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STUDY REGARDING THE NUTRITIONAL AND TECHNOLOGICAL QUALITY OF WHEAT

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Abstract

In the bakery industry, the wheat quality is essential for flour processing. Thus, the main objective of this paper is to present the results of the research on yield quality of seven winter wheat samples collected from Prahova County farms. To determine the wheat quality, the following analysis were performed: thousand grain weight (TGW g), hectolitre mass (HLM kg/hl), moisture content (%), protein content (%), carbohydrates content (%), lipid content (%), ash content (%), wet gluten content (%), gluten deformation index (mm) and falling number. For the physical parameter determined at wheat seeds the following data were obtained in average: 41.47g for TGW (g), 76.84 kg/hl for HLM and 12.72% for moister content. In average, the chemical composition of wheat seeds was the following: 14.22% proteins, 1.95% lipids, 65.98% carbohydrates, 1.78% ash. For the whole wheat flour the following results were obtained: the wet gluten content was on average of 28.02%, with variation between 25.5% for sample 2 and 30.5% for sample 5; the gluten deformation index was on average of 8.47% and the value of falling number varied between 227 s and 258 s. Those results show that all samples of wheat are suitable for use in the bakery industry.

Key words*: yield quality, wheat, nutritional value.*

INTRODUCTION

Wheat is considered the most important cultivated plant, being used by the 40% of the world population for bread and staple food. The wheat flour can be used for obtaining various bakery products and pasta (Toader et al., 2019). The wheat grains are usualy included in the *cereal mixtures* used for breakfast, also are used *in animal feed* or to obtain *gluten, starch, alcohol, spirits (vodka, whiskey), beer, biofuel like ethanol* etc. According to Roman et al. (2011) "straws can be used as raw material in the pulp and paper industry, for bedding, roughage, as an organic fertilizer or for producing energy" (Roman et al., 2011).

Grain quality can be defined by a series of physical and compositional properties where threshold requirements are set according to the end-use requirements. For grains like wheat, the physical properties of grain (i.e. size and shape) can influence the milling yield, which also determine the efficiency of processing and the grain value (Nuttall et al., 2017).

According to Dumbrava et al. (2012) "there are several factors like growing practices, time and type of harvesting, postharvest handling, storage management and transportation practices that can affect grain quality. Also, the quality of wheat used for bakery is influenced by the environmental conditions, the interaction between varieties, the applied crop technology as well as by the effect of some climatic accidents" (Dumbrava et al., 2012).

The following indicators can determine the quality of wheat grains: moisture content, hectolitre mass, foreign matter, percentage of coloured, damaged and broken grains, milling quality, protein content, vigour, mycotoxins, presence of insects and fungi (Lusse J., 2006).

Wheat flours baking potential is influenced by several factors, especially the protein content (MacRitchie F., 1987; Toader et al., 2019). Based on the solubility in different solvents, the major flour protein types are classified into albumins, globulins, gliadins and glutenins (Shewry P.R., 2002; Xue et al., 2019). The gluten proteins (i.e. gliadins and glutenins) can determine the baking quality of wheat flour: gliadins mainly contribute to dough extensibility and viscosity and glutenins contribute to dough strength and elasticity (Wieser H., 2007). The gluten content can be influenced by the cultivar, climatic conditions, nitrogen fertilizer rate and time of application, residual soil nitrogen and the available moisture during grain filling (Vita P. et al., 2007; Dupont F. et al., 2003).

The wheat quality has a critical importance throughout the grain value chain. The wheat delivered by the producers must comply with the required specifications and the producers will be remunerated in accordance with its quality. The storage facility must determine the grain quality in order to establish if it complies with the required standards and then to store it until it can be processed. The processor requires grains that complies with his needs, to obtain a specific product that meets the consumer's demand (Lusse J., 2016).

MATERIALS AND METHODS

Wheat quality is essential for flour processing in the bakery industry. So, the main objective of this paper is to present the results of the research on yield quality of seven wheat samples collected from Prahova County farms. To determine the quality of wheat, the following analysis were performed: thousand grain weight (TGW g), hectolitre mass (HLM kg/hl), moisture content (%), protein content (%), carbohydrates content (%), lipid content (%), ash content (%), wet gluten content (%), gluten deformation index (mm) and falling number.

