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Rye Flour and Resting Effects on Gingerbread Dough Rheology

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Abstract. Dough represents a decisive stage during manufacturing of all products, which have as main ingredient flour. Rheology describes the properties of doughs and explains their behavior during processing. Gingerbread dough is very complex. The aim of this work was to explore how replacement of wheat four with rye flour and resting time improved dough rheology. Brabender Farinograph E and Farinograph method AACC 54-21, Constant Dough Weight Procedure were used to evaluate rheological properties of dough. Dough development was delayed through low water content and high level of sugars. Wheat flour replacement with rye flour improved rheology, the doughs were formed more rapidly and were less sticky. Dough resting allows the flour components to hydrate and the dough become more consistent and dryer. A 25-30% wheat flour replacement seemed to be optimum.

Keywords: gingerbread, rheology, dough, rye flour, farinograph

INTRODUCTION

For all bakery products dough properties are very important, they influence the stages of dough processing but also some of the final products characteristics are also influenced: form, height, crumb porosity, specific volume and symmetry. Rheological properties of dough are important also for other products, as pasta, biscuits, cookies and gingerbread. Sensitive instrument were developed recently for modern food science, to explore the rheology in fundamental way but despite of that, the older instruments, more empirical, remain very popular (Weipert, 2006). Older instruments are improved, digitized, and new ones are created. Empirical rheometers remain very popular through scientist and technologist, which work in the field of bread making.

Dough rheology, of other product than bread, is very important to control the quality of products. Gingerbread is a very popular product, especially during the winter (Christmas) but it is consumed during the entire period of year. The gingerbread production is tricky because its complex recipe and difficult to process dough. For other product, such as biscuits or cookies, were made many researches related with dough rheology (Blanchard, 2012; Fustier, 2009; Pedersena, 2007; Sudha, 2007; Van Bockstaele, 2011) but the rheology of gingerbread remain little explored (from the authors' knowledge).

Gingerbread products specific for Romanian market are similar to German products but not identical. Gingerbread characteristics are related to other bakery products as biscuit, cookies and cakes. The main ingredient for gingerbread production is flour. For the gingerbread product are used rye flour and wheat flour. The dough from rye is very sticky and difficult to process so the wheat flour is preferred. Through this replacement the dough rheology is improved but the textural properties of gingerbread is affected. Under the consumers demand for high quality product wheat flour must be replaced with rye four. It is necessary to understand better the dough rheology to prepared doughs, which could be process easier and with better results.

This work intends to study the effect of rye flour used to replace the wheat flour commonly used in Romanian gingerbread production. We studied the dough rheology during kneading and resting period.

MATERIALS AND METHODS

The kneading properties of dough were investigated using Brabender Farinograph-E. The gingerbread formula is very complex; flours represented, by weight, only half of ingredients present. Because of that Farinograph method AACC 54-21, Constant Dough Weight Procedure (AACC, 1995) was used. The replacement of wheat flour was in 20, 30, 40 and 50%. The mixing period was 60 minutes. The formulas are presented in table 1. Flours were added as equivalent to 14% moisture. All ingredients, except flour and baking agent were mixed separately before testing and were added after in the mixing bowl over flours and baking agents.

Wheat flour with 0.65% d.w ash and rye flour with 0.9% d.w. ash were used, 14.6% and respectively 14.2% water content. All other ingredients used were raw material for gingerbread industrial production.

Tab. 1

Gingerbread formula

Ingredients	Weight (g)
Wheat and rye flour	258.1
Sodium bicarbonate	3.41
Ammonium bicarbonate	1.68
SAPP 28	1.68
Spices	4.6
Salt	0.82
Lecithin	1.7
Solid vegetable fat	17.3
Sorbitol	13.9
Glycerin	2.3
Honey	9.1
Invert sugar syrup	137.4
Caramel	27.9
TOTAL	480

Doughs prepared on industrial planetary mixer were weight, 480 g, after 0; 60 and 150 minutes of resting and placed in the mixer bowl. The mixing period was 20 minutes, at 30°C.

