Special hop varieties for unique beers – Part 2

DRY HOPPED BEERS | In the first part of this publication (see BRAUWELT International 6, 2012, pp. 354-358), tasting results for single-variety beers were described. These beers were hopped in the brewhouse, using both, traditional and new and promising varieties. In this second part, the results of tastings of dry hopped beers carried out globally are presented. These are based on more than 1500 individual evaluations of seven lager beers.

CHARACTERISTICS OF HOP VARIETIES used and details of the production of the standard beer used for dry hopping are described in the first part.

Hopping

All beers were brewed in accordance with the same hopping recipe (see Part 1). In addition, 50 g pellets type 90/hl of beer were added to each of the dry hopped beers in the storage tank (table 1). After a contact period of two weeks, beers were filtered prior to filling so that all plant components of the pellets were removed.

Beer analyses

Table 2 shows the analytical results of the beers in terms of bitterness, hop aroma and polyphenols.

A comparison of polyphenols and iso-alpha acids between the beers from Part 1 and the dry hopped beers described here shows only slight deviations within normal analytical variance. These components were thus not affected by dry hopping. On the other hand all dry hopped beers show an increase of linalool which is inline with a more intensive hop aroma. Therefore the sensory impression of these beers can be clearly distingushed from those which were exlusively hopped in the brewhouse (see Part 1).

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As during boiling, volatile hop oil components in particular are mostly evaporated, these components mainly contribute to the hop aroma of dry hopped beers. Though linalool is less volatile, it behaves in a similar way and can thus be regarded as being representative for a change of aroma in dry hopped beers. A higher concentration of alpha acids is typical in dry hopped beers.

Table 3 shows a comparison of alpha acids analysed in late and dry hopped beers. When pellets are in contact with unfiltered beer, bitter substances are dissolved from the hops. Compared to the late hopped beers from Part 1 (hop addition at the beginning of boiling as well as 5 min before the end of boiling), alpha acid concentration increases in the range 0.6 to 6.6 mg/l.

Tasting results

All beers were evaluated in terms of hop aroma, bitterness and overall flavour impression, using a standardised tasting sheet (see Part 1, fig. 1).

Hop aroma – intensity and quality

Evaluation of hop aroma in terms of intensity and quality is shown in figures 1 and 2 as relative frequency for point scores awarded in each instance.

HOP DOSAGE

	Start of boiling	5 min before end of boiling	after main fermentation
Hopping (pellets type 90, crop 2010)	60%*	40%*	50 g per hl

*based on total alpha quantity

Table 1

ANALYSES OF DRY HOPPED BEERS

		BU EBC 9.8	Iso-alpha-acids (mg/l)*	Linalool (µg/l)**	Polyphenols (mg/l)***
DE Hallertauer Magnum	DEHM	25.5	23.5	22.2	142
DE Hallertauer Herkules	DEHS	26.2	21.8	20.2	151
US Apollo (Hopsteiner)	USAP	29.1	20.6	30.6	140
US Bravo (Hopsteiner)	USBR	22.6	19.7	41.3	132
US Calypso (Hopsteiner)	USCP	30.7	21.4	33.4	140
US Delta (Hopsteiner)	USDE	25.8	19.4	52.0	150
NZ Nelson Sauvin	NZNS	29.4	20.8	34.0	148

*Method HHV 29 (in-house method, HPLC) **Method HHV 05 (in-house method, GC)

***Method Analytica-EBC 9.11

Table 2

Practically all tasters perceived a hop aroma when tasting the dry hopped beers and this hop aroma in each beer was assessed by at least one third of all participants as "intensive" to "very intensive", i.e. four or five points. By comparison, beers brewed with USAP and NZNS were classified as "very intensive" much more frequently. 69 and 78 per cent of tasters respectively scored these beers either four or five points although linalool concentrations of only about 34 µg/l were measured in these beers with the higher hop aroma scores. In contrast, intensity of the beer with the highest linalool content (USDE) was assessed as being on the "weak" side (fig. 1). It is evident again that, in addition to the known aroma substances like linalool other substances which strongly influence dry hopping flavour need to be investigated. When brewing dry hopped beers, it is thus advisable initially to use the overall oil content for producing reproducible aroma intensity within one hop variety.

