



System for the evaluation of malting quality of wheat varieties

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Abstract

A new system for the calculation of malting quality of wheat varieties was designed. The malting parameters affected by a variety more than by a year or a site were used in the system. These parameters include wort viscosity, soluble nitrogen content, free amino nitrogen content, diastatic power, final attenuation of wort, and extract of malt. The system was used to assess the malting quality in 38 wheat varieties. The point value of each parameter was calculated using the regression equations, and the total value of the malting quality of wheat was determined by the modified “superiority measure” method. The results of the assessment of the wheat malting quality showed considerable differences between the varieties. Several varieties exhibited a more pronounced tendency to accumulate nitrogenous substances in grain. Some varieties, even with a slightly higher content of nitrogenous substances, provided above average malt quality. The set included the varieties that exhibited the optimal content of nitrogenous substances in grain, yet they did not give malt of good quality. Spring wheat varieties Alondra, Anabel, and Seance achieved significantly above average malting quality. Dagmar, Evina, Sultan, Rumor, Sailor, and Brokat exhibited slightly above average malting quality. The proposed system for monitoring malting quality of wheat varieties can help find the varieties suitable for the production of quality wheat malt.

Key words: wheat, wheat malt, brewing quality

1 Introduction

Wheat grain, similarly as barley grain, is a natural material whose characteristics are affected by a number of external and internal factors. The basic factors determining quality of wheat grain and subsequently malt include the variety and growing conditions. The quality of wheat malt affects not only the individual phases of the beer production but also sensory properties (flavour, colour, foam) of wheat beer. However, the suitability of wheat varieties for the malt and beer production is not systematically monitored.

Quality of wheat malt is assessed according to the same parameters as quality of malt made from barley, although the technology used for the production of wheat malt partly differs from that used for the malt made from barley. The technological process of the wheat beer production is mark-

edly influenced by local customs. The differences are in the amount of the extract added with the wheat malt. Usually, for the production of wheat beer, 30% to 70% of wheat malt is used. The differences between barley and wheat and technology used for the production of wheat and barley beer require a different view of both input materials.

The effects of the quality of wheat grain on the malt and beer production have not been studied in as much detail as in barley (Back, 2005). The requirements for quality of wheat malt have been discussed in many studies (Sacher and Narziß, 1992; Back, 2005; Tietze et al., 2013; Faltermaier et al., 2013; Faltermaier et al., 2014) and are also given in specifications of malt houses producing wheat malt.

In the Czech Republic, the system of the evaluation of the malting quality of wheat varieties does not exist. This study represents a possible method for the evaluation spring and winter wheat varieties in terms of their suitability for the production of good wheat malt.

2 Material and methods

2.1 The evaluated parameters

The parameters for the evaluation of wheat varieties were selected based on the analyses of 11 spring wheat varieties (Sachambula et al., 2017) and 27 winter wheat varieties (Psota et al., 2018). Based on these studies, the following technological parameters of malt and sweet wort were selected for the evaluation: wort viscosity, soluble nitrogen content, free amino nitrogen content, diastatic power, final attenuation, and extract content in the malt dry matter. These parameters characterize cytolytic, proteolytic, and amylolytic modification of wheat malt and were mostly affected by the variety.

2.2 Determination of weights and limit values

The weights of the evaluated parameters and their limit values were determined subjectively based on experience and requirements of malt houses and breweries (Table 1).

2.3 Calculation of the point evaluation for the respective parameters

A nine-point scale is used: nine points indicate the best level of the parameter, while point one is an unacceptable value.

The conversion of the absolute values of the parameters to the point evaluation is performed using a linear regression equation:

$$y = a + bx$$

where a and b are coefficients (Table 1), x is the absolute value of the given parameter.

$$a = 1 - b \cdot UL$$

$$b = (9 - 1)/(OL - UL)$$

where OL is the optimal limit and UL the unacceptable limit of the absolute values of the given parameter. An optimum range of 9 points was established for the parameter of nitrogenous substance content. Absolute values lower or higher than the optimum have the point evaluation lower than 9. Two equations are therefore used for the conversion (one for suboptimal values, the other one for superoptimal values).

