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ORIGINAL ARTICLE

COMPARATIVE EVALUATION OF WET GLUTEN QUANTITY AND QUALITY THROUGH DIFFERENT METHODS

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The wet gluten quantity is usually determined by the manual washing or Gluten Index Method (GIM), a fully automatic rapid method. The aim of this study was to compare the GIM with the Romanian methods used for analysis of wet gluten quantity and quality, and to establish the ratio between wet gluten content and grain protein content for different Romanian wheat varieties. The results indicate that there is no statistically significant difference between the tested methods. The linear correlation coefficients calculated for the wet gluten content measured by GIM and manual washing methods were $r^2 = 0.93$, in case of SR ISO 21415-1:2007 method, and $r^2 = 0.90$, in case of the method proposed in 2008 (Manual de gradare pentru seminte de consum). The WG/P ratios ranged between 1.91 and 2.26.

Key words: wet gluten quantity, wheat quality, Gluten Index Method

1. Introduction

Gluten forming proteins play key roles in baking quality of wheat by improving the water absorption capacity, extensibility and elasticity of the dough.

The quantity and quality of gluten are considered the most important quality parameters of wheat flour. Wet gluten content is determined by washing the dough obtained from flour or wheat meal, with water or other solution (e.g. NaCl solution), in certain conditions, to remove the starch and other soluble compounds of the sample (Mis, 2000). The rubbery mass that remains after washing is the wet gluten. The results obtained are highly influenced by the working condition and the type of solution used for dough washing. It is recommended to use NaCl solutions (2%) for washing the gluten to annihilate the influence of different minerals normally occurring in drinking water. In order to avoid the proteolytic enzymes of the wheat acting on the gluten forming proteins, the washing time shouldn't be longer than 30 min (Bordei *et al*., 2007).

The gluten content is directly correlated to the grain protein, which is strongly influenced by the pedoclimatic conditions. However, the wheat genotype is considered the most important factor influencing the qualitative characteristics of gluten (Mariani *et al*., 1995; Simic *et al*., 2006; Bilgin and Korkut, 2005). Any increase in total protein content of the flour determines a gluten content increase (Perten *et al.*, 1992). Ratio between wet gluten content and grain protein content showed that WG/P ratio is considered as an indicator of wet gluten production per protein unit. Simic *et al*. (2006) reported that Croatian wheat with WG/P ratios ranging between 2.7 and 3.0 have gluten with optimal baking characteristics, while cultivars with strong gluten characteristics showed the WG/P ratio closer to 2.3.

The wet gluten quantity could be determined by manual washing or GIM that is a fully automatic and rapid method. GIM is advantageous because it provides information on both quantity and quality of wet gluten, it is user-friendly, fast (one analysis takes 7 minutes), and the required amount of samples is quite small (10 g flour).

Tests carried out in many countries indicate that flours for the production of bakery products have the gluten index values of 60 to 90 (Curic *et al.*, 2001). A high gluten index, exceeding 95, indicates strong gluten, while index values lower than 60 indicate flours too weak for bread production.

The aim of this study was: (i) to compare the GIM with SR ISO 21415-1:2007 method and the official method mentioned in the 'Manual de gradare pentru seminte de consum' (2008) used for the evaluation of the quantity and the quality of wet gluten, and (ii) to determine the ratio between wet gluten content and grain protein content for different wheat samples. Even if not all three compared methods are standardized, they are equally recommended and nowadays accepted for wet gluten quantity and quality evaluation by the Romanian Ministry of Agriculture and Rural Development.

2. Materials and methods

Ten wheat samples harvested in the wheat-growing regions of Moldavia, Romania, in 2009 were used in the present study. The wheat samples were ground in the laboratory Mill 120 (Perten Instruments AB).

The wet gluten content of the wheat samples was determined manually according to methods stated in SR ISO 21415-1:2007 and in Manual de gradare pentru seminte de consum (2008) and through GIM (AACC 38-12.02 method). The gluten index values for all wheat samples were determined using the Glutomatic 2200 system (Perten Instruments AB). The moisture content was determined according to the SR ISO 712:2005 method, the protein content by the NIR technique (Inframatic, model 8600, Perten Instruments AB), and the gluten deformation according to the SR ISO 90/2007.

All tests were carried out in triplicate, and the average values were reported together with standard deviation (SD).

3. Result and discussion

The results of the wet gluten content, wet gluten deformation and gluten index are presented in Table 1 as mean values and standard deviations. In case of the wet gluten content determined by GIM, the standard deviation of the repeatability was 1.15, smaller than the case of the manual washing method. Figures 1, 2 and 3 show the wet gluten, wet gluten deformation and gluten index of the two wheat samples analyzed.

