EMMER WHEAT USING AND GROWING IN THE CZECH REPUBLIC

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Abstract

Emmer wheat [(*Triticum dicoccum* Schrank (Schuebl)] is after bread, durum and spelt wheat further species of wheat used for economic purposes. Organic farmers and producers have become more and more interested in marginal crops such as the tetraploid emmer wheat because of its suitability for organic farming. In spite of its historical role, present distribution of emmer is very limited. The work analyzes the problem of growing possibilities of emmer and its suitability for cultivation in organic farming. In the Czech Republic it is grown only a few farms, but in Austria is more popular now. Possible candidates for the cultivation of emmer has several options about where to obtain a suitable variety. The best option appears to be the choice of legally protected variety Rudico. Another option would be to obtain seed from abroad or multiplication of seed of its own genetic resources. Among important properties of emmer belongs e.g. considerably high resistance to some fungal diseases, which make it advantageous in organic system of growing. Hulled grain requires procedure of peeling. High grain quality, first of all high protein content, predetermines emmer wheat for preparation of healthy dishes in bio quality. The grains are suitable for the production of unyeasted products because of their specific quality. As the emmer wheat is grown especially in the organic farming system, the processing of grains has to respect the individuality of this obsolete cereal species. It may be used for the production of healthy regional food products.

Key words: emmer wheat, *Triticum diccocum*, organic farming, seed multiplication, genetic resources

Production of healthy foodstuffs and elimination of negative effects of the farming on the environment are the main purposes of the organic farming system. As the organic farming is limited by a lot of legislative regulations regulating the use of supportive instruments (e. g. pesticides, soluble nitrogenous fertilizers, etc.), the efficiency of growing of cereals decreases. Therefore, organic farmers aim to take advantage of a wide diversity of cultural crops and find such crops able to provide a sufficient yield rate and good-quality products, even if grown in low-input conditions. Wheat genetic resources do not usually manage to achieve the productivity of modern bred dominating cultivars (Ehdaie *et al*. 1988; Ehdaie *et al*. 1991). In spite of this fact, organic farmers are interested in them. It is caused by the fact that land races are less demanding and more adaptable to the environmental conditions (Dengcai et al., 2003; Kotschi, 2006). They provide lower but more stable yield rate in marginal areas (Collins and Hawtin, 1999). Although there are a lot of available genetic resources, a direct use is limited in the sustainable farming system for a while (Wolfe *et al.*, 2008). Tetraploid emmer wheat - *Triticum dicoccum* (SCHRANK) SCHUEBL is one of the model crops; it is suitable for the low-input or organic farming systems. It belongs to hulled wheat species and it has been traditionally grown and used as a part of human diet (Zaharieva et al., 2010). As it is tolerant to drought, it has survived in extreme montane conditions e. g. in Italy and Spain, on the Balkan Peninsula, in Turkey, on the Caucasus and in India too. It has been grown in Ethiopia too (Reddy et al., 1998). This wheat species has even become more interesting in last few years as requirements for the diversity and good-quality foodstuffs have increased (Hammer and Perinno, 1995). It has also confirmed its place in the organic farming system where it may fully develop its less demanding potential. As it contains a high proportion of protein in grain (up to 20 % in the case of particular cultivars), it may be used for the production of good-quality and healthy local foodstuffs (Konvalina et al., 2008). The emmer has never been bred. Nowdays, there are just available land races and wild forms of the emmer wheat.

MATERIAL AND METHOD

Information system of the evidence of genetic resources (EVIGEZ), which is accessible on http://genbank.vurv.cz/genetic/resources web site in Czech and English, was applied for the evaluation of available genetic resources of the emmer wheat. The available genetic resources were evaluated according to the following criteria: taxonomical classification, country of origin, degree of breeding and growing type (winter, spring).

Possibilities of gaining of the emmer wheat [*Triticum diccocum* (SCHRANK) SCHUEBL] seeds were analysed. Exact small-plot trials (with Rudico, a cultivar protected by the legislation) were set up at two stations (Prague, České Budějovice, Uhříněves just in 2009) for two years (2008 - 2009). The purpose was to evaluate the emmer wheat's characteristics and to compare it to a modern soft wheat cultivar (*Triticum aestivum* L.) called SW Kadrilj. The trials were established and carried out on certified organic trial parcels. Inclination to lodging, length of plant and resistance to the most important wheat diseases (brown rust and mildew) were tested and evaluated in the growing season. The following parameters of baking quality were tested after the harvest and dehulling of the grains by International Association for Cereal Chemistry (ICC) methods: crude protein content (ICC 105/2), Falling Number (ICC 107/1), wet gluten content (ICC 106/2), gluten index (ICC 155) and index of sedimentation – SDS test.

