SELECTION OF MINOR WHEAT SPECIES CULTIVARS AND GENETIC RESOURCES FOR ORGANIC FARMING, WITH EMPHASIS ON BAKING QUALITY PARAMETERS

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Wider collection of Triticum dicoccon (emmer), T. monococcum (einkorn), spring form of T. spelta (spelt) and obsolete, alternative forms of T. aestivum landraces and other genetic resources, cultivated in exact field small-plot trials under the conditions of organic farming was evaluated with the view of baking quality parameters and suitability for organic farming, in comparison with 3 check T. aestivum cultivars. The highest crude protein content in grain dry matter (16 - 18 %) was found in the spelt group, followed by einkorn and obsolete forms of T. aestivum (15 - 17%) and emmer (15 - 16 %);.check cultivars about 13 % in average. On the other hand, values of Gluten Index and SDS sedimentation test were in minor wheat species considerably lower in comparison with the check cultivars. The lowest values of GI (17 - 34 %) and SDS-test (15 – 27 ml) were found in einkorn, followed by emmer (GI 26 – 40 %, SDS-test 25 – 30 ml), obsolete forms of T. aestivum and spelt (GI 50 – 68 %, SDS-test 53 – 70 ml); check cultivars GI 70 – 78 %, SDS-test 59 – 72 ml). With regard to low values of SDS-test and GI (especially in einkorn and emmer), that indicated weak gluten, it is possible to recommend them especially for non-proofing and wholemeal products.

***Key words**: minor wheat species, organic farming, baking quality*

In relation to expansion of organic farming in the Czech Republic, interest in nontraditional, minor, old or alternative crops that have common feature – their cultivation is not common in present, though many of them played an important role in the past is increasing. These are predominantly less yielding crops, but they have many positive characteristics, e.g. undemandingness and suitability to use

them in less productive areas [DENGCAI et al., 2003]. They do not require pesticides and industrial fertilizers. This predestinates these crops for the organic or low input growing systems [DOTLAČIL, 2002]. Examples of these minor crops are some species of *Triticum* genus – *T. monococcum* (einkorn), *T. dicoccon* (emmer), *T. spelta* (spelt) and obsolete, alternative forms of *T. aestivum.*

Considering increasing requirements for richness, food-diversity and good-quality of foodstuff products, the interest in these species of wheat is still increasing among consumers, too [HAMMER & PERINNO, 1995; OLSEN, 1998].

Gathering, evaluation and utilization of wheat genetic resources had a long tradition in the former Czechoslovakia and these activities continue in the two present countries – the Czech and Slovak Republics. Wheat collection in the Czech Gene Bank is the biggest one among plant genetic resources in the Czech Republic [STEHNO et al., 2005]. Collected samples of wheat genetic resources, landraces and obsolete cultivars are multiplied and tested for their properties and characters. Based on complex information there can be selected accessions, suitable for their use in breeding or agricultural practice.

Spelt wheat is grown in the Czech Republic primarily by organic farmers. For that purpose suitable winter genotype was selected from wheat collection and registered as Rubiota cultivar in 2001. Emmer is of increasing importance for organic farming. In 2004 a genotype with high disease resistance, very good yield level and stability and was selected from the collection. The CRI (Crop Research Institute) in Prague applied for legal protection of the selected material under the proposed name Rudico. Einkorn genetic resources are tested in field experiments for their possible use in practice or as donors of valuable properties and traits [STEHNO et al., 2005].

This study is focused on the quality parameters of landraces and other genetic resources of einkorn, emmer, spelt and obsolete, alternative forms of common wheat, which are the part of collection of the Gene Bank of CRI in Prague.

MATERIAL AND METHOD

Screen of baking quality parameters was made in the wide collection of *T. monococcum* (24 genetic resources), spring forms of *T. spelta* (15 landraces and other genetic resources), *T. dicoccon* (103) and obsolete alternative forms of *T. aestivum* (28). As checks there were used 3 spring bread wheat cultivars Jara (old one), Granny and SW Kadrilj, registered in the Czech republic at present.

Seed samples were obtained from the Czech Gene Bank in CRI Prague – Ruzyně. Number of samples per species differed owing to different number of accessions in the gene bank and also because of limited amount of the seeds available.

Seed samples for quality evaluation originated from the organic system of growing (experimental fields certified for organic cultivation in CRI Prague).

Based on the results of this screen, reduced collection of minor wheat species landraces and other genetic resources (*tab. 1*) was selected for exact small plot trials (4 m^2 in 3 replications), conducted in 2008 in two experimental localities - České Budějovice (experimental fields of University of South Bohemia – 388 m above sea

level, average annual temperature 8.2°C, average sum of precipitation 620 mm) and Prague – Ruzyně (experimental fields of CRI – 340 m above sea level, average annual temperature 7.8°C and average sum of precipitation 472 mm). Experiments were carried out in both localities in organic growing system, without mineral fertilizers and pesticides.

