M. Cvengroschová, G. Šepeľová, D. Šmogrovičová

Influence of pre-isomerised hop on taste and foam stability of beer

Addition of hop products into a wort boiling process supplies colloidal, biological, organoleptic and foam stability as well as hop affects bitterness, aroma, colour and gushing. Nowadays hop pellets, extracts and pre-isomerised hop products are used. Using of pre-isomerized hops makes manipulation easier because of lower dosing and increases utilisation. Price level of the hops comparing with HHT hops is lower by one half in average and bitterness analytical results are reached on the same level. During measurement of bitter substances by BU method there were no differences in values, but isohumulones measurement shows that felt bitterness is higher, it is BU x 1,2. There was no influence neither on foam stability nor gushing creation. The negative taste properties were found during organoleptic tests; mainly in beers with higher hop content, tart and higher hoppy and ester taste was determined as negative taste properties.

BC 12 Hop/36 Beer

(Descriptors: Hop, foam stability, organoleptic properties .

Deskriptoren: Hopfen, Schaumhaltbarkeit, organoleptische Eigenschaften).

1 Introduction

Addition of hop products into a wort boiling process supplies colloidal, biological, organoleptic and foam stability as well as hop affects bitterness, aroma, colour and gushing [1,2]. Nowadays hop pellets, extracts and pre-isomerised hop products are used.

Hop addition supports excretion of fatty acids during solids removal and its dosing in time is very important in the organoleptic aspect. If cooled wort has to contain low vaporous aromatic hop matters content, it is useful to dose hop soon, or to reach hop extract. If it is required to use a high amount of hop essential oils, it is useful to add hop later or use non-extracted hop product [3].

At the start of wort boiling bitterness arises intensely by influence of unisomerised α-acids. Accumulation of α-acids content is uniform and reaction on hop dosing is slower. The addition of pellets at the start of wort boiling leads to faster dissolution and isomerisation of α-acids, whereas with the additon of extract, dissolution and isomerization of α-acids at the start is slower and after certain time faster than in the case of pellets [4,5]. As minority component of α-acids, adrehumulone and prehumulone are resin acids. Their isomerised derivates significantly improve foam stability and thereby improve commercial beer brands [6].

Bitterness intensity and ability to stabilise foam are dependent on the size of the hydrophobic character of the hop compounds. Isocohumulones evidently show lower bitterness than other more hydrophobic hop compounds. Equally evident are bitterness differences between cis- and trans-isomers, of whom cis-isomers are more bitter. Trans-isomers are accumulated in foam during the fermentation process and thereby it is possible to explain the observed enrichment of finished beer by cis-isomers [7].

At present it is very popular to use reduced isomerised extracts because of their better foam- and as well photical stability. Standard determination of beer bitterness using these extracts (BU determination) is not suitable, recounted factors on felt bitterness are 1,0 – 1,1 for tetrahydro-iso-α-acids (THIA) and 0,7 for rho-iso- α-acids (RHIA). Bitterness quality sensorycally felt by taste decreases with rising amount of THIA and RHIA. Isomerised hop pellets decrease right by one third the usage of bitter acids and it is possible to affect hop aroma of beer without economic losses. The same method is applicable with hop extracts [8].

Isomerised hop pellets are used as a replacement for pellets type 90. Extraction of α-acids at wort boiling works very fast (10 min.) and therefore it is possible to add them later in the process in one dosage in order to utilise essential oils. Isomerised pellets as well as pellets type 90 show a lot of advantages at a good price [9]. Secundary gushing occurrence, spontaneous overfoaming caused by a source other than malt quality was registered in beers produced from isomerised hop extracts [10].

Isomerised and hydrogenised products of bitter hop acids positively affect the foam stability. Their hydrophobic attribute and their molecular internal structure have a positive effect. The role of polyphenols, which are generally capable of cross bonds with proteins, as well as the influence of pH are still unclear. The negative role of lipides, ethanol, higher alcohols, esters and basic aminoacids is shown [11].

