



Barley varieties registered in the Czech Republic after harvest 2018

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Abstract

This study presents the results of malting quality and agronomic characters obtained within three-year testing of barley varieties for the registration in the Czech Republic. New spring barley malting varieties rich in extract, i.e. Cosmopolitan, Ismena, Klarinette, Laureate, LG Aurus, and Runner were registered after the 2018 harvest. The extract of the varieties Cosmopolitan, Laureate, and LG Aurus was higher than 83%. The values of Kolbach index, diastatic power and apparent final attenuation were at the above-average to optimal level. The level of cytolytic modification was at the above-average to optimal level with the exception of the variety Runner which exhibited higher β -glucan content in wort (192 mg/l). In addition, non-malting varieties of winter six-row barley Azrah, Impala, Journey, Laurin, SU Jule, and a hybrid variety SU Hylona were registered.

Key words: barley, variety, malting quality

1 Introduction

In the Czech Republic, new barley varieties are registered under [Act 219/2003](#) on the basis of a three-year testing, which is carried out according to the Methodology of Barley Utility Value Testing ([Dvořáčková, 2016](#)). The tests for the registration of new varieties include monitoring the utility value, i.e. yield and other yield characteristics, resistance to diseases, lodging and traits characterizing malt quality. The quality of malt samples was evaluated on the basis of the characteristics given in the malting quality index ([Psota and Kosař, 2002](#)).

The present study evaluates the technological and agronomic quality of the spring barley malting varieties Cosmopolitan, Ismena, Klarinette, Laureate, LG Aurus, and Runner, which completed the trials for the registration in 2018. In addition, the non-malting varieties of winter six-row barley Azrah, Impala, Journey, Laurin, SU Jule and the hybrid variety SU Hylona were also registered. The utility value of the non-malting varieties is given only in the table without verbal description.

2 Material and Methods

Malting quality of the studied spring barley varieties was assessed based on the analysis of 12 malt samples made in the micromalting plant. Seed samples were delivered by the National Plant Variety Office of the Central Institute for Supervising and Testing in Agriculture (CISTA) in Brno in 2016–2018.

Malting quality was assessed mainly on the basis of the parameters making up the malting quality index (further only MQI) ([Psota and Kosař, 2002](#)). Further, we studied whether the variety provided clear wort. In the set of the varieties under study, none met the criteria for recommendation and production of the beer with the protected geographical indication “České pivo” ([European Commission, 2008](#)).

2.1 Determination of technological quality

2.1.1 Selection of the testing sites

Grain samples of the tested varieties were collected annu-

ally from four testing sites in which the standard varieties exhibited the optimal content of nitrogenous substances (10.2–11.2%). Thus it was secured that the technological parameters determined were not negatively affected by a low or, on the contrary, an unfavorably high content of nitrogenous substances in grain. In the course of the three-year testing cycle, a total of 12 values were obtained from each studied parameter.

2.1.2 Varieties under study

The list of all barley varieties registered after harvest 2018 is given in Table 1. For comparison of the utility value of the advanced breeding lines with the utility value of the already registered varieties, CISTA includes in the registration trials the standard varieties which, after previous negotiations with applicants and representatives of foreign companies, proceed together with the tested varieties throughout the three-year testing procedure.

The set of the standard registered varieties always includes at least one variety which completed the registration procedure with the recommendation for production of beer with the protected geographical indication “České pivo”, further varieties with the malting quality for the production of other types of beers, and at least one non-malting variety which achieves high yield of grain. The standard varieties serve for the assessment of yield while the other parameters, such as resistance to diseases or resistance to lodging are assessed according to scales (Dvořáčková, 2016). The MQI parameters are assessed within fixed scopes.

2.1.3 Malting and malt analysis

Samples of barley varieties (500 grams) were malted in the KVM (Uničov, Czech Republic) automatic micromalting equipment. The RIBM always uses the same regime of steeping, germination and kilning for varietal testing. The conditions and procedure of malting are given in Table 2. Sieving fractions over 2.5 mm are used for the micromalting test. Malt analyses are given in Table 3 including references to the methods used (EBC Analysis committee, 2010, MEBAK, 2011, Baxter and O'Farrell, 1983).