RESULTS AND DISCUSSIONS

Gingerbread doughs were mixed for 60 minutes but this period of time was not enough for complete development of dough so the dough consistency and time development could not be determined. After 60 minutes the consistency was higher than 1000 BU so, the kneading was stropped. To evaluate the mixing curve we analyzed the dough consistency at different period of time, up to 60 minutes of kneading (*Fig. 2*) and time necessary to achieve the consistency of 500 BU and 1000 BU (*Fig. 3*)

In *Figure 1* are presented the farinogram of gingerbread dough with 100% and 50% wheat flour. The consistency of dough, with rye flour, rise more rapidly than the consistency of dough with only wheat flours, but the final consistencies is not very different. The consistencies of all doughs during mixing are presented in *Figure 2*.

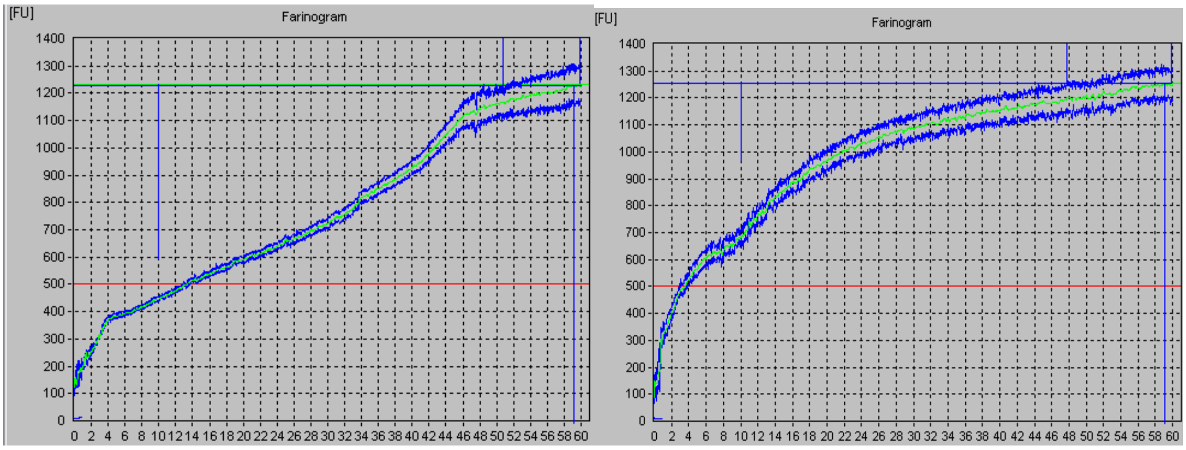

Fig. 1. Gingerbread dough mixing curve (left-100% wheat flour; right-50% wheat flour)

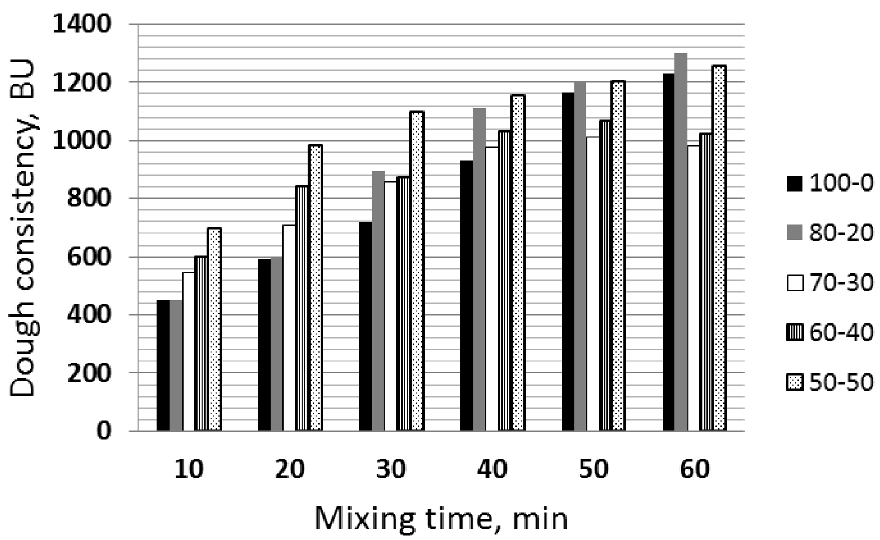

Fig. 2. Dough consistencies during mixing at different wheat flour: rye flour ratio

