

RHEOLOGICAL BEHAVIOUR OF DIFFERENT WHEAT VARIETIES

BANU IULIANA¹, STOENESCU GEORGETA², IONESCU VIOLETA², VASILEAN INA¹, APRODU IULIANA¹

¹*Dunarea de Jos Galati University, Faculty of Food Science and Engineering, 111, Domneasca St., 800201, Romania*

²*Research laboratory Arcada, Arcada Mill, Lunca Siretului, Zonă Banda Barbosi /1 bis, 800416, Romania*

Received 26 April 2009

Revised 27 July 2009

The Mixolab is an instrument that can be used to characterize the rheological behavior of dough subjected to a dual mixing and temperature constraint. Different varieties of wheat (Alex, Dropia, Boema, Azimut, Apache, Josef, Capo and Renesansa), cropped in the East of Romania, were tested on the Mixolab. The changes of the Mixolab curve trend depended on the value of the particle size indexing, falling number and proteine quality. Renesansa variety is characterized by strong water absorption, while Capo and Dropia varieties are strong varieties since they are characterized by a longer development time. Apache variety is characterized by a high C2, giving indications about the good quality of the proteins. Based on C3 varieties Azimut and Apache appear to form strong hard gells, and Capo has a high C5. Taking into account the obtained results we may conclude that Mixolab is a complex device that can be used to characterize the wheat varieties.

Keywords: wheat varieties, rheological behaviour, Mixolab, Alveograph.

1. Introduction

To reduce possible losses of production caused by drought, and other adverse environmental factors biotic (foliar diseases of the ear, etc.) and abiotic (low temperature, high temperature etc.), INCD Fundulea recommended that Romanian farmers should cultivate Romanian varieties, to ensure the achievement of safe harvest (Ittu, 2007).

For central and Southern area of Moldavia the varieties recommended for cultivation are: Dropia, Flamura 85, Boema, Glosa, Gabriela, Eliana, Fundulea 4, Faur and Gruia.

Beyond these recommendations the farmers usually choose the varieties that they cultivate. In the present paper, we analyzed the above mentioned area and we identified: three Romanian varieties – Alex, Dropia and Boema, two French varieties – Azimut and Apache, two Austrian varieties – Josef and Capo and one Serbian variety – Renesansa.

Every year, in the harvest period, the Institute of *Food Bioresources from Romania* analyzed wheat quality. This analysis is carried out relying on the following indices: moisture, impurities, weight test, protein content, wet gluten, gluten deformation, gluten index and falling number.

The present study aimed at investigating the rheological behaviour for different wheat varieties cropped in the East of Romania. The rheological investigation was performed using the Mixolab device. This instrument is used to characterize the rheological behaviour of dough subjected to dual mixing and temperature constraint. The same approach was previously tested by Haros et.al, 2006, Collar et.al, 2007, Rosell et.al, 2007, Kahraman et.al, 2008.

2. Materials and methods

The next wheat varieties were analysed: Alex, Dropia, Boema, Azimut, Apache, Josef, Capo and Renesansa.

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

- the gluten index through the SR ISO 21415-2:2007 method (ASRO, 2008);
- the wet gluten content through the SR ISO 21415-2:2007 method (ASRO, 2008);

- particle size indexing using the AACC 55-30 method (AACC, 2000).

The rheological characteristics were tested on the Chopin Mixolab using the method from Chopin Mixolab User's Manual (2005). The typical curve recorded by the Mixolab is shown in Figure 1. The parameters enlighten in the curve are:

- C1 (Nm) – indicates the peak torque of the dough, used to determine the water absorption;
- C2 (Nm) – measures the protein weakening based on the mechanical work and temperature;
- C3 (Nm) – expresses the starch gelatinization;
- C4 (Nm) – indicates the stability of the formed starch gel;
- C5 (Nm) – measures the starch retrogradation during the cooling stage;
- α – represents the slope of the curve between the end of the period of 30°C and C2; gives indication about the rate of the proteins' thermal weakening;
- β – represents the slope of the curve between C2 and C3; gives indications about the gelatinization rate;
- γ – represents the slope of the curve between C3 and C4; gives indications about the rate of enzymatic hydrolysis.