TGW was determined by weighing 8 samples of 100 seeds which were taken from the pure mass and HLM by using the Hectolitre Measuring System - Chondrometer with 0.5 l capacity.

The chemical analyses were made within the Yield Quality Laboratory from the Faculty of Agriculture, USAMV of Bucharest, using a spectrophotometer infrared NIR Inframatic 9200 Product Instalab-Analizer.

The energetic value was determined by the relationship between the daily necessary nutrients and the contribution of these substances provided per product unit (usually 100 g).

The formula for calculating the energetic value (kcal) for the wheat seeds was:

Energetic value = % proteins x 4.1 + % lipids x 9.3 + % carbohydrates x 4.1.

Wet gluten content of the wheat samples was determined manually according to SR ISO 21415-1:2007 methods and the gluten deformation index according to SR ISO 90/2007.

The method used for gluten determination consist in the separation of proteinic substances such as gluten, using NaCl solution for dough washing (dough is obtained from wheat groat), and after drying the obtained gluten. For gluten deformation index, the method was to leave a wet gluten sphere rest for one hour at 30°C, to measure the initial and final diameters and to calculate the differences (Figure 1).

Figure 1. Aspects from gluten deformation index analysis
(Yield Quality Laboratory within Field Crop Department)

Falling Number test, according to ISO 3093-2005 standard, it was determined in laboratory were was use a Falling Number device.

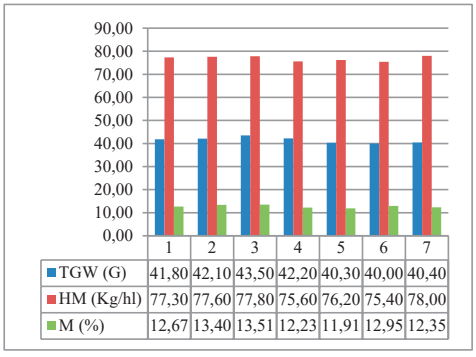
All chemical analyses were performed in three replicates and the results were statistically analysed by Fisher's least significant differences (LSD) test.

RESULTS AND DISCUSSIONS

Physical quality parameters

Analyzing the data in Figure 2 regarding the physical quality indicators of wheat seeds it can be observed that the thousand grains weight of the wheat seeds was, on average, 41.47 g. This value shows a good quality of the wheat used for bakery industry.

According to Dumbrava et al. (2012), the thousand grain weight can be influenced by the specific soil and climatic conditions of the cultivation area, the crop technology, the presence of foliar diseases, the pest attack, the grain chemical composition and the state of the grains upon harvesting (impurities content, the percentage of broken grains).



	1	2	3	4	5	6	7
TGW (G)	41,80	42,10	43,50	42,20	40,30	40,00	40,40
HM (Kg/hl)	77,30	77,60	77,80	75,60	76,20	75,40	78,00
M (%)	12,67	13,40	13,51	12,23	11,91	12,95	12,35

Figure 2. Physical quality parameters of wheat samples

The hectolitre mass is currently an important indicator for the milling industry, because in the milling units, the total flour extraction is determined based on its value.

In our research, the hectolitre mass of wheat samples ranged between 75.4 kg/hl at sample 6 and 78.0 kg/hl at sample 7, the average being 76.84 kg/hl. Those results show that all wheat samples can be included in the "good for bakery" category.

The moisture content of wheat seeds is one of the most important criteria for assessing its quality. The optimum state of ripeness upon harvesting is also characterized by wheat moisture content, which must have a maximum of 15%. The storage of wheat largely depends on its moisture. At a normal temperature, wheat can be stored in good condition only if the moisture value is below 13%. If the moisture exceeds 14%, a series of chemical processes related to the acceleration of respiration with the production of heat and water will take place, followed by complex fermentation processes that will lead to the alteration of the grain mass (Toader et al., 2020).

Our research showed that for all samples, the moisture values did not exceed the STAS values of 14% (SR ISO 13548:2013).

The moisture values ranged between 11.91% and 13.51%, the average being 12.71%.

Biochemical parameters

The analysis of the chemical composition of the wheat seeds showed that the highest protein content was registered at sample 6 (14.81%) which significantly exceeded the average protein content. This was followed by sample 5 with 14.70% protein, while the lowest value was determined at sample 2 i.e. 12.70% (Table 1). According to the protein content analysis, it can be seen that most of the wheat samples are included in the "very good for bakery" category, except for sample 2 which is included in the "good for bakery" category.

