Influence of Pasteurization on Dry Hopped Beers

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Introduction

Dry hopping primarily imparts an intense hop aroma to beer, mainly due to highly volatile components which are usually lost during wort boiling. It is known, that such an aroma changes from the first hours after hop dosage to green beer until it is served to the customers. In order to investigate the influence of pasteurization on the hop aroma, several dry hopped beers were produced and analysed according to main bitter and aroma substances using HPLC, BU and GC-MS methods.

Material and Methods

From various breweries and internal projects 15 dry hopped beer samples were investigated. 8 of 15 beers were filtered, the others were left unfiltered. Each beer was packaged in glass bottles of 0,33 l. Dry hopping ranged from 250 to 555 g/hl. From these beers, pasteurization was carried out in a chamber-pasteurizer, which was directly heated with steam. To control the pasteurization effect, the temperature in the beer was measured with a temperature logger over the entire process. The Pasteurization Units could be calculated from the data obtained using the common formula (40-60 units in our study). The beers were analyzed after bottling and after the pasteurization process.

Performed analysis:

Bitter substances: **Iso-Alpha Acids, Alpha acids**, **Humulinones** with **EBC 9.47** method [**1**].
Bitter units: **IBU** according to **EBC 9.8** method [**2**].
Aroma components: **Aroma substances** as listed in **Table 1**. Analysis according to **EBC 9.49** method [**3**].

