
Technical University of Munich / Chair of Food Packaging Technology, Freising, Germany

Breweries are challenged to produce high quality products in a price-driven industry. Manufacturing Execusions Systems (MES) help to support competitiveness and enable to manage, supervise and evaluate the production process. For the effective use of MES functions a data exchange network between all relevant production facilities and the IT systems is essential. For this, the necessary data from plant units and related control systems has to be defined and connected in a comparable way. Currently, time-consuming definition work and expensive engineering and programming is required for each project. For the processing area of the brewery, appropriate standards are missing. In this project a communication interface (e.g. based on OPC-UA), relevant data points and required MES functions based on the well-established WS concept are defined. Based on the results a standard, covering the processing area, from malt intake till pressure tank incl. the required utilities will be published.

Mini-CV:
Raik Martin Bär, born in 1992 is a Ph.D. student at the Chair of Food Packaging of Technische Universität München (TUM). He finished his studies in Brewing Science at the TUM in 2016 with the degree of Master of Science. His current research work is centered in the development of a continous and immobilized fermentation procedure for the main fermentation by immobilisation of the yeast in a crossflow reactor.

Development of a continuous fermentation procedure for the main fermentation by immobilisation of the yeast in a crossflow reactor

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¹Versuchs- und Lehranstalt für Brauerei in Berlin (VLB) e.V., Research Institute for Beer and Beverage Production, Berlin, Germany

The purpose of a continuous main fermentation is to produce a beer with constant quality that is comparable in the demands of quality of a regular batch fermented beer.

The intention of the research project is to develop a continuous and immobilized fermentation procedure, which fulfills the quality demands of conventional batch fermentation in a brewery by using modern crossflow filtration technology for immobilization. Because former continuous fermentation procedures were not able to guarantee a long-time stability of the fermentation the advantages of a continuous fermentation procedure were not able to be applied in the brewery.

The main criteria are the long-time stability of the reactor system.

A new bioreactor principle was developed and has to be optimized in the quality determining process parameters. In this system the yeast is immobilized in a fermentation tank by a crossflow filtration module.

Mini-CV:
Deniz Bilge has built up his brewing profession from scratch starting with his technical apprenticeship as a Brewer & Maltster at the Beck & Co. Brewery in Bremen up to his doctorate degree in brewing technology. Hereafter engagements in the supplying industry and as technical director in an industry brewery followed before returning to the VLB in Berlin 2010 to work as a senior consultant and lecturer. As deputy department chief of the Research Institute for Beer and Beverage Production he is mainly responsible for technological aspects and scientific research projects. Deniz holds lectureships in the international VLB brewmaster courses as well as at the Technical University in Berlin.

Investigation of a new crystallizer with included post-treatment for ion depletion of spring water for the brewery industry

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¹Mannheim University of Applied Sciences, Institute for Process Control and Innovative Energy Conversion, Mannheim, Germany, ²Technical University of Berlin, Chair of Brewing Science, Berlin, Germany

Providing good water quality is essential to produce a constant first-class beer. Known processes do not work without chemicals. A prospective alternative can be freeze crystallisation. Until today the process is used in the food industry to concentrate juices but can also be used to remove ions. In the poster a small scale plant will be described by which it is possible to crystallize and post-treat water to purify it. A heat transfer surface, a mechanical forced conveyance and an attached pressing section were calculated, realized in a single-step plant and tested for applicability. It will be shown what results have been achieved and how the depletion can be controlled by the process varying the decalcification and reduction of Manganese, Iron, Nitrate and TOC.

Parameters are the temperature gradient and the rotation speed changing the ice growth, fluid characteristics and the ice purity. Technical and energetic calculations and measurements will be used to compare the results.

Mini-CV:
The author received a BSc in Chemical Technology and an MSc in Chemical Engineering at the Mannheim University of Applied Sciences. He also received a MBA in Engineering Management at the Wilhelm Büchner University in Darmstadt. Since then he is writing his PhD thesis about freeze crystallisation at the Technical University of Berlin and is working at the Institute for Process Control and Innovative Energy Conversion where his focus lies on thermal, chemical and renewable processes.
Development of a membrane assisted bioreactor for the continuous fermentation of wort into beer

De Causmaecker B.1, Noordman R.2, Hejne W.1, De Rouck G.1, Aerts G.1, De Cooman L.1

1KU Leuven, Faculty of Engineering Technology, Technology Campus Ghent, Laboratory of Enzyme, Fermentation and Brewing Technology, Ghent, Belgium; 2Pentair Flow & Filtration Solutions, Enschede, Netherlands

From an economic point of view brewery batch fermentations are not favorable due to slow fermentations, long maturation times and a relatively high downtime resulting in occupied vessels for several weeks. In this study a continuous fermentation system was developed and combined with a pilot cross flow filtration unit. This filtration unit allows for efficient removal of finished bright beer from the fermenter while maintaining a high cell density in the continuous fermentation system. In the developed system a pilsner type beer is produced with a residence time of 70 hours. The need for a separate maturation step is removed by application of enzymes to reduce the total diacetyl content and increase the colloidal stability of the beer. Fermentation performance and product quality are highly effected by bio-mass growth, viability and vitality over the course of continuous fermentation. These parameters and the resulting aroma profile are studied during the process and will be discussed.

Mini-CV:
At the lab of enzyme fermentation and brewing technology at the Technology Campus Ghent of KULeuven I have been participating in projects on beer flavour stability in close collaboration with the industry. Here I obtained a profound background on analytics of beer and raw materials but also on technical implications of malting and brewing processes related to flavour stability. Since 4 years I am also responsible for all brewing trials performed on the pilot brewine of our laboratory in Ghent.