Hop resins partly participate in refraction creation, their sense is mainly in production of components supplying the typical bitter taste to wort. The products formed are isocompounds or isohumulones. The isomerisation level of α-acids during the creation of iso-α-acids is influenced by wort boiling conditions, like wort pH, time of wort boiling, temperature and intensity of wort boiling, concentration of α-acids and some others components of wort extract [12].

The aim of this work was to study the influence of pre-isomerised hop utilisation during the wort boiling in wort of gravity 13 °P and its influence on taste and foam stability.

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2 Materials and methods

2.1 Hop products

- First dosage:

  Ethanol Hop Extract – Hopsteiner, Variety: Hallertauer Magnum, Alpha acids: 30 %

- Second dosage:

  HHT hop – Hopsteiner – Hop Pellets 90, Hallertau, Variety: Hallertauer Tradition, Alpha acids: 7,7 %

  Premiant hop – Hop Pellets 90, Žatec, Variety: Premiant, Alpha acids: 9,56 %

  PIH hop – Pre-Isomerised Hop, Variety: Blended Hops, Conversion: 95 %, Alpha acids: 10,9 %

- Third dosage:

  Aroma hop – Hop Pellets 90, Žatec, Variety: Žatec, Alpha acids: 3,6 %

We used three types of hop products in a second dosage. Premiant for lower hopped worts (total alpha acids for the three dosages: 6700 g α) and HHT hop for higher hopped worts (total alpha acids for three dosages: 9300 g α). In both cases the first dosage was hop extract and the third dosage, aroma extract. In our experiments we used in the second dosage PIH hop instead of HHT and Premiant hop. We prepared 13 °P worts and blended 11 °P from lower hopped worts (Premiant, PIH) and 12 °P from higher hopped worts (HHT, PIH) by HGB system.

2.2 Microorganisms

We used operation strain of brewer's yeast *Saccharomyces cerevisiae* subsp. *uvarum* W 34/70. Culture was kept on slanting wort agar at 4 °C and it was pre-inoculated every three months. We used wort with gravity 13 °P.

2.3 Wort boiling conditions

Wort boiling ran in a slanting cylinder vessel of 1930 hl volume. Duration of wort boiling was 90 minutes. Pre-isomerised hop was used in a second batch, 30 minutes from the start of wort boiling instead of HHT hop in higher hopped 13 °P wort and instead of Premiant hop in lower hopped 13 °P wort.

2.4 Wort fermentation

Primary fermentation ran in cylindro-conical tanks (CCT) of 2170 hl volume, filled on 83 %. Pitching temperature was 9.5 °C and during primary fermentation it was kept at 14 °C. The fermentation process was carried out under carbon dioxide overpressure of maximum 50 kPa.

Yeasts were removed on the 5th – 6th fermentation day, when apparent extract decrease was minimal or no decrease registered. Primary fermentation was stopped when diacetyl concentration decreased to the required level of 0.15 mg/l. Beer maturation ran in classical vessels (horizontal tanks) at approximately 1 °C.

2.5 Analytical methods

Low-molecular nitrogen compounds were determined by ninhydrin method. Wort and beer samples were diluted to FAN concentration of 1 to 3 mg/l (wort 150 times, beer 50 times). After measurement of absorbance at 570 nm, the FAN content was calculated as follows:

$$N = \frac{(A_H - A_S)\ \ 2V}{A_{ST}} \quad \text{(mg/l)}$$

N	free amino nitrogen (mg/l)
A_H	absorbance of main test at 570 nm
A_S	value of blind test (it is deducted only for analysis of dark wort or beer)
V	diluting correction coefficient
A_{ST}	absorbance of standard glycine dilution

Vicinal diketones concentration was determined as total vicinal diketones after distillation with water stream by EBC recommended spectrophotometrical method [13].