Table 4 is an analysis of the oil contents of the feedstock pellets.

A comparison of the total oil contents leads to a better correlation to the evaluation of the aroma intensity in each beer shown in figure 1. But the beer with the strongest aroma intensity (NZNS) was not produced with pellets richest in oil. On the other hand the lower oil content of the USDE pellets does correlate with the 'weak' perceived hop aroma.

Figure 2 shows the assessment of hop aroma quality. Dry hopping with DEHS and USDE was liked least in the beers produced in this test series. With regard to three and more points, USAP and NZNS were assessed to be very similar, whereas NZNS was given only one point much more frequently. The USCP, DEHM and USBR beers scored three or more points from greater than 70 per cent of tasters. The hop aroma contributed by the USBR variety was perceived as having the best qualitywith almost 50 per cent of all tasters awarding it at least four or five points.

Figure 3 is a description of hop aroma.

Beers produced from the USBR and USAP varieties were mostly described as "fruity", flowery" and "citrusy". In contrast, DEHS was referred to be more "spicy" or "herbal". In the case of beer brewed with the NZNS variety, some characteristics were perceived as most intensive particularly with the descriptions "fruity", "citrusy", "herbal" and "other". The description

ALPHA-ACIDS OF LATE AND DRY HOPPED BEERS

	DEHM	DEHS	USAP	USBR	USCP	USDE	NZNS
Alpha-acids* (late hopped)	4.3	4.0	4.3	4.0	4.0	3.1	4.3
Alpha-acids* (dry hopped)	6.9	9.9	10.9	4.6	7.2	4.7	9.7

*Method HHV 29 (in-house method, HPLC)

