QUALITY PARAMETRES OF EMMER WHEAT LANDRACES

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ABSTRACT

Emmer wheat, Triticum dicoccum SCHUEBL, is an old variety of cereals which has been traditionally grown in aride areas. Nowdays, it is mainly grown in Italy, Spain, Turkey, Austria and in the Czech republic. This article deals with a study of quality parametres and selected economic parametres of 6 varieties coming from the genetic resources of emmer wheat. High crude protein content in grain was proved during the trials. Nevertheless, such a characteristic is not suitable for the classical bakery processing (production of leavened products). Low figure of the harvest index is supposed to be the most problematic economic character. However, emmer wheat is a suitable variety for organic farming system. Growing of emmer wheat contributes to an extension of the agrobiodiversity in the countryside and to the suistainable development of a region.

Keywords: wheat, emmer, landraces, baking quality

DETAILED ABSTRACT

V roce 2006 bylo zvoleno 10 odrůd pšenice dvouzrnky (jarní formy) z kolekce genové banky při VÚRV v Praze-Ruzyni a byl proveden screening. Následně bylo vybráno 6 odrůd pšenice dvouzrnky (Tabulka 1) a 2 kontrolní odrůdy pšenice seté (Vaněk, SW Kadrilj). Jako screeningové kriterium byl zvolen obsah hrubého proteinu a úroveň produktivity klasu. Na dvou stanovištích, VURV Praha-Ruzyně (RI) a Zemědělské fakulty JU v Českých Budějovicích (CB) byly založeny maloparcelkové pokusy (2,5 m^2) ve dvou opakováních (2007).

Po sklizni byl vyhodnocen sklizňový index, výtěžnost zrna po vyloupání, hmotnost tisíce zrn (HTZ) a objemová hmotnost. Jakostní analýzy byly provedeny v laboratořích České zemědělské univerzity v Praze. Pro laboratorní analýzy byly využity následující metody: obsah hrubého proteinu (Kjeldahl - ICC No. 105), obsah mokrého lepku a gluten index - (ČSN ISO 5531, Glutomatic 2200), Zeleny test (ICC No. 116/1), číslo poklesu (Falling number ICC No. 107), obsah škrobu (polarimetricky podle Ewerse, ČSN ISO 56 0512-16, Polamat A).

Z dosažených výsledků je patrné, že hospodářské znaky jsou v porovnání s kontrolními odrůdami pšenice seté hodnoceny negativně a poukazují na nižší výnosovou úroveň. Jako nejproblematičtější znak se jeví nízké hodnoty sklizňového indexu (Tabulka 2). Je to způsobeno tím, že testované odrůdy nebyly nikdy prošlechtěny a mají krajový charakter. Výtěžnost zrna po vyloupání (75%) je odpovídající. Objemová hmotnost je oproti pšenici seté snížena stejně jako hmotnost tisíce zrn.

Během jakostních analýz se podařilo potvrdit vysoký obsah hrubého proteinu v zrnu (u některých odrůd přesáhl v maloparcelkových pokusech 20%). Problematická je jeho kvalita s ohledem na pekařské zpracování (nepříznivé hodnoty gluten indexu a Zelenyho testu) (Tabulka 4 a 5). V případě potravinářského využití dvouzrnky je potřebné se zaměřit na jiné než klasické pekařské zpracování (i když někteří autoři poukazují na fakt, že dvouzrnkový chléb je sice plochý, má ale výborné senzorické vlastnosti).

Z výsledků našich pokusů je patrné, že dvouzrnka je druh vhodný pro pěstování v ekologickém zemědělství. Nemůže sice s moderním odrůdám konkurovat v úrovni výnosu, naproti tomu poskytne velmi kvalitní produkci. Pěstování dvouzrnky přispívá k rozšíření agrobiodiverzity na orné půdě. Je také potřeba zohlednit příznivý vliv na zdraví konzumentům kdy místní producenti získají možnost vyrábět zdravé potravinářské výrobky a přispět tak k udržitelnému rozvoji regionu.