2.4 Calculation of the malting quality of wheat

Calculation of the Malting Quality of Wheat (MQW) is based on the modification of a so-called “superiority measure” (Lin and Binns, 1988). This system is quite flexible and can be easily modified; the studied parameters can be easily changed. The system was used to design the Malting Quality Index for barley (Psota and Kosař, 2002). The MQW for the given variety is calculated from the point values of the individual malting quality parameters:

$$MQW_j = 9 - \sqrt{P_j}$$

where

$$MQW = \text{Malting Quality of Wheat,}$$

$$P_j = \sum (B_{ij} - 9)^2 W_i / \sum W_i,$$

where, B_{ij} = point evaluation of the i -parameter of the j -variety and W_i = weight of the i -parameter.

The MQW ranges from 1 (worst, unacceptable) to 9 (best, optimal). Since in its principle it is a weighted average of squares of deviations of the point evaluation of the individual parameters from the maximum value (9 points), the genotypes reaching similar values in the individual malting quality parameters gain a better evaluation. Thus, a variety that receives 8 points in all characteristics has a higher MQW than, for example, a variety that reached 7 points for two parameters, 9 points for two parameters, and 8 points for the other three parameters.

3 RESULTS AND DISCUSSION

3.1 Selection of the quality parameters

The parameters significantly influenced by a variety were selected for the malting quality evaluation based on the results of the analyses of wheat varieties published previously (Sachambula et al., 2017; Psota et al., 2018). The selected parameters characterize cytolytic, proteolytic, and amylolytic modification.

3.2 Content of nitrogenous substances in the non-malted wheat grain

The amount of the nitrogenous substances in the wheat grain is significantly affected by the environment. In the winter wheat varieties studied for the three-year period, the nitrogenous substance content was affected by the year from 61.7%, locality from 14.4%, and the variety only from 11.3% (Psota et al., 2018). The effect of the variety on the nitrogenous substance content was substantially lower, nevertheless, it was included in the system for the evaluation of the malting quality of wheat varieties.

The portion of starch in grain declines with the increase of the portion of the nitrogenous substances.

Table 1 Limit values and weights of qualitative parameters for wheat varieties

	Abbreviations	Units	References	Unacceptable limit	Optimal limit	Regression coefficients		Weight
				1	9	a	b	
Nitrogen substances in grain wheat (factor 6.25)	PB	%	EBC 2010 3.3.2	10.0	11.0	-79.00	8.00	0.01
				12.5	11.5	101.00	-8.00	
Extract of malt	E	%	EBC 2010 4.5.1	83.0	85.0	-331.00	4.00	0.30
Diastatic power	DP	u. WK	EBC 2010 4.12	250	350	-19.00	0.08	0.10
Final attenuation of wort	FA	%	EBC 2010 4.11.1	80.0	83.0	-212.33	2.67	0.10
Free amino nitrogen	FAN	mg/l	EBC 2010 4.10	85.0	105	-33.00	0.40	0.10
Soluble nitrogen in wort	SNw	mg/l	EBC 2010 4.9.3	650	750	-51.00	0.08	0.10
Viscosity of wort	Vw	mPa.s	EBC 2010 4.8	2.00	1.65	46.71	-22.86	0.25
Sum of weights								0.96

The increased portion of the nitrogenous substances significantly affects most of the parameters evaluated in malt and wort. For this reason, the nitrogenous substance content was included in the evaluation system. The nitrogenous substance content in the evaluated sample of the given wheat variety must be in the optimal scope or close to this optimum. Malt wheat should contain less than 12% of nitrogenous substances (Narziß et al., 2017). Nitrogenous substances in wheat grain as well as other cereals are stored mainly in the aleurone layer and in the endosperm.

3.3 Cytolytic modification

Viscosity of sweet wort belongs to the basic parameters evaluated in wheat malt as it indicates its usability for the beer production. During malting, cytolytic enzymes degrade cell walls of the endosperm to smaller molecules and initiate the degradation of high molecular weight substances to low molecular weight substances which pass to the sweet wort; this results in lower values of viscosity. As plant fibre has high absorption ability, arabinoxylans, β -glucans, and dextrans increase wort viscosity (Sadosky et al., 2002). Wheat grain has a lower β -glucan content than barley grain, but it has more arabinoxylans, increasing thus sweet wort viscosity.

The value of sweet wort viscosity was affected by the variety from 50.0% in spring wheat varieties and from 81.6% in winter wheat varieties. The wort viscosity varied from 1.61 to 1.78 mPa.s in spring wheat varieties and from 1.69 to 2.31 mPa.s in winter wheat varieties (Sachambula et al., 2017; Psota et al., 2018). According to Back (2005), the viscosity value of sweet wort should move below 1.80 mPa.s. Narziß et al. (2017) reported viscosity in a range from 1.65 to 1.85 mPa.s. In the sys-

tem designed for this study, the values ≤ 1.65 mPa.s are considered optimal and the sweet wort viscosity value ≥ 2.00 mPa.s is unacceptable (Table 1).