Table 1. Chemical composition of wheat varieties (% d.m.)

Wheat samples	Quality parameters*			
	P (%)	L (%)	C (%)	A (%)
1	14.20	1.89	66.53	1.89*
2	12.70^{000}	2.02	65.60	1.72
3	13.98	2.16**	66.31	1.56^{000}
4	14.51	1.91	64.90^{0}	1.91*
5	14.70	1.94	67.50*	1.74
6	14.81*	2.14**	66.82*	1.98**
7	14.62	1.65^{00}	64.21^{000}	1.64^{0}
Average	14.22	1.95	65.98	1.78

Note: P (% d.m.) - protein content; L (% d.m.) - lipid content; C (% d.m.) - carbohydrates content (% d.m.); M - moisture content (% d.m.); ^{000}- very significant negative differences; ^{00}- distinct significant negative differences; ^{0}- significant negative differences; **- distinct significant positive differences; *- significant positive differences.

The lipids content of the studied samples ranged between 1.65% and 2.16%. Higher lipid contents were observed at sample 3 (2.16%) and sample 6 (2.14%), which exceeded the average with a distinctly significant value (Table 2).

The lowest lipid values were recorded in samples 7 (1.65%), 1 (1.89%), 4 (1.91%) and 5 (1.94%), respectively.
Regarding the carbohydrates content of the wheat seeds, in table 1 a higher content (over 67%) can be observed at sample 5.
Samples 1, 3 and 6 had a carbohydrates content which ranged between 66.31% and 66.82%, compared to samples 4 and 7 which registered lower values.
The values of ash content ranged between 1.56% (in sample 3) and 1.98% (in sample 6).
Seeds from samples 2 and 5 had a medium ash content of 1.72% and 1.74%, respectively.
All results regarding the chemical composition and statistical processing are included in Table 1 and Table 2.
The level of significance (DSL5%, 1%, 0.1%) from Table 1 has been based on the values of Table 2.

Table 2. Statistical results of the chemical composition

Statistical index	DM (%)	P (%)	C (%)	L (%)	Ash (%)
Average	87.30	14.22	65.98	1.87	1.78
Sample variance	0.19	0.29	0.72	0.02	0.01
Standard deviation	0.43	0.54	0.85	0.13	0.11
Sd	0.18	0.22	0.35	0.05	0.05
CV (%)	0.49	3.79	1.28	6.53	6.40
DSL 5%	0.387	0.484	0.760	0.115	0.102
DSL 1%	0.548	0.684	1.074	0.162	0.144
DSL 0.1%	0.782	0.976	1.533	0.232	0.206

The energetic values of wheat seeds (Figure 3) ranged from 338.54 kcal at sample 7 and 355.06 kcal at sample 5.

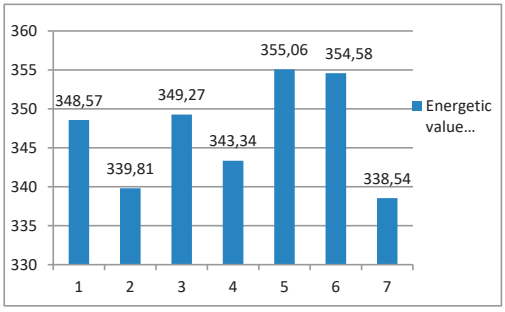


Figure 3. The energetic value of wheat seeds

Falling Number characterizes the carbohydrates activity in the wheat seeds, which is given by the activity of alpha-amylase, that influences the quality of the wheat used in bakery. The optimum value for baked wheat is between 180 and 260 seconds.
In our research the value of the falling number ranged between 227 s and 258 s, the average being 243 s (Figure 4). Those results show that all flour samples are suitable for use in the bakery industry.

