



Barley varieties registered in the Slovak Republic after the harvest of 2019

Vratislav Psota^{1*}, Marián Svorad², Markéta Musilová¹, Veronika Halášová³

¹ Research Institute of Brewing and Malting, Mostecká 7, CZ-614 00 Brno, Czech Republic

² Central Control and Testing Institute in Agriculture, Department of Variety Testing, Topolčianska 488/29, SK 956 07 Velké Ripňany, Slovak Republic

³ Slovak University of Technology in Bratislava, Faculty of Chemical and Food Technology Institute of Biotechnology, Radlinského 9, SK 812 37 Bratislava, Slovak Republic

* Corresponding author: psota@beerresearch.cz

Abstract

This study presents the results of malting quality and agronomic characters obtained within state varietal tests of malting barley in the Slovak Republic. After the harvest of 2019, new spring malting barley varieties of Avus, Bernet, and LG Nabuco were registered. The spring barley varieties provided malt with extract content above 83%. All varieties degraded nitrogenous substances easily. The values of Kolbach index ranged from 47.5 to 49.5%. Diastatic power was at the optimal level and moved above the level of 300 WK un. in all the studied varieties. Also, cell wall degradation was optimal and friability was higher than 90%. Content of β -glucans in wort reached favourable values (72–141 mg/l). Quality of wort characterized by apparent final attenuation was at the above average value to the optimal level (81–81.8%) in the studied spring barley varieties.

Keywords: barley, malting quality, variety

1 Introduction

Despite a rising demand for malting barley, its production in the Slovak Republic is declining. In 2019 it was estimated that 367,000 tonnes of spring barley and 212,800 tonnes of winter barley were harvested. Malting varieties of Kangoo (37%), Overture (26%), Malz (7%) and Odyssey (7%) were the most represented varieties in the registered reproduction areas. Most of other spring barley varieties were also malting (Dráb et al., 2019).

In the Slovak Republic, new barley varieties are registered under Act 597/2006. Pursuant to this act, varietal tests are conducted by the state administration authority body, which is the Central Controlling and Testing Institute in Agriculture (CCTIA).

The CCTIA:

- issues varietal testing methodology and methodological guidelines for varietal testing and the registration and recognition of cultivated plant propagation material,
- carries out varietal tests for the registration or the

- registration renewal of varieties of cultivated plants, decides on the registration, registration renewal and termination of varieties of cultivated plants.

Decree of the Ministry of Agriculture of the Slovak Republic No. 365/2007 informs about the duration of the tests: “The economic value of a variety shall be tested for two to three years in the case of one-year species; if the variety has completed varietal tests for diversity, equilibrium and stability and achieves very good economic results, these tests need not be carried out in the third year.”

Within the tests for registration, new varieties are examined for yield and other yield parameters, resistance to diseases, lodging and characters indicating the quality of malt.

In the presented study, technological and agronomic quality of spring malting barley varieties of Avus, Bernet, and LG Nabuco was assessed; varietal tests for their registration were completed with the harvest of 2019.

2 Material and methods

Malting quality of the studied spring barley varieties was assessed in Bernet and LG Nabuco varieties after three years of testing based on an analysis of twelve malt samples and in Avus after two years of testing based on an analysis of eight malt samples (Table 1). The samples were supplied by the Central Controlling and Testing Institute in Agriculture in Bratislava in the period of 2017–2019.

Variety / Code	Maintainer / Agent in the SR
<i>spring barley</i>	malting varieties
Avus	Saatzucht Streng-Engelen GmbH & Co. KG
STRG687/15	RWA Slovakia spol.s r.o.
Bernet	Sejet Plantbreeding I/S
SJ148376	Limagrain Central Europe Cereals, s.r.o.
LG Nabuco	Limagrain Europe
LGBN1315	Limagrain Central Europe Cereals, s.r.o.

Table 1 Set of registered spring barley varieties after the harvest 2019

2.1 Selection of the testing stations

Each year, grain samples of the tested varieties were collected from four testing stations where standard varieties exhibited the optimal content of nitrogenous substances (10.2–11.2%). In this way we secured that the determined technological parameters were not negatively affected by unfavourably low or, on the contrary, unfavourably high content of nitrogenous substances in grain.

2.2 Malting and malt analysis

Grain samples (0.5 kg) were malted in the micromalting plant of the KVM company (CR). The method traditionally used in the Research Institute of Brewing and Malting, which is almost identical with the **MEBAK (2011)** method, was used for laboratory malting. Only the grain fraction over 2.5 mm was malted.

Steeping was conducted in a steeping box. The temperature of both water and air was kept at 14.0 °C. Length of steeping: on the first day – 5 hours; on the second day – 4 hours. On the third day the water content in germinating grains was adjusted to the value of 45% by steeping or spraying.

