THE QUALITY OF HULLED WHEAT SPECIES IN ORGANIC FARMING

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Abstract: As organic farmers are searching perspective crops for growing, there is possible to choose neglected wheat species and also have a new market and sell opportunities. Concerning wheat, there are landraces so called hulled wheat species (einkorn, emmer wheat, spelt) comprising parts of collections of the world gene banks. Our paper aims at presenting the results of the study and the assessment of spring wheat forms, four einkorn cultivars, eight emmer wheat cultivars, seven spelt wheat cultivars in particular, as compared to modern bread wheat variety. Small-plot trials were established at three different localities within the Czech Republic in 2010 and 2012 in organic farming fields. The results of the trials show that the grains were characterised by a high proportion of protein in grain (up to 18.1%). However, they may be difficult to use for common baking (low Gluten index and sedimentation value). The main advantage was a high share of nutritionally valuable Albumins, Globulins and insoluble rest protein fractions in comparison with modern control varieties of bread wheat.

Key Words: organic farming, hulled wheat, baking quality, protein fractions

INTRODUCTION

Plant genetic resources are considered a unique and non-renewable source with which to enhance the plant genetic base (Dotlacil et al. 2010). The significance of the genetic diversity of low-input organic varieties has increased in the last several years. Genetic diversity resources have to be identified and strategies to enable the use of those diverse varieties in the organic breeding processes have to be developed and implemented (Serpoly et al. 2001).

Wheat (Triticum aestivum L.) is one from the most important crops for human diet (Moudry et al. 2013a). Despite a remarkable development in organic farming throughout Europe (Moudry et al. 2013b), there are not enough varieties which have been purposely bred for use within the organic farming system (Stehno et al. 2010). In particular, conventional bred and tested varieties which were reproduced under the organic farming conditions are grown there (Lammerts van Bueren et al. 2002). But there are many references from different authors (Wolfe et al. 2008) being reported lower baking quality of bread wheat within organic farming.

Organic farming can work with a wider diversity of crops (Konvalina et al. 2011). There are many neglected wheat species such as Triticum monococcum, dicoccum or spelta which have potential to be grown in organic farming. They are more tolerant to many stress factors (Konvalina et al. 2014), e.g. decreasing quality of arable land (Kopecky et al. 2016). But they can provide grain in high quality (Piergiovanni et al. 1996). Hulled wheat species could be suitable for cultivation in marginal areas, under conditions of low-input or organic farming, where modern soft wheat varieties are unable to develop their full productive potential, because they are selected for favourable pedoclimatic and intensive agronomic conditions (Lacko-Bartosova et al. 2015).
Our article aims at evaluating the grain quality and protein fractions characteristics in a set of 25 varieties of hulled and bread wheat varieties grown in organic farming.

MATERIAL AND METHODS

Used varieties

The landraces of einkorn: Triticum monoccocum 38, Triticum monoccocum 44, No. 8910 and Schwedisches Einkorn. Emmer wheat (Triticum diccocum Schrank ex Schübler): Rudico, Weisser Sommer, May-Emmer, Triticum dicoccon (Brno), Triticum dicoccon (Dagestan), Triticum dicoccon (Palestine), Triticum dicoccon (Tapioszele) and Triticum dicoccon (Tabor). Spelt wheat (Triticum spelta L: Triticum spelta (Ruzyne), Triticum spelta (Tabor 22), Triticum spelta (Tabor 23), VIR St. Petersburg, Spalda bila jarni, Triticum spelta No. 8930 and Triticum spelta (Kew). All the varieties were spring wheat forms and came from the Gene bank of the Crop Research Institute in Prague-Ruzyne. As control were used 4 landraces varieties namely Postoloprt ska presivka 6, Rosamova ceska cervena presivka, Cervena perla and Kasticka presivka 203; and 2 modern varieties of bread wheat (Triticum aestivum L.) namely Vanek and SW Kadrilj.

Field Trials

Varieties were sown in a randomized, complete block design on the organic certified research area in Ceske Budejovice, Prague Ruzyne and Uhrineves (CZ) during 2010 and 2012. The seeding rate was adjusted for a density of 350 germinable grains per m². The crop stands were treated in compliance with the European legislation (the European Council Regulation (EC) No. 834/2007, the European Commission Regulation (EC) No. 889/2008. There was no artificial nitrogen application during the growing season. Trial were weeded by harrowing.

Laboratory analysis

The baking quality analysis in grain were tested after the dehulling of the grains by The International Association for Cereal Chemistry (ICC) methods: crude protein content (ICC 105/2); index of sedimentation - SDS test (ICC 151); wet gluten content (ICC 106/2), gluten index (ICC 155) and baking experiment (Lachman et al 2012). Gluten content was measured by ELISA Technologies. Protein fractions were measured according the methodology developed by Osborn (1907) with modifications (Lookhart and Bean 1995).

Statistical analysis

Data were processed by the Statistica 9.0 (StatSoft. Inc., USA) programme. The comparison of varieties and their division into statistically different categories were provided by the Turkey HSD test.