INTRODUCTION

Emmer wheat (Triticum dicoccum SCHUEBL, tetraploid species: 2n=28, AABB genom) which is divided into 99 botanic varieties [14], belongs to glumeous varieties of wheat that have a long tradition of growing and use as human diet [13]. Finding of the fact that, at least once, it was inserted to the cropping and growing (it was domesticated) also demonstrates the human interest in this species [3].

The Levant region (Iran, Iraq, Jordan, Syria and Palestine) is its area of origin. Wild predecessor of emmer wheat (T. dicoccoides) may be still found there [5]. Emmer wheat has never been breeded and nowdays just landraces and wild forms may be found. As a part of human diet, it played very important role in the period of ancient nations (the Babylon nation, the Assyrian nation, the Egyptian nation) [14].

Considering increasing requirements for richness, diversity and good-quality of foodstuff products, the interest in this species of wheat has been still increasing [8], [16], [15]. Such a renewed interest in emmer wheat varieties has its origin in countries with well-developped intensive agriculture. On the other hand, the surface of areas of emmer wheat has been decreasing in countries with less developped farming sector [13].

It is grown in extreme mountane conditions on smaller areas in the Balkan, Turkey, Caucasia and in India, it is still grown in Etiopia [17]. [9] speaks on 10 000 ha of emmer wheat in Turkey in 1993. Considering European countries, it is the most grown species of cereals in Italy and Spain. [13] state the fact that the surface of the areas of emmer wheat in Italy is about 1 500 ha and the total yield varies from 2 500 to 3 000 t grains without glumes. Several hectars may be found in the Asturia region (Spain). Considering Central Europe, for example Meierhof biodynamic farm in Waldwiertel in Austria [1] and several organic farms in the Czech republic [10] grow it too. It was also grown in Slovakia in the 1950's [2].

Several authors state the favourable quality indicators for the human diet. They mention the high crude protein content on the first place, nevertheless, it is not suitable for the bakery processing. The litterature may contain the results of the quality analysis contrary to each other. Therefore, this study is focused on the quality parametres of the varieties of emmer wheat which are part of the collection of the Gene bank at Research Institute of Crop Production in Prague-Ruzyně. Particular economic characters are mentioned there too and they are compared with the economic characters of the control varieties of soft wheat.

MATERIALS AND METHODS

In 2006, 10 varieties of emmer wheat (spring form) have been chosen from the collection of the Gene bank in the Crop research Institute in Prague-Ruzyně and the screening has been carried out. 6 varieties of emmer wheat (Table 1) and two control varieties of soft wheat (Vánek, SW Kadrilj) have have been chosen subsequently. Crude protein content and spike productivity were considered as the screening criteria. Small-parcel double trials (2,5 m^2) were set up at two stations, at the Research Institute of the Crop Production in Prague (RI) and at the Faculty of Agriculture in České Budějovice (CB).

The characteristics of the trial stations: RI – altitude of 364 m; mean air temperature of 7,9°C; total precipitation of 525,9 mm; sunshine duration of 1668,3 hours, pH ($CaCl_2$) of 7,3; P - 78 $mg.kg^{-1}$; K - 210 $mg.kg^{-1}$; Mg - 148 $mg.kg^{-1}$; Ca - 4360 $mg.kg^{-1}$. CB – altitude of 388 m; mean air temperature of 8,2 °C; total precipitation of 620 mm; sunshine duration of 1564,3 hours; pH ($CaCl_2$) of 6,3; P - 138 $mg.kg^{-1}$; K - 155 $mg.kg^{-1}$; Mg - 163 $mg.kg^{-1}$; Ca - 1557 $mg.kg^{-1}$.

The harvest index (HI), grain percentage after the peeling, thousand grain weight (TGW) and the hectoliter weigth (HW) were evaluated after the harvest of cereals.