Strategies to improve lactic acid production from brewing-relevant lactic acid bacteria strains in wort substrates

Bellut K.1, Zarnkow M.2, Jacob F.2, Arendt E.1, Peyer L.1

1University College Cork, School of Food and Nutritional Sciences, Cork, Ireland; 2Technical University of Munich, Research Center Weihenstephan for Brewing and Food Quality, Freising-Weihenstephan, Germany

Recent success of sour beers calls for more work to be done in order to understand how to optimise lactic acid (LA) production during fermentation of wort by lactic acid bacteria (LAB). Due to their self-inhibition by low pH, buffering capacity (BC) is a crucial parameter. Four LAB strains were studied for their pH inhibition using microtitre analysis. Malt-based worts were produced using different mashing profiles, as well as by adding enzymes or buffers. BC of the worts was analysed by automated titration. End-product growth inhibition was found at LA concentration higher than 5 g/L. Wort treated with external proteases could increase the free amino nitrogen and thus the BC of the wort. After fermentation, this wort could lead to higher LA yields (up to +25 %) compared to an untreated control. Depending on the LAB strain, different sugar preferences were observed. In conclusion, LA yield from wort can be optimised if a strain-dependent approach during mashing is followed.

Mini-CV:
Konstantin Bellut graduated with a Master in Brewing and Beverage Technology from the Technical University of Munich (TUM) in Weihenstephan-Freising. During his Master’s programme he received a scholarship from the unternehmertum, the center for innovation and business creation at TUM, where he lived out his entrepreneurial spirit in various consulting and founding projects. But his passion for brewing and science eventually led him to the University College Cork, Ireland where he enrolled for a PhD programm under the supervision of Prof. Dr. Arendt. His research focuses on the application of lactic acid baceria and novel yeasts in innovative low-alcohol and alcohol-free beer production methods.

Flash pasteurization: How long is the optimal heat-holding time/temperature for achieving the best beer quality?

Feilner R.
Krones AG, Neutraubling, Germany

The result of the work is a “hot-short process” that enables the current heat-holding sections measuring about 50 metres to be shortened to as little as 10 % of the traditional length. The most important task was to find the maximum temperature for ruling out pasteurisation-related turbidity in filtered beers, and to be able at the same time, when producing turbid beers using the same flash pasteuriser, to assure turbidity stabilisation by reaching a denaturisation temperature. Filtered and turbid beers were compared in both processes in regard to the effect on turbidity stability, foaming characteristics, microbiology, thermal stress and ageing stability. The “hot-short” process exhibited significant technological and commercial advantages. A difference in the thermal stress entailed by the higher temperatures could not be found by quantifying free radicals by means of electron spin resonance measurements (T-500 value).

Mini-CV:
Dr. Roland Feilner (born in 1981), finished his apprenticeship as brewer and malster. After that he studied food science technology in Weihenstephan and graduated in 2006 as an engineer. Furthermore he finished his industrial doctoral thesis at the T. U. of Berlin in 2013. The area of research was the reduction of unwanted flavors in wort. His career entry by Krones AG – Germany, started with membrane filtration of beer. Adjacent he worked as a process, and development engineer for thermal product treatment. Additionally the degassing and thermal treatment of beverages and juices was one of his main development areas. Actual he is the responsible for the product management in the Krones Business line for Softdrink, Dairy and Water.
**P077**

**On the way to the “smart brewery”: How to better profit from automation and IT technology**

Axinia E.
COPA-DATA GmbH, Salzburg, Austria

Our goal of the presentation is to create a practical bridge between the classic business goals of a brewery and the current technology trends of Industry 4.0, the Internet of Things and “smart manufacturing”.

How can brewery specialists respond to these disruptive forces? How should this affect your expectations of technology suppliers? We will highlight some practical examples: human-machine interfaces empower “ergonomic production”; interoperability of production equipment brings flexibility and cost reduction; intelligent sensors guarantee process and quality control at any level of detail; process data allows for predictive maintenance; performance indicators and reports are available in real time, wherever demanded.

The “smart brewery” is a paradigm shift and a huge opportunity which needs the creative involvement of the entire production team. This presentation will help you get started on this journey and progress faster and more successfully.

**Mini-CV:**
Emilian Axinia (M.Sc. Computer Engineering) has more than twenty years experience of engineering and automation projects in Food & Beverage Manufacturing. Ten years ago, Emilian joined COPA-DATA at their headquarters in Salzburg, as Food & Beverage Industry Manager. His focus is to develop flexible solutions based on the industrial software zenon, dedicated to improve production operation and productivity and optimize consumption and quality control.

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**P078**

**Monitoring the CO<sub>2</sub> purity level during fermentation as a parameter of quality monitoring and control**

Jörg M.
Centec GmbH, Sales and Project Management, Maintal, Germany

In this work, the subject of process oriented quality monitoring during the beer fermentation process is considered by means of an innovative, additional quality parameter of CO<sub>2</sub> purity. The focus is on the process steps of beer fermentation, where the quality of the beer fermentation process is monitored and controlled by measuring the CO<sub>2</sub> purity level. The general aim of such a measurement is to observe the course of the respective process and thus to avoid errors, that can affect the quality of the subsequent products and production process. If the individual process steps are significantly stable and precise, it can also conclude that the entire process is as stable and precise as well. A further objective of the measurement is the additional benefit for CO<sub>2</sub> recovery plants. The optimization of the CO<sub>2</sub> recovery yield and the fermentation process monitoring via the CO<sub>2</sub> purity value represents a worthwhile consideration for the equipment and retrofitting of this new process approach.

**Mini-CV:**
Jörger studied at the university of Weihenstephan/TUM by diploma brewmaster degree in 2002. During his first employment at ASIRAL GmbH sales department, he degrees by further education as Master Professional (CCI) of Technical Management at the IHK Munich, as well as Quality Manager at the TFH Berlin. Working afterwards for several different breweries in Germany, Mr. Jörg joined finally the company Centec GmbH in 2010, where he is responsible for the Sale and Projectmanagement department in Europe.

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**P079**

**“Asahi Super Dry” development strategies for beer dispensers challengingly contributing to the increase in its brand value**

Kitano J.
Asahi Breweries, Ltd., Research & Development Headquarters, Moriya-Shi,Ibaraki, Japan

Asahi Super Dry celebrates its 30<sup>th</sup> anniversary next year in 2018. Super Dry has been a long-selling product with its position established as the leading beer brand in the Japanese market.

