CORRECTION OF THE ENZYMATIC DEFICIT OF WHEAT FLOURS♦

Iuliana Banu[1*], Violeta Ionescu[2], Georgeta Stoenescu[2]

[1] "Dunărea de Jos" Galaţi University, Faculty of Food Science and Engineering, 111, Domneasca St., 800201, Galaţi, Romania
[2] Research Laboratory Arcada, Moara Arcada, Lunca Siretului, Zonă Banda Barbosi / Nr. 1 bis, 800416, Romania

*Corresponding author: iuliana.banu@ugal.ro

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Abstract: In the last years' crop, the flour obtained in the Romanian wheat grinding showed an enzymatic deficit. The purpose of this paper was to correct the rheological indices of the wheat flour using an ameliorator based on enzymes, soybean flour and emulgator.
The rheological determinations were made using the following equipment: the Alveograph NG Chopin, the Rheofermentometer F3 Chopin and the Mixolab Chopin. The results show that a significant improvement of the rheological parameters occurs for the doses of 0.6 – 0.1% enzymatic ameliorator. The slope β which indicates the gelatinization rate significantly decreases from 0.568 Nm/min to –0.014 Nm/min, for the witness sample, and the couple C5 that characterizes the starch retrogradation during the cooling stage also shows smaller values. These results obtained for the additivated samples help in obtaining bakery products with high volume and porosity.

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Keywords: *wheat flour, alveograph, rheofermentograph, mixolab, enzymatic deficit*

INTRODUCTION

In order to obtain bakery products of high quality it is necessary for the bread to have an optimal level of enzymatic activity. A poor or too intense activity creates difficulties in conducting the bread making technological process, and the products obtained are not of good quality.

The main processes taking place in the dough are the hydrolysis and the oxydoreduction. The hydrolysis processes are degradation processes of the macromolecular components of the flour – such as starch, proteins, pentozanes, and of other components such as lipids, phytinic compounds, and they are accompanied by the formation of simpler products. The oxydoreduction processes consist in the oxydation/reduction of some of the components in flour – proteins, pigments.

The activity of the enzymes is influenced by the temperature, *pH*, the state of the substrate, the water activity etc. The preparation temperature of the dough is for most of the enzymes under the optimal activity temperature. For most of the enzymes, the optimal activity temperature is reached in the baking process when the optimal activity temperature is reached and when, because of the changes in the substrate as a result of the dough heating, its attackability rises.

Most of the enzymatic systems in the dough start their activity when the kneading starts and goes on along the technological process, also during the baking process until when, because of the dough heating, the inactivation temperature is reached [1].

The wheat contains a big number of specific enzymes and the variation of their activity levels influence the quality of the cereal raw materials. The main factors that influence the variation of the activity levels of the endogene enzymes are the cultivated soil, the type of the soil, the environment conditions during the cultivation, the crop conditions, the preservation conditions, the processing mode.

In the last years' crop, the flour obtained in the Romanian wheat grinding showed an enzymatic deficit. Under the circumstance, its additivation is necessary and it is to be done in the factory or in the mill. For the flour additivation in mills commercial enzymatic preparates are used, and for its additivation in the baking units ameliorators containing flour and different additives (enzymes, chemical compounds) are used.

The purpose of this paper was to correct the rheological indices of the wheat flour using an ameliorator based on enzymes, soybean flour and emulgator.

MATERIALS AND METHODS

The physical-chemical determinations have been done using the following methods:

- the moisture content was determined through the ICC 110/1method,
- the ash content through the SR ISO 2171:2002 method,

- the wet gluten content through the SR ISO 21415-2:2007 method (Sistem Glutomatic 2200, Perten Instruments AB),
- the falling number value through the ICC 107/1 method (Falling Number, model 1400PT, Perten Instruments AB).

The main quality indices of the flour used in determinations (PO) are mentioned in Table 1. They constitute the arithmetical average of two determinations, the repeatability conditions mentioned in the standards underlying the practical determinations being respected.

The rheological determinations were done using the following equipment:

- The NG Chopin Alveograph, the AACC 54-30 method [2],
- The F3 Chopin Rheofermentometer [4]
  It measures the developping parameters of the dough (250 g flour, 7 g yeast pressed under the form of suspension, 5 g salt and water that ferment according to the parameters imposed by the Chopin protocole, 28.5 ºC temperature, hydratation according to the elasticity values in the alveogramme, the mass of the dough sample 315 g, 3 hour-test duration and the weight mass of 2000 g, the kneadin being made in the Alveograpf malaxor) and it determines the quantity of gases formed and retained by the dough.
- The Chopin Mixolab [3]
  The device settings during the determinations are those shown in Table 2.