Germination was conducted in a germination box. The temperature during germination was 14.0 °C. The total time of steeping and germination was 144 hours.

Kilning was performed in a one-floor electrically heated kiln. The total kilning time was 22 hours, pre-kilning at 55 °C, kilning temperature was 80 °C for 4 hours.

Quality of malt samples was assessed based on the parameters given in the Malting Quality Index (**Psota and Kosař, 2002**).

In the course of the tests, Malting Quality Index (nitrogenous substances in non-malted grain, extract in malt dry matter, relative extract at 45°C, Kolbach index, diastatic power, apparent final attenuation, friability, β-glucans in wort, wort clarity and haze) was determined according to the methods presented in publications of **MEBAK (2011)** and Analysis committee of the EBC (**EBC,**

2010). The variety was assessed according to the Malting Quality Index (**Psota and Kosař, 2002**). Wort clarity determined visually was assessed as follows: 1 = clear, 2 = weakly opalizing, 3 = opalizing, 4 = cloudy (Table 2).

Agricultural characters of varieties (Table 3) include:

- yield of grain at standard 14% moisture content. Yield of grain and yield of grain over 2.5 mm in spring barley in terms of the response of the varieties to the soil and weather conditions and suitability of grain for malting are assessed within the production area (maize, sugar-beet, potato and mountain),
- agronomic data (time to heading, maturity, straw length, resistance to lodging),
- resistance to diseases (powdery mildew of barley (*Blumeria graminis*), leaf brown rust of barley (*Puccinia hordei*), complex of leaf spots (*Pyrenophora teres*), leaf scald of barley (*Rhynchosporium secalis*),
- quality parameters of the grain (thousand grain weight and sievings over 2.0 mm).

3 Results and Discussion

Breeding and cultivation techniques have brought progress in yield and malting quality in spring malting barley. In 2020, CCTIA in Bratislava registered three new malting varieties. Within testing for the registration, micromalting tests of the varieties of Avus (2018–2019) and Bernet and LG Nabuco (2017–2019) were performed.

Huge attention is traditionally paid to the effect of nitrogenous substances on malt quality (**Bishop, 1930**). Many authors (e.g. **Holopainen et al., 2014**) have found a significant negative correlation between the nitrogenous substance content and the starch content. Generally, the level of 10.8–11.2% of nitrogenous substance content is required. By reducing starch degradation, reserve proteins can impede the malting process (**Kauffman et al.,**

Table 2 Barley grain and malt analyses

Methods	Unit	References	2018–2019				2017–2019			
			Odyssey	Overture	Soulmate	Avus	Odyssey	Soulmate	Bernet	LG Nabuco
			S	S	S		S	S		
Degree of steeping 1	%	-	32.4	34.3	33.3	31.8	32.1	32.9	32.5	32.2
Degree of steeping 2	%	-	40.1	42.3	41.3	39.3	39.8	40.9	40.2	39.9
Malt yield d. m.	%	Briggs 1998	91.5	91.2	91.4	91.9	91.7	91.5	91.5	91.9
Respiration losses d. m.	%	Briggs 1998	4.4	4.4	4.1	4.0	4.3	4.1	4.2	4.1
Rootlet losses d. m.	%	Briggs 1998	4.2	4.4	4.4	4.1	4.0	4.4	4.4	4.0
Starch content of barley	%	NIR	63.9	63.0	63.7	63.3	64.1	63.7	63.3	64.3
Protein content of barley (factor 6.25) d. m.	%	EBC 2010, 3.3.1	10.7	10.8	10.4	10.5	10.5	10.3	10.3	10.8
Extract of malt (congress mash) d. m.	%	EBC 2010, 4.5	82.5	83.3	83.5	83.2	82.7	83.6	83.3	83.7
Mash method according to Hartong and Kretschmer VZ 45 °C	%	MEBAK 2011, 4.1.4.11	43.1	51.9	45.6	43.5	43.8	45.9	45.0	47.9
Kolbach index	%	EBC 2010, 4.9.1	46.6	50.1	50.0	47.5	47.3	51.2	48.6	49.5
Diastatic power	WK	EBC 2010, 4.12	344	377	430	391	336	425	306	329
Final attenuation of laboratory wort	%	EBC 2010, 4.11	81.0	81.8	82.0	81.4	81.6	82.5	81.5	81.8
Friability	%	EBC 2010, 4.15	87	90	95	96	90	96	92	93
High molecular weight β -glucan content of malt, SFA	mg/l	EBC 2010, 4.16.2	176	134	83	72	149	69	141	122
Protein content of malt (factor 6.25)	%	EBC 2010	10.3	10.2	10.0	10.3	9.9	9.7	9.5	10.2
Total nitrogen of malt, Kjeldahl method	%	EBC 2010	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.6
Soluble nitrogen of wort, Kjeldahl method	mg/l	EBC 2010	858	918	895	874	837	886	821	898
Soluble nitrogen of malt, Kjeldahl method	mg/100g	EBC 2010	765	821	800	781	747	791	733	802
Appearance (clarity) of wort		MEBAK 2011, 3.1.4.2.6	1.00	1.25	1.25	1.50	1.00	1.17	1.08	1.00
Haze of wort (90°)	EBC	EBC 2010	1.05	1.95	1.35	2.31	0.99	1.13	1.03	0.71
Haze of wort (12°)	EBC	EBC 2010	0.97	2.16	1.39	2.38	0.86	1.13	0.90	0.62