In 2009, Asahi started to promote “Super Dry Extra Cold”, Super Dry with its temperatures below freezing point (0 ~ -2°C), to advance its brand image to the next stage, adding new value to the product. In 2014, “Super Dry Extra Cold” got available at more than 10,000 bars and restaurants, and has now become one of the most successful marketing goods to expand Asahi’s business.

This presentation will report some examples of the successful development and marketing of the equipment and its marketing plans for the future.

**Mini-CV:**
Junichi Kitano has been working for the department of engineering for draught beer equipment of Asahi for 20 years since 1997 and is in charge of draft beer equipment development.
Hop citrus character – why are all the molecules floral?

Marriott R.12, Wilson C.1
1Totally Natural Solutions Ltd, East Peckham, United Kingdom, 2Bangor University, Bangor, United Kingdom

Citrus character from hop addition to beers is an important flavour characteristic that has been developed in new hop varieties that are now popular for dry hopping. There have been a number of studies that have shown a correlation between citrus character and some monoterpene alcohols such as linalool and citronellol but all the molecules identified that are either found in hops or metabolised from hop precursors are overwhelmingly floral in character. Synergism between these is thought to develop citrus characters but this cannot be demonstrated with the pure compounds alone. In contrast almost all of the characteristic aroma molecules in citrus oils are aliphatic or terpene aldehydes for example decanal, geranial, citronellal and sinensal which have significant lower odour thresholds than the corresponding alcohols. This work explores the influence of oxidation reactions in the formation of terpene aldehydes that potentially contribute to citrus flavour and aroma in hops and beer.

Mini-CV:
Prof Ray Marriott spent 35 years in industry working with natural products and industrial scale supercritical CO2 processes before moving to academia in 2008 firstly at University of York and then at Bangor University running a project to develop new applications including extraction and fractionation of materials and biocatalysis in scCO2. He has a life-long interest in flavour chemistry and metabolism of high impact flavour molecules.

Mini-oak chips: a promising tool for development of flavour enriched beer

Hanko V., Mačaj K., Nešpor J., Jelínek L., Dostálek P.
University of Chemistry and Technology, Department of Biotechnology, Prague, Czech Republic

Maturation in wood is one of the key steps in the production of high-quality alcoholic beverages. Nowadays wooden barrels or small wooden fragments (chips, bars or cubes) are commonly used for production of wine and some distillates. Usage of these wooden materials in brewing industry is not suitable due to their small surface area, which causes insufficient transfer of flavour active compounds (FACs) into beer. In this work medium toasted wooden chips were used. These chips were milled, fractionated and then particles (< 0.5 and >5 mm) were dosed into the model solutions in which the concentration of FACs were monitored. The results showed that the reduction of the particle size led to a significant decrease of contact time required for the transfer of FACs into beer. Based on the results, modified wooden chips can be regarded as an alternative of beer maturation in wood.

Mini-CV:
Born in 1991. Studies: MSc degree in Biotechnology at the University of Chemical Technology Prague (UCT) in 2016 (MSc thesis „Application of bitter-free hop materials in brewing“). Currently he is a PhD student and scientific researcher at the same university. His PhD research is focused on extension of shelf life of beer.

Insight into the American IPA. A deconstruction of America’s popular beer style

Shellhammer T., Lafontaine S.
Oregon State University, Dept. of Food Science and Technology, Corvallis, United States

The IPA is a style that has propelled the growth of the American craft beer market. While being nationally (and increasingly globally) popular, the differences in flavors and overall characteristics among beers within this style can be large. This study examined the IPA style using chemical and sensory analyses of over 30 popular American IPAs (based on sales). Differences in chemistry were examined instrumentally using HPLC, GC, UV-spectroscopy, and an Anton Paar Alcolizer. Cluster analysis and principal components analysis were applied to this data set to identify subgroups having similar/dissimilar chemical flavor profiles. A subset was analyzed sensorially by trained panelists using descriptive analysis. At least three subgroups emerged from both the chemical and sensory deconstructions of the commercial beers. Results from this study provide brewers and product developers greater insight into this popular beer style and aid in designing new beers.

Mini-CV:
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 ASBC, the current President of the District NW MBA, and serves on the Board of Examiners of the IBD. Dr. Shellhammer received his Ph.D. from the University of California, Davis in 1996.
Can brewing with unmalted quinoa produce good beers?

**Kordialik-Bogacka E., Bogdan P.**
Lodz University of Technology, Institute of Fermentation Technology and Microbiology, Lodz, Poland

The use of quinoa as a partial substitute for barley malt gives brewers the opportunity to develop final products with new sensory characteristics. However, many favourable properties of quinoa from nutritional point of view can induce technological problems and compromise the quality of final product. There is still limited information on the processability of quinoa. The aim of this study was to evaluate the quality attributes of mash, wort and beer produced from barley malts mixed with various quantities of unmalted quinoa. In this investigation the malt was substituted with up to 30% quinoa seeds or up to 40% quinoa flakes. The benefits of the application of commercial enzyme mixture for brewing with quinoa were also assessed. These findings enabled to indicate advantages and limitations of quinoa used as a substitute for barley malt.

**Mini-CV:**
Edyta Kordialik-Bogacka graduated from Lodz University of Technology in 1994 with a MSc in biotechnology. Since 1995 she has been working at the Institute of Fermentation Technology and Microbiology of the same University. She obtained her PhD degree, studying foaming ability of brewing yeast Saccharomyces cerevisiae. With the topic „Waste brewing yeast – sorption ability of heavy metals” she completed her habilitation in 2015. Her recent research has been focused on the application of oats, pseudocereals and syrups as brewing adjuncts and physiological activity of yeast. She serves in the Editorial Board of the journal “Fermentation- and Fruit- & Vegetable Processing Industry”. She is a member of the EBC Brewing Science Group.

