DOUGH RHEOLOGICAL PROPERTIES OF BROWN FLOUR TYPE 1250 WITH ADDITIVES, STUDIED WITH THE HAUBELT FLOURGRAPH E7 AND BRABENDER EXTENSOGRAPH

— research paper —

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Abstract: We studied the rheological characteristics of brown flour type 1250, from Romanian wheat. We used two apparatus that work based on empirical methods of determination, the Brabender Extensograph and Haubelt Flourgraph E7. We compared the values obtained from the two apparatus and for the same studied and we discussed the correlations established between them.We permuted parameters as: energy [cm^2], resistance to extension [BU],[HE], extensibility [mm], maximum resistance[BU];[HE] ratio and maximum ratio. Generally values of all correlation indices were above 0.8, so the two devices may similarly characterize the dough. The energy values were best correlated at 90 minutes (R^2= 0.9516), resistance to extension at 45 minutes (R^2=0,9105), and extensibility at 90 minutes (R^2= 0.967). We thus demonstrated that the equipment used can give values that similarly characterize the behavior of dough, if the same method of determination is used.

Keywords: dough, rheology, wheat brown flour, Extensograph Brabender, Haubelt Flourgraph E7

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INTRODUCTION

Rheological measurements are relevant tools in the food industry for physical characterization of raw material prior to and during processing, and of final food products (Tabilo-Munizaga et al., 2005) (Haros et al., 2006) (Banu et al., 2009).

In 1930 one of the first special instruments was designed for physical testing of wheat flour doughs, the so-called Brabender Farinograph and the Chopin Alveograph (Bloksma et al., 1988) (Kahraman et al., 2008). Using this tool we draw a diagram which is called extensogram. This is considered to be a measure of the stress placed upon the wheat flour dough. Measuring the tensile properties of dough is one of the most important techniques used to assess the quality of flours used for bread making (Rasper et al., 1991). (Müller et al. 1961) presented results of the analysis based upon the curve of the effort to stress. The difference between the resistance to extension for strong and weak flour are shown in the mass effective changes. Müller established in 1961 a relationship between dough quantity after tensiling and during the test and called it "effective mass", and the resistance to extension. For rheological determinations we used a quantity of "soft" solid matter with 86% dry matter content. To ensure 86% of dry matter it is recommended to use the balance equations to correct the proportions of flour (Iancu et al., 2010a).

To determine the rheological characteristics of dough we can also use the Haubelt Flourgraph E6, and dough consistency and softening degree is expressed in HE (Haubelt units). The correlation between the farinographic units and Haubelt units were made for brown flour with additives. The correlation indices, $R^2 = 0.9995$ (Iancu et al., 2010b) demonstrates that the two devices can similarly characterize the colloidal mixture.

The aim of this study is to establish the correlations between values of measured variables that would characterize rheometric elements as: dough formation, properties of dough formation and its vasco elastic properties These values were obtained with the Brabender Extensograph and Haubelt Flourgraph E7. The brown flour additive 1250 dough was examined.

MATERIALS AND METHODS

Materials

The brown flour (Mill Cibin Sibiu, Romania) supplemented with ascorbic acid 4g/100 kg flour; L-cysteine; α-amylase, hemicellulase, 8-9 g/100 kg

flour had the following characteristics moisture u=12.9%; wet gluten Gl_u=30%; gluten deformation ID=8 mm; gluten index I_{GL}= 44,4; Falling Number FN=280 s; titrabile acidity TTA=3.3 degree, ash 1,250%, water absorbtion WA= 61,5 %.

Methods

The physico-chemical properties of flour were determined according to: the wet-gluten content of No 106 /2 ICC STANDARD flour, the STAS 89-90-6238 gluten deformation index, the ash content of no.104/1 ICC flour, the acid content of STAS 90-88 flour, the "Falling Number", according to No 107/1, ICC Hagberg-Perten STANDARD, the hydration potential of No 115/1 ICC STANDARD flour; the thermobalance determination of the moisture content of flour.

The dough was made with the Brabender Flourgraph if it was studied with the Brabender Extensograph, and with the Haubelt Flourgraph E6 if it was studied with the Haubelt Flourgraph E7. The water quantity was of 60.2% with 2% salt.

Farinograph end extensograph characteristics were determined according to the ICC method. The following parameter were determined in a Brabender farinograph was water absorbtion-percentage of water required to yield dough consistency of 500 BU (Brabender Unit) and HE (Haubelt Einheit) if used Haubelt Flourgraph E6 (ICC-179). Brabender extensograph gave the resistance to constant deformation , extensibility , the ratio ,energy and other (Rasper and Preston, 1991) (Bordei coord., 2007), like Haubelt Flourgraph E7 (ICC-180).