3.4 Proteolytic modification

During malting, proteolytic modification occurs, i.e. high molecular weight nitrogen compounds are degraded and amino acids, peptides, etc. are formed and become part of sweet wort. Amino acids are important for yeast growth and polypeptides positively affect foam stability and contribute to the fullness of beer (Narziß and Back, 2012). The qualitative composition of nitrogenous substances is characterized by the content of free amino nitrogen (FAN).

Kolbach index informs on the size of the portion of the nitrogenous substances that got into the wort. The value of Kolbach index in the spring wheat varieties was affected from 21.9% by a year and 34.3% by the locality; in the winter wheat varieties this value was affected by a year from 52.3% and from 17.2% by a locality.

The spring wheat varieties affected the content of soluble nitrogen from 48.7% and winter wheat varieties from 30.7%. In FAN (mg/l), effects of the spring and winter wheat varieties were at the comparable levels of 26.5% and 25.1%, respectively (Sachambula et al., 2017; Psota et al., 2018).

The amount of soluble nitrogen depends on the amount of nitrogen in wheat grain and subsequently in malt. During malting, mainly the storage proteins are hydrolysed. Low molecular weight nitrogen compounds, namely amino acids, have a positive effect on fermentation. If the FAN concentration is high enough, yeast has more nutrients and fermentation can proceed faster and alcohol production is higher (Briggs et al., 2004). On the

other hand, high FAN content can lead to the formation of undesirable flavours (Back, 2005).

Back (2005) reported that the soluble nitrogen content should move in the range of 650–780 mg/100 g, i.e. approximately 710–855 mg/l. Jin et al. (2012) found the soluble nitrogen content in a wider range of 849 to 1246 mg/l and FAN from 120 to 166 mg/100 g, i.e. approximately 135 to 185 mg/l. Faltermaier et al. (2013) reported that the content of soluble nitrogen in a typical pale malt ranged from 600 – 800 mg/100 g, which is approximately 660 – 895 mg/l, and in FAN, from 100 to 140 mg/100 g, i.e. approximately 110 to 160 mg/l.

In the spring wheat varieties, the soluble nitrogen content and FAN ranged from 665 to 847 mg/l and 89 to 116 mg/l, respectively (Sachambula et al., 2017). In the winter wheat varieties, the soluble nitrogen content and FAN ranged from 642 to 832 and 82 to 112 mg/l, respectively (Psota et al., 2018). The share of FAN in the total soluble nitrogen content was around 14%, which corresponds to the values reported by Narziß et al. (2017). In the proposed evaluation system, the values of soluble nitrogen content of 650 mg/l and less are considered unacceptable, values of 750 mg/l and more are considered optimal. In the case of FAN, values of 85 mg/l or less are considered unacceptable and values of 105 mg/l or greater are considered optimal (Table 1).

3.5 Amylolytic modification

In the evaluation system of malting quality of wheat varieties, amylolytic modification is characterized by the following parameters: diastatic power, final attenuation and, first of all, extract in malt dry matter, a trait with a significant economic impact.

In spring wheat, diastatic power, final attenuation and extract content were affected by the variety from 65.6%, 42.8% and 47.1%, respectively (Sachambula et al., 2017). In winter wheat varieties, the variety was affected by diastatic power from 51.9% and final attenuation from 47.6%. In this case, the extract was influenced

by a variety only from 29.4%, whereas the year influenced this trait from 49.1% (Psota et al., 2018).

Diastatic power is a parameter characterizing the activity of amylolytic enzymes, namely β -amylase, that degrade starch to soluble sugars (Dunn, 1974). In spring and winter wheat varieties, diastatic power achieved the average values from 250 to 410 WK un. (Sachambula et al., 2017; Psota et al., 2018), and a similar range has been reported by Narziß and Back (2012). In the evaluation system of malting quality of wheat varieties designed in this study, the values of diastatic power of 250 WK un. are considered to be unacceptably low, and the values of 350 WK un. and higher are taken as optimal (Table 1).