**P084**
Sensory profile of a gluten free beer made 100% with corn malt

**Romero-Medina M.A.1, Escalona-Buendía H.1, Verde-Calvo J.R.1, Lelièvre-Desmas M.2**
1Universidad Autonoma Metropolitana, Biotechnology, Mexico City, Mexico, 2Institut Supérieur d’Agriculture, Lille, France

Using pigmented varieties of Mexican corn as main ingredient in brewing allows to develop new and innovative styles that incorporate flavors of typical Mexican beverages preserving those of regular barley beers and at the same time provides a gluten free alternative to people who have intolerance to the gluten proteins found in barley. In this study four beers were developed, three made with a mix of red and blue corn malt, and one made 100% barley which was used as a control, all beers contained dry chili as adjunct. The objective was to determine the effect of each corn in their sensory profile. Beers were characterized by QDA in appearance, odor and flavor. Attributes as burned tortillas, spicy, dry chili and cooked corn were found in corn beers, but also bitter, hoppy, malty and fruity attributes generally found in barley beers. This results suggest that corn beers are a good gluten-free option that offers similar sensory experience and preserves Mexican traditions in a modern way.

**Mini-CV:**
Angelica Romero is a PhD student with a food engineering degree who has 5 years of experience in Sensory Science and R&D focused on brewing science. Cofounder of “Cervecería a la Mexicana” she has participated as a cocreator of a new beer using Mexican corn malt in the beer process. She has extensive experience working as master brewer: she participated in the development of the pilot beer plant of the Autonomus Metropolitan University and has worked there as a brewer professional. In the science field, she has participated as a speaker in sensory and brewer courses for students and people of the brewing industry and also in international food congresses (IUFOST 2016, Dublin; SMBB 2013, Mexico) and brewer events (Cervefest 2016, Mexico). She is interested in research and development of fermented beverages, focused on beer science specialized on sensory quality and flavor analysis.

**P085**
Comparative brewing performances of quinoa, amaranth, einkorn, millet, buckwheat and chia to produce beer

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Over the last few years innovative brewers have developed the use of alternative adjuncts as a part of their beer recipe but often with technical constraints (wort filtration) and important annual harvest variability. In this project, the use of quinoa (Belgian and Peruvian), millet, amaranth, einkorn, buckwheat and chia as alternative adjuncts is considered. Trials with various levels of each raw cereal were tested at lab scale to select best mashing performances. Usual parameters like yield extract, colour, viscosity, FAN, pH, polyphenols, saccharification and filtration times were analyzed allowing us to produce beers with good brewing characteristics, interesting organoleptic profiles and nutritional assets.

**Mini-CV:**
Anne Pietercelie is lecturer at master level for engineers in Biochemical & Brewing industries, in close collaboration with Laurence Van Nedervelde, at the Brewing Sciences Department of the Institut Meurice (HELD). She is also get involved in various R&D projects like improving knowledge in nutritional values of beers.
CO₂ from Anaerobic Digestion sources a novel and safe source for the food and beverage industry?

Verkoelen F.
Haffmans BV, Business Development, Venlo, Netherlands

Biogas is a key renewable energy source that provides an alternative now and for the future. Biological material is broken down in an anaerobic fermentation process at which primarily methane (CH₄) and carbon dioxide (CO₂) is produced. As biological material several sources are available, all having different contaminants that require different treatments. The CO₂ is a second revenue stream that is gaining popularity as this is green CO₂. The fermentation, separation and CO₂ upgrading process is closely monitored to assure its quality. A “virgin vegetable matter" also called “energy crop” is recognized as an acceptable source for food grade CO₂, used in foods and beverages. Through legislation the feed process of an Anaerobic Digester is controlled. The journey to a cleaner world with biogas as a renewable energy source has started, supplying green CO₂ for various applications and industries, including Food and Beverage.

Mini-CV:
Frank Verkoelen Mechanical engineer, since 1984 working for Haffmans B.V. where he started as a project engineer for CO₂ recovery. After Project Management he changed to Research & Development where he became the manager R&D. During a period of 10 years he fulfilled the function of Sr. Product Management QA, responsible for sales of Quality Control equipment. Since 2012 he is Manager Strategic Projects for QC at Pentair Haffmans.

Characterization of free and esterified phenolic compounds in blue corn malt beers

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¹Metropolitan Autonomous University, Biotechnology, Mexico City, Mexico, ²Metropolitan Autonomous University, Biological Systems, Mexico City, Mexico

Maize is higher in phenolic compounds (PC) than wheat, rice and oats. Eight formulations of corn beers (CB) were made from the use of two types of malts (base and caramel blue corn) and different quantities of guajillo chili and hops. Free and esterified PCs were determined by HPLC. The identified free PCs were protocatechic (PA), p-coumaric (p-CA) and ferulic (FA) acids and their total concentration was found between 4.98 ± 0.2 and 3.46 ± 0.2 mg/L, and of identified esterified PCs were gallic acid, PA, syringic, p-CA, FA and synapic acid, and total concentration was 9.82 ± 0.6 and 6.79 ± 0.4 mg/L, in beers made with base and toasted malt, respectively. PCs were determined in CBs, which are of great importance as they provide beer; color, taste, chemical stability and health benefits due to its antioxidant activity.

Mini-CV:
Bachelor Degree in Food Chemistry / Master Degree in Biotechnology / PhD candidate (Biotechnology). Two years experience as professor. Five years experience as researcher about prebiotics, brewery, beer quality, and new products develop.

Analysis of significant factors in the formation of sugars during the mash process in beer production and its modeling with neural networks

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A statistical study based on a fractional experimental design with central points was carried out to simultaneously quantify the effects of temperature, pH, mash thickness, diastatic power and particle size distribution on starch hydrolysis during mash in beer production. The sugars, analyzed by HPLC, respond differently to each variable. The pH effect and the mash thickness are not included in previously published models. The results show that they are important and should be included to achieve a better characterization of the system. The experimental data were used in the training of a neural network. The neural network presents a good fit to the experimental data, adequately representing the effects of pH and mash thickness on the formation of sugars.