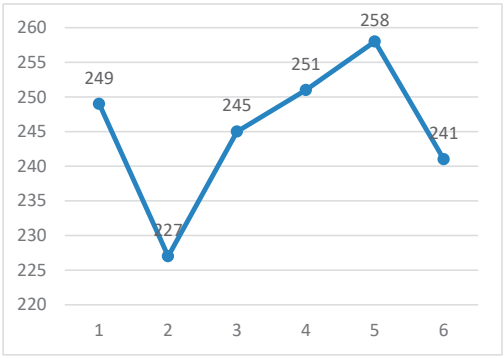


Figure 4. Falling number of wheat samples

Gluten is the main responsible factor for the extensibility and elasticity of the dough. Thus, in our research, *the wet gluten test* offers information on the quantity and quality of gluten from the analyzed wheat samples. According to Wheat Marketing Center (2004) "in the food industry the wet gluten reflects the protein content of the flour and represent a common flour specification required by the end-users" (Wheat Marketing Center, 2004).
The wet gluten content of the studied wheat samples was on average of 28.02% (Figure 5).

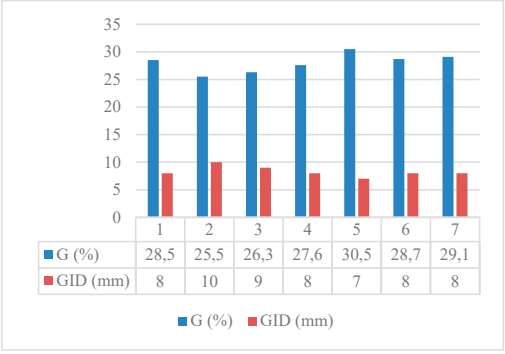


Figure 5. Wet gluten content and gluten deformation index for wheat
Note: G (% d.m.) - wet gluten content; GID (mm) - gluten deformation index

Seeds from sample 5 registered the highest value of wet gluten content, i.e. 30.5%, this being followed by samples 7, 6 and 1, with a wet gluten content above 28%.
The lowest values of the wet gluten content were registered at samples 2 and 3, i.e. 25.5% and 26.3%.
According to SR 90/2007 standard, wheat that is good for baking must have a wet gluten content of at least 24%. So, the analyzed samples comply with the quality requirements.
In the bakery, the gluten deformation index reflects the "proteolytic activity" of the wheat flour. So, if values exceed 15 mm, the gluten deformation is high, and if values are below 5 mm, the gluten is highly elastic, and the flour requires amelioration because the proteolytic activity is very low. According to standards, for the baking flours, gluten deformation index ranges between *3 to 25 mm* (Toader et al., 2019).
Regarding the gluten index deformation, figure 5 shows that all samples are "very good for bakery industry". The gluten index deformation was on average of 8.47 mm, the variation limit being of 7 mm for sample 5 and 10 for sample 2.
Figure 6 shows that there is a *positive correlation* between the wet gluten content and seeds protein content, the value of R^2 being 0.691.

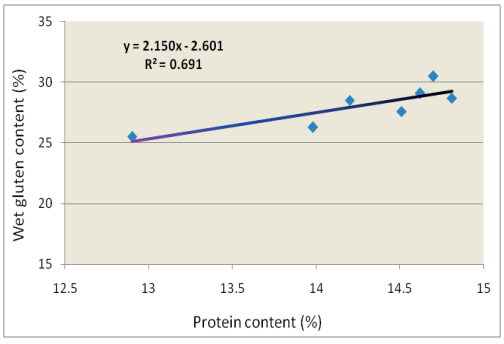


Figure 6. Correlation between protein content and wet gluten of wheat

Research show that there is a direct correlation between gluten content and the grain protein content, which is influenced by the "pedoclimatic conditions" from Prahova County area. The main factor which influences the qualitative characteristics of gluten is the "wheat genotype" (Mariani B.M. et al., 1995; Simic G. et al., 2006; Ionescu et al, 2010), and the increase at the total protein content in the flour determines an increase of the gluten content (Perten et al., 1992; Ionescu et al., 2010).

CONCLUSIONS

One of the main factors that influences the quality of bakery products is the quality of the raw material, i.e. the quality of the wheat seeds.
All the quality indicators that were analyzed in our research, i.e. the physical quality indicators, the biochemical indicators, the wet gluten content, the gluten deformation index and the falling number, showed a "good quality" of the wheat for bakery.
In our research, there was a "*direct correlation*" between the *gluten content* and the *grain protein content*, and the factor that influenced this correlation was the *pedoclimatic conditions*.
We can conclude that all wheat samples meet the quality requirements imposed by the Romanian standards.

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