

**THE BREWING VALUE OF PERSPECTIVE HOP HYBRIDS (A6/58, 285/70, 31/299)
AND SLOVENIAN VARIETIES AURORA AND DANA**Andreja ČERENAK¹, Iztok Jože KOŠIR¹UDC / UDK 633.791:631.52 (045)
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accepted / sprejeto: 18.12.2009**ABSTRACT**

The brewing value is the most important characteristic of hop varieties since the majority of hops are used in the brewing industry. The brewing value is first evaluated at Slovenian Institute of Hop Research and Brewing as part of Slovenian hop breeding programme. In the past years varieties have also been evaluated in foreign reference laboratory. In this article the results of brewing tests of hop hybrids in the microbrewery at Slovenian Institute of Hop Research and Brewing and varieties in reference laboratory in Germany are presented. It can be concluded from the brewing values that all hop varieties included in the evaluation are comparable to other well known varieties worldwide.

Key words: hop, *Humulus lupulus* L., brewing value, hybrid, variety

**PIVOVARSKA VREDNOST PERSPEKTIVNIH KRIŽANCEV HMELJA (A6/58,
285/70, 31/299) TER SLOVENSKIH SORT AURORA IN DANA****IZVLEČEK**

Pivovarska vrednost je najpomembnejša lastnost sort hmelja, saj se večina hmelja uporabi v pivovarstvu. Del slovenskega žlahtniteljskega programa hmelja je določanje pivovarske vrednosti na Inštitutu za hmeljarstvo in pivovarstvo Slovenije. V zadnjem letu so bile sorte ocenjene tudi v referenčnem laboratoriju v tujini. V članku so predstavljeni rezultati testiranja križancev hmelja v mikropivovarni na Inštitutu za hmeljarstvo in pivovarstvo Slovenije in sort v referenčnem laboratoriju v Nemčiji. Zaključimo lahko, da je pivovarska vrednost sort in križancev hmelja, vključenih v ocenjevanje, primerljiva z ostalimi dobro poznanimi sortami po svetu.

Ključne besede: hmelj, *Humulus lupulus* L., pivovarska vrednost, križanec, sorta

¹ Slovenian Institute of Hop Research and Brewing, Cesta Žalskega tabora 2, SI-3310 Žalec, Slovenia

1 INTRODUCTION

Despite of the fact that agronomic traits are very important for each hop variety, the brewing value is the most important characteristic that directly affects hop quality and as a result its evaluation. Most of Slovenian hops are exported to global markets therefore the evaluation of Slovenian varieties in foreign reference laboratories or breweries is very important.

The brewing value is determined with a chemical analysis of wort and beer brewed with selected hop variety/hybrid, but the results of the chemical analysis are only a starting point for the value of each variety. When talking about the quality and use of hop, it is necessary to consider organoleptic estimation, and the data obtained through the analysis of final product - beer. The data obtained from all chemical and brewing analysis form a basis for evaluation of used hop, which is particularly important in hop marketing.

Bitterness is an essential beer characteristic. The International Bitterness Units (IBU) scale provides a measure of the bitterness of beer and not a measure of isomerised alpha-acids in beer as it is thought by many brewers. It is usually assumed that 1 IBU is normally equivalent to 1 mg of iso-alpha-acids per litre of water or beer.

Beers brewed today show a wide range in their levels of bitterness. Lagers brewed in American large breweries range in bitterness from 12 to 15 IBUs while British ales range from 16 to 50 IBUs [6].

Commercial brewers measure the alpha-acids content in a laboratory; after a few test batches in the pilot brewery they adjust the hopping rate to the desired IBUs. To ensure consistency, large brewers purchase large quantities of hops and blend it throughout the year to achieve uniform consistency. Furthermore, practically all large breweries blend beer to even out fluctuations in bitterness from batch to batch, and sometimes add hop extracts to further adjust the bitterness [6,7].

Hop utilization is the percentage of alpha-acids that is isomerized and remains in the final beer. The utilization of bitter substances rarely exceeds 40 % in commercial breweries and is often as low as 25 %. Not all of the bitterness potential from the alpha-acids in the hop is utilized, which can be attributed to a number of reasons [6]:

- Form of Hops

The isomerization rate is initially affected by the form of hops. Isomerisation is slower and at a much lower rate with whole hops or plugs, slightly faster with standard pellets, and greater with extracts.