Mini-CV:
Héctor Rivera studied chemical engineering at the Instituto Tecnológico de Celaya and a master’s degree in science at the same institution. It has been a nanoproducer of beer for five years. He is currently working in the Mexican energy sector, without neglecting his research in brewing science. He has collaborated in projects of different technical nature with the food, energy and materials industry. His main interest is the modeling of biological systems with neural networks and other statistical tools. The title of his master’s thesis was: Determination of significant factors in mashing for beer production and its neural network modelling.
Evaluation of polyphenols and bitter substances derived from hops and their yield by producing hopped wort concentrates for the production of beer and beer type malt beverages

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Anhalt University of Applied Sciences, Department of Applied Biosciences and Process Engineering, Koethen, Germany

In the last years, the use of hopped wort concentrates has increased significantly. Hopped wort concentrate is a concentrated brewer’s wort with 60 to 70 °Plato. The use of a falling film evaporator (4-effect evaporator) is commercially the most common method for the concentration step. Besides all the possibilities and benefits of these concentrates, the concentration process seems to have a negative effect on some valuable parameters. It has been shown that hop losses of 10 to 15% occurred during the concentration step. Additionally, no answer has been given regarding the yield of polyphenols derived from hops in wort concentrates so far. In this work, the influence of the concentration step on the yields of polyphenols and bitterness substances of different hop products (e.g. pellets, hop extract, spent hops) was evaluated. While good bitterness yields were achieved with hop pellets, it was also shown that approx. 45% of the polyphenols of all hop products were lost.

Mini-CV:
Jean Titze had studied at the Technical University of Munich and did his PhD at the Department for Chemical-Technical Analysis and Chemical Food Technology in brewing science. For several years, he worked as a Brewery Consultant for the Research Center Weihenstephan and later on as a Senior Consultant for Deloitte & Touche focusing on the food and beverage industry. After that, he lived in Ireland for two years working as a Senior Research Scientist and Brewery Manager for the National University of Ireland at University College Cork. During the last three years, he has been working as Head R&D Cereal Ingredients at Doehler focusing on the production of cereal and malt extracts. He is now Professor at the Anhalt University of Applied Sciences for Food Technology of Plant-based Products.

Monitoring of an onion-like off-flavor component and its precursor in large-scale brewing

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1Asahi Breweries, Ltd., Production Technology Center, Moriya, Japan
2Asahi Breweries, Ltd., Research Laboratories for Alcohol Beverages, Moriya, Japan

Variations in the brewing process can alter the flavor profile of the finished beer and should ideally be minimized when the same beer brand is produced at different brewery locations. We focused on the production of 2-mercapto-3-methyl-butanol (2M3MB), which imparts an onion-like flavor to beer and has the potential to cause sensory variations between breweries, and also developed a new analytical technique to quantify the precursor of 2M3MB (Noba et al., WBC2016). In the present study, we monitored the levels of 2M3MB and its precursor, 2,3-epoxy-3-methyl-butanal (EMB), during the brewing process at our three breweries with documented variability in 2M3MB production. We found that 2M3MB levels were influenced by both the amount of EMB in wort which might vary according to the process conditions in boiling and aeration, and the conversion rate of EMB to 2M3MB in fermentation. This result would help us to understand the underlying reasons for variations in 2M3MB between the breweries.

Mini-CV:
Taku Irie received an M.S. degree in engineering from the University of Tokyo in 2000 and began working for Asahi Breweries, Ltd. After a few years as a technological staff member in the Packaging Section in some breweries, he had been in charge of the technological development of brewing at the Production Technology Center and Fukushima brewery. From 2012 to 2014, he worked at the Lehrstuhl fur Brau- und Getranketechnologie, TU Munchen as a guest researcher. Since April 2014, he has again been working at the Ibaraki R&D Promotion Office, Production Technology Center.

Characterization of ale yeasts – a study of technological, analytical, biological and sensory attributes

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1Brau Union Österreich AG, Quality & Development, Environmental Protection, Linz, Austria
2University of Natural Resources and Life Sciences, Vienna (BOKU), Institute of Food Technology, Vienna, Austria

Beer styles brewed with ale yeasts have been increasingly successful in recent years powered by the craft beer trend. For product development it is important to understand the specific flavor characteristics as well as process performance of the different strains. Eleven ale yeasts and one wine yeast have been compared in technological, analytical, biological and sensory aspects. The strains performed standardized fermentations in plain, amber ale, pale ale and belgian saison worts to obtain evaluation data. Marked differences were found in all analysed categories. A clustering of the fermentation products, resulted in a sequenced arrangement of groups according to their origin. Yeasts from Belgium, the USA and UK could be separated by the two markers n-propanol and ethyl acetate only. In technological studies, a predictive model for the control of esters, acids and higher alcohols in dependence of pitching and fermenting conditions has been developed.

Mini-CV:
Born 1990; BSc of Food Science and Biotechnology (University of Natural Resources and Life Sciences, Vienna (BOKU), 2015); tutor for food technology (Institute of Food Technology, 2014–2016); head of the university BrewCrew (Institute of Food Technology, 2013–2016); brewer (Lichtenthaler Bräu, 2014–2016); various activities (Brau Union Österreich AG, since 2014); numerous national and international beer awards; master’s thesis (Brau Union Österreich AG & University of Natural Resources and Life Sciences, Vienna (BOKU), since 2016)
Serial re-pitching has been a common practice in lager brewing, mainly due to economic reasons. However, the rationale behind it is not understood completely. On this basis, the aim of our study was to monitor genetic changes along with physiological responses during the re-pitching cycles repeated for 15 and 31-times at the industrial and laboratory-scale, respectively. After each repitching, yeast vitality/viability was determined and at the selected repitching cycles also the phenotypic microarray analyses, flocculation degree, volatile aroma compounds and expression profiles of genes responsible for diacetyl production were determined.

**Mini-CV:**

Assist. prof. Neža Čadež, PhD. is biologist (1997), doctor of biotechnological sciences (2005) and assistant professor of microbiology. Since 1997 she is employed at the Department of Food Science and Technology at Biotechnical faculty as a researcher, teacher and curator of Collection of Industrial Microorganisms. Since 2007 she is lecturing at BSc, MSc and PhD study programs of Biotechnology and Microbiology subjects such as Analytical biotechnology, Industrial Microbiology, Microbial Biotechnology and Yeast Biotechnology. As a researcher she is active in the fields of ecol-ogy and taxonomy of industrially relevant yeasts, characterization and role of microbial communities in fermented foods and culture collection management.