Table 1. Wet gluten content, wet gluten deformation and gluten index for wheat and wheat flour samples

Sample / Parameter	Average	SD	Min	Max
Wheat				
Wet gluten, %				
SR ISO 21415-1:2007 method (Wg-m1)	25.9	1.63	24.4	29.2
Method described in Manualul de gradare pentru seminte de consum:2008 (Wg-m2)	27.2	1.80	25.4	31.1
AACC 38-12.02 method	24.8	1.15	23	29.1
Wet gluten deformation, mm				
SR ISO 21415-1:2007 method (D-Wg-m1)	10,1	2.61	7	8
Method described in Manualul de gradare pentru seminte de consum:2008 (D-Wg-m2)	11.9	3.56	15	18
Gluten index				
AACC 38-12.02 method	89.6	7.77	84	98

The wet gluten content was higher in case of the method described in 'Manualul de gradare pentru seminte de consum', that requires 30 min storage period of the dough with the washing solution (Table 1). The storage time caused significant changes of the wet gluten properties. In case of wheat samples with poor gluten, higher differences were observed in terms of gluten deformations when comparing the SR ISO 21415-1:2007 method which doesn't require dough storage, and the

method from 'Manual de gradare pentru seminte de consum' (2008) that requires time storage. For example, in case of sample 2 (Figures 2 and 3) the gluten index was 78 and a gluten deformation differences of 3 mm (from 15 mm to 18 mm) was recorded, while in case of wheat sample 5 (Figures 2 and 3) the gluten index was 98 and the gluten deformation difference was 0.9 mm (from 8 mm to 8.9 mm).

Mis (2000) emphasized in his study the influences of the time storage on the wet gluten content and its quality expressed as gluten index. In addition, Mis (2000) showed that the time storage, as well as the gluten fragmentation (each gluten sample was split into 1 – 6 equal parts) and the amount of wet gluten used for analysis (from 0.5 to 3.5 g) influence the physical properties of the wet gluten and the final value of the gluten index measured by the GIM method.