RESULTS AND DISCUSSIONS

The comparison of the energy values obtained with the two devices is presented in Figure 1. From the graphical representation of values it was concluded that for the dough which was thermostated at 45 minutes the correlation was of R^2= 0.8656. The values obtained were between 77 cm^2 and 91 cm^2 (Figure 1). These values characterize the medium quality flour. After 90 minutes of thermostating the minimum value obtained was lower than after 45 minutes and the maximum value was higher than after 45 minutes. The values ranged between 74 cm^2 and 98 cm^2 (Figure 1).

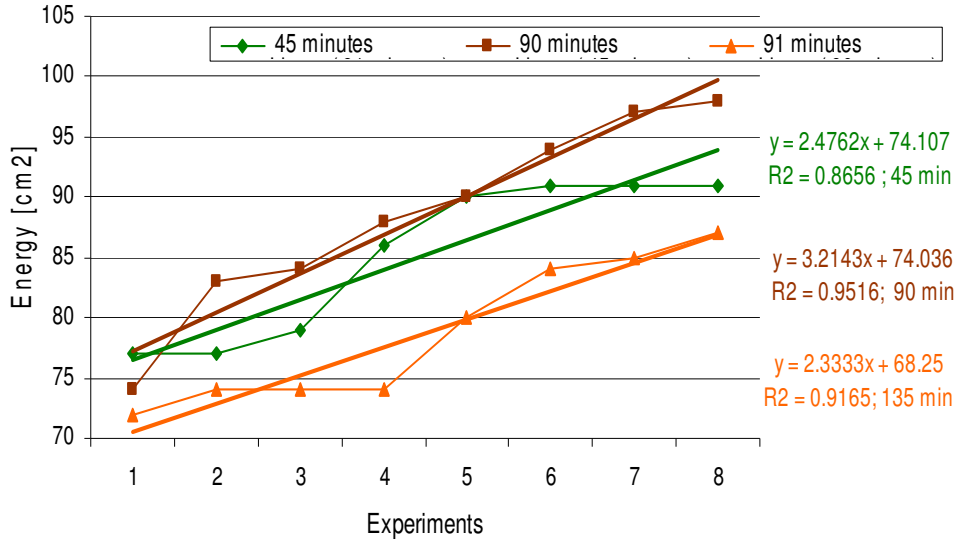

Figure 1. Energy values comparison at 45 minutes, at 90 minutes and at 135 minutes, obtained with the Brabender Extensograph and Haubelt Flourgraph E7, if a dough made out of brown additives flour type 1250 was used.

The correlation R^2= 0.9516 was better than at 45 minutes. At 135 minutes the values obtained ranged between 72 cm^2 and 84 cm^2 (Figure1). The values were lower than those obtained for 45, respectively 90 minutes, but with smaller values oscillations. The R^2= 0.9165 correlation index had a better values correlation at the minute 135 than at the minute 45 but lower than at the minute 90. Intermediate values of the presented ranges were obtained from the Brabender Extensograph and Haubelt Flourgraph E7.

The resistance to extension given by the two devices was specific for medium quality flour. The values obtained for 45 minutes ranged between 312 [BU], [HE] and 396 [BU], [HE]. At 90 minutes the values were higher than at 45 minutes and ranged between 395 [BU], [HE] and 523 [BU], [HE]. After 135 minutes we obtained values between 419 [BU], [HE] and 550 [BU], [HE]. Values were therefore higher than for 45 minutes and 90 minutes. Intermediate values were measured in Brabender units and Haubelt units. The best values correlation was obtained after 45 minutes of dough thermostating. The correlation index was R^2=0.9105 (Figure 2)