2.2 Determination of agronomical characteristics

Every year, the agronomical characteristics were assessed according to the methods of CISTA (Dvořáčková,

2016) in spring barley varieties (Table 4) in 14 testing localities and in winter barley varieties (Table 5) in 8 testing localities.

Table 1 Assortment of registered barley varieties after harvest 2018

Variety / Code	Maintainer / Agent in the CR
spring barley	malting varieties
Cosmopolitan SJ 152037	Sejet Planteformaedling I/S (DNK) SELGEN, a.s.
Ismena NORD 14/2403	NORDSAAT Saatzucht GmbH (DEU) SAATEN - UNION CZ s.r.o.
Klarinette SC 101-12A	SECOBRA Recherches (FRA) SOUFFLET AGRO a.s.
Laureate SY 412-328	Syngenta Participations AG (GBR) B O R, s.r.o.
LG Aurus LGBHE3427A	Limagrain Europe (FRA) Limagrain Central Europe Cereals, s.r.o.
Runner NORD 14/2534	NORDSAAT Saatzucht GmbH (DEU) SAATEN - UNION CZ s.r.o.
winter barley	non-malting varieties
Azrah STRG 432/09	Saatzucht Streng - Engelen GmbH & Co.KG (DEU) B O R, s.r.o.
Impala LEU 43408	Deutsche Saatveredelung AG (DEU) Ing. Marian Špunar
Journey KW 6-451	KWS LOCHOW GMBH (DEU) SOUFFLET AGRO a.s.
Laurin NORD 11002/8	NORDSAAT Saatzucht GmbH (DEU) SELGEN, a.s.
SU Hylona DEH 13/1807	ASUR PLANT BREEDING s.a.s. (FRA) SAATEN - UNION CZ s.r.o.
SU Jule BE 2008108012	W. von Borries-Eckendorf GmbH & Co. KG (DEU) Ing. Marian Špunar

Agricultural characters of varieties include:

- yield of grain at standard 14% moisture content in the non-treated (without the use of fungicides) and treated (two treatments with fungicides) variants of growing. 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 the use of grain for malting are assessed within the testing area (maize, sugar-beet, cereal, and potato). In winter barley, all the areas are assessed jointly.
- agronomical data (time to heading, maturity, number of productive stems, length of plants, resistance to lodging).
- resistance to diseases (powdery mildew of barley (*Blumeria graminis*), leaf rust of barley (*Puccinia hordei*), net blotch of barley (*Pyrenophora teres*), scald of barley (*Rhynchosporium secalis*), scab of barley (*Fusarium graminearum*, *F. culmorum*, *Microdochium nivale* etc.), physiological leaf spots of barley (non-specific leaf spots).
- quality parameters of the grain (thousand grain weight and sievings over 2.5 mm).

Table 2 Conditions and schedule of malting

	Time	Temperature of ingoing air	Temperature of outgoing air	Fan speed	Air recirculation
	h	°C	°C	%	%
Steeping					
Wet period	5.0	14.0	14.0	70	
Dry period	19.0				
Wet period	4.0				
Dry period	20.0				
Wet period	* 24.0				
Dry period					
Germination	72.0				
Kilning	1.0	14.0 to 55.0	14.0 to 25.0	70	0
	11.0	55.0	25.0 to 35.0		0
	1.0	55.0 to 60.0	40.0 to 45.0		40
	1.0	60.0 to 65.0	45.0 to 50.0		40
	2.0	65.0 to 70.0	50.0 to 55.0		40
	1.0	70.0 to 75.0	55.0 to 65.0		40
	1.0	75.0 to 80.0	65.0 to 78.0		80
	4.0	80	78		80

* Water content was adjusted to 45% by steeping or spraying.