Foam stability was measured in beer bottle as an interval between foam creation by carbon dioxide and its drop using device „NIBEM T“ (Haffmans).

BU determination was followed up by determining bitter substances after wort centrifugation and addition of octanol and hydrogen chloride acid. The measurement was done spectrophotometrically by the device "Shimadzu" at 275 nm.

Organoleptic assessment was made from the results of five tasters, who appraised young beer 13 °P from storage vessels (horizontal tanks) and finished beer 11 and 12 °P in organoleptic aspect – basic tastes: sweet, body, bitterness as well as positive and negative tastes: hoppy, esters, astringent, diacetyl, DMS, sour and others. In case of wort with higher hopping the beer profile was determined as well.

3 Results and discussion

It is well known that isomerised hop pellets decrease the usage of α-acids by about one third. Thus it is possible to regulate hop aroma without economic losses. Isomerised hop pellets are used as a replacement of pellets type 90 and they have a lot of advantages at a very good price.

The aim of this work was to study the influence of pre-isomerised hop utilisation (PIH) during the wort boiling in worts with higher

Table Hop dosage

Hop dosage	13 °P with higher hop dosage	13 °P with higher hop dosage (PIH)	13 °P with lower hop dosage	13 °P with lower hop dosage (PIH)
2nd batch 30 min.	25 kg (7,7%α) HHT	10 kg (10,9 %α) PIH	15 kg (9,56%α) Premiant	7,5 kg (10,9 %α) PIH

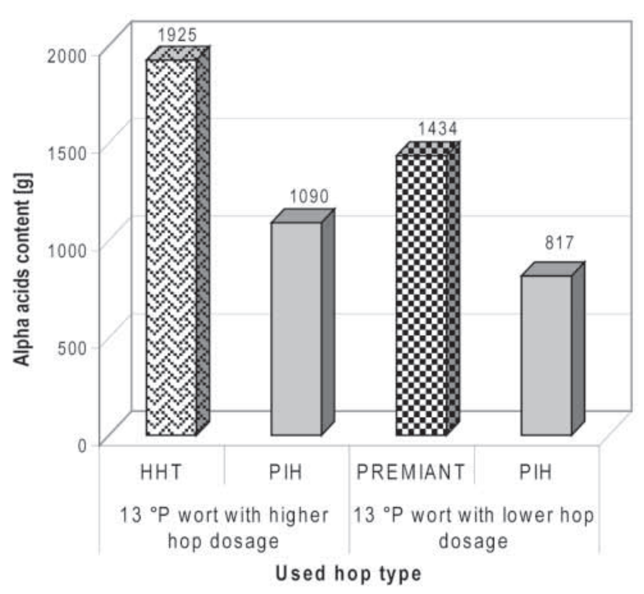

Fig. 1 Hop products dosage into the 13 °P wort with higher and lower hop dosage

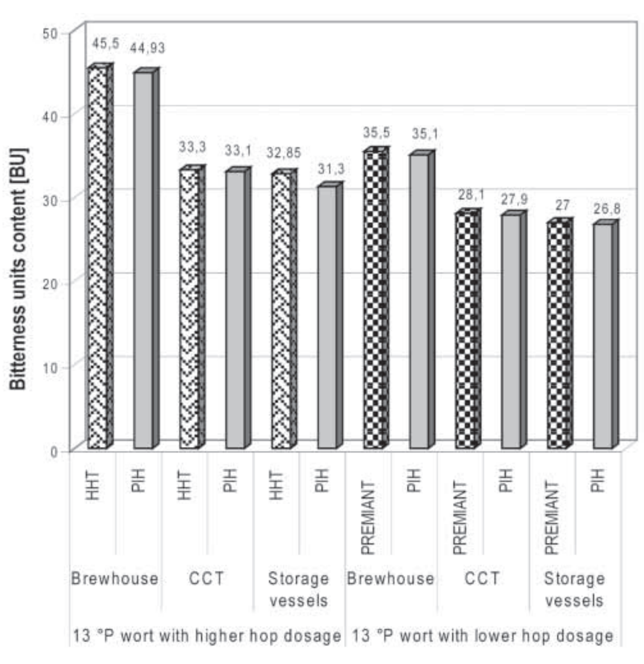

Fig. 2 Bitterness units content view on each department in influence of used kind of hop in 13 °P worts with higher and lower hop dosage

