A NEW APPROACH TO SENSORY EVALUATION OF BEER BITTERNESS

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Introduction

Beer bitterness is one of the key attributes of sensory quality of beer. Sensory bitterness of beer covers various aspects of the bitter sensation - intensity, pleasantness (or complexity) and the rate of decay of bitterness after drinking. Comprehensive bitterness perception is very important, especially for Czech beer (1) and other pilsner style lagers. Majority of beer bitterness-imparting compounds are iso-alpha acids, intensity and bitterness character settings is probably provided by the product of harsh-tasting body substances (i.e., isohumulones) and some bitterness substitutes such as the modifying effect of polyphenols (2) and malt derived hordatines (3) has been described. Organoleptic bitterness perception is very individual and depends on a matrix of beer.

Basic characteristics of bitter perception are following:

**The bitterness intensity**: Describes the quantity of bitterness. It depends on “bitterness” of the substance or mixture of substances. Threshold intensity and subjective perception is very individual. The bitterness decay: After the culmination a bitter sensation followed decay into the disappearance of a sense of bitterness. The decay is evaluated either as bitterness intensity after a certain time or by the time profile of decay from drinking to the sensation decrease to a minimum. The bitterness character: Describes the quality (pleasantness) and the character (soft, harsh, lingering) of bitter perception.

Evaluation of beer bitterness is a part of descriptive tests in the methods collections of MEBAK (4), EBC (5) and ASC (6). In these methodologies specific procedure for the evaluation of bitterness is not explicitly described. The basic descriptor is bitter taste; bitterness decay can be classified as “bitter aftertaste”.

Aims of this study

The aim of our study was to develop and validate a methodology for the comprehensive evaluation of beer bitterness, “all in one” test covering all the attributes of beer bitterness with respect to factors distorting an objective assessment.

Material and methods

The intensity of bitter taste after swallowing a sip increases, culminates and subsequent declines. Bitter sensation is cumulative, with repeated drink the perception enhances. Therefore we tested the possibilities of “one sip” procedure to determine the temporal profile of sensory bitterness. Procedure by Cechka et al. (7) has been used and supplemented by the character of bitterness assessing. Elaborated procedure is as follows: A bitter sensation is assessed and recorded after taking a sip in a mouth, after swallowing a sip and at 10 seconds intervals during 120 seconds. Evaluation is led by the panelists which announces the time of swallowing a sip, and other times the recording of perceptions in the report. The bitterness intensity is assessed in a range of 0-5 (imperceptible - very weak - weak - medium - strong - very strong) with the permission of half point. Bitterness character is rated on a scale from 1 to 5 (very soft - soft - harmonious - medium - coarse - rough - rough, adhering). Sensory evaluations were carried out by 8 to 10-member trained panel of certified assessors of the Research Institute of Brewing and Malting. Evaluation was anonymous. Technical and other conditions by the Analytica EBC were respected. Some samples were evaluated by a numerous panel (67 or 24) of experts at a specialized seminar held by the Hop Research Institute in Žatec.

Pilot scale experimental lagers and commercial pale beers were used. Brews were hopped by Saaz pellets, “non-bitter” pellets (residue of pellets 60), a pure preparation of alpha acids (86% purity), and the oxidized preparation of pure beta acid (98% purity). Bitterness time profile of various bitter substances was evaluated. Individuality of bitter sensation and the number of samples in one session was tested. Full and brief procedure of the assessment has been developed.

Results and discussion

Experiments: The time course of the bitterness intensity is shown in Figure 1. The bitter sensation is observed by the evaluator after taking a sip in his mouth, in contact of the beer with the taste buds. After swallowing a sip intensity of perception increases rapidly and usually culminates in the 10th second. Bitter sensation disappears after about 120 seconds (depends on the input intensity and sensitivity of the evaluator). Even non-hopped beer and the beer hopped by non-bitter hop pellets showed a slight bitterness, probably caused by polyphenols and other substances of malt extract. All beers, hopped by pure alpha acids, beta-acids and oxidized beta-acids deposited on non-bitter hop pellets exhibit measurable sensory bitterness (Figure 2). The results of alpha beers show a considerable contribution of the oxidized beta acids, to the intensity of bitter perception. The beer bitterness is involved by substances other than the transformation products of hop resins.

Method: It was found that the evaluation of the time profile of the character (soft – harsh, lingering) of beer bitterness is sufficient, at most of beers, the values after swallowing a sip and after one third of bitter sensation decay (after 40 seconds). Determination of bitterness character of common beers in the second half of bitter perception decay is questionable due to low bitterness intensity. Full report of the simultaneous determination of time course of bitterness intensity and character is suitable in special cases (new kinds, brands of beer or sensory defects detection). Intermediate procedure shown in Table 1 for most applications in panels of trained assessors should be sufficient. Evaluation in panels of experienced professionals and consumer panels can be carried out by a brief procedure (Table 2).

Expression of results: Processing, evaluation and expression of the results depends on the purpose of the evaluation. The values recorded by each assessor for a given time is calculated as the mean (arithmetic mean, median). For a simple fingerprint comparison the results can be visualized in graphical form using a conventional x-y graph (or smoothed by 5th degree polynomial) (Fig. 1) or a spider graph (Fig. 2). The dynamics of bitterness decay can be characterized by a slope of the line between points 0-120 sec. (Fig. 3). In order to reliably determine the differences between two (or more) samples repeated determination and processing of results using ANOVA is necessary. In one session 6-8 samples with an interval of 7.5 min. between samples can be evaluated.

Examples of use: The bitterness of oxidized alpha acids in comparison with the iso-alpha acids in experimental beers (Table 3). The comparison of beer bitterness profile of a new hop cultivar Kazbek with Saaz (Fig. 4). Changes in the beer bitterness profile during storage – beers A, B (Fig. 5).

Conclusions

The elaborated method for the comprehensive determination of the beer bitterness in the proposed modifications may find wide application range in research and in practice. The application could be useful when documenting bitterness profiles of beer brand, to determine changes caused by technology and raw materials composition modifying, for testing the changes in the beer bitterness in the course of storage etc. A necessary condition for an objective, reproducible evaluation and validity of the results is stable panel of evaluators continuously trained on the standards (model beers).

Acknowledgements

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References


Table 1: Sensory evaluation protocol: Time profile of bitterness (%: intensity, reduced-character)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Time (sec)</th>
<th>Bitterness</th>
<th>Character</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saaz</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Non-bitter pellets (60)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Beer &amp; bitter pellets</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
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Table 2: Sensory evaluation protocol: Time profile of bitterness (brief)

Table 3: Results of “alpha” and “beta” beers evaluation

Figure 1: Time profile of beer bitterness intensity

Figure 2: Time profile of bitter bitterness intensity (pure bitter acids on a non-bitter hop pellets)

Figure 3: Rate of the bitterness decay evaluated by the regression line

Figure 4: Comparison of beer bitterness time profiles of two hop cultivars

Figure 5: Comparison of beer bitterness time profiles changes in two stored beers

Table 4: Comparison of beer bitterness profile of a new hop cultivar Kazbek with Saaz (Fig. 4). Changes in the beer bitterness profile during storage – beers A, B (Fig. 5).