BrewingScience
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Abstracts BrewingScience articles (July/August 2010)

S. Kappler, Ch. Schönberger, M. Krottenthaler and T. Becker

Isohumulones – a Review

Isohumulones, an isomerisation product from hop *(humulus lupulus sp.)* derived humulones are the main bittering substance in beer. They contribute to more than 85 % of the allover bitterness of beer [65]. Hops and its constituents as well as its application in the brewery is subject of investigations for more than a century already. Hops as an ingredient in beer has been used since the early Middle Ages. The objective back than was to save beer from microbiological spoilage and to use the hops as a flavouring ingredient [6]. Today we know that hops and its constituents also improve foam stability and contributes to the flavour stability of beer in various ways [71]. This paper gives a short overview about the most important literature which was published throughout the last decades.

Descriptors: hops, humulones, isohumulones, isomerisation, beer flavor, beer quality, bitterness

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P. Hughes

Novel Approaches to the Measurement of flavour-related Properties: A Brief Overview and Future Prospects

The challenges of relating analytical data to sensory evaluation are well-known, and may be attributed to recognised sensory biases and interactions (matrix-effects) that influence the sensory activity of flavour attributes. One approach to obviating these difficulties is to attempt to mimic sensory detection mechanisms to determine the activity of flavour attributes. In this short paper, two examples are given. Firstly, the feasibility of determining beer bitterness by exploiting the lipophilicity of hop bitter acids and measuring changes in pH across a model membrane. Secondly, the derivation of a measure of astringency by observing the binding of beer polyphenol complements to an appropriate protein. Whilst such an approach needs much fine-tuning and benchmarking against existing analytical and sensory tests, it nonetheless offers an alternative strategy for enhancing the predictiveness of beer flavour based on analytical measures.

Descriptors: hops, bitterness, astringency, iso-α-acids, polyphenols, lipophilicity

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S. Hanke, V. Ditz, M. Herrmann, W. Back, T. Becker and M. Krottenthaler

Influence of Ethyl Acetate, Isoamyl Acetate and Linalool on off-flavour Perception in Beer

Beer flavour is a very complex flavour created by interaction off several hundred aroma compounds. Obvious off-flavours which can be detected by the consumer decrease the drinkability and acceptance of a beverage. The image of a brand can be damaged. It is known that undesired flavours, like stale flavour, can be masked by positive ones like certain hop flavours. Therefore it is of interest to find out if other off-flavours can also be masked by positive aroma compounds. Positive flavour impressions are e.g. linalool and some esters among others. Whether these compounds can suppress the perception of dimethyl sulphide (DMS), diacetyl and isovaleric acid in beer is unknown until today. In this study the influence of ethyl acetate, isoamyl acetate and linalool on flavour thresholds of DMS, isovaleric acid and diacetyl was investigated. The obtained results show that linalool decreases the perceived intensity of off-flavours at low concentrations but increases at higher concentrations. Esters also showed suppressing and synergistic effects. The flavour composition is an important factor for flavour perception and must be taken into account when comparing flavour thresholds of flavour compounds determined in different beers types.

Descriptors: off-flavour perception, dimethyl sulfide, diacetyl, esters, flavour threshold, linalool

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Abstracts BrewingScience articles (May/June 2010)

M. Biendl

New International Calibration Standard (ICE-3) for HPLC Analysis of α-and ß-acids

Submitted on behalf of the International Hop Standards Committee
The International Hop Standards Committee (IHSC), announces the release of a new calibration standard, ICE-3, for the HPLC analysis of α- and ß-acids. This standard replaces ICE-2, which is now withdrawn.