The quality analysis were executed in the labratories of the Czech Agricultural University in Prague. The following methods were used to carry out the laboratory analysis: Crude protein content (Kjeldahl - ICC No. 105), Wet Gluten Content and Gluten index - (ČSN ISO 5531, Glutomatic 2200), Zeleny – Sedimentation value (ICC No. 116/1), Enzyme (α-amylase) activity (Falling number ICC No. 107), Starch content (according Ewerse, ČSN ISO 56 0512-16, Polamat A).

RESULTS AND DISCUSION

Not only the quality evaluation of grain, but also the analysis of the selected economic characters was executed after the harvest. The following text indicates the results of the harvest index, the proportion of grain and glumes in the yield, thousand grain weight and hectoliter weight.

The average harvest index achieved 0,27 at the RI station and 0,34 at CB station (Table 2). There is a certain difference between the particular varieties. D1 and D3 get to the highest figures (0,36). The variation coefficient gets to 22,2 % (RI) and 14,7 % (CB). The figures correspond to the contributions of the other authors who state the

Table 1 List of varieties

Variety	ECN[1]	BCHAR[2]	Name	Origin	*Triticum dicoccum* (SCHRANK) SCHUEBL:
D1	01C0200117	412064	Horny Tisovnik	CZ	var. *rufum* SCHUEBL
D2	01C0200947	412048	Ruzyne	-	var. *rufum* SCHUEBL
D3	01C0201262	412051	Tapioszele 1	-	var. *serbicum* A. SCHULZ
D4	01C0201282	412017	Tapioszele 2	-	var. *rufum* SCHUEBL.
D7	01C0203989	412013	Kahler Emmer	D	var. *dicoccum*
D10	01C0204501	412013	No. 8909	-	var. *dicoccum*

Notes: [1] ECN = identificator ; [2] BCHAR = taxonomical code ;

Table 2 Economic characters I.

Variety	Harvest index			Grain percentage (%)		
	location		mean	location		mean
	RI	CB		RI	CB	
D1	0,31	0,41	**0,36**	83	80	**87**
D2	0,18	0,32	**0,25**	73	74	**74**
D3	0,37	0,35	**0,36**	81	76	**79**
D4	0,27	0,27	**0,27**	79	70	**75**
D7	0,25	0,32	**0,29**	78	72	**75**
D10	0,25	0,36	**0,31**	76	75	**76**
mean	**0,27**	**0,34**	-	**78**	**75**	-
SD	**0,06**	**0,05**	-	**3,56**	**3,45**	-
CV	**22,2**	**14,7**	-	**4,6**	**4,6**	-
controlling varieties of bread wheat						
M6	0,47	0,47	0,47	-	-	-
M10	0,49	0,47	0,48	-	-	-
mean	**0,48**	**0,47**	-	-	-	-

harvest index does not reach the level of the HI of the breeded varieties of soft wheat [18] and it fluctuates around the average level of 0,3 [13].

The proportion of non-glumeous and glumeous grains is an important factor influencing the yield of cereals. It varies between 60-80 % and the average figure varies from 70 to 75 % [13]. The average yield rate of our trials reached 78 % at the RI and it got to 75 % at CB (Table 2). This character of the varieties is supposed to be quite stable (CV of 4,6 % at the both stations). The other authors state the similar figures too [4, 11]. They state the average figure to vary between 64,1-72,8 %). [2, 14] suppose the proportion of the glumes to vary between 17 and 37 %, it means the proportion of the non-glumeous and glumeous grains to vary between 63-83 %.

Thousand grain weight (TGW) is by 10 g lower than TGW of the modern varieties. There is not any considerable difference between the varieties, CV of 13,6 % (RI) and of 6,3 % (CB) (Table 3). [13] state the same figures, they indicate TGW varying between 30 and 45 g and they emphasise it to be influenced by the genotype and environment.