Table 3 Barley grain and malt analyses (2016–2018)

Methods	Units	References	Sunshine	Laudis 550	KWS Amadora	Odyssey	Cosmopolitan	Ismena	Klarinette	Laureate	LG Aurus	Runner
			S	S	S	S						
Protein content of barley (factor 6.25)	%	EBC 2010	11.1	11.1	10.2	10.4	10.4	10.4	10.6	10.3	10.5	10.2
Starch content of barley	%	NIR	63.6	63.8	64.2	64.6	64.6	64.2	64.4	64.2	64.5	64.3
Degree of steeping 1	%		32.4	31.6	31.1	31.5	31.8	32.6	32.5	32.1	33.7	33.6
Degree of steeping 2	%		40.1	39.1	38.8	39.2	39.2	40.1	40.0	39.7	41.5	41.3
Malt yield d. m.	%	Briggs 1998	90.9	91.2	91.2	91.9	91.8	92.0	91.5	91.9	91.2	91.6
Respiration losses d. m.	%	Briggs 1998	4.6	4.3	4.5	4.3	3.9	4.2	4.2	3.8	4.4	4.2
Rootlet losses d. m.	%	Briggs 1998	4.5	4.5	4.3	3.8	4.3	3.8	4.2	4.3	4.4	4.2
Extract of malt, congress mash	%	EBC 2010	82.7	82.4	83.9	82.9	83.1	82.4	82.9	83.9	83.5	82.5
Mash method according to Hartong and Kretschmer VZ 45 °C	%	MEBAK 2011	43.6	38.6	50.1	42.0	48.3	44.0	39.0	45.8	44.6	44.9
Kolbach index	%	EBC 2010	49.9	43.7	52.6	46.7	48.4	49.3	43.2	50.6	47.5	46.1
Diastatic power	WK	EBC 2010	443	346	397	327	350	275	279	333	341	279
Final attenuation of laboratory wort	%	EBC 2010	82.9	80.5	83.5	82.3	82.9	81.9	81.2	82.3	82.3	82.0
Friability	%	EBC 2010	92	85	98	89	92	87	84	90	88	84
High molecular weight beta-glucan content of malt, SFA	mg/l	EBC 2010	49	153	36	144	106	166	119	145	156	192

Methods	Units	References	Sunshine	Laudis 550	KWS Amadora	Odyssey	Cosmopolitan	Ismena	Klarinette	Laureate	LG Aurus	Runner
			S	S	S	S						
Protein content of malt (factor 6.25)	%	EBC 2010	10.1	10.1	9.2	9.4	9.3	9.4	9.6	9.2	9.4	9.2
Total nitrogen of malt, Kjeldahl method	%	EBC 2010	1.61	1.61	1.47	1.51	1.50	1.51	1.54	1.47	1.51	1.47
Soluble nitrogen of wort, Kjeldahl method	mg/l	EBC 2010	899	788	860	778	809	831	743	832	801	761
Soluble nitrogen of malt, Kjeldahl method	mg/100g	EBC 2010	802	703	769	693	722	740	663	743	717	679
Soluble nitrogen of malt, Kjeldahl method	%	EBC 2010	0.802	0.703	0.769	0.693	0.722	0.740	0.663	0.743	0.717	0.679
Viscosity of laboratory wort from malt	mPa.s	EBC 2010	1.451	1.491	1.454	1.466	1.458	1.479	1.485	1.467	1.465	1.475
Colour of malt, visual method	EBC	EBC 2010	3.22	2.90	3.55	3.18	3.57	3.58	2.80	3.88	3.26	3.38
Saccharification time	min	EBC 2010	10	11	10	10	10	10	11	10	10	11
Glassy corns	%	EBC 2010	0.0	0.1	0.0	0.0	0.1	0.1	0.2	0.1	0.0	0.1
Partly unmodified grains	%	EBC 2010	0.3	1.6	0.2	1.2	0.5	1.4	2.3	1.3	1.1	2.1
Homogeneity (by friabilimeter)	%	Baxter, O'Farrell 1983	99.7	98.4	99.9	98.8	99.5	98.7	97.7	98.7	98.9	97.9
Appearance (clarity) of wort		MEBAK 2011	1.08	1.00	1.08	1.00	1.17	1.33	1.08	1.17	1.00	1.00
Haze of wort (90°)	EBC	EBC 2010	0.89	0.90	1.10	0.69	1.32	2.30	1.15	1.45	0.77	0.68
Haze of wort (12°)	EBC	EBC 2010	1.08	1.05	1.14	0.82	1.29	2.34	1.22	1.49	1.00	0.84
Total polyphenols in wort	mg/l	EBC 2010	70.7	64.5	91.7	82.3	83.9	79.5	69.3	77.5	86.7	74.8
Free amino nitrogen	mg/l	EBC 2010	198	168	207	172	186	186	157	186	182	164
Free amino nitrogen	mg/100g	EBC 2010	153	129	172	153	148	154	125	126	148	141