Descriptors: Iso-a-acids, *Rho*-iso-a-acids, Tetrahydroiso-a-acids, Hexahydroiso-a-acids, calibration standard, HPLC analysis, methodology

Source: BrewingScience – Monatsschrift für Brauwissenschaft, 63 (May/June 2010), pp. 92-93

A. Sorgatz, F. Gabler and I. Voigt

A New Stepless Control Concept for Multi-Lane Bottle Conveyors

Multi-lane bottle conveyors are in use at almost all bottling plants. They are not only needed for the transportation of bottles but also for decoupling the failure sensitive machines of the plant by storing and providing bottles. This increases the overall efficiency of a plant by bridging short downtimes. These buffer conveying systems have to be controlled with regard to their filling level. State of the art is the stepwise detection of the filling level by mechanical switches, which are actuated by accumulating bottles. This leads to a stepwise control.
In this paper a new control concept is presented which allows controlling multi-lane conveyors stepless by monitoring the infeed and the output of the conveyor. This enables a more precise control of the conveyor sections velocities and outputs of the up- and downstream machines. No mechanical jam switches are necessary.
The developed control algorithm was successfully implemented and tested at an industrial scale pilot plant. Test runs showed an equal flow of bottles due to the continuous adaption of the machine outputs and conveyor sections velocities and the minimization of the conveyors dead time.

Descriptors: conveyor control, bottling plant, buffer system

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M. Christian, J. Titze, V. Ilberg and F. Jacob

Combined Particle Analysis as a New Tool to Predict Gushing Shown with Alcohol-Free Beverage Products

Combined particle analysis was applied as a tool to predict gushing in alcohol-free beverage products. Gushing is known as spontaneous overfoaming of carbonated beverages that is an intermittent problem for brewers and the beverage industry. Therefore, preventive tests to examine raw materials for their gushing risk are of interest for the industry. Previously, the focus of gushing tests was on the overfoaming of carbonated samples in specifically shaken bottles, after which the amount of overfoaming was recorded as the measure of gushing. As these tests require a number of days to be performed, it often happens that the raw materials have already been processed before the results are available. Here the combined particle analysis is presented as a “real time” alternative to such tests. This testing methodology was applied in beverage products (for producing spritzers) where it was shown that this analysis was successful in predicting gushing. In the test samples for producing apple spritzers putative gushing causing particles with sizes of only 1–2 nm were identified. Significantly higher stray light intensities for these particles with sizes of 1–2 nm were detected for the gushing-positive compared to gushing-negative samples. The particle charge titration method revealed higher titrated volumes for the gushing-positive samples (to neutralize the entire particle surface charge) than for the gushing-negative ones. Therefore, the higher titrated volumes were associated with significantly higher amounts of 1–2 nm-particles. Accordingly the titrated volume for charge-

neutralization was proposed as measurement parameter to “quantify” gushing-relevant 1–2 nm-particles in order to estimate the gushing propensity. In further beverage products (for producing apple-cherry-spritzers) small particles were not detected, which explains why considerably lower titrated volumes were used and no gushing was observed. The results demonstrate that the particle size and the particle surface charge are promising analytical parameters to predict the gushing propensity of beverage products.

Descriptors: beverage, combined particle analysis, fruit spritzer, gushing, particle charge analyzer, particle size measurement

Source: BrewingScience – Monatsschrift für Brauwissenschaft, 63 (May/June 2010), pp. 72-79

J. Titze, M. Christian, V. Ilberg and F. Jacob

Particle Analysis – A Combined Method to Analyze the Colloidal Characteristics of Particles