The hectoliter weight of emmer wheat is lower the this one of the modern varieties of wheat [13]. It got to the similar value at our both trial stations (733 $g.l^{-1}$ at RI and 738 $g.l^{-1}$ at CB) (Table 3). The lower value at one of the stations could be considered as a result of the later yield of certain varieties. The other authors state the similar figures, e.g. [6] states the figure of 654 $g.l^{-1}$ and [19] of 788 $g.l^{-1}$.

Evaluated varieties provide higher crude protein content than controlling ones. At location RI is difference 3,5% and CB 2,6% on behalf emmer (Table 4). The higher protein content provide D4 (Tapioszele 2) – 20,1%. According to standartd ČSN 46 1100-2 is possible to include all emmer varieties in quality group elite. Coeficient of variation (CV) is 8,9% (VURV) and 12,4% (CB). The higher protein content of emmer with comparison of soft wheat grown in the same conditions acknowledges e.g. [12, 14].

At the location RI emmer provide the higher wet gluten content than controlling varieties about 9%, at CB was the same. CV attained 20% at both location. Crude protein content, quality and content of gluten provide negative relation. Varieties with high gluten content but its low quality aren´t usefull for making proofing dought from backery point of view [21].

Gluten index have possitive corelation with quality of gluten. High value of gluten index showed strong gluten which is very difficult working. Low value is characterised by weak gluten which isn´t suitable for backery processing. In case of RI location provide 30 (CV 85,1%) at CB it is 36 (CV 37,9) (Table 4). This trait is very unstable. Gluten index provide double value in case of controlling varieties. Gluten of emmer is weak and isn´t good for backery processing.

Sedimentation value determine viscosoelastic character of gluten albumines and theire quality which provide fermentative processes in dought (proofing) for. With crude protein content and bread volume corelate in positivelly way. The value are low at both locations. Varieties aren´t able to surmount value (ČSN 46 1100-2) as minimum for submission into quality category B (bread). Controlling varieties provide high value (VURV

Table 3 Economic characters II.

Variety	TGW (g)			Hectoliter weight ($g.l^{-1}$)		
	location		mean	location		mean
	RI	CB		RI	CB	
D1	36	36	**36**	741	746	**743**
D2	27	32	**30**	721	754	**738**
D3	35	33	**34**	759	739	**749**
D4	29	31	**30**	723	735	**729**
D7	27	33	**30**	734	719	**727**
D10	28	30	**29**	718	735	**727**
mean	**30**	**33**	**-**	**733**	**738**	**-**
SD	**4,08**	**2,07**	**-**	**15,55**	**11,83**	**-**
CV	**13,6**	**6,3**	**-**	**2,1**	**1,6**	**-**
controlling varieties of bread wheat						
M6	41	38	**40**	818	792	**805**
M10	41	40	**41**	779	754	**767**
mean	**41**	**39**	**-**	**799**	**773**	**-**

– 63 ml, CB – 54 ml) (Table 5). According to [20] are sedimentation value at half with comparison of modern varieties.

Starch content is the same in case of all varieties and is very fixed. The lower starch content provide varieties D2 (Ruzyně) a D4 (Tapioszele2) at both location. The higher content provide variety D3 (Tapioszele 1) (65,9% RI and 64,8% CB) at both locations. [7] features the lower value of starch content (52,7-56,8%).

Falling number detect damage of storage matter of grain wheat endosperm by hydrolytic enzymes, which are syntetised in consequence of start germination before harvest in grain. For insertion into quality group elita is minimum value 240 s according to ČSN 46 1100-2. This value didn´t get only one variety D3 (Tapioszele 1) at RI location (Table 5). At the same location is higher level of CV (20%). This fact could be explained by later harvest some of varieties (came after rainy time), it is conformed by [21]. This author note that falling number is very sensitive to rainy time during harvest. At CB location there was harvested in time and varieties provide the high value with low variability.

RESULTS

The reached results indicate the fact that the economic characters of emmer wheat are negative in comparison with the ones of the control varieties of soft wheat and

Table 4 Quality parametres I.