S = standard varieties

Notes to some parameters given in the table:

- Wort clarity is assessed as follows: 1 = clear, 2 = weakly opalizing, 3 = opalizing, 4 = cloudy.
- Malt yield in dry matter (%) = weight of deculmed malt in d.m. (weight of barley in d.m. / 100).
- Respiration losses (%) = 100 - (malt yield in d.m. + rootlet losses).
- Rootlet losses (%) = 100 - weight of deculmed malt / (weight of non-deculmed malt / 100).
- Total malting losses in d.m. (%) = [(weight of barley in d.m. - weight of deculmed malt in d.m.) * 100] / weight of barley in d.m. (Briggs, 1998).

3 Results

The micromalting tests with the varieties Cosmopolitan, Ismena, Klarinette, Laureate, LG Aurus, and Runner were conducted in 2016–2018 within testing for registration. The highest malt yield (92.0%) was exhibited by the variety Ismena. In the set of the varieties under study, no variety met the criteria for recommendation and production of beer with the protected geographical indication “České pivo” (European Commission, 2008).

The malts obtained from the spring barley varieties exhibited a high extract content (82.4–83.9%). The content of nitrogenous substances in non-malted grain moved within the optimal values (10.2–10.6%).

A high content of soluble nitrogen (over 800 mg/l) was exhibited by the varieties Laureate (832 mg/l), Ismena (831 mg/l), Cosmopolitan (809 mg/l), and LG Aurus (801 mg/l). Proteolytic modification characterized by Kolbach index ranged from 43.2–50.6%. Proteolytic modification of the varieties Laureate and Ismena was high (50.6% and 49.3%). Free amino nitrogen was in the range of 157–186 mg/l and formed 22.2% of soluble nitrogen (39.0–48.3%). Relative extract at 45 °C characterizing the activity of namely cytolitic and proteolytic enzymes was at the optimal level (39.0–48.3%). The activity of amylolytic enzymes hydrolyzing starch, namely β -amylase, was at the optimal level. The value of diastatic power ranged from 275–350 WK units.

Table 4 Important agricultural properties (2016–2018)