Particle analysis and its potential in describing the physico-chemical characteristics of particles in beer were investigated. It was the aim to figure out the feasibility for its application in brewing and beverage science. To describe existing problems in the beverage industry caused by insufficient physico-chemical stability of the beverages a rule of great generality according to the particle characteristics was also defined as follows: *Beverages are liquids, in which colloids, also called particles, exist in disperged (e.g. beer) or emulsified (e.g. milk) form.* One main particle characteristic is the surface. This can be seen in many interfacial phenomena, like the surface potential. Mathematically it was shown, that especially for small particles the ratio between surface and volume increases. Surfaces carry electric charges, which terminate or change the physico-chemical characteristics of the particles. By combining (1) the particle charge detection with polyelectrolyte titration for determining the surface charge, the surface potential and charge density of particles with (2) the particle size analysis by dynamic stray light to analyze the particle size and particle size distribution, the particles could be characterized.
The results, conducted with the help of a Forcier test, revealed that with the increased aging of beer the particle charge, measured by the titrated volume, as well as the surface potential decrease. Both dimensions are in a linear relation with a coefficient of determination of R^2 = 0.9611. The results could not explain if the decrease has been caused by the reduction of particle surfaces due to agglomeration or by a significant loss of surface charges of the particles. However, using a particle size measurement, it was found out that small particles (sizes < 50 nm) disappeared and larger particles with sizes from 700 nm to 2000 nm occurred. So it could be demonstrated that the coarsening of particles was caused by agglomeration.
In addition to that, the mechanism of forming a 1:1 stoichiometrical charge complex was graphically displayed by the particle size measurement. The highest coefficients of determination (R^2 = 0.9997) were found for the titrated volume and the concentration of beer in a dilution series by mixing beer and water, which shows the use of particle charge titration for quantitative determination. In contrast to that, it could be illustrated by nearly identical particle size distribution curves at different concentration levels that it is not possible to “quantify” the detected particles by using only particle size measurement. Therefore, the particle analysis was introduced as a combined method. Due to the statistically good results of this particle analysis, future experiments should involve impacts on the colloidal stability of filtration or flash pasteurization in the beverage industry to get more information in the area of physico-chemical stability of beverages. Besides further experiments, interlaboratory tests should be conducted additionally to utilize the presented particle analysis for the brewing and beverage industry.

Descriptors: beverage, charge titration method, combined particle analysis, particle charge analyzer, particle size measurement

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Abstracts BrewingScience articles (March/April 2010)

S. M. Deckers, K. Gebruers, G. Baggerman, Y. Lorgouilloux, J. A. Delcour, C. Michiels, G. Derdelinckx, J. Martens and H. Neven

CO_2-Hydrophobin Structures Acting as Nanobombs in Beer

Part 1: A critical review of hypotheses and mechanisms

Primary beer gushing is defined as the wild and uncontrolled overfoaming of packaged beer induced by contaminated raw materials as barley and malt. It is generally admitted that most probably amphipathic molecules such as hydrophobins and non-specific lipid transfer proteins (ns-LTPs) are responsible for this phenomenon. These molecules are synthesized by moulds and by vegetal tissues respectively in order to modify the polarity of surfaces and the solubility of molecules. At present, hydrophobins are extensively studied as they are considered as the major responsible molecules involved in primary gushing. Although a strong reduction (more than 85 %) of the initial concentration of hydrophobins present in malt occurs during the brewing process, the residualquantity remaining in finished beer is sufficient to provoke the gushing of packaged beer and the subsequent dramatic commercial damages to a particular beer brand. This review compiles the relevant fundamental physical and chemical properties of CO_2 and experimental observations at laboratory and pilot scale. A plausible mechanism of primary gushing is presented. It is based on the effective role of hydrophobins association to CO_2 nanobubbles, acting as “nanobombs” and perhaps as “nucleation sites” causing effects from overfoaming to strong gushing depending on the concentration and the carbonation rate. In beer formation of CO_2 bubbles proceeds through heterogeneous nucleation. The rapid heterogeneous nucleation initiated at the opening of the container in excessively gushing beer suggests the the presence of catalysts to overcome the energy barriers. Since hydrophobin molecules are able to bind to carbonic acid, they prevent part of the CO_2 from dissolution. These structures will aggregate in timeframes of days or even weeks depending on the beer by forming nanobubbles of a typical critical radius. The internal pressure of these nanobubbles is proportional to the carbonation pressure of gaseous CO_2 in the container at filling (about 3.0 till 4.0 ATU of CO_2). At the opening of the container, the difference of partial pressure of carbonic acid in the bottle and in the atmosphere provokes the explosion of these nanobubbles and results in a strong gushing effect.

Descriptors: Hydrophobin, carbonic acid, primary gushing, mechanism, beer, barley

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Saison, D., Vanbeneden, N., De Schutter, D. P., Daenen, L., Mertens, T., Delvaux, F. and Delvaux, F. R.