and lower bitterness units content. Pre-isomerised hop was added after 30 minute***s*** from the start of the wort boiling instead of HHT and Premiant hops (for details *see* Materials and methods). HHT and Premiant utilisation is 30 %, but PIH utilisation is about 50 %. On the basis of hop utilisation calculated for both kinds of wort and dosing adaptation according to hop package the amount of dosage of PIH hop was calculated for both kinds of wort. The amount of added a-acid per brew using PIH hops was, compared with the original amount, 56 – 57 % (Fig. 1).

Analytical results in the brewhouse, CCT and in storage vessels differentiated minimally and bitterness level was the same (Fig. 2). Bitterness units were measured by spectrophotometrical method (for details *see* Materials and methods). The method does not determine organoleptic bitterness because of isoextracts and for this reason it is necessary to carry out the isohumulones measurement where the factor on felt bitterness is 1,2. BU measurement gave us identical values of bitterness, in 12 °P beer with HHT hop used the value was 29,4 BU on average and in case of PIH it was 28,6 BU. We did not register any positive trend in beer foam in case of addition of pre-isomerised hop. Foam stability values were about 245 – 255 seconds without noting an influence by using different kinds of hops.

We carried out organoleptic assessment in these kinds of beer. We took the samples of 13 °P young beers from the storage vessels. We noticed higher astringent and bitterness in the beers with PIH hop. Bitterness was described as unpleasant and tart. In the case of lower hopped beers, higher bitterness and tartness was registered as well.

Organoleptic assessment by five degustators was carried out. 12 °P beer was assessed in a point of taste – basic tastes: sweet, body, bitterness, positive and negative tastes: hoppy, astringent, esters, diacetyl, DMS, sour and others. The total rating of the tasting panel was 5,5 for beers hopped with PIH and 6,5 for beers with HHT. The basic taste was equal in both cases (bitterness, sweet, body), but in the case of pre-isomerised hops a higher hoppy taste and present tartness was registered (Fig. 3). Successfulness of beer differentiation was 60 % in triangular test. In case of 11 °P lower hopped beer successfulness was only 20 % and rating for this beers was 6,0. Except negative taste attributes we did not register any other negative attributes, e.g. gushing problems.

4 Conclusion

Using of pre-isomerized hops makes manipulation easier because of lower dosing and increased utilisation. Price level of the hops compared with HHT hops is lower by one half on average and bitterness analytical results are reached on the same level. During measurement of bitter substances by BU method there were no differences in values. There was no influence neither on foam

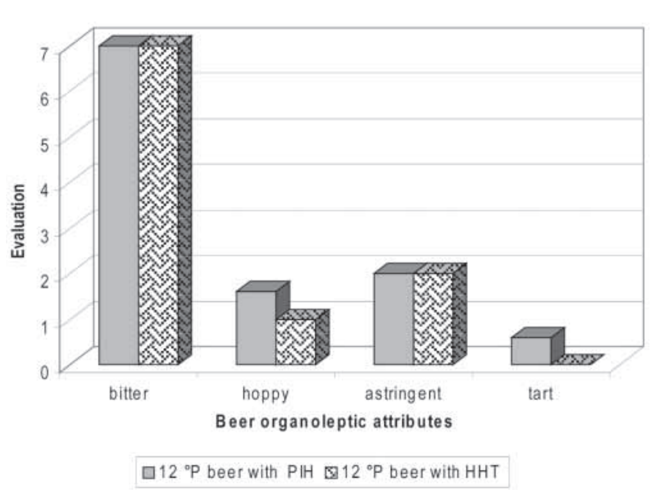

Fig. 3 Beer organoleptic attributes in dependence on used hop in higher hop dosage worts