Variety	Intesity	Mean of the standards	KWS Amadora	Laudis 550	Odyssey	Sunshine	Vendela	Cosmopolitan	Ismena	Klarinette	Laureate	LG Aurus	Runner
Grain yield in (t/ha)			S	S	S	S	S						
maize growing region	N	6.07	6.09	5.94	5.92	5.95	6.42	6.13	6.23	6.25	6.28	6.37	6.41
	T	6.53	6.58	6.54	6.16	6.42	6.94	6.57	6.71	6.69	6.66	6.71	6.94
sugar beet and cereal growing regions	N	7.48	7.39	7.41	7.53	7.38	7.69	7.77	7.91	8.01	8.04	7.68	7.80
	T	7.87	7.91	7.57	7.95	7.75	8.17	8.35	8.37	8.22	8.38	8.02	8.34
potato and forage growing regions	N	6.51	6.73	6.29	6.78	6.17	6.59	7.10	6.96	7.28	7.01	7.01	7.10
	T	7.38	7.84	7.00	7.29	6.99	7.76	8.06	8.01	7.62	7.60	7.40	8.21
Grain over 2.5 mm (t/ha)													
maize growing region	N	4.81	4.53	4.80	4.91	4.78	5.03	4.91	4.58	4.82	5.32	4.87	4.82
	T	5.49	5.37	5.46	5.31	5.60	5.70	5.52	5.58	5.44	5.91	5.46	5.60
sugar-beet and cereal growing regions	N	7.01	6.97	6.97	7.14	7.07	6.88	7.38	7.25	7.46	7.79	7.28	7.09
	T	7.52	7.63	7.21	7.66	7.51	7.60	8.02	7.81	7.68	8.18	7.67	7.78
potato and forage growing regions	N	6.22	6.43	5.99	6.53	6.00	6.17	6.78	6.58	6.96	6.83	6.81	6.70
	T	7.21	7.67	6.82	7.16	6.85	7.54	7.90	7.79	7.42	7.44	7.27	7.93
Agronomic data													
straw length (cm)			68	71	71	72	71	67	69	70	69	71	67
earliness of ripening**			110	110	111	111	110	111	109	110	111	110	109
standing power (lodging resistance)			6.1	6.7	5.5	7.0	7.2	6.7	7.3	6.8	6.0	5.6	7.0
Resistance to diseases													
powdery mildew of barley (<i>Blumeria graminis</i>)			8.9	8.9	9.0	5.8	6.7	8.9	8.9	8.3	8.9	8.8	9.0
leaf rust of barley (<i>Puccinia hordei</i>)			5.1	6.5	6.0	7.1	7.1	6.0	5.5	6.5	6.5	7.0	6.0
net blotch of barley (<i>Pyrenophora teres</i>)			6.8	6.5	6.8	7.0	5.9	6.3	6.8	7.0	7.2	6.9	6.7
scald of barley (<i>Rhynchosporium secalis</i>)			7.2	7.5	8.1	8.0	6.2	8.2	8.6	7.7	7.6	6.5	6.6
scab of barley (<i>Fusarium graminearum</i> , <i>F. culmorum</i> , <i>Microdochium nivale</i> etc.),			6.9	7.3	7.0	5.6	6.3	6.2	6.3	6.4	7.2	7.2	6.0
physiological leaf spots of barley (non-specific leaf spots)			8.2	6.0	8.3	7.9	8.1	8.4	8.3	8.5	8.5	8.0	8.5
Grain quality													
1000 grain weight (g)			48	46	48	49	46	49	49	47	50	52	50
sieving fractions over 2.5 mm (%)			92	91	93	93	89	92	89	90	94	92	89

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.

* days from sowing to cropping maturity (time from 1/1 to the maturity day)

Intesity: N – non treated with fungicides and morphoregulators

T – treated with fungicides and morphoregulators

Degradation of cell walls was easy (friability over 85%) in the varieties Cosmopolitan, Laureate, LG Aurus, and Ismena. Favorable values of β -glucan content in wort were recorded in the varieties Cosmopolitan (106 mg/l) and Klarinette (119 mg/l).

The wort color in the studied varieties was from 3.2 to 3.8 EBC units and it strongly reflected the level of pro-

teolytic modification. The varieties LG Aurus and Runner always provided clear wort. Only the variety Ismena provided wort haze determined by nephelometer at the level of 2.3 EBC units. In the other varieties this level was significantly lower.

Malt of the variety **Cosmopolitan**, which was bred in Denmark, provided an above average extract yield

Table 5 Significant agricultural properties (2016–2018)

