Possible impact of hops on taste and drinkability of beer

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SUMMARY

Drinkability can be used as a benchmark to characterise a beer. However, there appears to be no clear answer to the impact of sensory factors on beer drinkability. Hops can make positive or negative contributions to the taste and aroma of beer. The sensory evaluation of quality and harmony of the hop smell and the hop taste of a beer can determine whether the drinker will be inclined to drink more. The beer matrix plays a key role in the effect of single hop components on the sensory character of a beer. There are some indications that less known aroma and bitter substances and also polyphenols can influence beer flavor, but further investigation needs to be carried out. In order to understand the influence of hops on the taste and drinkability of a beer, it is necessary to assess the taste thresholds and the taste value of important taste components in hops in different beer types.

INTRODUCTION

The impact of single substances derived from raw materials on drinkability is still unknown. Hops can make positive or negative contributions to the taste and aroma of beer. An objective sensory evaluation method was developed to assess quality of smell and quality of taste of beer. With the help of this instrument quality & harmony of hop smell and hop taste of various beers have been ascertained.

SENSORY EVALUATION SCHEME

A software-based sensory evaluation scheme was developed. Sensory attributes are focused on flavour impressions related to hops. Tasters have to score their personal flavour impressions of smell, taste and bitterness for a named beer type. Categories smell and taste have the same composition. Intensity and quality of hop character have to be appointed. Furthermore they have the option to score hop flavours like fruity, floral, citrus, fresh-grassy, hop-spicy or others (not typical for hops). Seven diagrams of the course of bitterness are given for an assessment. Bitterness of the beer has to be estimated. The perception of bitterness is separated in intensity and harmony. Absorption is divided in three phases: before, at and after swallowing. A summary of all impressions is given in spider plots. This tool enables the comparison of different brewing trials.

POLYPHENOLS

Narziss stated the role of polyphenols as still unclear (1). Xanthohumol and iso-xanthohumol were investigated by Fritsch for their impact on beer taste. Especially iso-xanthohumol occurs

in concentrations up to 3 ppm in commercial beers and has a taste contribution which is characterized to have a remarkably well-balanced bitterness which does not have a lingering aftertaste. Determination of taste thresholds of xanthohumol and iso-xanthohumol in unhopped beer revealed a value of 0,9 mg/L for xanthohumol and 0,5 mg/L for iso-xanthohumol (2). Taste activity values (TAV) were calculated for Lager/Pilsner and Stout/Porter beers. By definition, a taste contribution can be expected for compounds possessing TAVs >1 (3). In Lager/Pilsner beer xanthohumol has TAV <1 and therefore has no sensory relevance. However, in Stout and Porter beers, xanthohumol may exceed its threshold. As iso-xanthohumol offers TAVs of < 4,2 and < 6,6 a taste impact can be expected for Lager/Pilsner and Stout/Porter beer (2). Weiss (4) worked on the role of polyphenols on beer taste. Thresholds of catechin and epicatechin in Lager beer were determined. He described catechin at 170 ppm in beer as astringent and at 300 ppm bitter whereas epicatechin at 250 ppm was characterized to be astringent and bitter. By a quantification of both substances in beer he found 60,5 mg/L catechin and 11,1 mg/L epicatechin. A calculation of TAVs of catechin and epicatechin results in values lower than 1 and would feed to the assumption that there is no sensory impact on beer flavour. Recombination trials were carried out and demonstrated the importance of these substances for beer taste

HOP OILS

There is a huge variation in thresholds of single aroma substances. In the literature thresholds of aroma components are often determined in water or in alcohol solutions. The total matrix is important for an impact of various aroma substances on the sensory character of beer. Aroma substances, especially terpene hydrocarbons (myrcene, caryophyllene, humulene, etc.) could negatively influence the sensory character of beer. Aroma substances can also have a sensory impact on the bitterness of beer. The alcohol content has an influence on flavour characteristics of beer, too. The sensory character of a low matrix beer can be improved by adding terpene alcohols (e.g. linalool). In fig. 1 the addition of a non-terpene hop oil fraction (enriched in linalool and other terpene alcohols) demonstrates increased harmony of the beer bitterness.