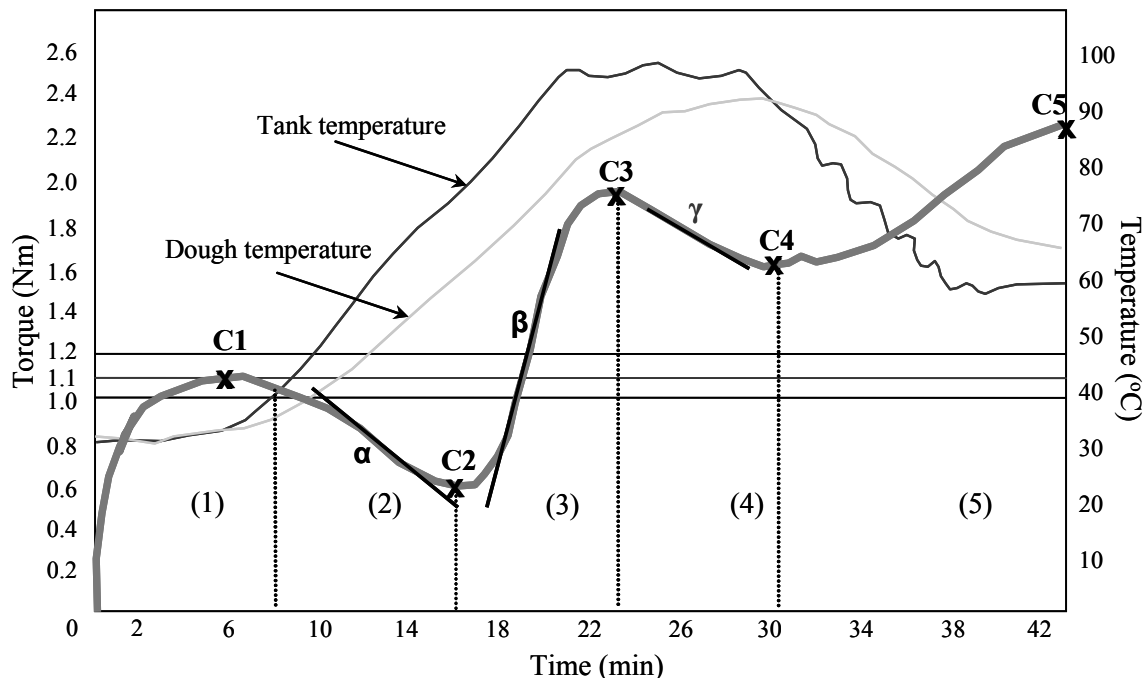


Figure 1. Typical curve recorded by the Mixolab Zone

Zone (1) - dough development (constant temperature. 30°C); Zone (2) – thermal weakening of the proteins; Zone (3) - starch gelatinization; Zone (4) - enzymatic activity, constant heating rate; Zone (5) - starch retrogradation

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

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

3. Results and discussions

The wheat varieties were characterized in terms of gluten quality and thermo-mechanical behavior by means of Mixolab device. The mean value of wet gluten was 26.3% (coefficient of variation 11%) and the mean of gluten index was 89% (coefficient of variation 12.7%). Particle size index (PSI) is a measure of the texture of a wheat kernel. The Romanian wheat varieties are characterised by PSI of 61.8% (standard deviation 0.98) and the Apache, Azimut, Josef, Capo and Renesansa by PSI of 54.3% (standard deviation 1.25%).

The Mixolab parameters of the wheat varieties are presented as box plots in Figure 2 and Figure 3.