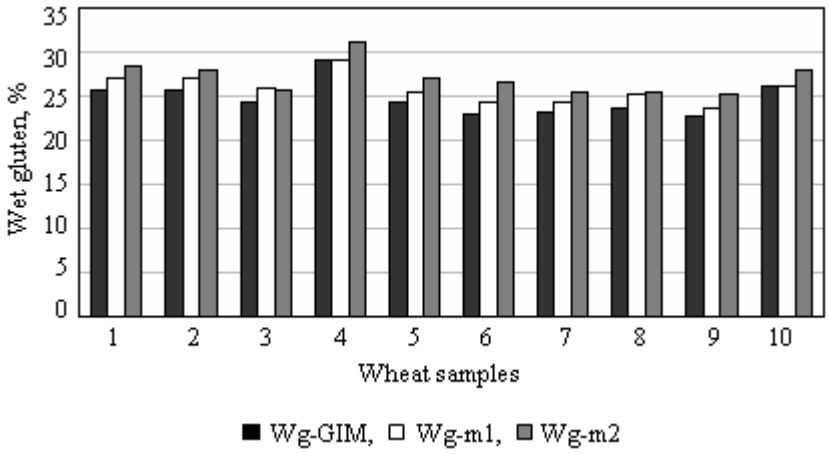

Figure 1. Wet gluten content of the wheat samples

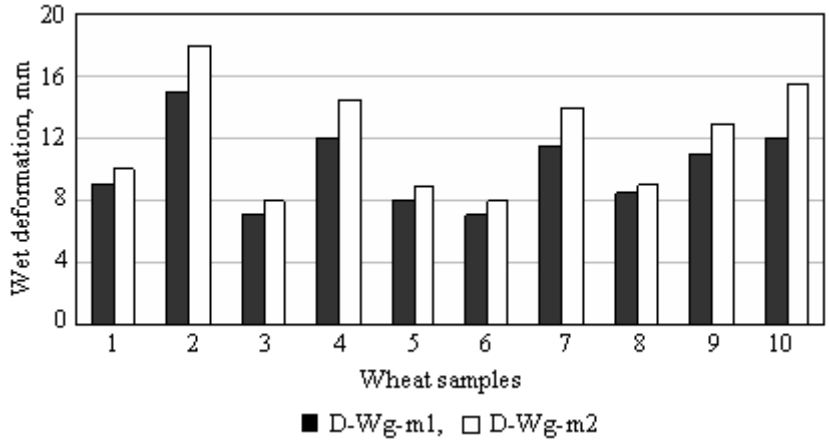

Figure 2. Wet gluten deformation of the wheat samples

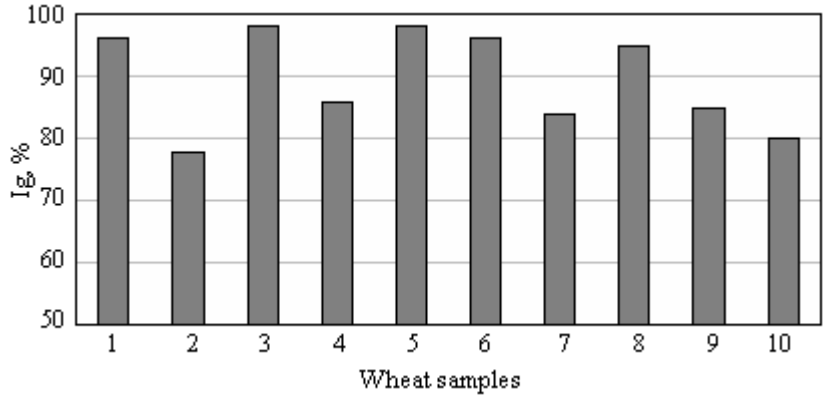

Figure 3. Gluten index of the wheat samples

In order to compare the three methods used to assess the wet gluten content, the F-test was applied. The results of statistical evaluation showed that there is no statistical significant difference between the testing methods. When considering GIM and Wg-m1 the F = 1.42 < Ftab (0.05) = 3.18,while in case of considering GIM and Wg-m2 the F = 1.17 < Ftab (0.05) = 3.18.

For GIM and Wg-m1, and for GIM and Wg-m2, the linear correlation coefficient of wet gluten content was estimated as follows:

$$\text{Wg-m1} = 0.8081 \times \text{GIM} + 5.8265,\ r^2 = 0.9287,$$
$$\text{Wg-m2} = 0.8775 \times \text{GIM} + 5.4175,\ r^2 = 0.9009.$$

Curic *et al.* (2001) reported a linear correlation coefficient of $r^2 = 0.945$ when comparing GIM and the manual washing methods used to measure the wet gluten. Our statistical results show that GIM can be recommended for determining the wet gluten quantity and can be used to replace the classical method consisting of manual gluten washing. Therefore, it is important to state the method used when reporting this parameter.

Regarding the ratio between the wet gluten content and the grain protein content, the results are presented in Figure 4. The WG/P ratios were small (Chung *et al.*, 1996; Williams, 1997; Simic et al., 2006) and ranged between 1.91 and 2.26. When analyzing the Canadian wheat Chung *et al.* (1996) and Williams (1997) reported a WG/P ratio of 2.6, for the Western Extra Strong wheat, and 3.0 for Western Soft White Spring wheat. Simic et al. (2006) reported for the Croatian wheat, WG/P ratios ranging from 2.27 to 2.90.

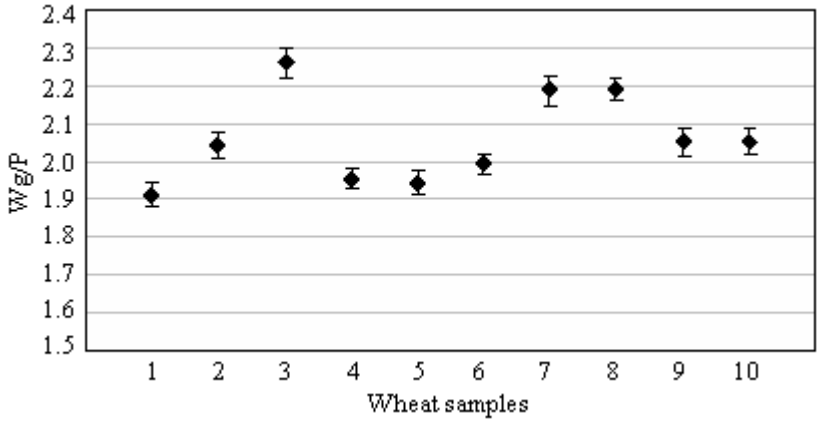

Figure 4. The ratio between wet gluten content and grain protein content (Wg/P)

4. Conclusions

The results of the statistical evaluation show that there is no statistically significant difference between the wet gluten content determined by the three testing methods. The GIM method can be recommended for the determination of the wet gluten quantity and successfully replace the classical method consisting of manual gluten washing. The WG/P ratios estimated through the three testing methods ranged from 1.91 to 2.26 in case of all the wheat samples.

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