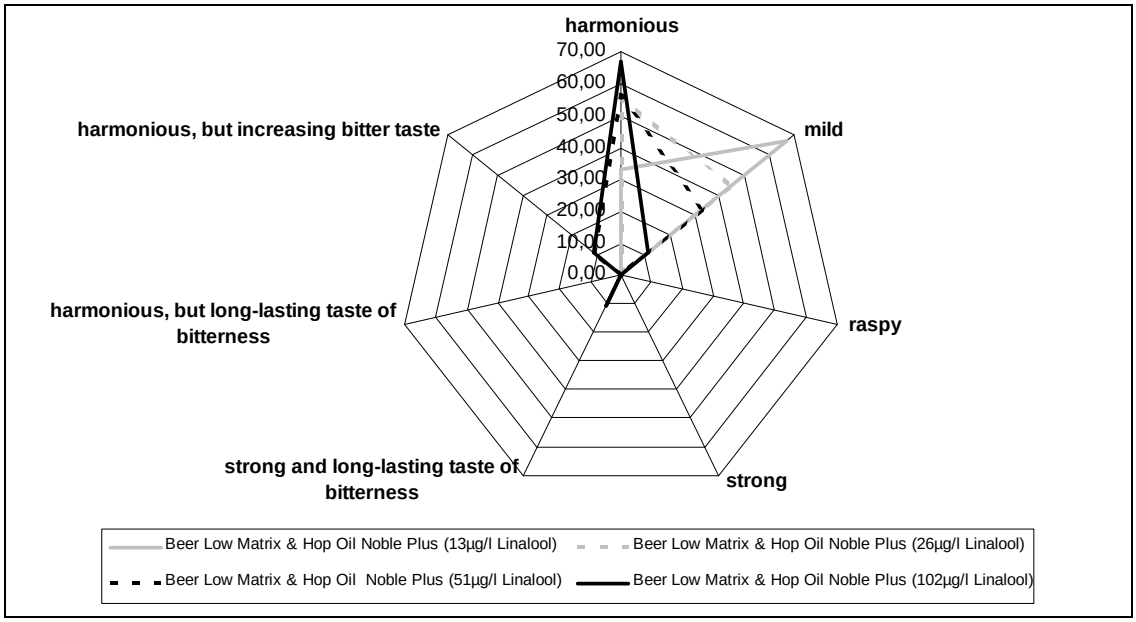

Figure 1: Bitter profile of a low matrix beer with addition of a purified hop oil

Bitter characteristics of a full matrix beer can be improved, too, but there is a maximum limit. Fig. 2 shows the bitter profile of a full matrix beer with increasing amounts of a non-terpene hop oil fraction.