Variety	Intensity	Mean of the standards	KWS Meridian	Titus	Azrah	Impala	Journey	Laurin	SU Jule	SU Hylona
			6-row							
			S	S						
grain yield (t/ha)	N	7.62	7.69	7.55	7.52	7.59	7.94	7.83	7.68	7.92
	T	9.10	9.20	9.01	9.25	9.28	9.14	9.27	9.27	9.45
Agronomic data										
straw length (cm)			97	107	96	99	98	100	101	108
earliness of ripening*			183	184	183	185	184	184	184	184
standing power (lodging resistance)			6.3	7.7	7.7	7.4	7.5	7.6	7.7	6.2
Resistance to diseases										
powdery mildew of barley (<i>Blumeria graminis</i>)			6.9	7.5	6.0	7.6	7.3	7.3	5.9	6.8
leaf rust of barley (<i>Puccinia hordei</i>)			7.1	7.4	6.4	7.2	7.1	7.4	6.7	7.2
net blotch of barley (<i>Pyrenophora teres</i>)			6.8	6.3	7	6.7	6.4	6.7	6.5	6.7
scald of barley (<i>Rhynchosporium secalis</i>)			7.8	7.0	7.5	7.8	7.5	7.6	7.5	8.0
scab of barley (<i>Fusarium graminearum</i> , <i>F. culmorum</i> , <i>Microdochium nivale</i> etc.)			7.8	7.5	7.4	7.5	7.7	7.2	8.1	8.2
physiological leaf spots of barley (non-specific leaf spots)			6.9	7.4	6.9	7.4	6.1	6.9	7.2	7.0
Mechanical properties (grain quality)										
1000 grain weight (g)			44	47	46	42	44	47	48	41
sieving fractions over 2.5 mm (%)			84	83	83	74	84	89	82	70

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.
* days from sowing to cropping maturity (time from 1/1 to the maturity day)

Intensity: N – non treated with fungicides and morphoregulators
T – treated with fungicides and morphoregulators

(83.1%) at the optimal content of nitrogenous substances in non-malted grain (10.4%). Proteolytic modification was optimal (Kolbach index was around the value of 48.4%). The wort exhibited high values of soluble nitrogen (809 mg/l). Free amino nitrogen was at the level of 186 mg/l and formed 23.0% of soluble nitrogen. Amylolytic modification was high (diastatic power moved around the value of 350 WK units). Degradation of cell walls was at the level of 92% and β -glucan content in wort moved on average around 106 mg/l. The variety provided optimal wort quality, apparent final attenuation ranged on average around 82.9%. In most cases, the variety provided clear wort. Wort color intensity was above average (3.6 EBC un.). Considering the values of the above technological parameters, the variety Cosmopolitan has a very good malting quality with the point evaluation 9 (8.7).

It was recorded in the Common Catalogue of Varieties of Agricultural Plant Species (European Commission, 2019) and it is admitted in Denmark and Great Britain.

Cosmopolitan is a mid-early malting variety. The plants are mid high to low, the variety is mid resistant to lodging and mid resistant to stem breaking. It has medium sized grain, portion of sieving fractions above 2.5 mm is medium high. It is resistant to powdery mildew of barley, medium resistant to leaf rust of barley, medium resistant to net blotch of barley, resistant to leaf scald and medium resistant to scab of barley. Yield of sieving fractions above 2.5 mm in the treated variant growing in the sugar-beet and cereal and potato regions is very high, in the untreated variant growing in the potato region high to very high, in the untreated variant growing in the sugar-beet and cereal regions high, in both variants growing in the maize region it is medium high.

The malt of the variety **Ismena**, which was bred in Germany, provided an above average extract yield (82.4%) at the optimal content of nitrogenous substances in non-malted grain (10.4%). Proteolytic modification was above average (Kolbach index moved around the value of

49.3%). Wort exhibited high values of soluble nitrogen (831 mg/l). Free amino nitrogen was at the medium level of 186 mg/l and formed 22.4% of soluble nitrogen. Amylolytic modification was above average (diastatic power moved around the value of 275 WK units). Degradation of cell walls was at the level of 87% and β -glucan content in wort moved on average around 166 mg/l. The variety provided optimal wort quality, apparent final attenuation ranged on average around 81.9%. In most cases, the variety gave clear wort. Wort color was above average (3.7 EBC units). Considering the values of the studied technological parameters, the variety Ismena has very good malting quality with the point evaluation 7 (6.7).

It was recorded in the Common Catalogue of Varieties of Agricultural Plant Species (European Commission, 2019) and it is admitted in Poland.