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**P092**

**Genetic and phenotypic changes in brewing yeast Saccharomyces pastorianus during long term serial re-pitching**

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1University of Ljubljana, Biotechnical Faculty, Ljubljana, Slovenia, 2Pivovarna Lasko Union d.o.o., Ljubljana, Slovenia

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**P093**

**The use of selected strains of Lachancea thermotolerans for brewing of sour beer**

Sheppard J.

North Carolina State Brewery, Food, Bioprocessing and Nutrition Sciences, Raleigh, United States

A research program was undertaken to isolate and identify various species of wild yeast collected in nature, that may have application in commercial brewing. After preliminary screening, two strains from the species Lachancea thermotolerans were identified and selected for further investigations. These strains were characterized as to their ability to ferment brewer’s wort under conditions similar to a typical ale fermentation. The results of the characterizations showed an ability for both strains to ferment maltose, with yields of ethanol and glycerol similar to those obtained with S. cerevisiae. In addition, the wild strains produced significant quantities of lactic acid and various aromatic esters, resulting in a distinctly sour beer, with a pleasant fruity character and no discernible funkiness. In comparison to conventional sour beer production, use of these strains can dramatically reduce the time required and provide a high level of consistency to the finished product.

**Mini-CV:**

Dr. Sheppard is a Professor in the Department of Food, Bioprocessing and Nutrition Sciences at North Carolina State University in Raleigh, North Carolina USA, previously appointed at McGill University in Montreal, Canada. His research focusses on brewing yeast and fermentation strategies. In addition to his research lab, he also manages the licensed NC State Brewery and has recently formed a company (Lachancea LLC) to commercialize novel yeast species with applications to brewing and other beverage fermentations.

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**P094**

**Impact of Brettanomyces bruxellensis on the flavour profile of wort primary, secondary, and co-pitch fermentations**

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1University of Guelph, Molecular and Cellular Biology, Guelph, Canada, 2Escarpment Laboratories, Guelph, Canada

We investigated the impact of B. bruxellensis on the flavour profile and ethanol production in a primary, secondary, and co-pitch/mixed fermentation model. Using three B. bruxellensis strains (two beer and one wine isolate) in combination with three Saccharomyces cerevisiae strains (neutral POF-, fruity POF-, and phenolic), we aimed to determine the impact of B. bruxellensis on the flavour profile of each fermentation, in particular whether ester synthesis was additive and whether secondary or co-pitch fermentations were more phenolic than primary fermentations using the same B. bruxellensis strain. Following GC-MS analysis of the final beer product to determine levels of volatile flavour compounds, we observed that secondary and co-pitch fermentations were less fruity than the primary fermentations, as evidenced by lower levels of esters. In addition, the secondary and co-pitch fermentations were more phenolic, with higher levels of phenols observed than in the primary fermentations.

**Mini-CV:**

Caroline Tyrawa is currently a graduate student in the Molecular and Cellular Biology department at the University of Guelph. She studies the yeast Brettanomyces bruxellensis, which is gaining recognition and importance in the brewing industry. Her graduate work aims to provide a better understanding of B. bruxellensis’ role in fermentation and determine optimal conditions under which to propagate this yeast. Prior to her research work, Caroline spent a summer working for Escarpment Laboratories, a Canadian brewing yeast supplier. She has also had the opportunity to provide guidance and assistance to undergraduate researchers carrying out beer research projects.
Recent notable microbiological contaminations of craft beer in the United States

Begrow W.
Founders Brewing Company, Grand Rapids, United States

Craft beer consumption in the US has grown significantly since the 1990s. Because craft beer is often unfiltered and unpasteurized, it is susceptible to microbiological contamination and spoilage. Several notable recall events related to microbiological contamination have occurred with craft beer in the United States in recent history. This poster will provide a robust summary of recall events and cover the microbiological causative agents in detail.

Notable events that will be covered:
- 10 Barrel Swill recall in July 2014 for Saccharomyces cerevisiae var. diastaticus (superattenuation)
- Good Island Bourbon County Stout recall in January 2016 for Lactobacillus acetotolerans (lactic acid bacteria)
- Left Hand Brewing Co. recall of Nitro Milk Stout in September 2016 for Saccharomyces cerevisiae var. diastaticus

Mini-CV:
Wade Begrow is the microbiologist at Founders Brewing Company in Grand Rapids, MI. He is an avid fan of quality beer and has a strong interest in brewing and fermentation microbiology. He is an expert on traditional and advanced microbiological techniques to detect bacterial and fungal beer spoilers in the brewing process. Before his role at Founders, he was the microbiologist at Bell’s Brewery in Comstock, MI. Wade is a member of the Master Brewers Association of the Americas and is a member of the MBAA Food Safety Committee. He presented at the 2016 World Brewing Congress in Denver, CO.

A rapid high throughput quantitative polymerase chain reaction (qPCR) based diagnostic test for premature yeast flocculation (PYF) in malts

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1University of Tasmania, Hobart, Australia; 2Tassie Beer Dr. Hobart, Australia; 3Dalhousie University, Halifax, Canada; 4Coopers Brewery Ltd., Adelaide, Australia

The standard procedure for the detection of barley malt that causes PYF is by fermentation assays. While there exists a standard ASBC assay (Yeast-14) it is desirable to have a more rapid less laborious method to compliment this assay. Despite PYF often being related to fungal infection of grain, little effort has been directed to identity PYF-responsible fungal taxa and further developing a diagnostic test for them. This study focused on the development of a qPCR based test for PYF that is a reliable, efficient and economic screening tool for PYF. The test, based on primers and probes unique to the PYF causing fungi is validated by testing the primer and probe pairs on a comprehensive set of malt samples, representing the global supply, accomplishing the objective of developing a robust diagnostic test for PYF. The test has the potential to be commercialised. If successfully adopted the test will greatly benefit the malting industry.