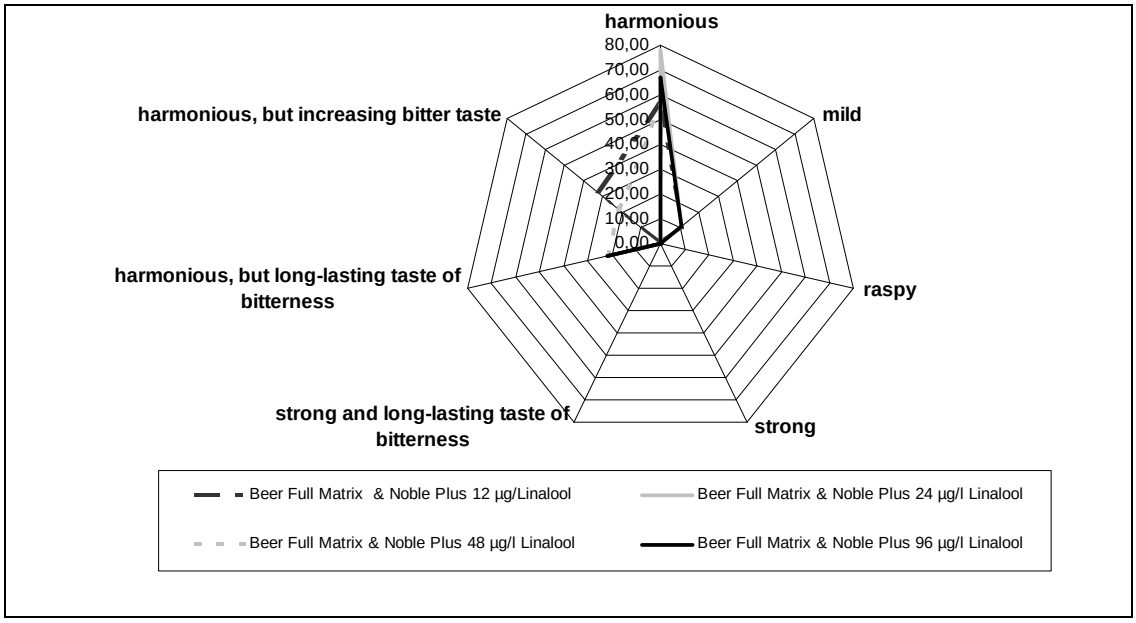

Figure 2: Bitter profile of a full matrix beer with addition of a purified hop oil

Fig. 3 demonstrates the influence of aroma substances on beer bitterness. A full matrix beer was spiked with a hop oil containing terpene hydrocarbons and terpene alcohols. Even though the terpene hydrocarbons were added below their thresholds they had a sensory impact on beer bitterness. Linalool is a character impact compound for hop flavour in beer (5,6) with a threshold in unhopped beer of 5 µg/L (5). In all of the hop oil additions to beer it had a sensory impact on beer flavour.

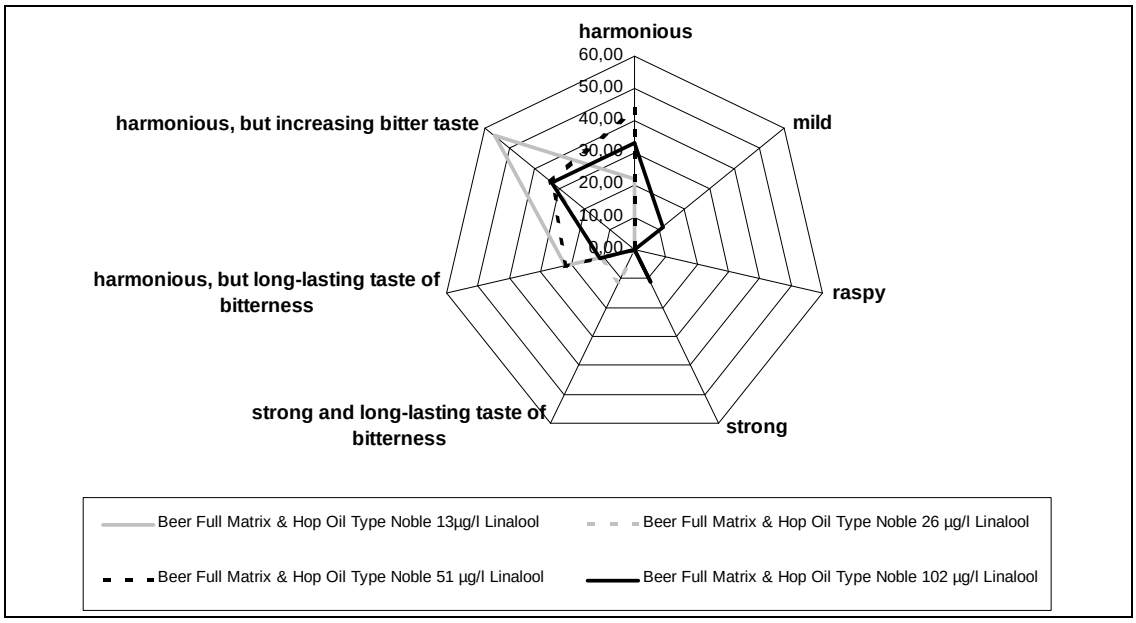

Figure 3: Bitter profile of a full matrix beer with addition of a hop oil

BITTER SUBSTANCES

The composition of hop bitter substances consists of more than only alpha- and beta-acids. There is a variety-dependent amount of unspecific hard and soft resins. Unspecific soft resins means those soft resins remaining once the specific alpha and beta acids have been deducted. Particularly in aroma varieties this fraction is always higher. Table 1 demonstrates a higher ratio of these unspecific substances in aroma compared to bitter or high-alpha varieties (7).