- Boil Conditions

Boil conditions can affect isomerization in a number of ways. For example the longer the boil continues, the more isomerization occurs, although eventually the reaction reverses itself, degrading the iso-alpha-acids.

- Hopping Rate

Isomerization is also affected by a hopping rate; as the hopping rate increases, the rate of isomerization decreases. This effect can be partially offset by adding bittering hops in stages.

- **Fermentation Conditions**
Fermentation conditions can affect the amount of iso-alpha-acids that remain in beer in a number of ways. The loss of iso-alpha-acids also occurs during fermentation as they are adsorbed to the yeast cell walls.
- **Maturation and Filtration Conditions**
After the fermentation, maturation and filtration conditions affect the extent to which not only bitterness, but also other hop components survive in the final beer.

Dry hopping is the process of adding hops to the primary fermenter, the maturation tank, or the casked beer to increase the aroma and hop character of the final beer. Some brewers believe dry hopping should not be done during primary fermentation because of the risk of contaminating the beer with microorganisms. Dry hopping does not add to beer bitterness and any lingering bitterness will dissipate in a few weeks because alpha-acids are only slightly soluble in cold water. It should also be noted that a beer that has been dry hopped is usually also late hopped in the kettle. British brewers use this method to give a special hop character to cask-conditioned ales [3,6].

To summarise, in Slovenian breeding programme the most perspective hop hybrids are also evaluated at the Institute's microbrewery [4]. In order to receive an estimation from a foreign reference laboratory, some Slovenian varieties were sent to St. Johann microbrewery in Germany. The results of the past years are presented in the article.

2 MATERIAL AND METHODS

2.1 Microbrewery trial at Slovenian institute of hop research and brewing

2.1.1 Material

In the micro-brewing tests at the Slovenian Institute of Hop Research and Brewing the hybrids labelled as 31/299, A6/58 and 285/70 were used. A standard, a combination of Aurora (AU; bitter hop) and Savinjski golding (SG; noble aroma hop) varieties as late addition in kettle was used since both varieties are the most frequently used in Slovenian breweries. Hybrid 31/299 was used in the kettle as aroma hop brewed in combination with Aurora bitter hop, while A6/58 and 285/70 were used as bitter hops and Savinjski golding as a late addition in the kettle. The amount of hop with regard to the alpha-acids content was the same in all combinations (Table 1).

Hop combinations (cones):

1. A6/58 ; SG
2. 285/70 ; SG
3. AU ; 31/299
4. AU ; SG (control)

Production of wort and beer:

- Standard wort from Pivovarna Laško PLC brewery was used
- Amount of hop: corresponding to 120 mg/L alpha-acids
- Hopping: 50 % aroma hop, 50 % bitter hop (corresponding to alpha-acids content)

- Hopping programme: 105 min (3 addings: first 15 min before boiling, second after 45 min, third 15 min before the end)
- Clearing and cooling of wort: 90 min
- Fermentation: 6 days, temp. 12-14 °C (yeasts – *Saccharomyces Pastorianus*)
- Maturation: 3 weeks, temp. 2-3 °C

Table 1: Hop amount per 30 L of wort
Preglednica 1: Odmerki hmelja na 30 L pivine

	A6/58		285/70		31/299		control	
Hop variety/ hybrid	A6/58	SG	285/70	SG	AU	31/299	AU	SG
Quantity of hops (g)	18.2	52.9	12.9	52.9	17.4	46.2	17.4	52.9

2.1.2 Methods

The following analytical methods to support experimental trials were used in the research. In hop cones moisture, alpha-acids and xanthohumol contents were determined by Analytica-EBC methods [1].

In wort the content of extract, alpha-acids, iso-alpha-acids, polyphenols and antocyanogens was determined. At the same time pH value, bitterness, colour and P.I. value were measured with standard methods from Analytica-EBC and MEBAK Band II [1,2].

After the maturation, the same parameters as in wort with an addition of alcohol content were determined in all beers undergoing trials. For sensorial beer estimation the DLG test from MEBAK, Band II was used [2].