Results

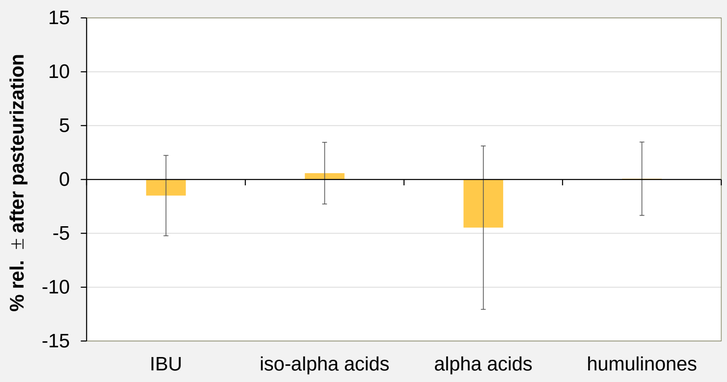

Fig. 1 Influence of pasteurization on bitter substances

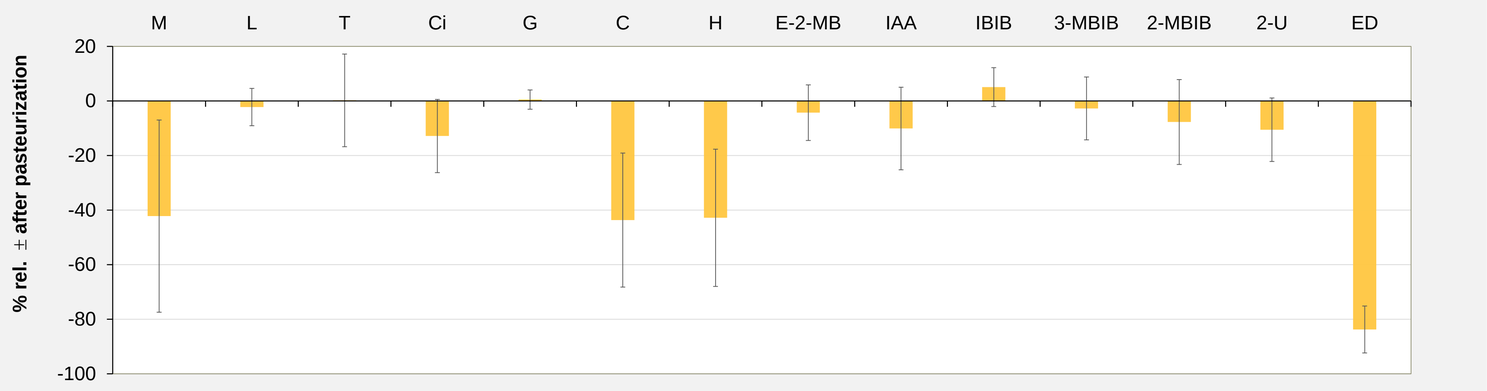

Fig. 2 Influence of pasteurization on aroma substances

Figure 1 gives an overview on the bitter substances in all 15 dry hopped beers, shown as relative increase or decrease, based on the initial value before pasteurization. Their bittering units (IBU) ranged from 26.7 to 63.5 and corresponding iso-alpha acids from 20.2 to 39.1 mg/l. Comparing each analysed component, the alpha acids were on a level ranging from 3.7 to 19.8 mg/l, similar to the range of humulinones of 3.0 to 18.1 mg/l. However, pasteurization showed the biggest impact on the alpha acids. The loss of alpha acids could partly be explained by the increase of the iso-alpha acids, as isomerization of alpha to iso-alpha acids is known as a thermal reaction. Of course, conditions for this reaction are rather poor in beer. Besides a certain isomerization, formation of degradation products has to be taken into account as well. Concerning all beers, pasteurization resulted in the following variations in %-rel. of initial values: bittering units -1.7; iso-alpha acids +0.6; alpha acids -4.8; humulinones +0.2. In summary, for the analyzed bitter substances no significant change due to pasteurization was observed.

Figure 2 shows the average deviations (% rel.) of aroma substances after pasteurization from their initial concentration in µg/l.

For most of the analyzed compounds, the impact of pasteurization is rather low, as variations are less than 20% of the initial value before pasteurization.

Concerning all beer samples, Ethyldodecanoate ranged from 15 to 105 µg/l before and 5 to 25 µg/l after pasteurization. From this component, less than 16% have been found after thermal treatment, independent from the initial concentration. None of the other aroma substances showed a similar decrease.

Myrcene, Caryophyllene and Humulene behaved the same way, resulting in approx. 40% of the initial concentration lost after pasteurization. Comparing these 3 components, the standard deviation of Myrcene was clearly higher.

If an increase was observed, it was mainly found for Terpineol. However, still half of the samples had lower concentrations after pasteurization.

No change occurred for Linalool and Geraniol.

M	L	T	Ci	G	C	H	E-2-MB	IAA	IBIB	3-MBIB	2-MBIB	2-U	ED
Myrcene	Linalool	Terpineol	Citronellol	Geraniol	beta-Caryophyllene	Humulene	Ethyl-2-methylbutanoate	Isoamyl-acetate	Isobutyl-isobutyrate	3-Methylbutyl-isobutyrate	2-Methylbutyl-isobutyrate	2-Undecanon	Ethyl-dodecanoate

Tab. 1 Abbreviations of aroma substances

Summary

It could be demonstrated, that pasteurization of dry hopped beer significantly lowers the concentration of certain aroma substances, such as Myrcene, Beta-Caryophyllene or Humulene. On the other hand, aroma compounds like Linalool or Geraniol showed no change at all, Terpineol and Citronellol tended to a slight change. For all analysed bitter acids, no significant impact of pasteurization (40 to 60 units) was observed.

As further changes in aroma will occur during storage of beer in the package, this “reduction” of hydrocarbons in the bottle might help to improve the flavour stability of the packaged beer. However, this loss of aroma must be considered when using pasteurization for dry hopped beers.

References

(1) Analytica **EBC 9.47**
Iso-α-acids and reduced iso-α-acids (Rho, Tetra, Hexa) in beer by HPLC; modified. The most recent international standards or pure substances were used for the calibration.
(2) Analytica **EBC 9.8**
Bitterness of Beer
(3) Analytica **EBC 9.49**
Hop aroma components in beer by Headspace-Trap Gas Chromatography (HT-GC).