STUDIES CONCERNING THE QUALITY OF BREAD WHEAT VARIETIES FROM ROMANIA

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Abstract: Nine bread wheat varieties from Romania were analyzed (2007 and 2008, summer crops, 65 samples). Thousand kernel weight, test weight, ash content, gluten content, gluten index, falling number, gluten swelling index, and rheological properties with Mixolab and Alveograph were investigated. The characteristics were influenced by climatic growing conditions and genetic factors. A characteristic for Romanian wheat for 2008 crop was the poor gluten content because the crop practices and environmental conditions. Other characteristic of the 2007 and 2008 crops was the very high falling number value. In fact, in Romania this characteristic it is maintained in the last years. The flour obtained from milling of the wheat, crops 2007 and 2008, is necessary to be supplied with vital gluten and exogenous α-amylases. The extensibility and the dough strength were very lower, from 12 to 26 mm, respectively 87.3×10^{-4} J. The values for C3, C4 and C5, registered at Mixolab, were low for all varieties.

Key words: *wheat, physical-chemical characteristics, rheological properties, Mixolab, Alveograph*

INTRODUCTION

Grain quality at the mill is the result of the interaction of genotype with environmental conditions from sowing to delivery to the mill, and this interaction is potentially different for each aspect of grain quality [1-4]. For instance, gluten content, one of the most important wheat quality features is known to be influenced by climatic conditions, cultivar, nitrogen fertilizer rate, time of nitrogen application, residual soil nitrogen and available moisture during grain filling [4, 5]. The relationship in protein fraction composition is largely dependent on the total of nitrogen accumulated in the grains, although genetic variation has been reported, particularly for the gliadins [6]. Bordes et al [7] realized a complex study on a representative of worldwide hexaploid bread wheat. The traits assessed during the vegetative period, thousand kernel weight, test weight, grain hardness, grain protein content, pentosane viscosity and grain color were measured. The rheological properties of the derived white flours were estimated using mixograph and alveograph tests. For most of the traits, a wide phenotypic variation was observed for all samples. Several parameters (mixograph width parameters before and after peak time, alveograph dough tenacity and extensibility, near infrared measurements, like those for protein content, and absorbance measurements of palmitic acid and linoleic acid content) made it easier to discriminate between the cultivars. Cauvain et al [1] considered that the variety, starch properties, milling quality, grain hardness, protein contents, protein quality and dough characteristics, pre-harvest sprouting, defects, test weight, moisture content, pesticide residues and contaminants represent the grain quality attributes important that are influenced by genotype and growth environment. Vita et al [4] analyzed fourteen durum wheat cultivars introduced in Italy between 1900 and 1990. Grain protein content, alveogramme parameters, carotenoid pigments content, ash content and the glutenin and gliadin subunit compositions were then measured to assess grain quality. The results reported suggest that over the 20th century the breeders selected cultivars that not only most of the times out yielded their predecessors in relatively poor environments, but also responded remarkably stronger to environmental improvements. These advantages were attained by consistently boosting the number of grains per unit area, while the mean weight of the grains remained virtually unchanged.

The present study was aimed at investigating the quality for different wheat varieties cropped in the east of Romania. Thousand kernel weight, test weight, ash content, gluten content, gluten index, falling number, gluten swelling index, and rheological properties with Mixolab and Alveograph was investigated.

MATERIALS AND METHODS

The wheat varieties sample was collected from farmers (2007 and 2008, June-July, 65 samples). Nine wheat varieties recommend for crop in the east of Romania (mentioned in the Romanian catalogue for wheat varieties) were analyzed.

Evaluation of physical-chemical characteristics

The physical-chemical characteristics of the wheat varieties were evaluated as follows:

- test weight through the SR ISO 7971-2:1995 method [8];
- 1,000 kernel weight was determined for each sample by weighing 100 randomly selected;
- mean size index Godom and Wilm [2];
- the moisture content through the AACC 44-51 method [9];
- the ash content through the SR ISO 2171:2002 method [8];
- the gluten index through the SR ISO 21415-2:2007 method [8];
- the wet gluten content through the SR ISO 21415-2:2007 method [8];
- protein content through the ICC 195-1995 method [10];
- the Zeleny test through the ISO 5529 method [8];
- the swelling index was determined through the Berliner method [7];
- the falling number through the AACC 56-81B method [9].

Evaluation of rheological properties

The rheological characteristics were tested by means of:
- the NG Chopin Alveograph using the AACC 54-30 method [9];
- the Chopin Mixolab using the method from Chopin Mixolab User's Manual [11].

All tests were carried out at least in duplicate, and the average values were adopted.

Statistical analysis

Descriptive statistics (mean, standard deviations, range and coefficients of variation) were performed by using the package Statistica for Windows 4.3.