Degradation of starch is also characterized by final attenuation. The average values of this parameter in spring wheat varieties moved from 79.7% to 81.3%, in winter wheat varieties from 78.6% – 81.4% (Sachambula et al., 2017; Psota et al., 2018). A similar range has been reported by Narziß et al. (2017). For the evaluation of malting quality of wheat varieties proposed in this study, the values of final attenuation at the level of 80% and less are considered unacceptably low and the values at the level of 83% and higher optimal (Table 1).

Similarly as in barley, the extract content in malt dry matter is affected by the content of nitrogenous substances. The average extract values in spring wheat varieties ranged from 81.9% to 84.8%, in winter barley varieties it was in the range from 82.3% to 85.4% (Sachambula et al., 2017; Psota et al., 2018). This corresponds to the range of 83% to 85% reported in the literature (Narziß and Back, 2012; Back, 2005). Based on the results achieved and data from the literature, this study considered the values of the extract content in dry matter of 83% and less as unacceptably low, and 85 % and more as the optimal (Table 1).

3.6 Examples of the MQW calculation

Analytic values of hypothetical varieties and corresponding point evaluation of the individual quality parameters are given in Table 2.

Table 2 Examples of the MQW calculation

Parameters	MQW	PB	E	DP	FA	FAN	SNw	Vw	PB	E	DP	FA	FAN	SNw	Vw
Weight		0.01	0.30	0.10	0.10	0.10	0.10	0.25	0.01	0.30	0.10	0.10	0.10	0.10	0.25
Units	9-point scale	%	%	WK un.	%	mg/l	mg/l	mPa.s	9-point scale						
Varieties															
A	3.6	11.7	83.5	307	80.1	89	691	1.80	7.4	3.0	5.6	1.3	2.4	4.3	5.6
B	6.3	12.0	84.5	330	81.0	100	700	1.70	5.0	7.0	7.4	3.7	7.0	5.0	7.9
Abbreviations:															
MQW – Malting quality of wheat; PB – Nitrogen substances in grain wheat (factor 6.25); E – Extract of malt;															
DP – Diastatic power; FA – Final attenuation of wort; FAN – Free amino nitrogen; SNw – Soluble nitrogen in wort;															
Vw – Viscosity of wort; 9-point scale – 1 (worst, unacceptable) to 9 (best, optimal)															

Example: MQW calculation, the variety “A”:

$$\begin{aligned}
P_A &= (9-7.40)^2 * 0.01 = 0.03 \\
&+ (9-3.00)^2 * 0.30 = 10.80 \\
&+ (9-5.56)^2 * 0.10 = 1.18 \\
&+ (9-1.27)^2 * 0.10 = 5.98 \\
&+ (9-2.40)^2 * 0.10 = 4.36 \\
&+ (9-4.28)^2 * 0.10 = 2.23 \\
&+ (9-5.57)^2 * 0.25 = 2.94 \\
\text{Total} &= 27.51
\end{aligned}$$

$$P_A = 27.51/0.96 = 28.66$$

$$MQW_A = 9 - \sqrt{28.66} = 9 - 5.35 = 3.65$$

Example: MQW calculation, the variety “B”:

$$\begin{aligned}
P_B &= (9-5.00)^2 * 0.01 = 0.16 \\
&+ (9-7.00)^2 * 0.30 = 1.20 \\
&+ (9-7.40)^2 * 0.10 = 0.26 \\
&+ (9-3.67)^2 * 0.10 = 2.84 \\
&+ (9-7.00)^2 * 0.10 = 0.40 \\
&+ (9-5.00)^2 * 0.10 = 1.60 \\
&+ (9-7.86)^2 * 0.25 = 3.33 \\
\text{Total} &= 6.79
\end{aligned}$$

$$P_B = 6.79/0.96 = 7.07$$

$$MQW_B = 9 - \sqrt{7.07} = 9 - 2.66 = 6.34$$

3.7 Malting quality of spring and winter wheat varieties

Each year, malt samples were made from spring and winter wheat samples obtained from three testing localities in harvest years 2013 to 2015. It means that the results of the analyses were the average of nine measurements. All the varieties thus had the same growing conditions (Sachambula et al., 2017; Psota et al., 2018). The achieved results were used for the calculation of malting quality using the proposed system.

Some spring wheat varieties did not provide samples with the optimum content of the nitrogenous substances (11.0% to 11.5%); this had a negative impact on the extract content and some other characteristics. Probably some wheat varieties are more susceptible to higher nitrogen accumulation in the grain (Table 3). Spring wheat varieties Alondra, Anabel, and Seance achieved significantly above-average malting quality.