Table 1. *The quality indices of the flour used in the determinations as witness sample (P0)*

Parameters	Values
Moisture content [%]	14
Ash content [%]	0.58
Wet gluten content [%]	34
Falling number value [s]	488

Table 2. *The settings of the mixolab during the experiments performed*

Settings	Simulator test	Chopin +
Mixing speed [rpm]	80	80
Dough weight [g]	75	75
Tank temperature [ºC]	30	30
Temperature first plateau	30	30
Duration first plateau, until torque will be 0.90×1.1 Nm [min]	30	8
Temperature second plateau [ºC]	-	90
First temperature gradient [min - ºC/min]	-	15 - 4
Duration second plateau [min]	-	7
Second gradient temperature [min - ºC/min]		10 - 4
Temperature third plateau [ºC]	-	50
Duration third plateau [min]	-	5
Total analysis time [min]	-	45

The following parameters were recorded: water absorption, development time, stability at mixing, dough weakening (C2 and α), starch gelatinization (C3 and β), amylase activity (C4 and γ), and starch gelatinization (C5).
In order to correct the enzymatic activity we have used different doses (between 62.5 and 125 g/100 g flour) of ameliorator based on enzymes, soybean flour and emulgator.

RESULTS AND DISCUSSION

Through additivation, we have obtained a reduction of the falling number from 488 to 304 s.
The alveogramme and rheofermentogram parameters for the witness sample and for the additivation samples are shown in table 3. Comparatively analyzing these parameters we can notice that through additivation, the energy and the P/L ratio increase. When the additivation is done using doses over 100 g ameliorator/100 g flour, the alveogram parameters are inferior to the minimal dose used, i.e. 62.5 g/100 g flour. The results of the rheofermentogram are spectacular for the additivated samples. The data in Table 3 indicate a significant rise of the total volume of formed gas and that of the retained gas in the dough. The best results are recorded for the minimal doses of ameliorator, for which the coefficient of the gas retention is 98.1%.

Table 3. *The characteristics of the alveogram and rheofermentogram for the witness sample and the additived samples*

Parameters	P0	P1 62.5 g/ 100 g	P2 100 g/ 100g	P3 125 g/ 100 g
Falling number [s]	488	421	405	394
Alveorgramme parameters				
Dough elasticity (P) [mm]	72	82	80	65
Dough extensibility (L) [mm]	116	118	91	128
P/L ratio	0.62	0.69	0.88	0.51
Energy (W) [$Jx10^{-4}$]	264	348	276	302
Flexibility index (Ie)	59.3	68.6	65.2	69.4
Dough blowing index (G)	24	24.2	21.2	25,2
Rheofermentogram parameters				
Dough permeability by time when gas starts to escape from the dough (Tx) [h]	1.48	1.57	2.01	2.34
Maximum time for gas production (T’1) [h]	2.39	1.52	2.39	2.03
Total gas production [mL]	1331	1689	1659	1693
Volume of the gas lost [mL]	48	33	43	38
Retention volume [mL]	1283	1657	1616	1655
Retention coefficient [%]	96.4	98.1	97.4	97.7

The parameters that characterize the curves recorded at the Mixolab for the samples analyzed are shown in Table 4. Analyzing these results we can notice the occurrence of some important differences between the witness sample and the additivated samples in the heating stage of the dough.

The temperature rise above 30 ºC determines the decrease of the dough consistence, which is explained by the intensification of the proteolytical enzyme activity in the same time with the temperature rise.
The continuous temperature rise causes, above 45 – 50 ºC, the proteins to start coagulating. The process is also accompanied by the release of most of the water bound to proteins in the kneading process, which emphasizes the dough softening which reaches at a certain point a minimal point.