Grain quality traits were evaluated by the standard methods – crude protein content in grain dry matter (Kjeldahl method, ČSN ISO 1871), wet gluten content in grain dry matter and Gluten Index (ČSN ISO 5531, applied on Glutomatic 2200), SDS sedimentation test (by Axford, ČSN 46 1100-2) and falling number (ČSN ISO 3093, with Falling Number 1400).

Table 1

List of wheat landraces and other genetic resources, evaluated in both experimental localities - České Budějovice and Prague – Ruzyně

T. monococcum		*T. dicoccon*	
Name	Origin	Name	Origin
T. monococcum 1	GEO	Weisser Sommer	DEU
T. monococcum 2	GEO	May-Emmer	CHE
T. monococcum	ALB	*T. dicoccon* (Brno)	CSK
T. monococcum No. 8910	DNK	*T. dicoccon* (Dagestan)	RUS
T. monococcum	ARM	*T. dicoccon* (Kew)	-
Schwedisches Einkorn	SWE	*T. dicoccon* (Tapioszele)	-
		Rudico	CZE
T. spelta		*T. aestivum* – obsolete alternative forms	
Name	Origin	Name	Origin
T. spelta (Ruzyne)	CSK	Postoloprtska presivka	CSK
T. spelta (Tabor 1)	-	Rosamova ceska cervena	CSK
T. spelta (Tabor 2)	-	Kasticka presivka 203	CSK
T. spelta No. 8056	-		
T. spelta No. 8930	-		
T. spelta (VIR St.Petersburg)	CSK		

RESULTS AND DISCUSSIONS

It is evident from our results of the wide collection minor wheat species screen (*tab. 2*) as well as results of the reduced collection from the both experimental localities (*tab. 3 – 4*), that all evaluated minor wheat species exceeded considerably values of crude protein content in grain dry matter of the check cultivars of common wheat. The highest average crude protein content in grain dry matter reached spelt wheat (16.54 % in average - *tab. 2*; 18.12 % - *tab. 4*) and obsolete alternative forms of *T. aestivum* (17.66 % in average – *tab. 3*), but all evaluated minor wheat species exceeded requirements for crude protein content in grain dry matter for bread making wheat for minimum of 11.5 % (Czech standard ČSN 46 1100-2). Values of crude protein content in grain dry matter in the check cultivars of common wheat varied from 12.30 to 13.90 %. Our results, indicating much higher values of crude protein content in evaluated minor wheat species, compared with present cultivars of common wheat, are in accordance with observations of many authors, for example MICHALOVÁ et al. [2003],

KONVALINA et al. [2008] – according them crude protein content in grain dry matter of hulled wheat varied generally from 15 to 19 % (sometimes to 24 %).

The results of wet gluten content in grain dry matter of evaluated minor wheat species corresponded with the results of crude protein content in grain dry matter; varied from 36 to 49 % in average and exceeded considerably values of wet gluten content in grain dry matter of check cultivars (varied from 28 to 33 %). Wet gluten content in grain dry matter in spelt varied usually from 35 – 45 %, but in some cases even to 54 % [MICHALOVÁ, 2000]. BOJŇANSKÁ & FRANČÁKOVÁ [2002] determined wet gluten content in several spelt cultivars in average of 37.1 %.

Table 2

Grain quality parameters in the wide collection of minor wheat species

Parameter	Crude protein content in grain dry matter (%)	Wet gluten content in grain dry matter (%)	Gluten Index (%)	SDS-test (ml)	Falling number (s)
T. monococcum					
Mean	15.40	40.45	17.17	15.17	372.92
SD*	0.86	3.62	8.25	5.21	19.45
VC** (%)	5.58	8.95	48.05	34.34	5.21
T. dicoccon					
Mean	14.73	36.78	25.89	25.12	357.80
SD	1.89	7.75	14.72	8.41	57.93
VC (%)	12.83	21.07	56.86	33.48	16.19
T. spelta					
Mean	16.54	45.19	55.40	60.27	347.00
SD	1.10	4.37	14.96	11.13	42.12
VC (%)	6.65	9.67	27.00	18.47	12.14
T. aestivum – obsolete alternative forms					
Mean	15.17	40.11	50.21	56.50	375.90
SD	1.43	5.94	18.70	11.76	23.77
VC (%)	9.43	14.81	37.24	20.81	6.32
T. aestivum – check cultivars					
Jara Mean	13.07	30.85	66.83	48.30	329.20
Granny Mean	12.52	28.55	82.52	55.21	393.10
Kadrilj Mean	12.39	28.36	85.02	74.02	294.41

* SD = Standard deviation; ** VC = Variation coefficient

SDS-test is quality parameter, predicative baking quality of gluten. It is evident from our results, that evaluated minor wheat species, especially einkorn and emmer, reached considerably lower values of this parameter in comparison with check cultivars of common wheat. In spelt and obsolete alternative forms of common wheat lower values of SDS-test were found too, but differences among these species and check cultivars were not so high.