RESULTS AND DISCUSSION

From the technological point of view, there is an important protein content and its quality. In case of hulled wheat species, there was high protein content. Regarding the tested collection of varieties, the average protein content in grain achieved 15.59% in einkorn, 16.04% – emmer wheat, 15.74% – spelt wheat, 13.21% – land races of bread wheat (Table 1). Regarding the modern varieties, the average protein content in grain achieved 12.79%. In the group of hulled wheat species, there was also high wet gluten content (36.5%; 38.0%; 42.2%) in comparison with control varieties of bread wheat (30.9%). Gluten index was very low in einkorn and emmer varieties with15. SDS test and Zeleny test was in case of diploid (einkorn) and tetraploid (emmer) at the half level of other species (Table 1). On the other hand, in case of hexaploid spelt wheat there was baking quality higher (Gluten index – 36) and Zeleny test 34 ml – this level is comparable to the group of bread wheat varieties.
Table 1 The baking quality characteristics of different wheat species

<table>
<thead>
<tr>
<th>Species</th>
<th>Protein content (%)</th>
<th>Wet gluten content (%)</th>
<th>Gluten index</th>
<th>SDS test (ml)</th>
<th>Zeleny test (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Einkorn</td>
<td>15.59b</td>
<td>36.45bc</td>
<td>14.39a</td>
<td>29.04a</td>
<td>14.07a</td>
</tr>
<tr>
<td>Emmer</td>
<td>16.04b</td>
<td>38.04c</td>
<td>15.43a</td>
<td>33.15a</td>
<td>15.81a</td>
</tr>
<tr>
<td>Spelt</td>
<td>15.74b</td>
<td>42.26d</td>
<td>35.68b</td>
<td>57.35b</td>
<td>34.35b</td>
</tr>
<tr>
<td>Landraces of bread wheat</td>
<td>13.21a</td>
<td>33.11bc</td>
<td>41.46c</td>
<td>56.65b</td>
<td>35.96b</td>
</tr>
<tr>
<td>Control varieties of bread wheat</td>
<td>12.79a</td>
<td>30.87a</td>
<td>68.75d</td>
<td>65.38c</td>
<td>42.36c</td>
</tr>
</tbody>
</table>

Legend: Within column values followed by the same letter are not significantly different at $P < 0.05$ (Tukey HSD test).

From the nutritional point of view, there is an important composition of protein fractions (glutenins and gliadins) (Shewry et al. 2000). For human nutrition are important protoplasmatic fractions “albumins and globulins” and also insoluble rest (fractions which are close to protoplasmatic ones). In case of einkorn and emmer there was lower gluten content – but concentration is too high for people with the celiatic disease. On the other hand, there was better protein fractions composition in case of einkorn and emmer. Einkorn had Albumins, Globulins and Insoluble rest fractions more than 59% in comparison with bread wheat (Table 2). Very simmilar composition had also emmer and some varieties of spelt. High content of protoplasmatic fractions is good from nutritional point of view, however, It has influence on the negative way to technological quality.

Table 2 Protein fractions content of different wheat species

<table>
<thead>
<tr>
<th>Species</th>
<th>Gluten content (mg/100g)</th>
<th>Albumins + Globulins (%)</th>
<th>Gliadins (%)</th>
<th>Glutenins (%)</th>
<th>Insoluble rest (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Einkorn</td>
<td>153.45a</td>
<td>26.67c</td>
<td>27.93a</td>
<td>27.64a</td>
<td>17.76d</td>
</tr>
<tr>
<td>Emmer</td>
<td>194.86b</td>
<td>28.67b</td>
<td>30.06b</td>
<td>27.70a</td>
<td>13.67c</td>
</tr>
<tr>
<td>Spelt</td>
<td>248.17c</td>
<td>27.04b</td>
<td>31.03bc</td>
<td>29.95b</td>
<td>12.12b</td>
</tr>
<tr>
<td>Landraces of bread wheat</td>
<td>265.96c</td>
<td>26.30b</td>
<td>32.17c</td>
<td>30.59b</td>
<td>10.92b</td>
</tr>
<tr>
<td>Control varieties of bread wheat</td>
<td>248.52c</td>
<td>21.38a</td>
<td>34.67d</td>
<td>36.96c</td>
<td>6.99a</td>
</tr>
</tbody>
</table>

Legend: Within column values followed by the same letter are not significantly different at $P < 0.05$ (Tukey HSD test).

CONCLUSIONS

The hulled wheat species are supposed to be grown in organic farming, because of in this conditions can provide more stable and high yield in comparison with modern bread wheat varieties. Hulled wheat species had a high protein content and wet gluten content. There were differences between species – einkorn and emmer were not suitable for „clasical” baking processing. But there is potential for other products eq. wheat rice (einkorn) or pasta (emmer). Spelt will be possible to use in „clasical“ baking industry, but the best solution will be use grain in the mixture with bread wheat. The most important advantage of hulled wheat species is nutritional value of grain from the point of view of protein fractions composition – hulled wheat species had in average more albumins and globulins and insoluble rest fractions than modern varieties of bread wheat. On the other hand there is lower gliadin and glutenins content – it is possitive from nutritional point of view, but not from technological.
ACKNOWLEDGEMENTS
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REFERENCES