Table 4. *The parameters of the curves registered at the Mixolab for the witness sample and for the additived samples*

Parameters	**P0**	**P1 62.5 g/100 g**	**P2 100 g/100g**	**P3 125 g/100 g**
Water absorbtion [%]	57.5	57	56.4	55.6
Softening [UF]	–1973	–2908	–2534	–2403
Stability [min:s]	7.14	5	5.58	6.23
Development time [min:s]	3.51	1.37	1.31	1.24
C1 [Nm/min]	1.13	1.16	1.18	1.13
Time for C1 [min:s]	4.12	1.27	1.36	1.38
C2 [Nm/min]	0.43	0.30	0.29	0.31
Time for C2 [min:s]	17.33	18.30	18.39	18.58
C3 [Nm/min]	2	1.83	-	1.86
Time for C3 [min:s]	24.34	29.12	-	28.38
C4 [Nm/min]	1.59	1.77	-	1.71
Time for C4 [min:s]	29.42	30.25	-	30.11
C5 [Nm/min]	2.73	2.6	2.57	2.71
Slope α [Nm/min]	–0.042	–0.032	–0.026	–0.046
Slope β [Nm/min]	0.568	0.144	–0.014	0.130
Slope γ [Nm/min]	–0.142	–0.056	-	–0.148
Amplitude [Nm]	0.08	0.07	0.09	0.09
Stability [min]	8.11	5.42	5.19	5.56

The minimal couple of the force in C2 point shows smaller values for the additivated samples, 0.29 – 0.31 Nm, compared to 0.43 Nm for the sample, reached after longer lapses of time 18.30 – 18.58 min, compared to 17.33 min at the native flour. The activity of the proteolyical enzymes is neatly characterized by the Mixolab in the α slope [5], the slope having bigger values for P1 and P2.
Above 50 – 55 ºC, the starch swells and gets gelling which causes the dough consistency to increase. For the additivated flour the couple C3 is smaller than for the witness sample (Table 4). The slope β which indicates the jellying speed significantly decreases from 0.568 Nm/min to –0.014 Nm/min, for P2.
Significant differences between the witness sample and the additivared samples occur on the plateau where the temperature is constantly maintained at 90 ºC. For the native flour, that has a very big falling number, the couple C4 that measures the stability of the formed starch jelly, a curving area is recorded. In exchange, for the additivated samples this part of the curve is ascendant, with a slight inflexion at P3 (125 g ameliorator/100 g

flour). The parameters in this area of the curve recorded in the Mixolab shows P2 as being the best additivation of the flour (Figures 1 – 3).

