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Breeding of malting barley and the possibilities of breeder's adaptation to changeable demands of malt and beer industry in Czech Republic and Europe

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Introduction – Position of malting barley in Czech agriculture

The beer production in Czech Republic has a long tradition, which started in 14th century. Several Czech varieties (Proskowetz Hana Pedigree, Diamant) were used world wide as the donors of malting quality traits. Barley has still a very important position in Czech agriculture. Spring and winter barley occupy the second and third position as for area of cultivation among cereal crops. Nevertheless, there has occurred dramatic variability both at spring and winter barley in the area of cultivation and particularly in yield due to changeable climatic conditions in the period 2000-2005 (Table 1). The lowest spring barley yield was recorded in 2000 due to a very dry period during vegetation. On the contrary, winter barley has reached 25% higher yield than spring barley. This situation evoked the idea of investigating malting quality of winter barley to consider it as the reserve for production of malting barley. The very cold winter of 2003 resulted in area and yield reductions. The yield of winter barley was 22% lower than the yield of spring barley and malting industry was not interested in winter malting barley. Except of it new varieties of spring barley in the period 2004-2006 manifest so high malting quality parameters which the varieties of winter barley are not able to perform.

Table 1. Comparison between the area of cultivation and yield of winter and spring barley in Czech Republic (1974-2005)

Year	Winter barley		Spring barley		Difference	
	1000 ha	t/ha^{-1}	1000 ha	t/ha^{-1}	t/ha^{-1}	%
1974	4	3.5	649	3.9	-0.4	-11
1984	123	5.1	469	4.5	0.5	13
1990	243	6.1	339	5.4	0.6	12
1994	185	4.2	495	3.7	0.4	13
1995	195	4.4	370	3.8	0.6	14
1998	187	4.1	393	3.8	0.3	8
2000	142	4.0	354	3	1.0	25
2001	157	4.4	338	3.7	0.7	18
2002	141	3.7	345	4	-0.3	-6
2003	98	3.1	450	3.9	-0.8	-22
2004	115	5.2	353	5.07	0.1	2
2005	125	4.5	397	4.44	0.1	2

Material and methods

In the present study we will evaluate exclusively results which were recorded in the Official State Variety Test organized by the Central Institute of Supervising and Testing in Agriculture in the Czech Republic. Malting quality traits were determined by the Research Institute of Brewing and Malting, PLC, Malting Institute Brno (RIBM). Malting quality index was adopted in 1995 (Psota *et al*., 1995) and made more precise in 1999 (Psota, 1999). When forming this system, eight basic technological

traits were agreed for evaluation, i.e.: protein content in barley (PC), extract of malt (EC), relative extract at 45 ^{o}C (RE), Kolbach number (KN), apparent final attenuation degree (FAD), diastatic power (DP), friability (FRI) and betaglucan in wort (BG). Weights and limit values corresponding to point "9" (best – optimum) and "1" (worst - unacceptable) were determined to the chosen technological traits based on mutual agreement on their importance for the manufacturing industry (Table2). The Committee for the quality evaluation of malting barley variety at RIBM slightly modified the system of evaluation (Psota and Kosar, 2002, Psota, 2006). Since 2003 clarity (Appearance) of wort is assessed as the decisive parameter for recognition as malting barley variety without respect to the level of other parameters. Assessment is as follows: 1=clear, 2= slight opal, 3=opal. Exclusively, barley candidate or varieties manifesting clarity of wort 1=clear are accepted.

Table 2. Changes on malting quality traits in CZ in the period 1974-2004

Variety	Period	PC (%)	EC (%)	RE (%)	KN (%)	DP (WK)	FDA (%)	FRI (%)	BGL (mg/l)
Valtický	1950-53	11.7	81.2	37.9	39.4	317	77.1		
Diamant	1967-69	10.9	81.6	38.1	41.7	305	78.4		
Favorit	1978-80	11.4	80.7	39.6	39.8	301	79.2		
Rubín	1988-90	11.4	81.4	45.6	42.3	282	80.8		
Akcent	1994-97	11.1	81.5	45.9	46.9	280	81.3	82	221
Olbram	1994-97	11	83	43.2	47.8	256	82.1	87	149
Maridol	1996-98	11.1	82.2	40.1	43.7	250	80.1	83	203
Malz	2002-04	10.8	82.9	39.0	43.6	312	81.6	85	202
Respekt	2002-04	11.2	82.2	42.6	45.0	386	81.6	81	237
Bojos	2002-04	10.9	82.9	37.4	43.4	383	80.4	86	117

Abbreviation of malting quality parameters –See Table 3.