S = standard variety

1994). Malt made from barley grain with a higher nitrogen content provides a lower content of fermentable extract (Briggs, 1998).

The nitrogenous substance content in a non-malted grain moved within the optimal values (10.3–10.8%). The obtained malts made from the spring barley varieties exhibited high extract content (83.2–83.7%). The highest extract content in the malt dry matter (83.7%) was detected in LG Nabuco.

Proteolytic modification characterized by Kolbach index was strong and moved from 47.5–51.9%. Proteolytic modification in LG Nabuco was high (49.5%). Relative extract at 45 °C, characterizing the activity namely of cy-

tolytic and proteolytic enzymes, was in the studied varieties at the optimal level (43.5–47.9%). Activity of starch hydrolyzing amylolytic enzymes, namely β -amylase, was at the optimal level. The value of diastatic power moved within the range of 306–391 WK un. Based on the level of apparent final attenuation, the studied varieties showed good quality of wort composition (81.4–81.8%). Apparent final attenuation is affected by many factors (Koljonen et al., 1995), deciding on the actual extract use and amount of ethanol formed (Bathgate, 2016).

One of the factors that can affect apparent final attenuation is cytolytic modification (Edney, 1998). Degradation of cell walls in Avus, Bernet, and LG Nabuco varieties

Table 3 Important agricultural properties

Variety	2018–2019					2017–2019				
	Mean of the test	Odyssey	Overture	Soulmate	Avus	Mean of the test	Odyssey	Soulmate	Bernet	LG Nabuco
Grain yield	(t.ha ⁻¹)	S	S	S		(t.ha ⁻¹)	S	S		
maize production area	6.13	5.97	5.87	6.10	6.39	6.74	6.62	6.72	6.82	6.71
sugar-beet production area	6.07	6.00	5.68	5.71	6.32	6.59	6.47	6.35	6.66	6.62
potato and mountain production areas	6.68	6.61	6.40	6.16	7.19	7.16	7.20	6.82	6.92	7.23
Grain yield over 2.5 mm										
maize production area	5.79	5.67	5.44	5.62	6.15	6.48	6.32	6.33	6.53	6.44
sugar-beet production area	5.74	5.70	5.27	5.26	6.09	6.33	6.17	5.98	6.38	6.36
potato and mountain production areas	6.31	6.28	5.93	5.68	6.92	6.88	6.87	6.42	6.63	6.94
straw length (cm)	79	80	77	77	79	85	79	75	83	83
earliness of ripening (days compared to Odyssey)	-1.0	0.0	0.0	-1.0	-1.0	-1.0	0.0	-1.0	-2.0	-2.0
standing power (lodging resistance)	6.1	5.7	5.8	6.0	6.3	6.1	5.7	6.2	6.7	6.5
Resistance to diseases										
powdery mildew of barley (<i>Blumeria graminis</i>)	7.7	8.4	8.6	8.4	7.8	8.4	8.6	8.4	7.7	8.6
leaf brown rust of barley (<i>Puccinia hordei</i>)	7.1	7.4	7.1	7.0	7.2	6.8	6.9	6.7	6.7	7.3
complex of leaf spots (<i>Pyrenophora teres</i>)	5.3	5.4	5.4	5.7	5.7	5.9	5.0	6.1	5.4	6.0
scald of barley (<i>Rhynchosporium secalis</i>)	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Mechanical properties (grain quality)										
1000 grain weight (g)	44.7	44.8	44.0	44.0	46.9	43.8	44.5	40.8	44.9	45.3
sieving fractions over 2.5 mm (%)	94.5	95.0	92.7	92.2	96.3	96.1	95.4	94.2	95.8	96.0
S = standard varieties Point evaluation 1 = fully lodging, fully attacked 9 = non lodging, resistant to diseases Weight of 1000 grains relates to sieving fractions over 2.0 mm at 14% humidity.										

was fast (friability 92–96%). All the studied varieties had favourable values of β -glucan content in wort (72–141 mg/l). β -Glucan content in wort is affected by β -glucan in grain (Gupta et al., 2010) and β -glucanase activity.