Table 3

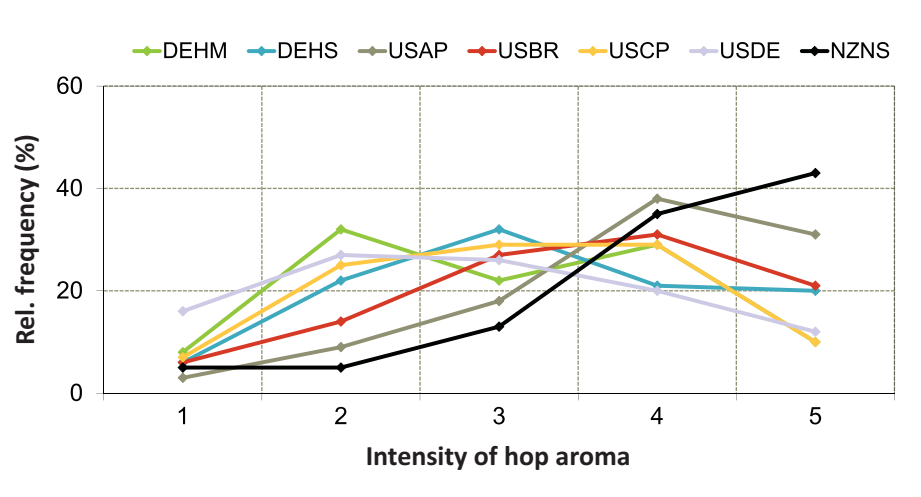

Fig. 1 Intensity of hop aroma

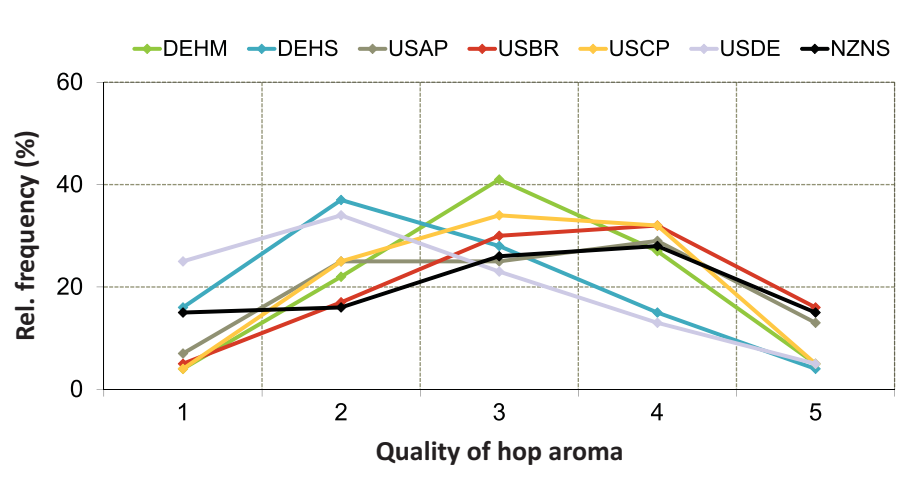

Fig. 2 Quality of hop aroma

OIL CONTENT OF PELLETS USED

	DEHM	DEHS	USAP	USBR	USCP	USDE	NZNS
Total oil in ml/100 g*	1.7	1.4	2.1	2.2	1.5	0.6	1.3

*Method Analytica-EBC 7.10

Table 4

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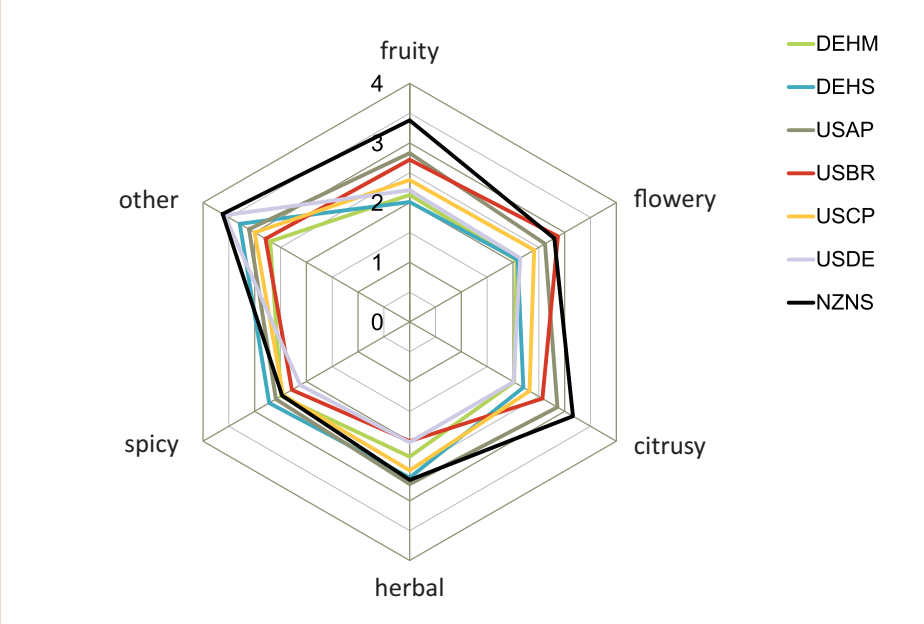

Fig. 3 Descriptions of hop aroma

	DEHM	DEHS	USAP	USBR	USCP	USDE	NZNS
	15	14	**24**	**23**	17	**23**	22
	27	21	23	18	**28**	14	**24**
	10	16	9	15	9	11	9
	17	11	16	14	25	15	18
	15	**22**	18	17	15	18	19
	15	16	10	13	6	20	9

Rel. frequency (%)