RESULTS AND DISCUSSIONS

Triticum L. cultivars are the dominating genetic resources of cultural crops. More than 9000 samples belong to the soft wheat (*Triticum aestivum* L.) and almost 1000 samples belong to the hard wheat (*Triticum aestivum* L.). There are 117 samples of the emmer wheat too. *Diccocum* (36 samples), *rufum* SCHEBL (34 samples) and *serbicum* A. SCHULZ (12 samples) are the most frequent botanical varieties. *Table 1* presents the list of the other botanical varieties.

Table 1

Numbers of accesions of emmer in the Genebank in Prague (total 117)

Triticum dicoccum (SCHRANK) SCHUEBL var:			
Botanical variety	Number of accessions	Botanical variety	Number of accesions
aeruginosum FLAKSB	5	*novicum* KOERN	1
atratum (HOST) KOERN	3	*pseudomacratherum* FLAKSB	1
chevsuricum DEKAPR	1	*rufum* SCHUEBL	34
dicoccum	36	*semicanum* KOERN	1
fictesemicanum FLAKSB	1	*serbicum* A. SCHULZ	12
fuchsii (ALEF) KOERN	1	*taschkentum* UDACZ	1
haussknechtianum A. SCHULZ	9	*tragi* KOERN	1
liguliforme KOERN	1	*tricoccum* (SCHUEBL) KOERN	2
nigrum STOLET	1	*volgense* (FLAKSB) FLAKSB	6

Concerning the country of origin, which mostly determines the suitability of cultivars for local climatic conditions, samples originating in the Czech or Slovak Republics (*table 2*) prevail there. The origin of these samples is, nevertheless, not sure. They may come from the Czech or Slovak Republics, or they may come from unknown extinct collections and could have been involved in collections of the Prague Gene bank's genetic resources later (their origin may be unknown there). Such unknown samples represent the second largest group. Samples coming from Germany or Russia, which may be suitable for the Czech climate (similar geographical conditions), also belong to a large group of samples.

Table 2

Origin of emmer in the Genebank in Prague

Origin	Number of accessions	Origin	Number of accesions
Armenia	7	Lithuania	2
Azerbaijan	6	Germany	10
Czech and Slovak Republics	31	Russia	12
Georgia	2	Switzerland	2
India	3	Ukraine	3
Iran	4	unknown	25
Israel	2	Other[1)]	8

Remark: [1)] Denmark, Kuwait, Romania, Spain, Sweden, Turkey, USA, Uzbekistan

Land races prevail in the collection of genetic resources. Wild forms are rarely represented there (just six samples). They are mostly represented in collections of gene banks situated in the areas of origin of the wild emmer wheat forms. Their use is very complicated from

the point of view of growing itself. They may, however, play an important role in the question of a resistance in the breeding process. Furthermore, there are also breeding sources and breeding cultivars (*table 3*). Concerning the development stadium, spring forms of the emmer wheat are the most numerous types figuring in the research (108 of 117 samples). On the other hand, winter forms are represented in a negligible amount (just 9 samples).

Table 3

Kind and type of emmer in the Genebank in Prague

Kind of varieties	Number of accessions	Type	Number of accesions
Landrace	90	Spring form	108
Breeding source	8	Winter form	9
Breeded strain	11		
Wild form	6		
Unknown	2		