3 RESULTS AND DISCUSSION

3.1 Microbrewery trial at Slovenian institute of hop research and brewing

3.1.1 Analysis of wort

First we analysed the wort before adding hops to get original parameters not influenced by hops. After the hopping, all four types of wort were analysed with analysis protocols listed in the Methods section above (Table 2).

Table 2: Results of wort analysis
Preglednica 2: Rezultati analize sladice in pivine

	wort before hopping	Wort A6/58	Wort 285/70	Wort 31/299	Wort control
Extract (%)	10.99	10.89	11.38	10.96	10.54
pH	5.92	5.82	5.75	5.74	5.83
Colour (EBC)	5.4	7.4	9.1	8.2	7.7
Bitterness (BU)	-	54.3	56.4	56.3	54.2
Alpha-acids (mg/L)	-	39.2	40.6	43.3	41.8
Iso-alpha-acids (mg/L)	-	26.3	26.7	25.1	24.6
Polyphenols (mg/L)	113.3	175.9	171.5	159.7	157.3
Antocianogens (mg/L)	39.6	50.7	52.0	47.8	44.3
P.I.	2.9	3.5	3.3	3.3	3.6

3.1.2 Analysis of beer

After a three-week maturation period all four beers were analysed in accordance with the protocol and with the use of analyses described in the Methods section. The results can be divided into two groups: chemical analyses results and sensorial results.

3.1.2.1 Chemical analysis

In Table 3 the results of beer analysis brewed from different hybrids are shown.

Table 3: Results of beer analysis
Preglednica 3: Rezultati analize piva

	Beer A6/58	Beer 285/70	Beer 31/299	Beer control
Extract (%)	10.66	10.96	10.91	10.50
Alcohol (vol. %)	4.78	4.86	4.69	4.39
pH	4.63	4.56	4.53	4.61
Colour (EBC)	6.3	7.5	7.2	6.5
Bitterness (BU)	19.8	21.9	20.5	20.0
Alpha-acids (mg/L)	2.8	3.9	2.6	2.1
Iso-alpha-acids (mg/L)	20.5	24.1	22.4	20.3
Polyphenols (mg/L)	161.5	159.1	157.3	153.8
Antocianogens (mg/L)	48.4	44.9	39.0	41.3
P.I.	3.3	3.5	4.0	3.7

The content of polyphenols and antocianogens in the wort hopped with hybrid 31/299 was the same as in the control (SG/AU), while in the wort brewed with hybrids A6/58 and 285/70 the content of polyphenols and antocianogens was much higher. The same was also observed when analysing beers, where the content of polyphenols and antocianogens in the beer brewed with 31/299 reached the lowest value, while in the beers brewed with A6/58 and 285/70 the content was slightly higher.

The best efficiency of alpha-acid content, which resulted in the highest value of bitterness, the content of alpha-acids and iso-alpha-acids in the beer, was determined when hybrid 285/70 was used while in other three beers (A6/58, 31/299, control) the values were comparable.

3.1.2.2 Sensorial estimations

Seventy-six randomly selected beer tasters (age groups 20 - 60, males and females) were included in sensorial estimation. Beer kettled with a hop combination of 31/299 hybrid and Aurora variety received the highest grade among all included samples.

In this particular sample, the highest marks that stood out were given to the intensity and quality of bitterness. The intensity and quality of aroma in this sample received a slightly lower grade compared to the control. The beer samples brewed with hybrids A6/58 and 285/70 in combination with Aurora received a slightly lower grade compared to the control and were quite similar within all parameters. The lowest intensity of bitterness was achieved in beer brewed with A6/58 (Table 4).