Characterisation of the Flavour and the Chemical Composition of Lager Beer after Ageing in Varying Conditions

Aged beer flavour was studied by ageing a lager beer in different conditions (varying temperature-time profiles, different oxidative conditions and varying pH and ethanol concentrations). This led to beers with a varying aged flavour, which could be explained by differences in the reaction rate of ageing reactions. High temperatures, oxidative conditions and to a lesser extent, a lower pH, accelerated beer ageing. Enhanced (E)-2-nonenal formation probably led to the greater perception of cardboard flavour after ageing at high temperatures. Madeira flavour was only perceived after ageing at 20 °C and ribes flavour was mainly perceived in oxidatively aged beer. In beers with these flavour notes, high concentrations of acetal-dehyde, Strecker aldehydes and diacetyl were found and in the Madeira flavoured beer, also of 2-furfuryl ethyl ether and 5-hydroxymethylfurfural. In the end, this study provides an overview of the different aged flavours that can develop in different ageing conditions and the corresponding flavour compounds that make up the chemical composition of these flavours.

Descriptors: beer, flavour, ageing, carbonyl compounds, flavour stability

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Abstracts BrewingScience articles (January/February 2010)

G. De Rouck, A. G. Flores-Gonzáles, J. De Clippeleer, J. De Cock, L. De Cooman and G. Aerts

Sufficient Formation and Removal of Dimethyl Sulfide (DMS) without Classic Wort Boiling

The formation and removal of dimethyl sulfide (DMS) was studied during a new method for wort production, without classic wort boiling. This was compared with classic brewing trials comprising one hour of wort boiling. The new wort production method consists of fine milling of malt under water to minimize LOX reactions, mashing-off at 95 °C, membrane assisted thin bed filtration, in-line injection of clean steam in the filtered wort and stripping of the wort while entering the combination vessel ('boiling' kettle/decantor), optional clean steam injection during filling of the combination vessel, and finally decantation of the hot trub in the same combination vessel. Oversized chimneys with condensate traps are installed on both the mash vessel and the combination vessel to promote removal and prevent re-entrance of unwanted volatiles, including DMS. Like in classic wort production, the contents of DMS precursor and DMS were sufficiently reduced when applying the new brewing method and DMS presented no flavour problem in the finished beer. The processing time of the innovative wort production method until the end of filling of the combination vessel and optional stripping of the wort was only 2.5 hours as compared to at least 3.5 hours for classic brewing using the same brewing line. Therefore, application of the proposed innovative wort production method allows for preparation of significantly more brews per day with sufficient removal of unwanted volatiles.

Descriptors: wort production, DMS, wort boiling

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R. F. Vogel, P. Preissler and J. Behr

Towards an Understanding of Hop Tolerance in Beer Spoiling *Lactobacillus brevis*

Lactobacillus brevis comprises strains with diverse metabolic capabilities. Some specialized strains can grow even in highly hopped pilsner beers without the need of long term adaptation. Other strains develop tolerance upon prolonged hop exposition or remain sensitive. In this communication genetic analyses, proteomics and physiological tests in beer as well as studies in membrane physiology and cell wall composition are reviewed, which are useful to differentiate *L. brevis* strains along their beer spoiling potential and to elucidate decisive marker traits for categorizing beer spoiling *L. brevis* along their relevance for the brewer. Hop adaptation in *L. brevis* TMW 1.465 is a multifactorial process, which results in changes in metabolism, protein profile, membrane and cell wall composition and intracellular manganese levels. It involves mechanisms to cope with intracellular acidification and divalent cation limitation, redox imbalance and oxidative damage and mechanisms for energy generation and economy, genetic information fidelity and enzyme functionality, and as a result enables beer spoilage. Differentiation along the beer spoiling capacity is possible by comparative proteomics, or by physiological tests employing manganese efflux or reduction of tetrazolium to formazan upon growth in lager beer. A simple test for mangenese efflux provides a useful tool for categorization of beer spoiling *L. brevis*. On the other hand, genetic determinants potentially useful for PCR detection systems were widely spread in all strains with no reference to high hop tolerance. The further understanding of hop tolerance requires comparative genomic studies revealing critical strain differences and thus multiple (PCR) markers.