Malt made from **Avus** variety bred in Germany provided an optimal content of extract (83.2%) at the optimal nitrogenous substances content of 10.5% in a non-malted grain. Proteolytic modification was optimal (Kolbach index 47.5%). Amylolytic modification was also at an optimal level (diastatic power 391 WK un.). Cytolytic modification was at an above-average level. Degradation of cell walls was at the level of 96% but β -glucan content in wort moved around 72 mg/l. The composition of wort was above average (apparent final attenuation of 81.4%). The variety provided clear to opalizing wort. Considering the values achieved in the studied technological parameters, the variety of Avus has a very good malting quality with the point evaluation of 9 (8.5).

According to the EU Plant variety database, the variety is registered in Austria. In 2019 it also completed the

tests for the registration in the Czech Republic with similar results as in the Slovak Republic (Psota et al., 2020).

Avus is a mid-early spring barley variety (vegetation period and time to heading is at the level of the control variety of Soulmate – 109 and 66 days, resp. of mid high type (79 cm), medium resistant to lodging. The variety is resistant to powdery mildew of barley but sensitive to a complex of leaf spots. Its grain is big (TGW 46.18 g) and the portion of sieving fractions over 2.5 mm (96%) is high.

During the 2018–2019 tests, Avus achieved an above average yield in all production areas. Compared to the average value of the control varieties in the Slovak Republic, it achieved the yield of 6.63 t/ha, i.e. 108% (in maize production area 106%, sugar-beet production area 107%, and potato and mountain production areas to the average value of the controls).

Malt made from **Bernet** variety bred in Denmark provided an optimal extract content (83.3%) at an optimal nitrogenous substances content (10.3%) in a non-malted

grain. Proteolytic modification was optimal (Kolbach index 48.6%). Amylolytic modification was also at the optimal level (diastatic power 306 WK un.). Cytolytic modification was above average. Degradation of cell walls was at the level of 92% but β -glucan content in wort moved around 141 mg/l. The composition of wort was above average (apparent final attenuation of 81.5%). In most cases, the variety provided clear wort. Considering the values achieved in the studied technological parameters, the variety of Bernet has a very good malting quality with the point evaluation of 8 (8.2).

Bernet is a mid-early spring barley variety (vegetation period and time to heading is at the level of the control variety Soulmate – 112 and 71 days, resp.), of high type (83 cm), medium resistant to lodging. The variety is resistant to powdery mildew of barley but sensitive to complex of leaf spots. Its grain is big (TGW 44.93 g) and has a high portion of sieving fractions over 2.5 mm (96%).

During the 2017 to 2019 tests, Bernet achieved an above average yield in all production areas. Compared to the average of the control varieties in the Slovak Republic, it achieved the yield of 6.91 t/ha, i.e. 104% (in a maize production area 103%, sugar-beet production area 105% and potato and mountain production areas 105%) to the average value achieved in the controls.

LG Nabuco variety, bred in Holland, provided malt with an optimal extract content (83.7%) at an optimal content of nitrogenous substances (10.8%) in a non-malted grain. Proteolytic modification was high (Kolbach index 49.5%). Amylolytic modification was at the optimal level (diastatic power 329 WK un.). Cytolytic modification was optimal. Degradation of cell walls was at the level of 93% and β -glucan content in wort moved on average around 122 mg/l. The composition of wort was above average (the apparent final attenuation of 81.8%). In all cases the variety provided clear wort. Considering the values achieved in the studied technological parameters, LG Nabuco variety has very good malting quality with the point evaluation 8 (8.2).

According to the EU Plant variety database, the variety is registered in the Czech Republic, Denmark and Austria.

LG Nabuco is a mid-early spring barley variety (vegetation period and time to heading is at the level of the control variety of Soulmate – 112 and 71 days, resp.), of high type (83 cm), medium resistant to lodging. The variety is resistant to powdery mildew of barley but sensitive to complex of leaf spots. Grain is big (TGW 45.35 g) and has a high portion of sieving fractions over 2.5 mm (96%).

During the 2017 to 2019 tests, LG Nabuco achieved an above average value yield in a sugar-beet production area and potato and mountain production areas. Compared to the average of control varieties in the Slovak

Republic, it achieved the yield of 6.85 t/ha, i.e. 103% (in a maize production area 101%, in the sugar-beet production area 104% and potato and mountain production areas 104%) to the average value achieved in the controls.

4 Conclusion

The study presents results achieved by Avus, Bernet, and LG Nabuco varieties which were registered in the Slovak Republic after the harvest of 2019. Quality was assessed according to the Malting Quality Index. Content of the nitrogenous substances in the studied spring barley varieties was at an optimal level of 10.2 to 10.8%. The spring barley varieties were rich in extract. All the varieties had an extract higher than 83%. Proteolytic, amylolytic and cytolytic modification in the studied spring barley varieties was mostly at the optimal level. Wort quality assessed by a final apparent attenuation was at a similar level of 81.4–81.8%.

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