RESULTS AND DISCUSSION

Evaluation of physical-chemical characteristics

The mean, range and coefficients of variation of the physical-chemical characteristics measured are depicted in Table 1. Analyzing the results presented in this table it can be seen that the coefficients of variation range from 3.9% for moisture to 125.9% for the swelling index. The swelling index varied from 3.7%, for *Dropia* variety, to 100% for *Boema* variety. The wet gluten content for *Azimut* variety was smaller that the rest wheat varieties analyzed, the coefficient of variation was high 25.5%, with an average at 23.9%. The nitrogen supply to the crop from the soil and fertilizer is the main factor influencing protein concentration. There were also large variations in gluten index, this ranged from 67 to 99%, and the Zeleny test, from 21 to 48 mL. A characteristic for Romanian wheat for 2008 crop was the poor gluten because the crop practices an environmental condition. Other characteristic of the 2007 and 2008 crops was the falling number value, very high. In fact in Romania this characteristic it is maintained in the last years. In Romania the winter sown is September – October and the ripening period is in June when the grain loses moisture before harvest. The weather during the vegetative period before grain growth has relatively little influence on falling number value and thousand-kernel weight. The weather, especially rainfall, during the ripening period is the main determinant of low falling number (FN) value (as result of sprouting)

[12]. The flour obtained from milling of the wheat, crops 2007 and 2008, is necessary to be supply with vital gluten and exogenous α-amylases [13].
Thousand-kernel weight (TKW) is often mentioned with size in the description slip of the characteristics of each cereal variety in the official catalogue [2]; TKW and kernel number per square meter are the two main indicators of yield [14]. The mean size index for the wheat varieties was 3.78 mm (coefficient of variation being 6.82%). Test weight is one of the primary criteria used in the wheat trade as it has a direct impact on the cost of transporting grain [2, 14]. With an average of 76.6 $kg.hL^{-1}$, test weigh ranged from 65.5 (considered as very small) to 82.9 $kg.hL^{-1}$ (considered very high), the coefficient of variation was 8.1%. The similar result was obtained for thousand-kernel weight (8.6% coefficient of variation). These results can be considered normal because they are influenced by climatic growing conditions and genetic factors.

Table 1. *Mean, range and variation coefficient of the physical-chemical characteristics*

Physical-chemical characteristics	Mean	Range	Coefficient of variation [%]
Test weight [$kg.hL^{-1}$]	76.6	17.4	8.1
Thousand-kernel weight [g]	41.3	8.9	8.6
Moisture [%]	10.7	1.2	3.9
Mean size index [mm]	3.87	0.71	6.82
Ash content [%]	1.5	0.4	8.5
Falling number [%]	407	76	6.7
Wet gluten [%]	23.9	17.7	25.5
Protein content [%]	12.7	5.1	13.4
Zeleny test [mL]	36.8	27	2.5
Gluten index [%]	87	32	12.7
Swelling index [%]	31.3	96.3	125.9

Evaluation of rheological properties

Mixolab and alveograph characteristics of the wheat varieties showed that there is a wide variation in the rheological properties. The mean, range and coefficients of variation of the Mixolab and alveograph characteristics are depicted in the Table 2.
The coefficients of variation of the torque C1, C2, C3, C4, C5 (Nm) were between 2.5% for C1 and 10.3% for C2. For the stability of the dough, that characterized the dough resistance to kneading, the coefficient of variation was 25.7%, and for amplitude of Mixolab curve, that significant the dough elasticity, the coefficient of variation was 27%.
The coefficients of variation for parameters from alveograph were low for dough swelling, 11%, and very high for dough strength, 41.2%.
The dynamic rheological parameters of dough are used to predict the bread making quality of wheat. Glutens from poor quality wheat are typically less elastic and more viscous than those from good quality wheat [14]. The shapes of the Mixolab and alveograph curve describe the behaviors of dough.

Table 2. *Mean, range and variation coefficient of the Mixolab and Alveograph characteristics for the wheat varieties*

Rheological characteristics	Mean	Range	Coefficient of variation [%]
Mixolab curve			
Water absorbtion [%]	62	56.3-64.4	4.2
Peak torque of the dough (C1) [Nm]	1.10	1.05-1.14	2.5
Protein weakening (C2) [Nm]	0.40	0.34-0.49	10.3
Starch gelatinization (C3) [Nm]	1.89	1.61-2.03	7.1
Stability of the starch gel formed (C4) [Nm]	1.57	1.27-1.75	9.3
C3-C4 [Nm]	0.32	0.22-0.50	33.1
Starch retrogradation during the cooling stage (C5) [Nm]	2.30	1.91-2.56	9.0
Amplitude [Nm]	0.07	0.05-0.12	27
Stability [$min.s^{-1}$]	6.79	4.41-9.43	25.7
Alveograph curve			
Dough elasticity (P) [mm]	94.1	55-136	26.9
Dough extensibility (L) [mm]	21.7	12-26	20.1
P/L	4.4	2.39-6.25	24.8
Dough swelling (G) [cm^3]	10.3	7.7-11.4	11
Dough strength (W) 10^{-4}J	87.3	38-152	41.2