Ismena is a mid-early to early malting variety. The plants are mid high to low, the variety is mid resistant to lodging and mid resistant to stem breaking. It has medium sized grain, portion of sieving portions above 2.5 mm is medium high to low. It is resistant to powdery mildew of barley, medium to less resistant to leaf rust of barley, medium resistant to net blotch of barley, resistant to leaf scald, and medium resistant to scab of barley. Yield of sieving fractions above 2.5 mm in the treated variant growing in the potato region is high to very high, in both variants growing in the sugar-beet and cereal regions and in the untreated variant growing medium high to high, in the treated variant growing in the maize region medium high, and low in the untreated variant growing in the maize region.

The malt of the German variety **Klarinette** was rich in extract (82.9%) at the optimal content of nitrogenous substances in non-malted grain (10.6%). Proteolytic modification was at the optimal level. The wort exhibited soluble nitrogen values at the level of 743 mg/l). Free amino nitrogen was at the low level of 157 mg/l and formed 21.1% of soluble nitrogen. Amylolytic modification was above average (diastatic power moved around the value of 279 WK units). Cytolytic modification was optimal. Degradation of cell walls was at the level of 84% and β -glucan content in wort moved on average around 119 mg/l. The variety provided above average wort quality, apparent final attenuation moved on average around 81.2%). In most cases, the variety gave clear wort. The color of the wort was medium to light (2.8 EBC units). In terms of the values of the studied technological parameters, the variety Klarinette has very good malting quality with the point evaluation 7 (7.5).

Klarinette is a mid-early malting variety. Mid high plants, the variety is mid resistant to lodging and mid resistant to stem breaking. It has medium big to small grain,

the portion of sieving fractions above 2.5 mm is medium high. It is resistant to powdery mildew of barley, medium resistant to leaf rust of barley, medium resistant to net blotch of barley, medium resistant to leaf scald, medium resistant to scab of barley. Yield of sieving fractions above 2.5 mm in the untreated variant growing in the potato regions is very high, in the untreated variant growing in the sugar-beet and cereal regions high, in the treated variant growing in the sugar-beet, cereal and potato regions and in the untreated variant growing in the maize region medium high, in the treated variant growing in the maize region it is medium high to low.

Malt of the variety **Laureate**, which was bred in Great Britain, was rich in extract (83.9%) at the optimal content of nitrogenous substances in non-malted grain at the level of 10.3%. Proteolytic modification was high (50.6%). The wort exhibited high values of soluble nitrogen at the level of 832 mg/l. Free amino nitrogen was at the medium level of 186 mg/l and formed 22.3% of soluble nitrogen. Amylolytic modification was high (diastatic power 333 WK units). Cytolytic modification was above average to optimal. Degradation of cell walls was at the level of 90% and β -glucan content in wort moved on average only around 145 mg/l. The variety provided wort with a favorable composition, apparent final attenuation moved on average around 82.3%. In most cases, the variety gave clear wort. Wort color was above average (3.9 EBC units). Considering the values achieved in the technological parameters, the variety Laureate has a very good malting quality with the point evaluation 7 (7.5).

The variety was recorded in the Common Catalogue of Varieties of Agricultural Plant Species (European Commission, 2019) and is admitted in Germany, Estonia, France, Lithuania, Latvia, the Netherlands, Austria and the United Kingdom. In 2019 it was also registered in the Slovak Republic (Psota et al., 2019).

Laureate is a mid-early malting variety. The plants are mid high to low, the variety is mid resistant to lodging and mid resistant to stem breaking. It has medium big grain, the portion of sieving fractions above 2.5 mm is high. It is resistant to powdery mildew of barley, medium resistant to leaf rust of barley, medium resistant to net blotch of barley, medium resistant to resistant to leaf scald, and medium resistant to scab of barley. Yield of sieving fractions above 2.5 mm in both variants growing in the maize, sugar-beet and cereal regions and in the untreated variant of growing in the potato region is very high, in the treated variant growing in the potato region it is medium high.