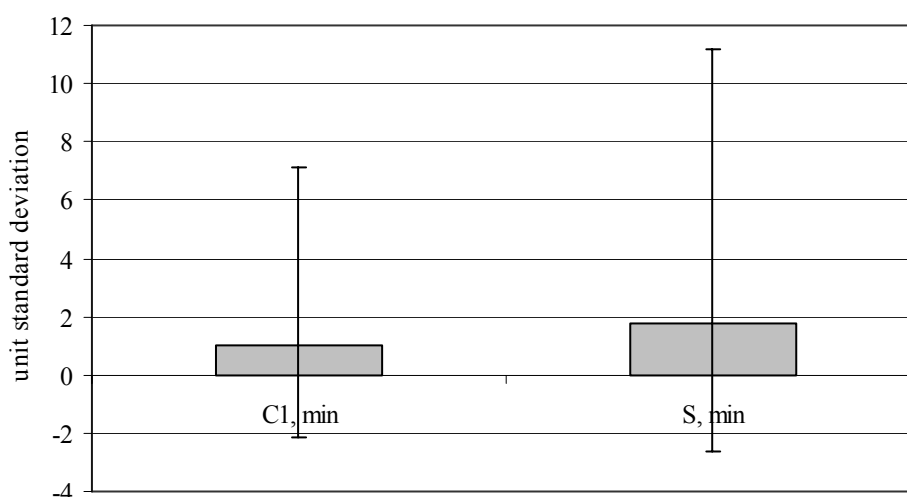


Figure 2. Box plot graph of wheat varieties for C1 and stability dough

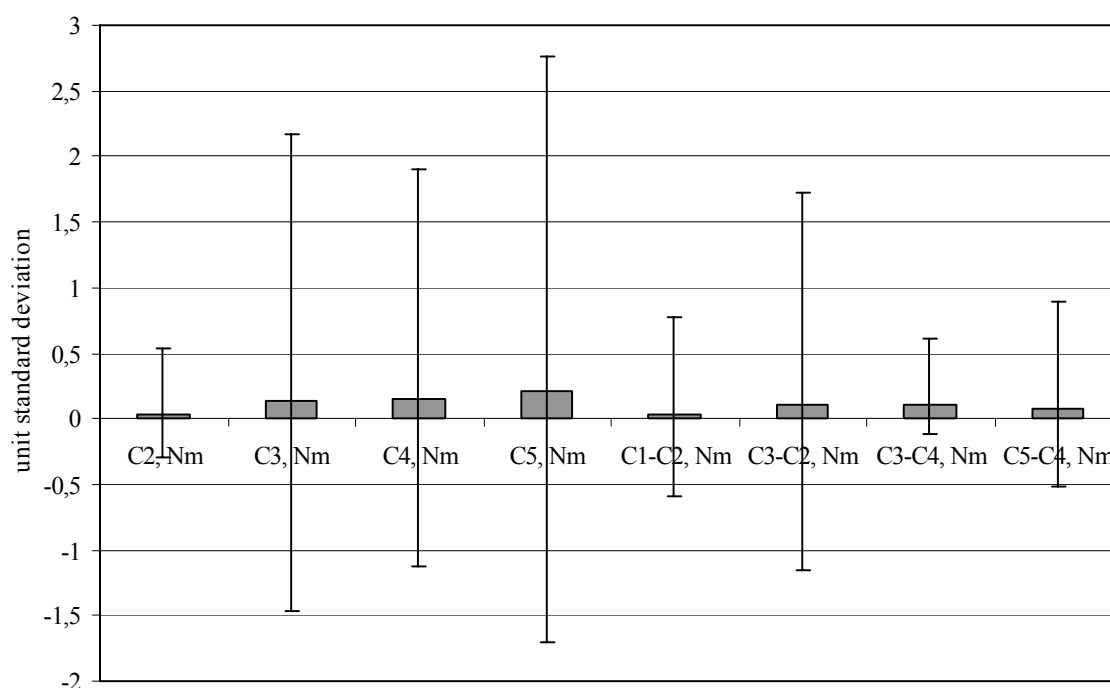


Figure 3. Box plot graph of wheat varieties for some Mixolab curve parameters

Comparison between Capo and Dropia varieties

Capo and Dropia are characterized by a longer development time, 4.82 min and 6.27 min respectively, indicating that both are strong flours. Dough stability was very different, 4.41 min for Capo and 9.43 min for Dropia (Figure 4).

In both cases, the weakening of the protein due to the mechanical kneading and temperature increase from 30 to 58°C, C2 (Nm) varied in limited range 0.4-0.38 Nm; therefore, the weakening rate of the protein under thermal constrains was very different -0.056 Nm/min, for Capo, and -0.016 Nm/min, for Dropia. Analysing the C3 (Nm) value one can see that Capo variety had a higher capacity of starch gelatinization and as a consequence a lower α -amylase activity compared to Dropia. Anyway the falling number values, of the two varieties, were close to 380-390 s. This means that starch susceptibility to enzymes might be responsible for the difference in terms of consistency of dough at

the end stage of starch gelatinization, the variety Capo having a higher glassiness (PSI for Capo much smaller than the Dropia). The two varieties had identical values for C3-C4, meaning that there is no effect of amylase activity on the starch. Dropia presented lower values for C4-C5 and C5, indicating the decrease of starch retrogradation, and thus delaying bread staling.