Rudico, an emmer wheat, legally protected variety, has been available in the Czech Republic since 2006. It is a spring form which was selected from the genetic resources by a mass positive selection (Stehno, 2007). It underwent and passed the test of difference, uniformity and stability (DUS test). Nowdays, it is proposed for the organic farming. There are not any other cultivars in the Czech Republic. In Austria, there are a lot of organic farms growing the emmer wheat cultivars. Obviously, it is also possible to get seeds from the countries growing the emmer wheat. In 2008 – 2009, a comparative evaluation of the particular agronomical and qualitative characteristics of Rudico (the emmer wheat cultivar) and SW Kadrilj (the soft wheat cultivar) was carried out. Rudico was resistant to mildew and brown rust. Lower resistance of SW Kadrilj (the control cultivar) was an evidence of a pressure of a pathogene at the parcel (Table 4). The emmer wheat is usually highly resistant to brown rust (Zaharieva *et al.,* 2010) and mildew too. Wild forms and land races of the emmer wheat were, therefore, used in American, Russian, Canadian, Italian, Indian and other breeding programmes with the purpose to improve the resistance of soft and hard wheat cultivars to abiotic and biotic stressing factors (Sissons and Haare, 2002). Rudico plants were very long (110 – 145 cm) in dependence on the station, conditions and year. However, they were quite resistant to lodging. The length of plant might, therefore, contribute to a higher competitiveness to weeds (Eisele and Kopke, 1997). Rudico yield rate was highest in Prague and low at both other stations. In 2009, it was seriously reduced in České Budějovice, which was caused by the lodged crop stand. It led to these serious losses (*table 4*). The yield rate found out in the research corresponded to data in the relevant literature (e. g. Marconi and Cubadda, 2005). Stalknecht *et al.* (1996) showed the
fluctuating yield rate of the emmer wheat in the USA (from 0.2 to 3.7 $t.ha^{-1}$). These authors also emphasized that the selection of the rentable genotypes allowed the yield rate varying between 1.5 and 2.5 $t.ha^{-1}$ (48 – 84% of the spring wheat yield rate) in the aride conditions. The emmer wheat achieved higher yield rate than the hard wheat in the dry conditions in Mexico, Pakistan and Eastern India (Trethowan and Mujeeb-Kazi, 2008). Rudico contained a high proportion of crude protein in grain, which was a big advantage of this cultivar. It achieved 18.7 % in České Budějovice in 2009. Concerning the control cultivar, the proportion of crude protein in grain achieved only 13.5 %. Higher proportion of crude protein was also registered in the other years. The high proportion of protein in the emmer wheat plants (grains) has been proved by a lot of studies (it has achieved even 18 – 23 %) (Zaharieva *et al.,* 2010). The Rudico's ability to absorb nutrients (nitrogen in particular) from the soil was proved in that way. Concerning the emmer wheat and the other hulled wheat species, Trčková *et al.* (2005) also described the ability to absorb nutrients from the soil. The wet gluten content was considered as positive too, Rudico (the emmer wheat cultivar) achieved higher values at both stations and in both years too. The emmer wheat has a disadvantage too - a worse quality of gluten. Therefore, it is not suitable for yeasty products. A lot of authors state that the emmer wheat bread is a worse-quality product (e. g. Piergiovanni *et al.*, 1996). It was not possible to indicate the gluten index by Glucomatic instrument at any of the stations in 2009 as the gluten was not solid and it was spred there. Concerning the swell of proteins, expressed by the results of the SDS test, it also achieved a half level in the case of the emmer wheat. Therefore, Rudico is not suitable for the production of yeasty dought. On the other hand, concerning the resistance to lodging, high values of the falling number were noticed there. As the emmer wheat caryopses are tightly closed in hulls, the emmer wheat unlodged crop stand is highly resistant to the lodging of grains inside the crop stand.

Table 4

Comparison of agronomic traits and quality of Rudico (emmer) and SW Kadrilj (bread wheat)

Variety	Year & Locality		Mildew[1)]	Rust[1)]	Index of lodging	Plant height (cm)	Yield (t.ha^{-1})	Crude protein (%)	Wet gluten (%)	Gluten index	SDS test (ml)	Falling number (s)
Rudico (emmer)	2008	CRI	9.0	9.0	9.0	110	-	15.9	42.9	51	37	400
		CB	9.0	9.0	7.8	145	-	16.3	44.3	54	41	408
	2009	CRI	8.8	8.0	9.0	128	4.9	11.8	24.2	4	32	402
		CB	9.0	9.0	5.9	145	1.7	18.7	40.2	4	32	272
		UH	9.0	8.3	7.6	130	3.3	15.2	35.0	20	35	397
SW Kadrilj (bread wheat)	2008	CRI	8.7	9.0	9.0	93	-	12.4	28.4	85	74	294
		CB	9.0	7.0	9.0	96	-	13.5	31.8	78	81	349
	2009	CRI	8.8	3.0	9.0	90	3.4	10.1	20.0	85	51	348
		CB	9.0	9.0	8.8	100	3.8	13.5	34.1	61	84	359
		UH	8.0	7.7	8.1	95	4.3	12.6	28.9	75	72	388

Remark: [1)]9=resistant;

CONCLUSIONS

The genetic resources of emmer wheat are available and accessible to all the interested people in the Czech Republic. All the information may be found on EVIGEZ web sites. Spring forms of the emmer wheat land races, originating from the Czech or Slovak Republic, Germany and Russia, prevail in the collection of the Prague Gene bank's genetic resources. Organic farmers interested in the growing of the emmer wheat may choose one of three possible ways of gaining of the cultivars. Import of seeds from abroad (e. g. from Austria), selection and reproduction of material from the genetic resources (it is a time-demanding and expensive process) or they may choose Rudico, legally protected variety. It is a spring form of the emmer wheat cultivar being very resistant to wheat diseases (mildew, rust), lodging and competitive to weeds (as the plants are long enough). Concerning the qualitative characteristics, it contains a high proportion of protein in grain, its quality is not, however, suitable for usual bakery products. Growing of the emmer wheat cultivars enhances the agrobiodiversity on arable land and it represents an interesting market opportunity for organic farmers. Its seeds are also valuable raw materials with a high nutritive value.

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