Results

Table 3 shows the changes on malting quality traits of Czech varieties in the period 1950-2004. There are many parameters which were significantly improved, particularly extract content, relative extract at 45ºC and Kolbach number. There are traits which were not known or evaluated until 1990 as β-glucan content and friability. When malting and beer industry started to evaluate these two traits, a big amount of new lines were excluded from official state trials. The main reason was the requirement on low β-glucan content (less than 150 mg/l wort) which was not saturated. In 2003 this parameter was increased on 250 mg/l. This decision provided possibility for registration of Czech varieties Malz and Respekt (Spunarova, 2001).

The leading varieties manifest very high proteolytic activity (Fig.1). Nevertheless, Pilsen brewery came to the conclusion that varieties with high proteolytic activity like Jersey and Prestige are not advantageous for the production of typical Czech Lager Bier (Table2). This is why particularly varieties with low values of relative extract and Kolbach number like Amulet, Radegast, Bojos are preferred (Fig. 2).

Since 2003 new parameter wort clarity was introduced. In spite of the fact that variety Marnie reached "9" at almost all parameters, this variety was not released in Czech Republic. In the neighbouring Slovakia, Marnie was released as the company Heineken dominates the market. In 2005 variety Timori was released in Czech Republic and 2006 in Slovakia. Timori is the first variety on the Czech and Slovak market which exhibits lower LOX activity (Tables 5 and 6).

Actually, variety 'Malz' reached a significant area of cultivation. In Czech Republic the malting barley market is dominated by the French company Soufflet. The list of 6 preferred varieties represents 82% of the area planted with spring barley for seed increase (Table 4).

Table 3. Requirements of malt and beer industry in CZ since 2003

Quality parameters	Abbreviation	Threshold for acceptance	Optimal value	Czech beer
		1 point	9 points	Optimal value
Protein content	PC	9.5	10.2	
		11.7	11.0	
Extract content	EC	81.5	83.0	min. 81.5%
Relative extract RE 45ºC	RE	35.0	40.0	max. 38%
(Hartong number)		53.0	48.0	
Kolbach number	KN	40.0	42.0	39+or-1
		53.0	48.0	
Diastatic power	DP	220	300	min. 220
Final degree attenuation	FDA	79.0	82.0	max. 80%
Friability	FRI	79.0	86.0	min. 75%
Betaglucan content	BG	250	100	max. 250 mg/l

Table 4. Area devoted to spring barley varieties seed increase in CZ in 2005

Number	Variety	Origin (country)	% of total area
1	Jersey	NL	30
2	Malz	CZ	15
3	Prestige	GB	15
4	Sebastian	DK	11
5	Tolar	CZ	8
6	Diplom	D	3
Total			82

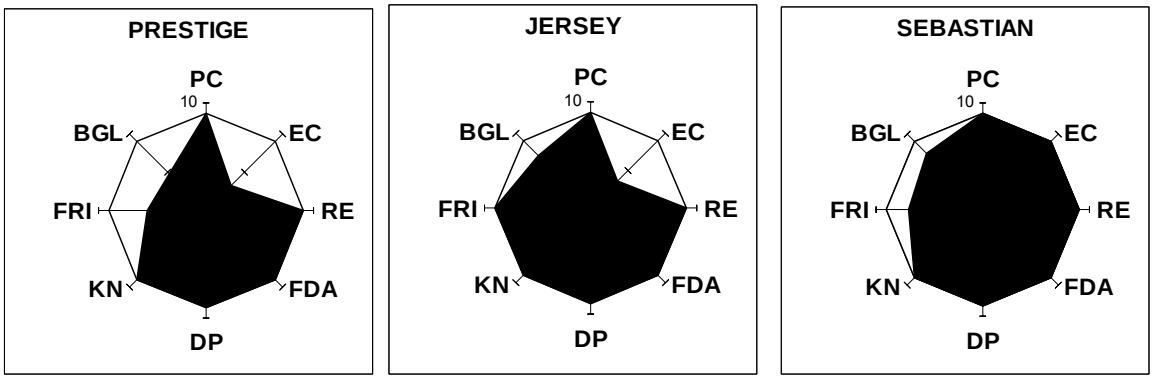

Fig. 1. Malting quality traits of the most cultivated malting barley varieties, Czech Republic (2005).