Fig. 4 Bitterness profiles

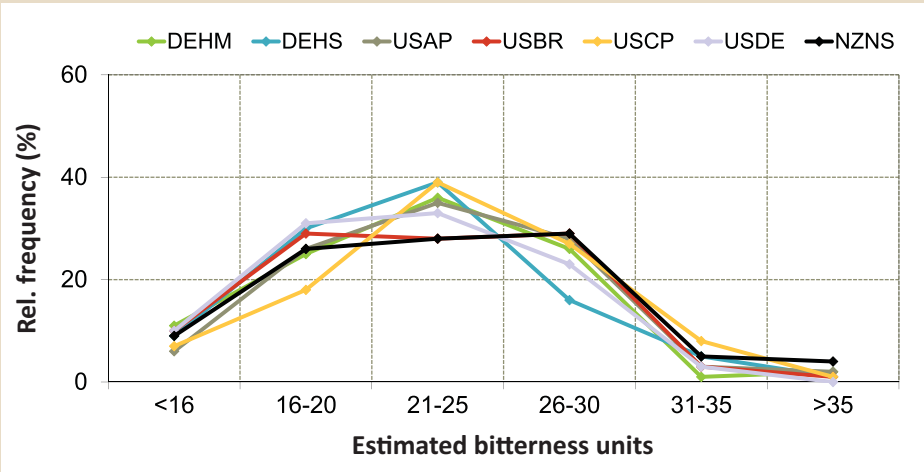

Fig. 5 Estimated bitterness units

"other", which was mostly associated as "untypical for hops", polarised the opinions of tasters and were regarded both as positive and negative. The terms "ripe grapefruit", "lychee" or even "mango" were oftentimes used, i.e. a tropical-fruity aroma character. These were in contrast to descriptions such as "sulphurous", "tar-like" or "resin-like" – properties that resulted in the beer being rejected (fig. 7). For the other varieties, no uniform opinion was shared by all tasters when describing hop aroma.

Evaluation of bitterness

Figure 4 depicts bitterness profiles evaluated by tasters. About 25 per cent of the tasters agreed that beers brewed with the USAP, USBR and USDE varieties had a perceived "harmonious" bitterness profile whereas those produced with DEHM, USCP and NZNS a "harmonious and slightly more lingering" profile. Only DEHS was assessed as slightly weaker. This is confirmed by the results in figure 5 showing the bitterness intensity perceived in sensory terms.

The bitterness units of all dry hopped beers (23.2 BU on average) were assessed to be only 0.5 BU higher compared to the average of all late hopped beers presented in Part 1. Even though considerably higher concentrations of alpha-acids were measured in dry hopped beers, they hardly contributed to an increase in bitterness intensity.

This slight increase in perceived bitterness intensity can certainly be attributed to the relatively small quantity of hop pellets added in the cold storage tanks. In some examples of commercial dry hopping, ten times more hops than the quantity used in our trials (50 g/hl) can be added although higher hop additions would have had a negative impact on the character of this "light-bodied" beer. Nonetheless, definite changes in hop aroma can be demonstrated even with the addition of only 50 g pellets per hl of beer as shown in these studies.

In terms of quality of bitterness (fig. 6), the NZNS and USBR brands are worth noting. 40 and 45 per cent respectively of tasters awarded them four or five points. At least 55 per cent of tasters, and usually many more, gave at least three points for the quality of bitterness of all seven beers, and more than 80 per cent in the case of USBR.

Overall beer impression

Figure 7 clearly indicates that evaluations of dry hopped beers differ substantially.