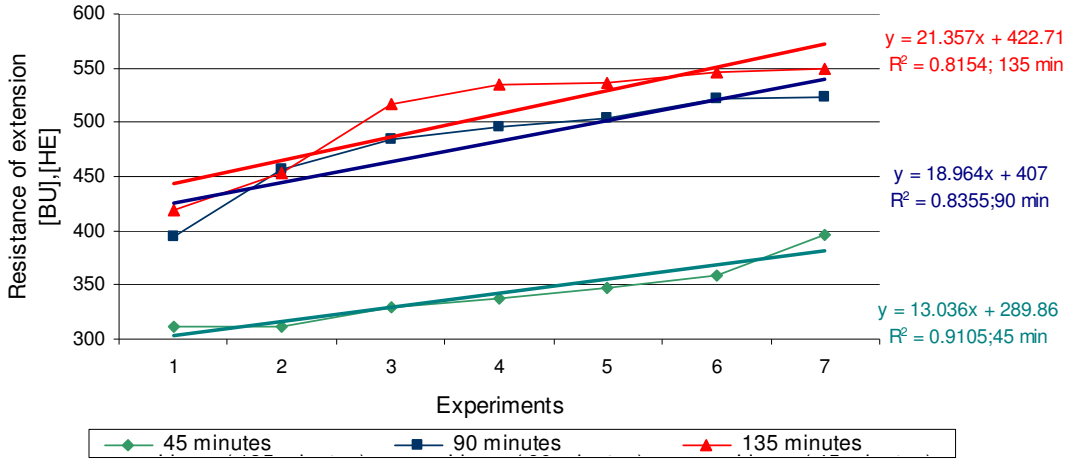

Figure 2 .Dough resistance of extension values comparison at 45 minutes , at 90 minutes and at 135 minutes obtained with the Brabender Extensograph and Haubelt Flourgraph E7, if a dough made out of brown additives flour type 1250 was used.

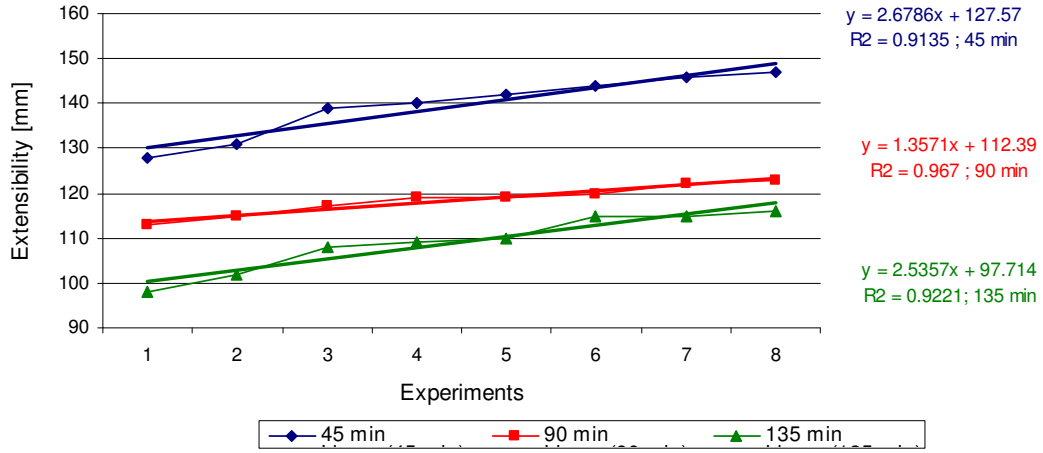

Figure 3. Dough extensibility values comparison at 45 minutes , at 90 minutes and at 135 minutes obtained with the Brabender Extensograph and Haubelt Flourgraph E7, if a dough made out of brown additives flour type 1250 was used.