Results of SDS-test showed high variability in this parameter – considerably higher than in the case of crude protein content and wet gluten content in grain dry matter.

The lowest values of SDS-test were found in einkorn (varied from 10 to 39 ml), followed by emmer (SDS-test values varied from 12 to 45 ml). These values indicated worse possibilities of utilization them for proofing dough. According to KONVALINA et al. [2008], gluten of emmer is weak and is not suitable for bakery processing. Emmer flour is, however, suitable for production of many kinds of non-proofing products [MARCONI & CUBADDA, 2005].

But, in einkorn and emmer the highest variability in SDS-test (VC 30 – 43%) was found. These values indicate good possibilities of selection in this quality trait.

Table 3

Grain quality parameters in the selected collection of minor wheat species from the experimental locality Prague – Ruzyne

Parameter	Crude protein content in grain dry matter (%)	Wet gluten content in grain dry matter (%)	Gluten Index (%)	SDS-test (ml)	Falling number (s)
T. monococcum					
Mean	16.18	43.89	18.67	19.83	367.00
SD	0.97	3.80	8.65	8.51	20.82
VC (%)	6.00	8.66	46.33	42.91	5.67
T. dicoccon					
Mean	16.06	42.98	38.29	28.29	397.57
SD	0.88	3.79	12.95	11.34	24.74
VC (%)	5.48	8.82	33.82	40.08	6.22
T. spelta					
Mean	17.17	47.17	52.50	64.17	373.33
SD	0.70	3.26	6.60	5.18	18.82
VC (%)	5.82	6.91	12.57	8.07	5.04
T. aestivum – obsolete alternative forms					
Mean	17.66	49.53	50.50	70.00	389.00
SD	1.11	2.85	2.50	8.00	1.00
VC (%)	6.29	5.75	4.95	11.43	0.26
T. aestivum – check cultivars					
Mean	12.66	29.25	78.12	59.18	338.90
SD	0.36	1.39	9.86	13.31	50.06
VC (%)	2.84	4.75	12.62	22.49	14.77

Gluten Index is another quality trait, characterizing baking quality of wheat gluten. Obtained results showed similar trends as in SDS-test. Higher variability in this parameter in comparison with variability in crude protein content and wet gluten conten was determined. As in SDS-test, the lowest values of Gluten Index were found in einkorn and emmer.

Falling number reached very high values in all evaluated wheat species and exceeded considerably requirements for falling number of bread wheat - min. 220 s (according to the Czech standard – ČSN ISO 3093).

Table 4

Grain quality parameters in the selected collection of minor wheat species from the experimental locality Ceske Budejovice

Parameter	Crude protein content in grain dry matter (%)	Wet gluten content in grain dry matter (%)	Gluten Index (%)	SDS-test (ml)	Falling number (s)
T. monococcum					
Mean	16.45	44.53	34.50	27.17	378.33
SD	1.22	3.18	9.88	8.19	32.91
VC (%)	7.42	7.14	28.64	30.19	8.70
T. dicoccon					
Mean	15.70	41.27	40.57	29.71	385.29
SD	0.57	2.22	11.76	12.89	39.08
VC (%)	3.63	5.38	28.99	43.39	10.14
T. spelta					
Mean	18.12	49.27	58.83	53.67	394.67
SD	0.70	1.97	16.54	11.74	38.59
VC (%)	3.86	4.00	28.11	21.87	9.78
T. aestivum – obsolete alternative forms					
Mean	16.44	41.42	67.50	62.00	416.50
SD	0.89	2.17	0.50	13.00	11.50
VC (%)	5.41	5.24	0.74	20.97	2.76
T. aestivum – check cultivars					
Mean	13.82	33.64	70.33	71.67	311.00
SD	0.49	2.54	10.07	15.50	43.03
VC	3.55	7.55	14.32	21.63	13.84

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CONCLUSIONS

We can say, based on our results, that evaluated minor wheat species (einkorn, emmer, spelt and obsolete alternative forms of common wheat) were able to keep in organic farming system without use of industrial fertilizers and pesticides their typical character of qualitative parameters, e.g. high crude protein content and wet gluten content in grain dry matter. With regard to lower values of SDS-test and Gluten Index, that indicated weak gluten and worse possibilities of utilization for proofing dough (especially in einkorn and emmer), it is possible to recommend them for non-proofing and wholemeal products, as addition to pastries, part of cereal breakfasts and so on. But, results of SDS-test and Gluten Index showed considerably higher variability in these parameters than in the case of

crude protein content and wet gluten content in grain dry matter – this indicates good possibilities of selection in these quality traits.

Moreover, especially in spelt and obsolete alternative forms of common wheat, it is possible to find some materials with baking quality parameters on the similar level as in present common wheat cultivars.

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