Mini-CV:
Mandeep Kaur received her PhD (Food Microbiology) from University of Tasmania, Australia. After completing her PhD, she worked as a Postdoctoral Research Fellow researching microbial ecology of barley and malt, especially malts associated with premature yeast flocculation (PYF). Mandeep pioneered the adoption of new microbial ecology testing and bioinformatics tools at UTas. Her research resulted in a breakthrough for developing a qPCR-based test for early detection of PYF malts with potential to use by malting and brewing industry. That research was supported by the Grain Research and Development Corporation and Cargill Australia. Presently, Mandeep is working as a Research Fellow in Meat Shelf-life at UTas with a vision to provide the meat industry with in-depth knowledge of microbial ecology of Australian red meat and predictive tools to monitor and manage supply chains.

Combined effect of CO₂ saturation and alcohol content on yeast performance during beer refermentation

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1Meurice R&D - Institut Meurice, Department of Brewing Sciences and Fermentation Technology, Brussels, Belgium; 2Fermitek, Division of S.J. Leuaffre, Marcq en Baroeul, France

Bottle refermentation is well known by Belgian brewers and is growingly used worldwide. Sadly, brewers are confronted with yeast performance trouble when refermenting beers presenting simultaneously substantial alcohol content and CO₂ presaturation. Note that even if the effect of alcohol content on fermentation rate has been known for a long time, the influence of CO₂ is less studied. Therefore, we investigated the combined effect of ethanol and CO₂ on bottle fermentation rate with several yeast strains. We noticed a good refermentation for a beer containing 5,2% v/v alcohol and up to 6 g/L of CO₂. However, for a 12% v/v alcohol beer, we observed a decrease of the fermentation rate when presaturation raised from 0.5 to 6 g/L. These observations clearly show that alcohol content and saturation have a negative synergic effect on refermentation and yeast growth rates. Positively, a higher pitching rate promotes the bottle fermentation kinetics without altering the beer flavour profile.

Mini-CV:
Anne-Catherine Vandeville got her master degree at the Institut Meurice (Brussels) as Biochemist specialised in Brewing Sciences in 2007. Until the end of 2010 she worked on a project dedicated to the fed-batch propagation and the fluidized-bed drying of brewer’s yeast. As a result, she managed the Drying Process Department until March 2013 (Institut Meurice). Currently, she is researcher in the Department of Brewing Sciences and Fermentation Technology of this institute.
Use of probiotic yeast in production of beer

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¹University of Chemistry and Technology Prague, Department of Biotechnology, Prague, Czech Republic; ²Técnico Lisboa, Department of Bioengineering, Lisbon, Portugal

The use of non-traditional microorganisms, such as probiotics, throughout the fermentation process is one of the possibilities for new product development. Probiotics are beneficial to human health, typically in improving immunity and maintaining the balance of intestinal microflora. The growth of probiotic yeast Saccharomyces cerevisiae (boulardii) was tested at different medium compositions, temperature, ethanol and iso-alpha-acid content. Subsequently three important technological parameters (original extract, fermentation temperature and pitching rate) were optimized (central composite design of experiments, statistical analysis of data) from the standpoint of flavor active volatile compounds formation (higher alcohols, esters). The results showed that probiotic yeast are able to ferment brewery wort and that temperature is statistically the most important parameter for formation of volatile compounds during fermentation.

Mini-CV:
Holds MSc degree in Bioengineering and PhD in Biotechnology from the University of Chemistry and Technology Prague. Between 2000-2004 he held a position of post-doctoral fellow at the Department of Bioengineering, University of Minho, Braga, Portugal. Since 2016 he holds a full professor position at the Department of Biotechnology, University of Chemistry and Technology Prague. His research interests are in the area of fermentation engineering (especially alcohol-free beers), beer foam (foam stabilization, quantification, gushing) and surface interactions of microorganisms (adhesion, biofilm formation, flocculation).

P098

Novel spoilage yeast detection method for bottom fermented beer and pitching yeast

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¹Forschungszentrum Weihenstephan for Brau- und Lebensmittelei, Freising, Germany; ²Central Washington University, Brewing Program, Washington, United States

Spoilage yeast Saccharomyces cerevisiae var. diastaticus is frequently found as beer and pitching yeast contaminant. It has a large impact on the quality of the final product. Various detection methods have been applied, which take multiple steps and long detection time. Here a method was investigated which measures the pressure of a small incubation vessel over time at 37°C. After incubating a suspicious sample inside the vessel (containing sterile YM-Bouillon), no further steps have to be taken. A top fermenting spoiler like S. cerevisiae var. diastaticus will produce CO₂ inside the vessel, triggering a pressure alarm of a defined detection level. Bottom fermenting yeast is not able to do so at 37°C. Five S. cerevisiae var. diastaticus strains were investigated along with 4 bottom fermenting yeast strains (S. pastorianus). Spiked samples with contamination rates as low as 0.001% (ration:10 cells/ml spoilage yeast in 1*106 cells/ml pitching yeast) were successfully detected.

Mini-CV:
Maximilian Michel finished in 2014 with a Dipl. engineer of brewing and beverage technology degree from the TU München, Weihenstephan. He then started a PhD-program at the Research Center Weihenstephan for brewing and food quality. His focus of research is non-Saccharomyces yeasts in brewing.

P099

Modification and differentiation of ale yeast

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The improvement and characterization of industrial yeast strains is an ongoing process. Methods based on evolutionary engineering like adaptation, mutation and hybridization are powerful tools for modifications. The fermentation characteristics and molecular background of different yeast strains and their modifications should be analyzed. The differentiation of culture strains is therefore of high interest. Different molecular fingerprint-methods based on PCR and restriction analysis were tested in this project. Here, the identification of modifications by the molecular techniques is also desirable. Furthermore the phenotypic and genetic changes and their stability of the fermentation characteristics should also be analyzed/monitored using such fingerprints. Detailed analysis of the genome by next generation sequencing should also be carried out. The present poster summarizes our current work for the characterization of modified yeast on strain level by molecular methods.