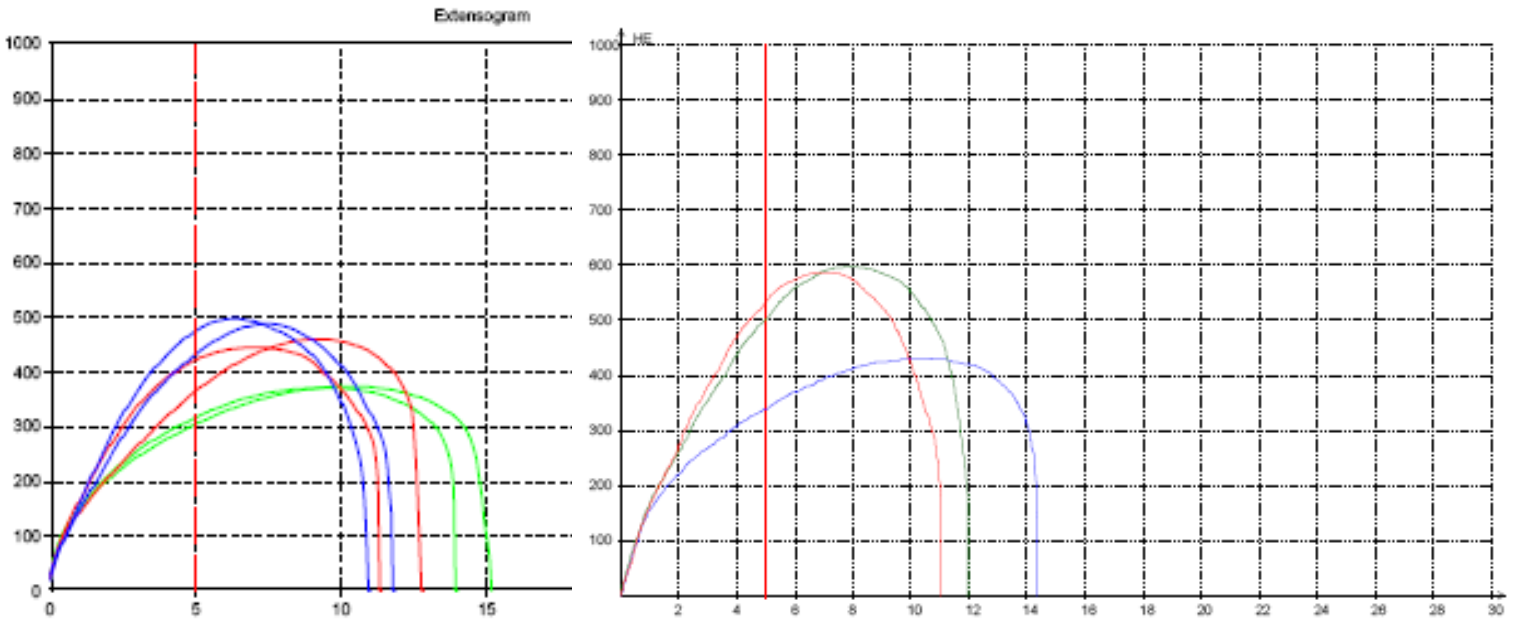

Figure 4 .Diagrams of the behavior at extension of a dough made out of brown additives flour type 1250, that were drawn using the Brabender Extensograph (left) and Haubelt Flourgraph E7 (right)

Dough extensibility after 45 minutes of thermostating had values ranging between 128 mm and 146 mm. At 90 minutes the values ranged between 113 mm and 122 mm, lower than for the previous values. After the two remodeling and a thermostation of 135 minutes in total, the values of dough extensibility from brown flour with additives type 1250 ranged between 98 mm and 115 mm. The values were obtained from the two apparatus.

The best correlation was given by the values obtained after 90 minutes of thermostating, namely $R^2 = 0.967$, compared with the values correlation after 45 minutes which was $R^2=0.9135$ and the one at 135 minutes which was $R^2 = 0.9221$ (Figure 3).

For maximal dough resistance from brown flour 1250 with additives we cannot compare values at 45 minutes but the values can be compared at 90 minutes and at 135 minutes the correlation was lower (Table 1). These comparisons were made between the values of the same size obtained with different apparatus with same diagram (Figure 4).

The ratio between the maximum resistance and dough extensibility, γ_m, have comparable values for the two apparatus and the deviation values were higher for the Brabender Extensograph than for the Haubelt Flougraph E7 (Table 1).

Dough resistance to extension at 50 mm on the recording paper keeps increasing with time. For the brown flour the differences between the obtained values were higher (Table 1).

Table 1. Oscilations ratings for the characteristics measured and calculated by the Brabender Extensograph and Haubelt Flourgraph E7 for the Brown flour additive type1250

Apparatus	Max Resistance [BU];[HE]			Ratio Number γ			Ratio Number (max) γ_m		
	45 min	90 min	135 min	45 min	90 min	135 min	45 min	90 min	135 min
Extensograph Brabender	381 ± 23.2	486.5 ± 82.6	493.5 ± 1.45	2.25 ± 0.43	3.55 ± 0.72	3.95 ± 0.145	2.7 ± 0.4	3.9 ± 0.7	5.28 ± 0.64
Haubelt Flourgraph E7	436.6 ± 24.6	457 ± 35.7	561 ± 48.4	2.5 ± 0.57	4.2 ± 0.25	4.8 ± 0.6	3.15 ± 0.38	4.9 ± 0.23	5.28 ± 0.64

The significance threshold was $\alpha = 0.05$ and standard deviation represented on the graph was calculated based on 6 flourgrams and 2 extensogram.

CONCLUSIONS

According to the present practical application, the best correlations for the studied sizes whose values obtained with the Haubelt Flourgraph and Brabender Extensograph E7 were:

- the energy needed to extend a dough from brown flour with additives type 1250, the highest correlation values was obtained after 135 minutes of thermostating and the lowest correlation after 45 minutes of thermostating.
- the resistance to extension, for the dough obtained from brown flour with additives type 1250, the values were best correlated after 45 minutes of thermostating, and the lowest values were registered after 135 minutes,
- the extensibility of brown flour with additives 1250 type dough had the maximum correlation at 90 minutes of resting and the lowest correlation after 45 minutes of thermostating and resting.

Although we used expressions such as "the best correlation", "the lowest correlation result", it was only to compare values between them. As absolute values, the correlations of studied measurements have values of over 0.8 with minor exceptions, which proves a good concordance.

We thus demonstrated that the used equipment give values that similarly characterize dough behavior, if the same method of determination is used.

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