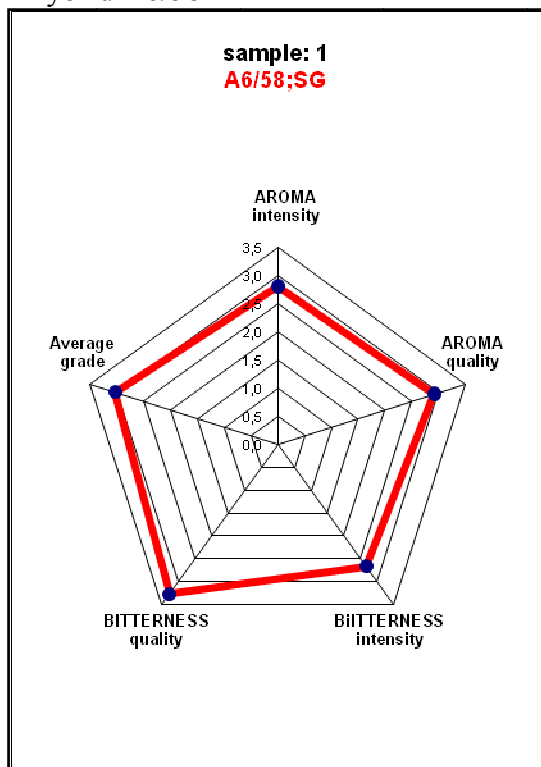
Table 4: The sensorial estimations of beer
Preglednica 4: Senzorična ocena piv

	A6/58	285/70	31/299	control
Hop aroma Intensity	2.8	2.7	2.8	3.0
Hop aroma Quality	2.9	3.0	3.0	3.2
Bitterness Intensity	2.7	3.1	3.1	2.9
Bitterness Quality	3.3	3.3	3.4	3.3
The average grade	3.0	3.1	3.3	3.2
Total	14.7	15.1	15.6	15.5

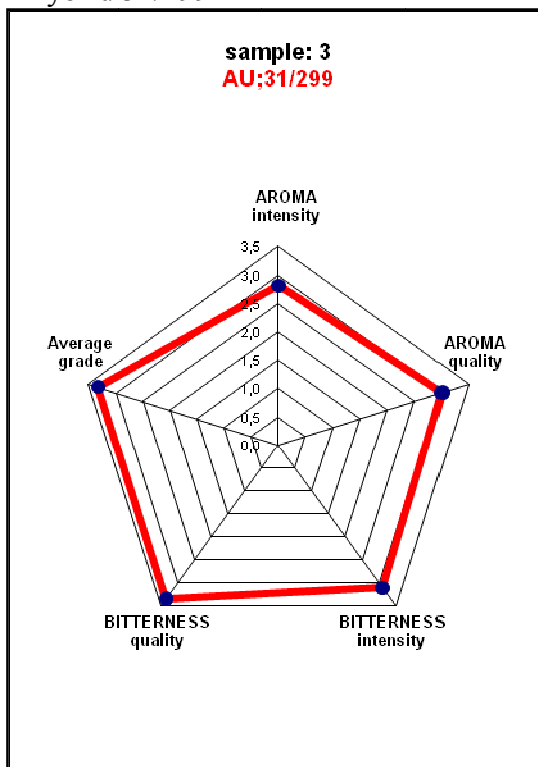
Note: The grades given were from 1 - 5 (where 1 is the minimum and 5 the maximum)
No. of beer tasters: 76

The results of beer tasting are shown in Figures 1 – 4.