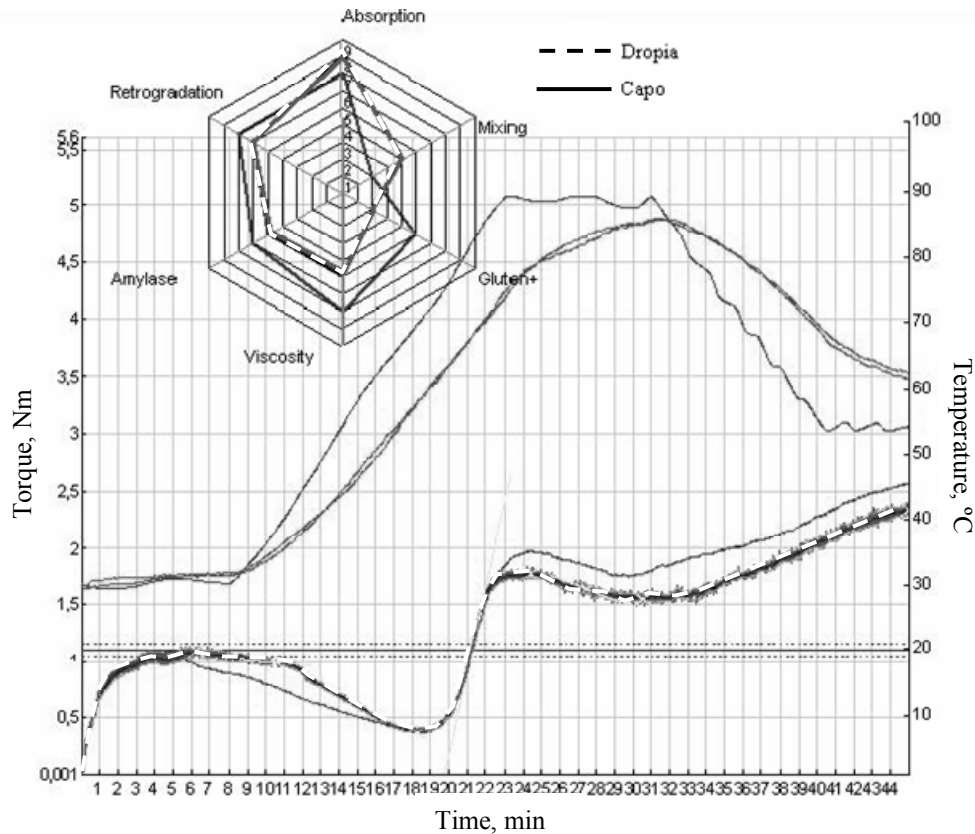


Figure 4. Mixolab curve for the Dropia and Capo varieties

Comparison between Josef, Capo and Apache varieties

Josef and Capo varieties had high water absorption (61.7 and 60.9%, respectively) compared to Apache (57.8%).

Josef variety had the lowest development time of the dough, but had a dough stability over 8 min, compared to just over 4 min in case of the other two varieties (Figure 5.)

C2-C1 value that gives indications about protein weakening was higher in case of Apache variety, meaning that this variety has the lowest proteolytic activity. Apache variety had very high values for C3 while, the PSI of this variety was the lowest, 52.4%. Similar C3 values are reported in the Mixolab applications Handbook (2006) for Apache variety.

Josef and Capo varieties showed an increase of C3 accompanied by a significant reduction of C3-C4, indicating higher starch stability and heat resistance. Capo variety had the highest C5 value, 2.56 Nm while the C5 of the Apache variety was 2.13 Nm; C4-C5 was 0.81 Nm for Capo and 0.6 Nm for Apache.

Comparison between Azimut and Alex/Sendreni varieties

The Azimut and the Alex varieties had similar rheological behavior. The major difference between the two varieties was the water absorption capacity while it was 56.3% for the Azimut and 62.6% for the Alex, since the Azimut variety had a much smaller particle size indexing. Comparing the rheological parameters of the two wheat varieties in the fifth stage of the Mixolab curve, one can see that the Azimut variety had a lower C5 value, while the C4-C5 values were slightly comparable (Figure 6.).