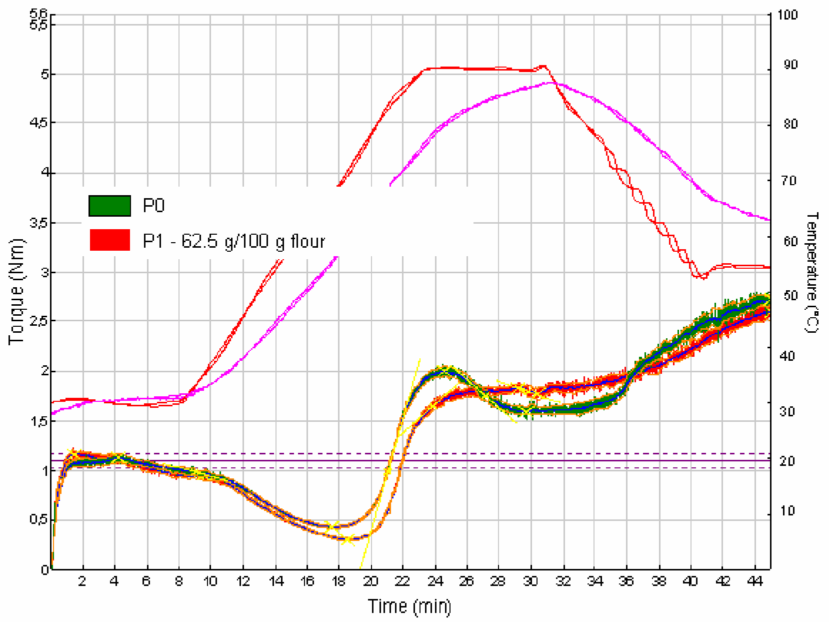

Figure 1. *The curves recorded at the Mixolab for the witness sample, P0*

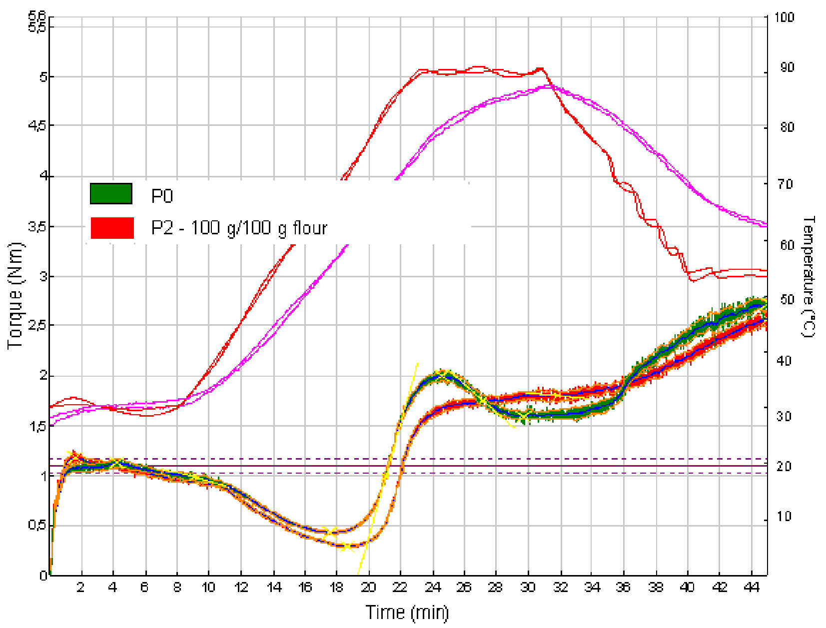

Figure 2. *The curves recorded at the Mixolab for the additivated sample P1*

The couple C5 that characterizes the starch retrogradation during the cooling stage shows smaller values for the samples P1 and P2, while for P3 the differences compared to P3 are not significant. Theses results will determine an improved volume or porosity for P1 and P2, compared to P0, but also to P3.

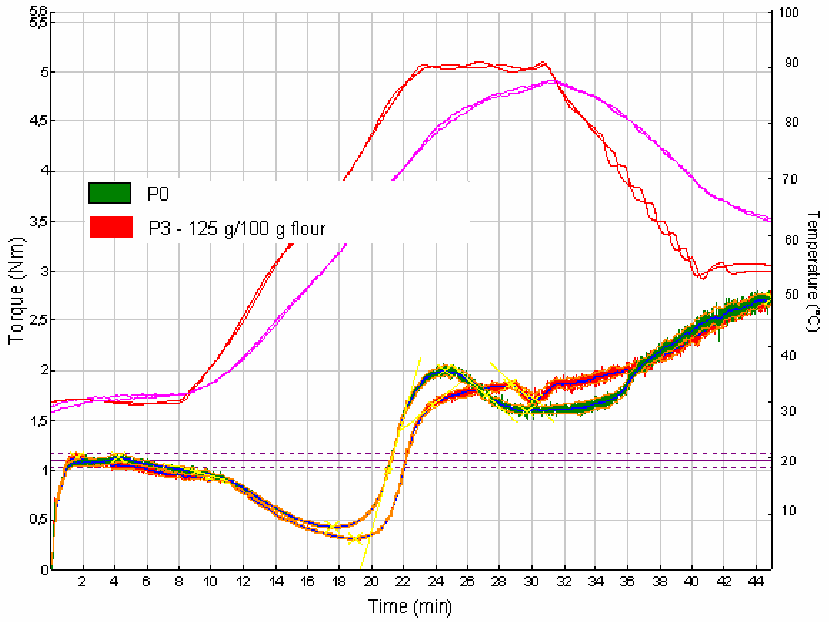

Figure 3. *The curves recorded at the Mixolab for the additivated sample P2*

CONCLUSIONS

In the last years' crop, the flour obtained in the Romanian wheat grinding showed an enzymatic deficit. The purpose of this paper was to correct the rheological indices of the wheat flour using an ameliorator based on enzymes, soybean flour and emulgator.
The rheological determinations were made using the following equipment: the Alveograph NG Chopin, the Rheofermentometer F3 Chopin and the Mixolab Chopin. The results show that a significant improvment of the rheological parameters occurs for the doses of 0.6 – 0.1% enzymatic ameliorator. The slope β which indicates the gelling speed significantly decreases from 0.568 Nm/min to –0.014 Nm/min, for the witness sample, and the couple C5 that characterizes the starch retrogradation during the cooling stage also shows smaller values. These results obtained for the additivated samples help in obtaining bakery products with high volume and porosity.

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