Some winter wheat varieties also had a strong tendency to accumulate nitrogenous substances in the grain. Some varieties, even with a slightly increased content of the nitrogenous substances in the grain, provided above-average quality malt. The set includes the varieties with the optimal nitrogenous substance content in the grain, yet they did not provide good quality malt. The varieties Dagmar, Evina, Sultan, Rumor, Sailor, and Brokat showed a slightly above-average malting quality (Table 4).

Wheat varieties are bred primarily for bakery or feed use. In both cases, the increased nitrogenous substance accumulation, clearly exhibited by some varieties, is a positive trait. Breeding for malting quality is performed only to a limited extent.

Table 3 Spring wheat malting quality

Parameters	MQW	PB	E	DP	FA	FAN	SNw	Vw	PB	E	DP	FA	FAN	SNw	Vw
Weight		0.01	0.30	0.10	0.10	0.10	0.10	0.25	0.01	0.30	0.10	0.10	0.10	0.10	0.25
Units	9-point scale	%	%	WK un.	%	mg/l	mg/l	mPa.s	9-point scale						
Varieties															
Alondra	6.5	11.3	84.8	334	80.6	103	699	1.65	9.0	8.3	7.7	2.7	8.2	4.9	9.0
Anabel	6.1	11.7	84.1	327	81.3	107	728	1.76	7.4	5.4	7.2	4.4	9.0	7.2	6.4
Seance	5.9	11.4	84.7	312	80.8	101	672	1.64	9.0	7.7	6.0	3.1	7.4	2.8	9.0
Tercie	5.3	11.7	83.9	305	80.9	100	724	1.78	7.2	4.6	5.4	3.3	7.0	6.9	6.0
Izzy	4.6	11.9	83.2	413	81.3	107	758	1.67	5.9	1.7	9.0	4.4	9.0	9.0	8.6
Dafne	4.5	11.7	83.8	353	80.9	89	665	1.73	7.7	4.2	9.0	3.3	2.6	2.2	7.1
Astrid	4.3	12.1	83.2	311	81.0	100	717	1.61	4.0	1.7	5.9	3.8	7.0	6.4	9.0
KWS Akvilon	4.0	12.2	83.4	285	79.7	94	722	1.70	3.8	2.8	3.8	1.0	4.6	6.8	7.8
KWS Scirocco	4.0	12.8	82.9	364	80.6	116	847	1.63	1.0	1.0	9.0	2.7	9.0	9.0	9.0
KWS Chamsin	3.8	12.2	81.9	277	81.3	102	727	1.71	3.5	1.0	3.2	4.5	7.8	7.2	7.7
Quintus	3.4	12.2	82.3	229	80.7	110	768	1.65	3.8	1.0	1.0	2.7	9.0	9.0	9.0

Abbreviations:
MQW – Malting quality of wheat; PB – Nitrogen substances in grain wheat (factor 6.25); E – Extract of malt;
DP – Diastatic power; FA – Final attenuation of wort; FAN – Free amino nitrogen; SNw – Soluble nitrogen in wort;
Vw – Viscosity of wort; 9-point scale – 1 (worst, unacceptable) to 9 (best, optimal)