The Alex and the Dropia had a rather similar rheological behaviour.

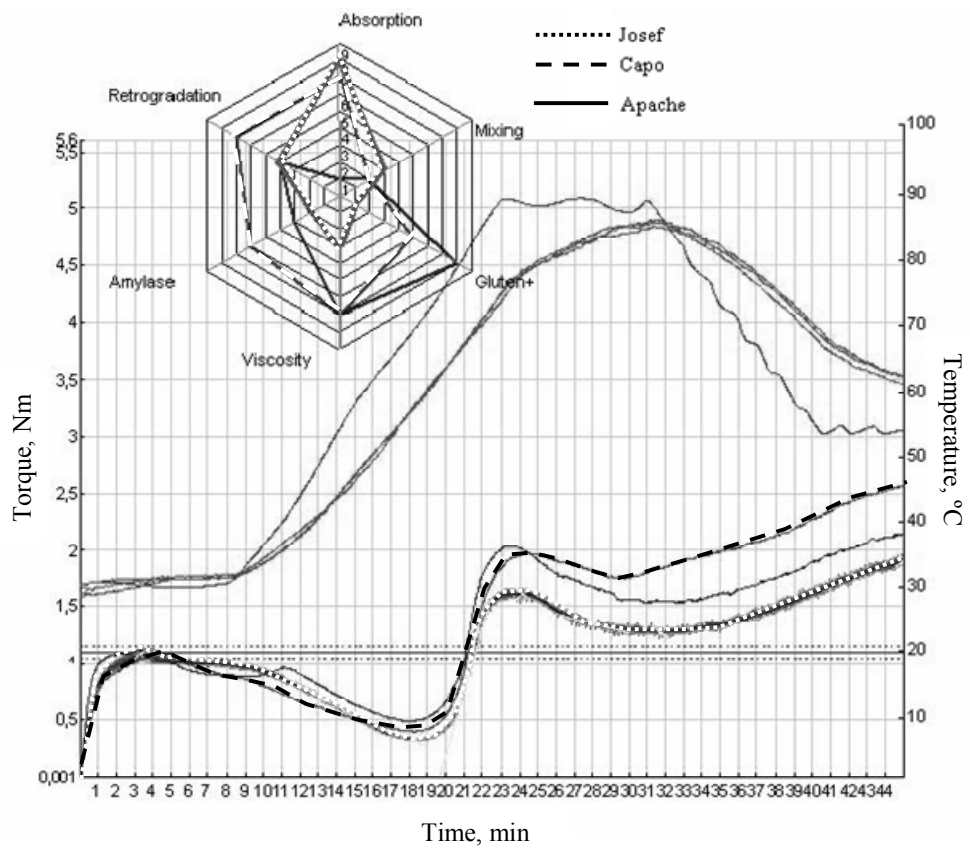


Figure 5. Mixolab curve for the Josef, Capo and Apache varieties

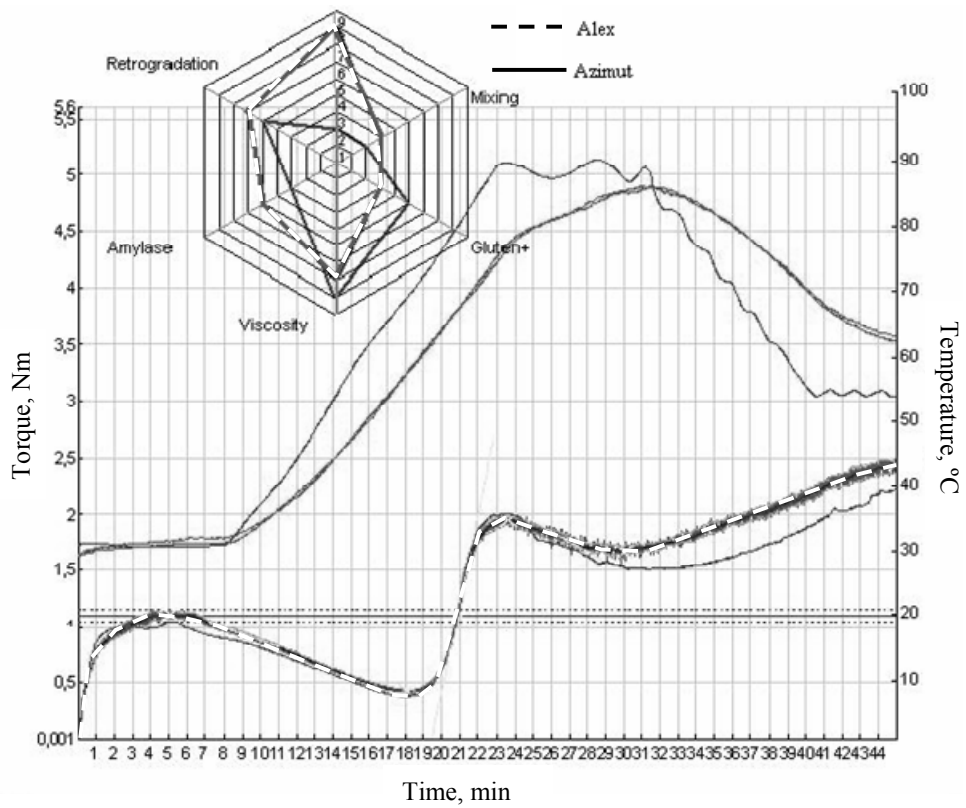


Figure 6. Mixolab curve for the Alex and Azimut varieties

Comparison between Josef and Azimut varieties

When comparing Josef and Azimut varieties, one can see that the particle size indexing was similar (comparable with the Romanian varieties Alex and Dropia), while important differences were found in terms of water absorption capacity (61.7% and 56.3%, respectively).

The Azimut variety showed small dough stability; C2-C3 was higher for this variety. The two varieties showed differences in terms of falling number values - 370 s and 412 s for the Azimut, and the Josef respectively. Moreover the C3 and C4 values indicate differences concerning the α -amylase activity.

Comparison between Josef, Renesansa and Dropia varieties

The Renesansa had the highest water absorption capacity, 64.4%. Dough development was higher for the Dropia (6.27 min), this variety having higher wet gluten content and a good protein quality compared to the Josef (development time of 3.28 min). The Dropia variety had a gluten index of 93% while Josef variety of 81%. The three varieties had higher stability of the dough, over 8 min.

4. Conclusions

Mixolab is an effective and efficient device to be used for characterizing the wheat varieties. The obtained results allow a complete picture of the rheological characteristics of the studied varieties. The Renesansa variety is characterized by strong water absorption. The Capo and the Dropia are strong varieties being characterized by long development times. The protein quality of the Apache variety is very good. The Azimut and the Apache are characterized by a strong gelling capacity (C3), and the Capo by a higher C5.