Variety	**Unspecific soft resins in % of alpha-acids**
Hallertau Magnum	37
Northern Brewer	43
Perle	52
Hallertau Mittelfrueh	76
Tradition	52
Spalt Select	73
Tettnanger	100
Hersbrucker	104

Table 1: Unspecific soft resins in various German hop varieties

Two of the most common analysis methods quantifying the amount of bitter components or alpha acids are the EBC methods EBC 7.5 (LCV) and EBC 7.7. The former method determines not only alpha acids but also unspecific bitter compounds (8,9). On the other hand the HPLC method EBC 7.7 is very specific for the determination of alpha acids. In figure 4 the ratio of LCV to α-HPLC of different aroma varieties is demonstrated . There is a range of 10 to 30 % of higher unspecific bitter substances. In particular Saphir (HSR) is characterized by its content of more than 30 % of bitter compounds other than alpha acids.

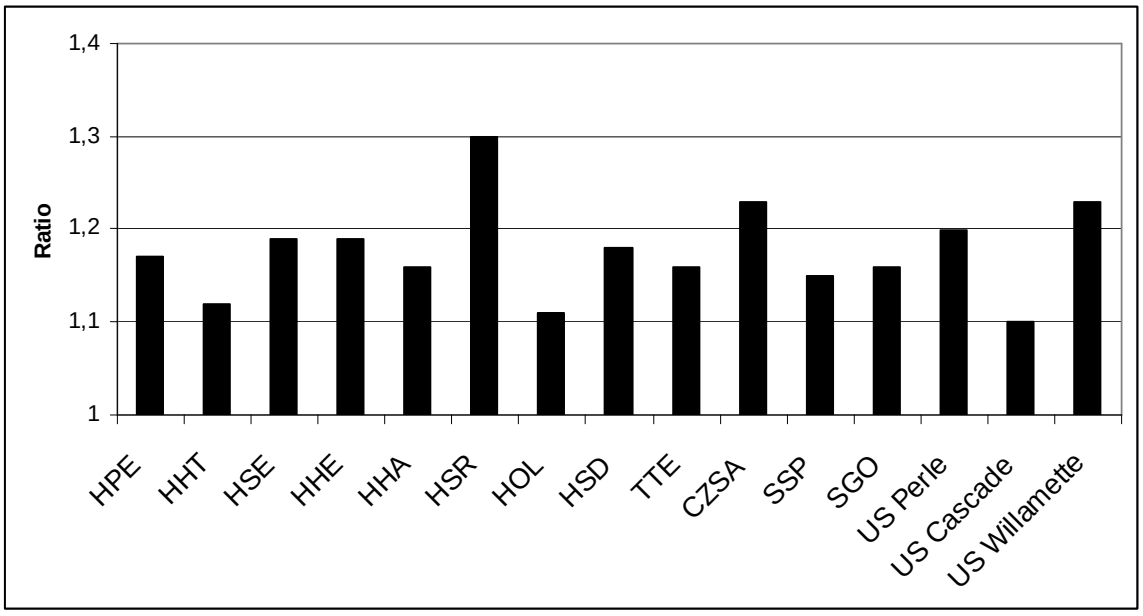

Figure 4: Ratio of LCV (EBC 7.5)/α-HPLC of different aroma varieties

The content of unspecific bitter compounds in bitter varieties tends not to vary much. As demonstrated in fig. 5 the ratio of LCV to α-HPLC is in a range of 7 to 15 % unspecific bitter substances.