Variety	Crude protein content (%)			Wet gluten content (%)			Gluten index		
	location		mean	location		mean	location		mean
	RI	CB		RI	CB		RI	CB	
D1	18,0	15,6	16,8	44,5	30	37,3	4	43	24
D2	20,4	18,6	19,5	55,8	42,9	49,4	51	43	47
D3	15,9	14,4	15,2	34,9	33	34,0	5	15	10
D4	20,2	20,0	20,1	53,4	45,2	49,3	11	17	14
D7	19,6	19,2	19,4	40,2	49,7	45,0	55	24	40
D10	19,0	18,3	18,7	57,2	44,5	50,9	53	43	48
mean	**18,9**	**17,7**	**-**	**47,7**	**40,9**	**-**	**30**	**36**	**-**
SD	**1,7**	**2,2**	-	9,2	7,7	-	25,5	13,7	-
CV	**8,9**	**12,4**	**-**	**19,2**	**18,8**	**-**	**85,1**	**37,9**	**-**
controlling varieties of bread wheat									
M6	15,8	14,8	15,3	38,2	41,1	39,7	83	90	87
M10	15,0	15,3	15,2	39,2	41,8	40,5	79	55	67
mean	**15,4**	**15,1**	**-**	**38,7**	**41,5**	**-**	**81**	**77**	**-**

Table 5 Quality parametres II.

Variety	Zeleny test (ml)			Starch content (%)			Falling number (s)		
	location		mean	location		mean	location		mean
	RI	CB		RI	CB		RI	CB	
D1	18,0	15,6	16,8	44,5	30	37,3	4	43	24
D2	20,4	18,6	19,5	55,8	42,9	49,4	51	43	47
D3	15,9	14,4	15,2	34,9	33	34,0	5	15	10
D4	20,2	20,0	20,1	53,4	45,2	49,3	11	17	14
D7	19,6	19,2	19,4	40,2	49,7	45,0	55	24	40
D10	19,0	18,3	18,7	57,2	44,5	50,9	53	43	48
mean	**18,9**	**17,7**	**-**	**47,7**	**40,9**	**-**	**30**	**36**	**-**
SD	**1,7**	**2,2**	-	9,2	7,7	-	25,5	13,7	-
CV	**8,9**	**12,4**	**-**	**19,2**	**18,8**	**-**	**85,1**	**37,9**	**-**
controlling varieties of bread wheat									
M6	15,8	14,8	15,3	38,2	41,1	39,7	83	90	87
M10	15,0	15,3	15,2	39,2	41,8	40,5	79	55	67
mean	**15,4**	**15,1**	**-**	**38,7**	**41,5**	**-**	**81**	**77**	**-**

they mean an inferior yield level. The low figures of the harvest index are supposed to be the most problematic feature. It is caused by the fact that the tested varieties have never been breeded and they are characterised by local and regional features. The grain percentage after the peeling of grains is about 75 % and it corresponds to the expectations. The hectoliter weight and TGW are inferior to these ones of soft wheat varieties.

High proportion of crude protein in grain was affirmed by the quality analysis (in several cases, it exceeded 20 % in small-parcel trials). Its quality (from the point of view of its use in bakery sector) seems to be quite problematic factor. It proves negative values of gluten index and Zeleny test. In case of emmer wheat, it is better not to use it in the bakery sector, but in the other sectors and branches. However, several authors emphasise the fact bread made of emmer wheat is flat but it has perfect sensoric qualities and features.

The results of our trials indicate the fact, emmer wheat is a suitable variety for organic farming system. It is not able to compete with modern varieties from the point of view of the level of yield, nevertheless it provides very good-quality grains. Growing of emmer wheat contributes to an extension of agrobiodiversity in the countryside. The effects of human health are also considerable, local producers may not only produce good and healthy local foodstuffs, but they may also contribute to the sustainable development of a region.

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