Due to the lack of spring malting barley, winter barley variety Tiffany was accepted in the period 2000-02. Since 2003 winter barley is not accepted as neither Tiffany, nor other released varieties (Mascara) nor candidate for registration (Vanessa) reach the malting quality of the top spring malting barley varieties.

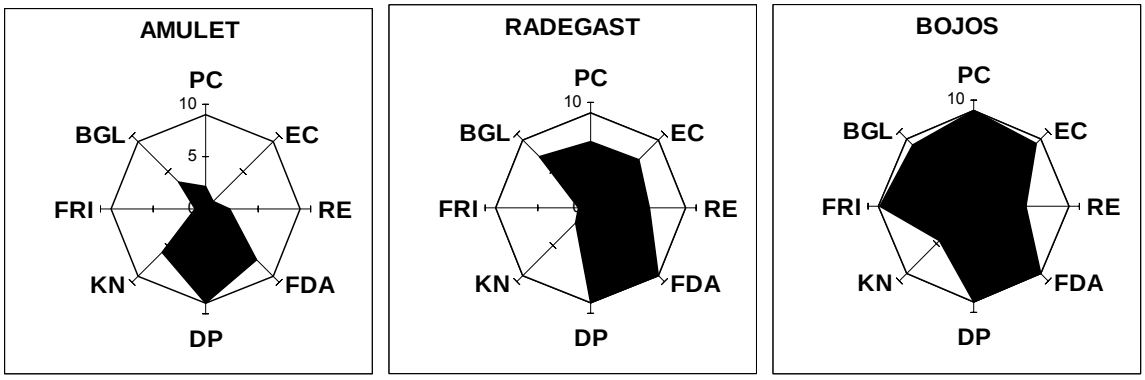

Fig. 2. Malting quality parameters of varieties advatageous for Czech type beer, Czech Republic (2005).

Table 5. LOX (u/mg) activity of malt - Official State Trials, Czech Republic, 2005 (Psota, 2006)

Variety	Origin (country)	Location				
		1	2	3	4	Average
Tolar	CZ	100	179	105	168	138
Jersey	NL	166	142	119	173	150
Braemar	GB	149	188	126	173	159
Xanadu	D	67	41	88	87	71

Table 6. LOX (u/mg) activity of malt - Official State Trials, Slovak Republic, 2005 (Psota, 2006)

Variety	Origin (country)	Location		
		1	2	Average
Timori	NL	7	5	6
Nadir	SK	101	78	90

The varieties Braemar and Xanadu were released in 2006 in the Czech Republic with the perspective to be preferred varieties by malting and brewing industry in the next years.

Discussion

Breeding of malting barley has a long tradition in the Czech Republic. In spite of the continuous improvement of agronomic and qualitative traits, there are still new requirements of the malting industry to improve some particular quality traits (Spunar *et al*., 2002). The situation will likely be more dramatic in the future, due to new competitors, such as the wine processing industry (Van der Veen 2005, Williamson, 2005). Beer must be sensorialy stable and healthy (Waesberghe, 2005). This is why except for some agronomic important parameters ensuring economic profitability of the production of malting barley, the most important role will be played by new malt quality traits such as low or null LOX content (Hirota *et al*., 2004, Skadhauge *et al*., 2005).

Conclusion

The beer production in Czech Republic has a long tradition, which started in 14th century. Several Czech varieties (Proskowetz Hana Pedigree, Diamant) were used world wide as the donors of malting

quality traits. Some of them were so improved (relative extract 45°C, Kolbach number) that they do not enable the production of top quality Pilsen Urquell type of beer. Breeding of new variety takes 10-15 years. The requirements of malting and beer industry change sometimes within one year. Friability and β-glucans were not evaluated until 1990. Since 1995 all varieties (candidates for release) showing a β-glucan content higher than 150 mg/l were excluded, independently of the level of other malting quality traits. This requirement manifested as nonsense and since 2003 genotypes with β-glucan content up to 250 mg/l are accepted. The registration of variety Krona brought the problems with the wort clarity. All varieties without wort clarity are not accepted for malting and beer industries. In the near future breeders will have to concentrate on barley with low or null LOX content to increase sensoric stability of beer. When the malt and beer industries decide which variety to accept for processing and the farmers absolutely respect their requirements, breeders must intuitively modify their selection criteria to be competitive on the market.

Acknowledgements

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