The malt of the Czech variety **LG Aurus** was rich in extract (83.5%) at the optimal content of nitrogenous substances in non-malted grain (10.5%). Proteolytic modification was at the optimal level. The wort exhibited

high values of soluble nitrogen (801 mg/l). Free amino nitrogen was at the medium level of 182 mg/l and formed 22.7% of soluble nitrogen. Amylolytic modification was high (diastatic power moved around the value of 341 WK units). Cytolytic modification was optimal. Degradation of cell walls was at the level of 88% and β -glucan content in wort moved on average around 156 mg/l. The variety provided very favorable wort quality (apparent final attenuation ranged on average around 82.3%). The variety always provided clear wort. Wort color was above average (3.3 EBC units). Considering the values of the technological parameters under study, the variety LG Aurus has very good malting quality with the point evaluation 8 (8.1).

In 2019 the variety was registered in the Slovak Republic (Psota et al., 2019). LG Aurus is a mid-early to early malting variety. The plants are mid high, the variety is mid too less resistant to lodging and mid resistant to stem breaking. Big grain, portion of sieving fractions above 2.5 mm is medium high. Resistant to powdery mildew of barley, medium resistant leaf rust of barley, medium resistant to net blotch of barley, medium resistant to leaf scald and medium resistant to scab of barley. Yield of sieving fractions above 2.5 mm in the untreated variant growing in the potato region is high to very high, in the untreated variant growing in the sugar-beet and cereal regions medium high to high, in the treated variant growing in the potato region medium high, in the untreated variant growing in the maize region and in the treated variant in the sugar-beet, cereal and potato regions medium high, in the treated variant in the maize region it is medium high to low.

The German variety **Runner** provided malt with above average values of extract yield (82.5%) at the optimal content of nitrogenous substances in non-malted grain at the level of 10.2%). Proteolytic modification was optimal (Kolbach index moved around the value of 46.1%). The wort exhibited soluble nitrogen values at the level of 761 mg/l. Free amino nitrogen was at the level of 164 mg/l and formed 21.5% of soluble nitrogen. Amylolytic modification was above average (diastatic power moved around the value of 279 WK units). Cytolytic modification was average. Degradation of cell walls was at the level of 84% and β -glucan content in wort moved on average around 192 mg/l. Within the tests, the variety achieved optimal values of apparent final attenuation (82.0%) and always provided clear wort. Wort color was above average (3.4 EBC units). Considering the values of the technological parameters, the variety Runner has very good malting quality with the point evaluation 7 (6.7).

The variety Runner was recorded in the Common Catalogue of Varieties of Agricultural Plant Species (European Commission, 2019) and is admitted in Poland.

Runner is a mid-early to early malting variety. The plants are mid high to low, the variety is mid resistant to lodging and mid resistant to stem breaking. It has medium big grain, the portion of sieving fractions above 2.5 mm is medium high to low. It is resistant to powdery mildew of barley, medium resistant to leaf rust of barley, medium resistant to net blotch of barley, medium resistant to leaf scald, and medium resistant to scab of barley. The yield of sieving fractions above 2.5 mm in the untreated variant growing in the potato region is very high, in the untreated variant growing in the potato region high, in the treated variant growing in the sugar-beet and cereal regions medium high to high, in both variants growing in the maize region and in the untreated variant growing in the sugar-beet and cereal regions medium high.

4 Conclusion

The study presents the results achieved by six varieties of spring barley which were registered in the Czech Republic after the 2018 harvest. The quality was assessed according to the Malting Quality Index. The content of nitrogenous substances in the spring barley varieties under study was at the optimal level (10.2 to 10.6%) and the varieties were rich in extract. More than 83% of extract was recorded in the varieties Laureate (83.9%), LG Aurus (83.5%), and Cosmopolitan (83.1%). Proteolytic, amylolytic and cytolytic modification in the varieties was mostly at the optimal level. The variety Laureate had high Kolbach index (50.6%). Quality of wort assessed by the apparent final attenuation in the spring barley varieties Cosmopolitan, LG Aurus, Laureate, and Runner was at the optimal level (over 82%).

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