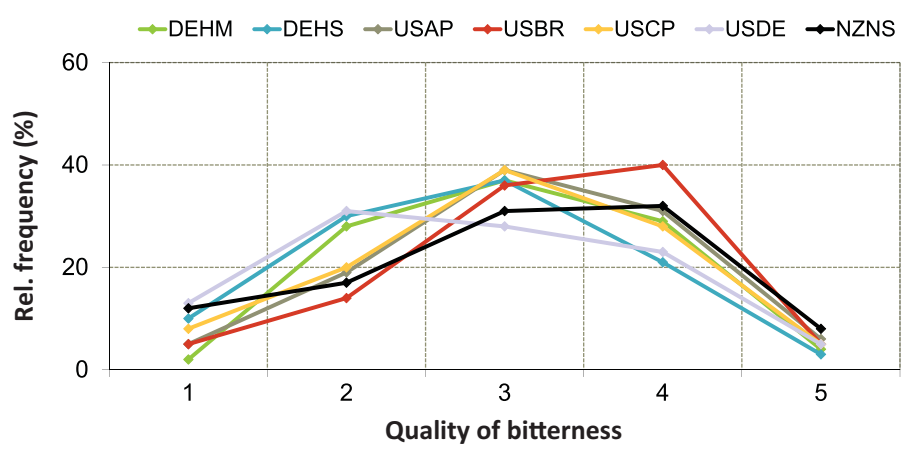

Fig. 6 Quality of bitterness

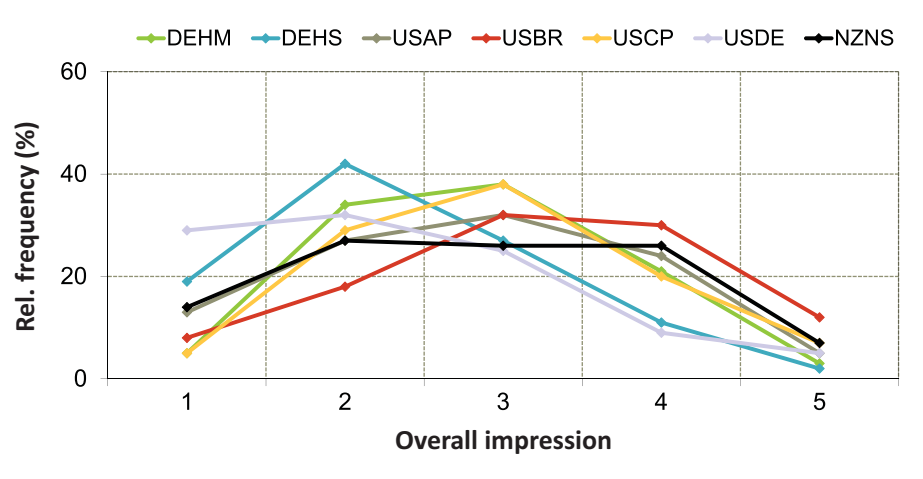

Fig. 7 Overall beer impression

Opinions on how to characterise these sometimes unfamiliar flavour impressions also differ very considerably. This can be seen best by the flat curve of the beer brewed with NZNS. Nevertheless, some tendencies can be identified. Tasters were less enthusiastic about dry hopping with the USDE and DEHS varieties. About 40 per cent of tasters awarded three and more points for beers dry hopped with these varieties, almost 20 per cent less than for the beers produced with NZNS (59 %), USAP (61 %), DEHM (62 %) and USCP (65 %) varieties. Beer brewed with USBR obtained the highest overall point score being awarded at least three points by 75 per cent of all tasters, and even four or five points by more than half of them (42 %).

Summary

Many interesting beers can be brewed using dry hopping techniques and in particular aroma characteristics of hops can be shown to be most significant. Brewers can select from a large number of traditional and new hop varieties. Using dry hopping techniques, they can achieve completely new aromas resulting in many different individual sensory evaluations. This could be due to the fact that dry hopping is not a technology in common use in many countries. Consequently aroma impressions introduced are, in many instances, not evaluated in accordance with classical beer types. While this technology is an integral part of brewing in both the United States and the UK, the future will tell whether dry hopped beers will be accepted by consumers in other parts of the world.

Opinions differ extremely widely, in particular in the case of dry hopped beers using the New Zealand Nelson Sauvin hop variety. The majority of tasters agree that the US Bravo variety has excellent brewing properties and, in addition to having very good bitterness characteristics, is eminently suitable for dry hopping owing to its excellent hop aroma characteristics. ■