Mini-CV:
Dipl.-Ing. Ilıs Cöllü studied Biotechnology at the University of Technology in Berlin, where she started working at the Department of Microbiology and Genetic led by Prof. U. Stahl in 2009. Her topics were the fermentation of functional fermented beverages. In 2012 she started working at the VLB-Berlin with topics on molecular methods. She is responsible for the analysis and identifications of microorganisms by molecular methods in commercial analytics and research topics. She is now working in the Department for Bioprocess Engineering and Applied microbiology.
Development of surface-engineered brewing yeast for acceleration of maturation and improvement of colloidal stability of beer

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1University of Chemistry and Technology, Department of Biotechnology, Prague, Czech Republic; 2University of Chemistry and Technology, Department of Biochemistry and Microbiology, Prague, Czech Republic

Cell surface display is a powerful tool for endowing novel functions on the host cell by displaying functional proteins on its surface. Proteins covalently bound on the yeast surface are simultaneously more active than free proteins in solution. We applied this methodology for development of brewing yeast with truncated active α-acetolactate decarboxylase (ALDC) from Acetobacter acetii ssp. xylinum attached to the cell wall. With these cells, no biacetyl was present in the wort after primary fermentation. Another application was done with a proline-rich peptide QPF attached to its cell wall. Yeast cells expressing the QPF peptide on their cell walls were able to bind about 20 % more proanthocyanidins in comparison with the control strain displaying just the anchoring domain. Since the above mentioned modifications did not affect the fermentation performance of the yeasts, this technique appears to be a promising approach for the optimisation of brewing yeasts.

Mini-CV:
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, Kvasný Prumysl. 2007 - Assoc. Prof. degree in biotechnology (Institute of Chemical Technology, Prague). 2012 - Professor of Biotechnology (Institute of Chemical Technology, Prague). 2013 - Visiting professor position at Department of Agraria, Sassari University, Sardinia, Italy. 2015 - F.O.Poupe award from Czech Brewing and Malting Association 2016 - Editor of Czech Journal of Food Sciences

Sour brewing: A comparison of acidification methods in the brewing process on wort and beer qualities

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1University College Cork, School of Food and Nutritional Sciences, Cork, Ireland; 2Technical University of Munich, Research Center Weihenstephan for Brewing and Food Quality, Freising-Weihenstephan, Germany

Sour beers are experiencing a renaissance. The choice on when and how to acidify along the brewing process, however, could have implications on the final beers. Acidification on a pilot-scale brewery was done after mashing, after lautering, or after boiling using Lactobacillus amylovorus FST2.11. The strain was selected for its low hop resistance and high yield of lactic acid. Soured worts were ultimately fermented using an ale yeast. During co-fermentation, lactobacilli outnumbered yeast cells (30:1 at day 5) until day 9. Even though the yeast was acid resistant in vitro, a more complete attenuation was achieved in the unacidified control, caused by the quicker use of fermentable sugars and FAN. Faster fermentation and lower β-glucan were obtained when mash was soured compared to unacidified mashes. Thorough acidification was reached during wort souring and co-fermentation (5.6 - 5.8 g/L lactic acid and pH of 3.5 - 3.7). Impact on flavour and sensory profiles were also detected.

Mini-CV:
Lorenzo Peyer graduated with a Master in Food Process Engineering at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland, followed by another one in Food Culture and Communications in Pollenzo, Italy. After having embraced both the coffee and beer industries as part of his working experience, he decided to enroll for a PhD program at the University College Cork, Ireland. Supervised by Prof. Dr. Arendt, his research focuses on the use of lactic acid bacteria for improving qualities of malt, beer and for developing novel alcoholic and non-alcoholic beverages.

Microbial beer stabilization

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1Pall GmbH, Food & Beverage, Dinslaken, Germany; 2Pall Filtersystems GmbH, Scientific Laboratory Service, Bad Kreuznach, Germany

The most perceived characteristic consumers seek from the purchase of products is the microbial safety. Due to the natural preservative effects of the beer components any pathogenic risks are low and easily mitigated by the production process. However there is a group of beer spoilage microorganisms which, if present, can negatively affect the beer’s taste, odor and clarity. The microbial integrity of beer is therefore the most important basic quality attribute which must be fulfilled in order for brewers to sustain their business. The poster describes the most common approaches used for microbial stabilization of beer and compares how the microbial stabilization effectiveness is controlled in the field. Results from the field including published data are discussed applying statistical laws based on the logarithmic reduction value (LRV). Risk profiles for various contamination levels upstream are shown for the different technologies.

Mini-CV:
Apprenticeship in German craft brewery and malteries (2,5 Y) Working as brewer in filter departments for various breweries (2 Y) Diplom - Brewmaster degree from Technical University Berlin/VLB Line brewmaster 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 (20 Y)
Deeper Insight into results of a round robin test by multivariate data analysis

**Kessler B.**, **Kessler W.**, **Dausch M.**, **Rettberg N.**

1. Dausch Technologies GmbH, Landau, Germany
2. Steinbeis Transferzentrum für Prozesskontrolle und Datenanalyse, Reutlingen, Germany
3. VLB Berlin, Berlin, Germany

Between 2008 and 2016, under the guidance of VLB, 40 breweries took part in a round robin test to characterize 11 beers from 8 German breweries. Numerous independent scientists performed the standard tests by using similar methods and equipment. These data are analysed as described in DIN ISO 5725 Part 1 and 2. The objective of using multivariate data analysis instead is to take not just single measurements into account in order to cluster the different brands of beer, but also to view all variables in a multidimensional way. Thus, a principal component analysis (PCA) is performed to extract the most important ones. The results show the inconsistency of the manufacturing process to produce the same quality over a number of years. Therefore, inline analysis e.g. spectroscopic methods should be developed to control the brewing process in the future and to balance resp. compensate the variations in the quality of the raw materials during manufacturing by means of smart production.

**Mini-CV:**
Betina Kessler received a Bachelor Degree in 2012 and a Master Degree in 2014 by the Technical University of Munich in "Brewing and Beverage Technologies". During her studies she focused a spectroscopic multicomponent analysis of energy drinks together with Dausch Technologies, Germany. Since 2015 she has been working at the R&D department for Dausch Technologies to develop multimodal spectroscopic control systems for a multicomponent inline analysis in the beverage, brewing and pharmaceutical industries.