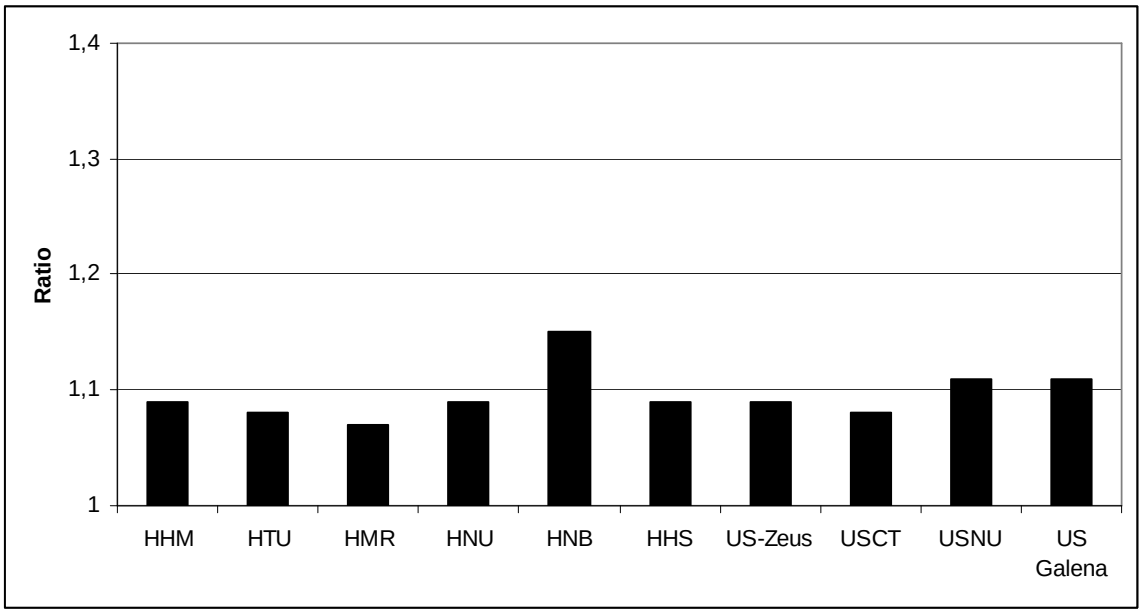

Figure 5: Ratio of LCV (EBC 7.5)/α-HPLC of different bitter varieties

Brewing trials should help to understand the sensory impact of single varieties on beer character. Under standardized conditions brewing trials were carried out. In figure 6 & 7 the difference of sensory and analytical bitterness is shown. This is higher in beers brewed with aroma varieties (fig. 6). At the same time the quality of bitterness is higher in aroma variety beers (fig. 6 & 7). Within these brewing trials Saphir demonstrated the highest difference.