stability nor gushing creation. Of the negative taste properties found during organoleptic tests – mainly in beers with higher hop content – tartness and higher hoppy and ester taste were determined as negative taste properties. The beers were assessed as not typical with unpleasant bitterness. In less hopped beers the distinguished ability of the samples was lower and beers were described as slightly bitterer.

5 Zusammenfassung/Résumé

Cvengroschová, M., Šepeľová, G., und Šmogrovičová, D.: Einfluss vorisomerisierten Hopfens auf Geschmacks- und Schaumhaltbarkeit — Monatsschrift für Brauwissenschaft 56, Nr. 11/12, 206 – 209, 2003.

BC 12 Hopfen/36 Bier

Die Zugabe von Hopfen während der Würzekochung beeinflusst die kolloidale, biologische, organoleptische sowie die Schaumstabilität ebenso wie Hopfen auf die Bittere, das Aroma, die Farbe und das Gushing Einfluss nimmt. Heutzutage finden Hopfenpellets, Extrakte und vorisomerisierte Hopfenprodukte Verwendung. Der Einsatz vorisomerisierten Hopfens erleichtert die Handhabung aufgrund der niedrigeren Dosierung und verbessert den Ausnutzungsgrad. Verglichen mit HHT-Hopfen ist der Preis durchschnittlich um die Hälfte billiger, und die analytischen Ergebnisse bezüglich der Bittere erreichen denselben Gehalt. Während der Messung bitterer Substanzen mit der BU-Methode gab es keine Unterschiede bei den Werten, jedoch zeigt die Messung der Isohumulone, dass die sensorische Bittere um den Faktor 1,2 höher liegt. Weder die Schaumstabilität noch die Gushingbildung wurden beeinflusst. Die negativen Geschmackseigenschaften wurden während organoleptischer Untersuchungen ermittelt. Hauptsächlich in Bieren mit einem höheren Hopfengehalt wurden negative Geschmackseigenschaften wie herbe und hopfigere sowie estrige Geschmacksnoten ermittelt.

Cvengroschová, M., Šepeľová, G., et Šmogrovičová, D.: Influence du houblon pré-isomérisé sur la stabilité de flaveur et la stabilité de mousse — Monatsschrift für Brauwissenschaft 56, No. 11/12, 206 – 209, 2003.

BC 12 Houblon/36 Bière

L'addition du houblon au cour de l'ébullition du moût influence la stabilité colloïdale, la stabilité biologique, la stabilité organoleptique ainsi que la stabilité de mousse. Le houblon influence également l'amertume, l'arôme, la couleur et le gushing. Aujourd'hui on utilise des pellets de houblon, des extraits et des produits de houblon pré-isomérisés. La mise en œvre du houblon pré-isomérisé facilite son utilisation à cause d'un dosage inférieur et d'un meilleur rendement. En comparaison avec du houblon Hopsteiner Hopfen Pellets (HHT), le prix du houblon est en moyenne moitié moins cher et les résultats analytiques concernant l'amertume obtiennent la même teneur. Pendant la mesure des substances amères avec la méthode BU, il n'y a pas de différences entre les résultats, toutefois pour la détermination des isohumulones, l'amertume évaluée dans la bière étaient de 1,2 fois supérieure. La stabilité de mousse et la formation de gushing n'étaient pas influencés. Les propriétés de flaveur négatives ont été déterminées par une évaluation organoléptique. On a déterminé essentiellement dans les bières avec une teneur en houblon plus élevée des propriétés de flaveur négatives telles que des notes d'âcreté, houblonnées, ainsi que des esters.

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