Acknowledgements

This research was supported by Project 52-132/01.10.2008 financed by Romanian National Centre for Programme Management (R&D Programme "Partnerships in Priority S&T Areas / 2nd National Plan for Research, Development & Innovation 2007-2013).

References

- Collar, C.; Bollain, C.; Rosell, C.M. 2007. Rheological Behaviour of Formulated Bread Doughs During Mixing and Heating. *Food Science Technology International*. **13**, 99–107.
- Haros, M.; Ferrer, A.; Rosell, C.M. 2006. Rheological behaviour of whole wheat flour, IUFoST World Congress 13th World Congress of Food Science & Technology, 1139-1148.
- Kahraman, K.; Sakyyan, O.; Ozturk, S.; Koksel, H.; Sumnu, G.; Dubat, A. 2008. Utilization of Mixolab to predict the suitability of flours in terms of cake quality. *European Food Research Technology*. **227**, 565–570.
- Ittu, Gh. 2007. *Zonarea soiurilor*. INCDA Fundulea, 19:1-15.
- Rosell, C.M.; Collar, C.; Haros, M. 2007. Assessment of hydrocolloid effects on the thermo-mechanical properties of wheat using the Mixolab. *Food Hydrocolloids*. **21**, 452–462.
- ***. 2005. *Chopin Mixolab User's Manual*: Tripette & Renaud Chopin, France.
- ***. 2006. *Mixolab applications handbook*. Rheological and Enzymatic Analysis: Chopin Applications Laboratory, France.
- ***. 2000. *AACC. Approved Methods*. American Association of Cereal Chemists: St. Paul, MN.
- ***. 2008. *ASRO. Metode de analiză a cerealelor și produselor de măcinș*, Bucuresti, ASRO.