Desriptors: *Lactobacillus brevis*, beer spoilage, hop tolerance, redox potential

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H. Withouck, A. Boeykens, B. Jaskula, K. Goiris, G. De Rouck, C. Hugelier and G. Aerts

Upstream Beer Stabilisation during Wort Boiling by Addition of Gallotannins and/or PVPP

Addition of stabilisation products in the upstream brewing process is a very convenient way of physico-chemical stabilisation without the need for extra filtration or the risk of beer losses. Therefore, in this study the use of appropriate stabilisation products upstream the brewing process, more specifically at the end of wort boiling, have been evaluated in relation to improved colloidal stability. Applications of PVPP (Polyclar 10, ISP) and gallotannins (Beerotan Q, BFTI) have been investigated. The lowest gallotannin levels (wort boiling: 5 g/hL; contact time in boiling kettle: 3 minutes) are already sufficient to obtain enhanced stability due to adequate removal of haze- sensitive proteins. Furthermore, the addition of 10 g/hL PVPP has an explicit effect on the amounts of polyphenols, which results in an improved colloidal stability. Lowering pH at mashing-in also results in improved physico-chemical properties and flavour stability.

Descriptors: colloidal stability, haze, wort boiling, gallotannins, PVPP

Source: BrewingScience – Monatsschrift für Brauwissenschaft, 63 (January/February 2010), pp. 14-22

L. Strack and U. Stahl

Brewer's Yeast Modification: Effects Both on Diacetyl Production and Alcohol Formation*

New industrial brewing yeasts[*1] have been generated by introduction of two genes involved in valine biosynthetic pathway in order to clarify their roles for the reduction of diacetyl content in beer. The *Saccharomyces cerevisiae* genes as well as lager[*2] genes both *BAT1* (encoding branched-chain amino acid aminotransferase) and *BAT2* (encoding branched-chain amino acid aminotransaminase) have been transferred into brewer's yeast. Within this approach it was possible to decrease diacetyl levels at the end of main fermentation without affecting the by-product profile of the beer negatively. Furthermore, our results pointed to the regulation of these genes concerning diacetyl formation.

Descriptors: brewer's yeast, metabolic engineering, diacetyl, maturation

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L. van Hoyweghen, M. Biendl and A. Heyerick

Radical Scavenging Capacity of Hop-derived Products

Dietary antioxidants are believed to be effective in the prevention of oxidative stress related diseases (eg. cancer and cardiovascular diseases). Polyphenols are widely recognized as potent antioxidants as they can scavenge reactive oxygen species (ROS). The hop plant (*Humulus lupulus* L.), used in a variety of health applications and indispensible as a beer ingredient, is an interesting source of polyphenolic antioxidants including tannins, flavonol glycosides and prenylated flavonoids. In addition, also hop oil and hop acids (including downstream products) have been reported as potent antioxidants. In this investigation, the radical scavenging activity of hop products (including different extracts and downstream products) was investigated using two different antioxidant assays: the ORAC to study the peroxyl radical scavenging capacity and HORAC to investigate the hydroxyl radical scavenging capacity. Quercetin and a grape extract containing oligomeric proanthocyanidins (OPC) were used for comparison. The peroxyl radical scavenging capacities of prenylated flavonoids were highly analogous to quercetin and OPC equaling 5–10 Trolox equivalents. The hydroxyl radical scavenging capacities of Xantho-Flav^{TM} products correlated with the concentration of xanthohumol and pure xanthohumol (> 95 %) corresponded to about 60 Trolox equivalents, which is 10–20 times higher than that of quercetin and OPC. Consistently, ethanol extracts showed a higher radical scavenging activity than CO_2-extracts. Furthermore, tannin extract proved an efficient peroxyl radical scavenger. Thus it can be concluded that xanthohumol-containing products show high radical scavenging capacities, which partly may be mediated by its metal ion chelating properties. Apart from their possible health benefits, these products might also contribute antioxidant power during the brewing process and during storage.

Descriptors: antioxidant, xanthohumol, health, hops

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