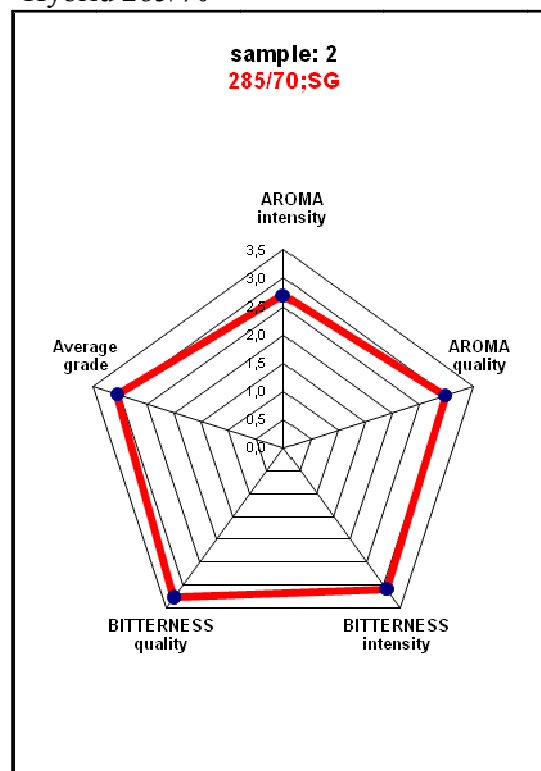
Hybrid A6/58



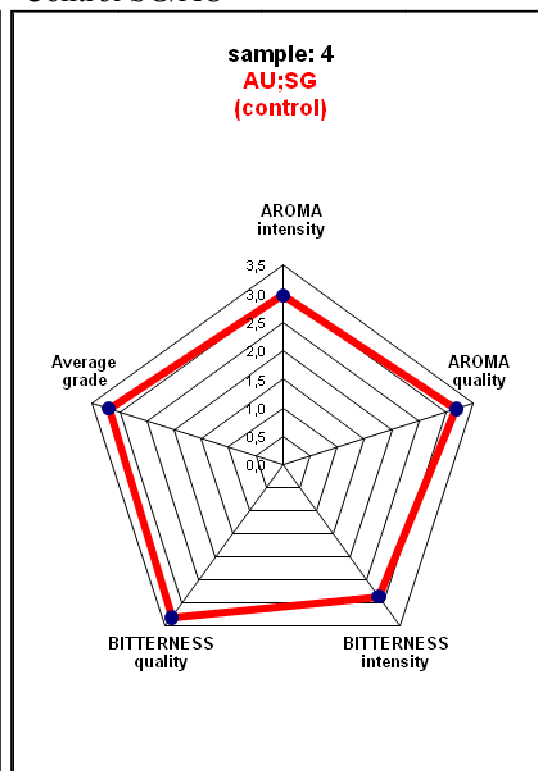
Hybrid 31/299



Hybrid 285/70



Control SG/AU



Figures 1-4: Sensorial evaluation of 4 different beer samples
Slike 1-4: Senzorična ocena 4 različnih vzorcev piva

3.2 Microbrewery trial at St. Johann microbrewery, Germany

In German reference laboratory beer tasters graded Dana and Aurora hop varieties. The aim of this evaluation was to get an independent grade for both varieties from a professional panel of tasters (10 members) and compare it with the results obtained in the microbrewery in Žalec. In St. Johann Research Brewery beer can be filtered, pasteurised and bottled as in macrobrewing (industrial scale) process, which is not possible in microbrewery in Žalec. Both samples were hopped only with one variety.

Both beers, brewed with Dana and Aurora variety received the same grade for the intensity of hop aroma. The quality of hop aroma of the beer brewed with Aurora was graded slightly higher than it was expected, since Aurora is a type of aroma variety.

Beer brewed with Dana variety received a higher grade for intensity of hop bitterness, showing better efficiency of bitter substances. The quality of bitterness was graded slightly worse, which was probably due to a higher percentage of cohumulone in alpha-acids.

To sum up, beers brewed with Aurora or Dana achieved comparable evaluation, slightly higher grades were given to Aurora because of better aroma and the quality of bitterness. Since Aurora is a representative of aroma hops and Dana of bitter hops the comparison between the two cannot be made. In general, the investigated beers cannot be compared directly. In general, beers are brewed with a combination of both aroma and bitter hops, so both investigated varieties received high grades, each in its own category.

4 CONCLUSIONS

It can be concluded from all the samples brewed from hop hybrids at the Slovenian Institute of Hop Research and Brewing that the obtained grades within all investigated parameters did not have a negative effect on the quality of beer; they were also comparable to the control, and brewed with a well known combination of Slovenian Aurora and Savinjski golding varieties. Further analysis of the investigated hybrids together with agronomic traits will be carried out in the future.

In conclusion, the evaluation of German professional tasters in St. Johann microbrewery showed that the new Dana hop variety is a bitter variety with good aroma characteristics, which enhance essential oil and the amount of linalool, contributing to a quite intense hop aroma in final beer. The alpha/beta-acid ratio is around 3, which is characteristic of high alpha variety. Aurora and Dana varieties offer a good brewing value and a pleasant and intense hop aroma, and provide a harmonic and medium to slightly robust bitterness. Their quality is comparable to customary German varieties (ex. Hallertauer Magnum, Hercules) [5].

5 LITERATURE

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