Mixolab is a complex device that renders the evolution of the bread during the entire technological process, from the dough making to the starch retrogradation; this measures torque when bread dough is subjected a dual mixing and temperature constraint [15]. Parameters of Mixolab curve from areas (1) and (2) mainly characterized protein correlation, and those from areas (3), (4) and (5) described starch behavior (starch gelatinization, gelling and retrogradation). The wheat varieties is characterized by a strong water absorption capacity, mean being 62%. The mean for C2 had the low values and signifying a poor quality for protein. The combined effect of the mechanical shear stress and the temperature constraint induced a decrease in the torque due to the beginning of the protein destabilization and unfolding [15, 16]. Alex variety had a good protein quality, the value for C2 being 0.49 Nm. In the "Mixolab applications handbook. Rheological and Enzymatic Analysis" [17] the optimum value for C2 it is considered 0.5 Nm.

The values for C3, C4 and C5 were lower for all varieties. This values characterized the rheological behavior of the dough in zones (4) and (5) of the Mixolab curve describing the starch retrogradation and gelatinization process [15, 18]. It is exists a relation between falling number and difference C3-C4, being reported a direct correlation for FN from 200 to 500 s, $r^2 = 0.6392$ [17]. A fairly wide range of stability was obtained, ranging from 4.4 to 9.4 $min.s^{-1}$.

The alveograph parameters give information about the elasticity and extensibility of dough. For the wheat varieties the mean for dough elasticity was 94.1 mm. The P values of standard wheat range from 60 to 80 mm, and of very good quality wheat from 80 to 100 mm; the values for extra strong wheat are higher than 100 mm [14]. The extensibility for wheat varieties was very lower, from 12 to 26 mm; the value regarded as good being 100 mm. The P/L obtained corresponds to very strong and low extensibility dough; the optimum values for P/L being 0.5-0.8. The mean for dough

strength (W) obtained for wheat varieties was very lower, 87.3; for good quality W is range from 250 to 300.
Both alveograph and Mixolab parameters revealed that there was less variation in the reology of dough made from the same variety, *Dropia*, that from the all varieties crop in the east of Romania (Table 2 and Table 3).

Table 3. *Mean, range and variation coefficient of the Mixolab and Alveograph characteristics for Dropia variety*

Rheological characteristics	Mean	Range	Coefficient of variation [%]
Mixolab curve			
Water absorbtion [%]	62.5	60-64.4	3.6
C1 [Nm]	1.10	1.09-1.13	18.2
C2 [Nm]	0.40	0.38-0.43	6.3
C3 [Nm]	1.89	1.77-1.98	5.9
C4 [Nm]	1.64	1.55-1.7	5.1
C3-C4 [Nm]	0.25	0.22-0.28	12
C5 [Nm]	2.43	2.33-2.49	3.6
Amplitude [Nm]	0.08	0.07-0.09	12.5
Stability [$min.s^{-1}$]	8.37	7.19-9.43	13.4
Alveograph curve			
P [mm]	117	100-136	15.5
L [mm]	23.3	20-26	13.1
P/L	5	4.79-5.23	4.4
G [cm^3]	10.7	10-11.4	6.6
W, 10^{-4}J	117.3	88-152	27.5

Almost all the characteristic ranges of *Dropia* variety were smaller than the ranges of the other varieties. Standard deviations of characteristics, whose range of *Dropia* variety were significant smaller than the range of other varieties (Table 4).

Table 4. *Standard deviations of Dropia variety and other varieties crop from Romania for alveograph parameters*

Rheological characteristics	Standard deviation	
	***Dropia* variety**	**Varieties**
P [mm]	18.08	25.28
L [mm]	3.05	4.35
G [cm^3]	0.71	1.14
W, 10^{-4}J	32.33	35.98
C1 [Nm]	0.021	0.027
C2 [Nm]	0.025	0.041
C3 [Nm]	0.112	0.134
C4 [Nm]	0.084	0.145
C5 [Nm]	0.087	0.208

CONCLUSIONS

Characteristics of the bread wheat varieties were influenced by climatic growing conditions and genetic factors. A characteristic for Romanian wheat for 2008 crop was the poor gluten because the crop practices an environmental condition. Other characteristic of the 2007 and 2008 crops was the falling number value, very high. In fact in Romania this characteristic it is maintained in the last years. The flour obtained from milling of the wheat, crops 2007 and 2008, is necessary to be supply with vital gluten and exogenous α-amylases. The extensibility and the dough strength were very lower, from 12 to 26 mm, respectively 87.3×10^{-4} J. The values for C3, C4 and C5, registered at Mixolab, were lower for all varieties.

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