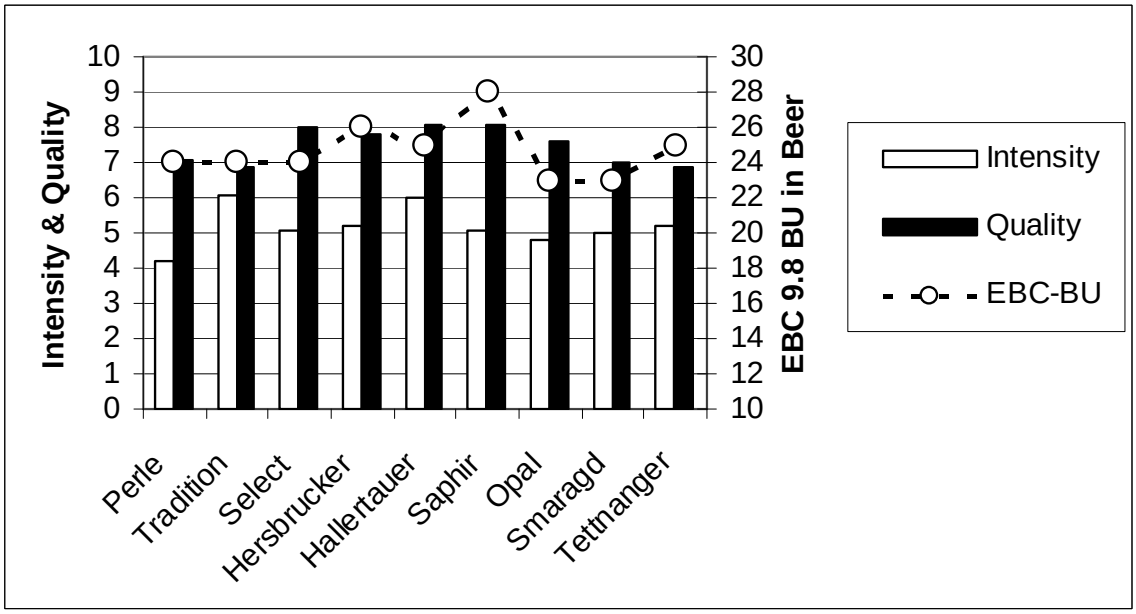

Figure 6: Sensory and analytical bitterness in beer brewed with different aroma varieties

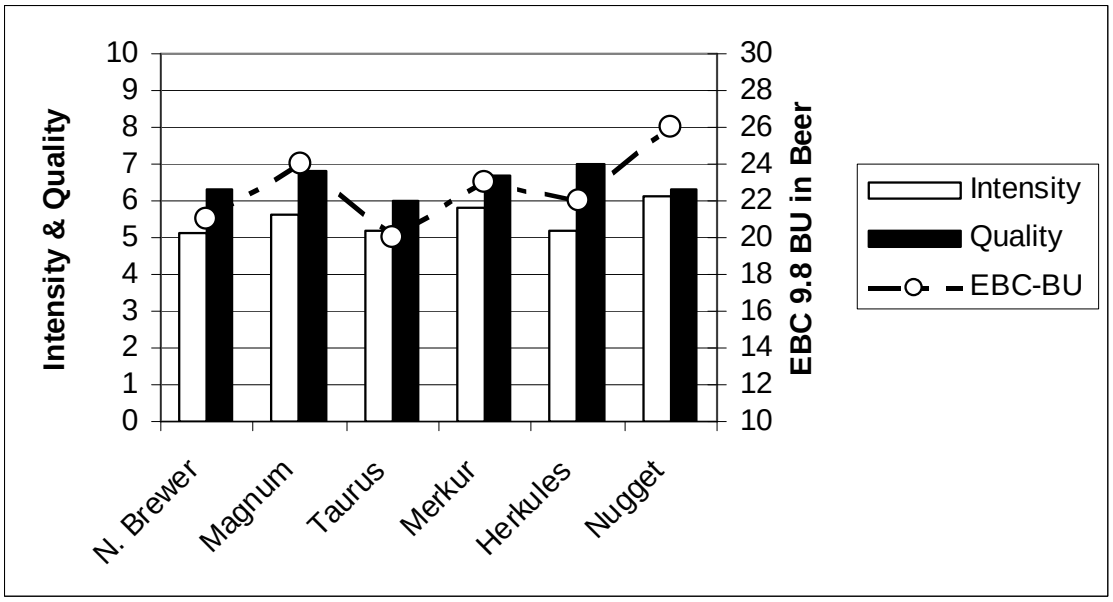

Figure 7: Sensory and analytical bitterness in beer brewed with different bitter varieties

Further brewing trials using a hard resin fraction of hops, ethanol extract and pellets were carried out (10). All 3 beers had same EBC-BU levels. Three different taster panels assessed these beers, but unfortunately no significant result could be found. Each panel preferred a different beer. The beer brewed with the hard resin fraction was characterized as having an harmonious and smooth bitterness. Aged beers were tasted again. Now the ethanol extract and hard resin beer was preferred by one panel. According to these results it could be assumed that hard resins make a positive sensory impact on beer taste.

SUMMARY - OUTLOOK

- Hop components have a sensory impact on beer flavour.
- The quality and harmony of hop aroma and taste substances are important for drinkability of beer.
- Beer matrix plays a key role in the implication of single hop components on sensory character of beer.
- Further sensory studies need to be carried out on aroma and taste substances.
- Basic research on the identification of taste substances derived from the unspecific soft and hard resin fraction of hops is necessary.
- Thresholds and taste values for important taste components in various beer types have to be assessed.

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