Table 4 Winter wheat malting quality

Parameters	MQW	PB	E	DP	FA	FAN	SNw	Vw	PB	E	DP	FA	FAN	SNw	Vw
Weight		0.01	0.30	0.10	0.10	0.10	0.10	0.25	0.01	0.30	0.10	0.10	0.10	0.10	0.25
Units	9-point scale	%	%	WK un.	%	mg/l	mg/l	mPa.s	9-point scale						
Varieties															
Dagmar	5.2	11.8	84.8	251	79.7	109	754	1.74	6.3	8.1	1.1	1.0	9.0	9.0	6.9
Evina	5.2	12.1	83.8	312	80.6	112	708	1.69	4.4	4.0	5.9	2.5	9.0	5.6	8.1
Sultan	5.1	12.1	84.1	332	79.3	109	688	1.75	4.6	5.4	7.6	1.0	9.0	4.1	6.7
Rumor	5.0	10.9	84.9	319	80.0	97	616	1.73	7.8	8.6	6.5	1.0	5.9	1.0	7.3
Sailor	4.8	11.5	84.5	266	79.7	108	668	1.73	8.9	7.1	2.3	1.0	9.0	2.4	7.1
Brokat	4.5	11.3	84.2	312	79.7	102	602	1.77	9.0	5.7	5.9	1.0	7.7	1.0	6.3
Seladon	4.5	10.8	84.8	294	79.7	95	604	1.80	7.2	8.3	4.5	1.0	4.8	1.0	5.5
Artist	4.2	10.8	84.0	324	80.2	91	598	1.78	7.2	5.2	6.9	1.4	3.5	1.0	6.0
Lavantus	4.0	11.1	84.1	288	79.6	93	588	1.78	9.0	5.3	4.0	1.0	4.1	1.0	6.1
Elan	4.0	11.7	83.8	348	79.6	102	662	1.86	7.7	4.4	8.8	1.0	7.7	2.0	4.1
Etana	3.8	11.3	83.4	303	80.3	100	657	1.72	9.0	2.5	5.3	1.8	7.0	1.6	7.4
Vanessa	3.8	10.7	84.0	401	79.4	92	662	1.88	6.3	5.0	9.0	1.0	3.7	1.9	3.6
Bohemia	3.3	12.4	81.9	299	81.0	105	654	1.75	2.1	1.0	4.9	3.8	9.0	1.3	6.7
Annie	3.2	12.7	82.4	317	80.8	104	684	1.85	1.0	1.0	6.4	3.2	8.6	3.7	4.5
Fabius	3.2	11.6	83.4	305	80.9	93	629	1.88	7.9	2.7	5.4	3.3	4.1	1.0	3.8
Cimrmanova raná	3.1	13.0	82.2	248	81.4	100	667	1.71	1.0	1.0	1.0	4.7	7.2	2.4	7.5
Elly	2.9	11.7	82.5	319	80.0	95	588	1.76	7.3	1.0	6.5	1.0	4.9	1.0	6.4
Tobak	2.8	11.1	83.6	250	79.3	96	622	1.88	9.0	3.5	1.0	1.0	5.6	1.0	3.7
Turandot	2.8	11.3	83.7	307	80.3	86	599	1.93	9.0	4.0	5.6	1.7	1.3	1.0	2.5
Patras	2.7	11.6	84.1	307	78.6	88	640	2.03	8.5	5.5	5.6	1.0	2.2	1.0	1.0
Athlon	2.7	12.8	82.6	281	78.9	106	688	1.87	1.0	1.0	3.4	1.0	9.0	4.0	3.9
KWS Ozon	2.5	11.1	83.6	295	79.6	82	593	1.94	9.0	3.4	4.6	1.0	1.0	1.0	2.5
Matylda	2.3	11.6	82.6	290	79.9	88	582	1.82	8.3	1.0	4.2	1.0	2.3	1.0	5.2
Genius	1.9	12.3	81.9	295	79.1	107	670	2.10	3.0	1.0	4.6	1.0	9.0	2.6	1.0
Matchball	1.5	11.1	82.7	347	78.9	82	640	2.31	9.0	1.0	8.8	1.0	1.0	1.0	1.0
Fakir	1.3	12.0	82.3	285	79.1	86	585	2.12	5.3	1.0	3.8	1.0	1.4	1.0	1.0
Zeppelin	1.3	11.7	82.6	284	79.2	86	583	2.13	7.3	1.0	3.7	1.0	1.2	1.0	1.0

Abbreviations:

MQW – Malting quality of wheat; PB – Nitrogen substances in grain wheat (factor 6.25); E – Extract of malt; DP – Diastatic power; FA – Final attenuation of wort; FAN – Free amino nitrogen; SNw – Soluble nitrogen in wort; Vw – Viscosity of wort; 9-point scale – 1 (worst, unacceptable) to 9 (best, optimal)

4 Conclusion

Wheat varieties are bred primarily for purposes of the milling-baking industry. If the variety does not meet the baking quality and provides a high yield, it is classified as a feed variety without any indication of the feed quality. The wheat grain is also used for malt production. However, malting quality is not routinely monitored in wheat. From the parameters commonly determined in malt produced from barley, we selected the parameters that characterize cytolytic (viscosity of wort), proteolytic (contents of soluble nitrogen and FAN) and amylolytic

modification (diastatic power, final attenuation, and extract content in malt dry matter) and which were more markedly affected by a variety. These parameters were used for designing a system for the evaluation of the malting quality of wheat varieties. The system detected the wheat varieties with slightly to markedly above-average malting quality. To find wheat varieties providing malt suitable for the production of wheat beer, it will be necessary to monitor the malting quality systematically.

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