The doughs with a higher proportion of rye flour were formed more rapidly than the doughs with only wheat flour. This is more obvious for the doughs with 100% and 50% wheat flours. The consistency increased rapidly and after that we observed a stabilization tendency. At intermediate ratio the maximum consistency were lower. The gingerbread dough is very rich in sugars and has a very low water content (around 24%) comparative with doughs for bread. The low level of water and high levels of sugars inhibit the hydration of flour components, especially protein, which will form gluten. In doughs with high level of rye flours the hydration occur more rapidly, the arabinoxylans swell rapidly and form more viscous dough (Izydorczyk, 2007). If we assimilate the width of mixing curve with dough elasticity (Bordei, 2007) the doughs with rye flour were more elastic. The mixing curve is formed from many peaks, some of them higher than others. In normal doughs the differences are not very obvious so the mixing curve appears as a band. The mixing curve of gingerbreads doughs is formed from peaks with very different height, so it appears as very irregular. This was more easily observed in the last part, were the dough is very sticky. We consider that the mixing curve with such aspect indicates sticky dough; higher curve's width and very irregular margins indicate stickier dough.

The development time of doughs could not be determined, being longer than 60 minutes. To estimate how rapidly the doughs were formed we measured the time necessary to reach 500 and 1000 BU consistency. The values are presented graphically in figure 3. The absorption of water and forming of dough were easier in the doughs with higher amount of rye flour than in the dough with only wheat flour. At 1000 BU for the dough with 30% rye flour the consistency is highest. We must consider that during the mixing in dough different processes occur, processes with antagonist effect. The flour's component hydration increase the dough's consistency by gluten formation and water absorption while through a longer mixing time the gluten is weakened and consistency decreased. The medium is very complex and difficult to analyze.

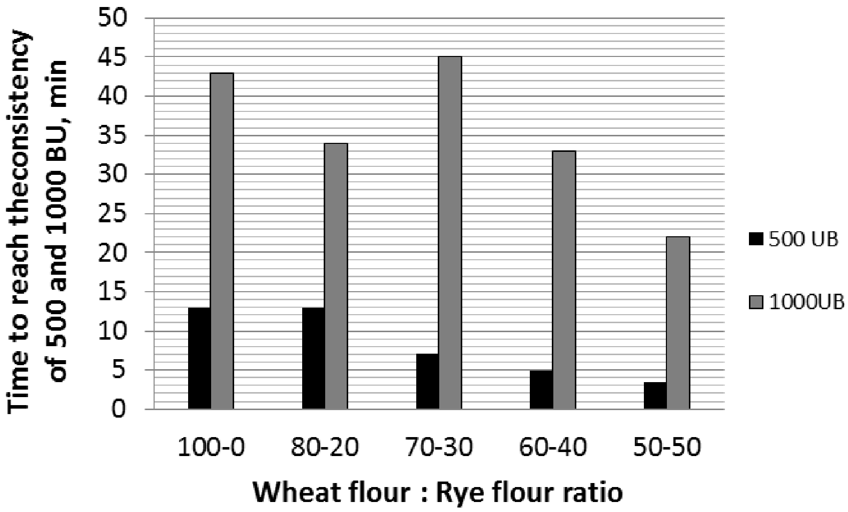

Fig. 3. Necessary time for dough consistency to

To improve the dough rheology it is a common method to rest the dough. During resting the dough become more plastic, pliable, less elastic and very often the consistency decrease by enzymatic hydrolysis of gluten. In *Figure 4* could be observed how the dough rheology is influenced during resting. Dough resting was realized at 25°C. The initial consistency increased during resting, from 371 BU to 570 and 650BU after 1 and respectively 1 ½ hour of resting. Dough with no resting period had a relative low consistency and, if we consider the mixing curves from *Figure 2*, which indicated an incomplete mixing. During resting the water was absorbed by flour components and the consistency increase despite no gluten formation occur during resting. We considered that during resting gluten relaxation appear because appear a small increases of consistency immediately after beginning of mixing.

Longer resting time determined a better hydration and the dough consistency was higher than the consistency of dough with no resting. We observed a tendency for mixing curves first to decrease and after reaching a minimum to increase again. Again, the minim consistency was lower for dough with no resting.

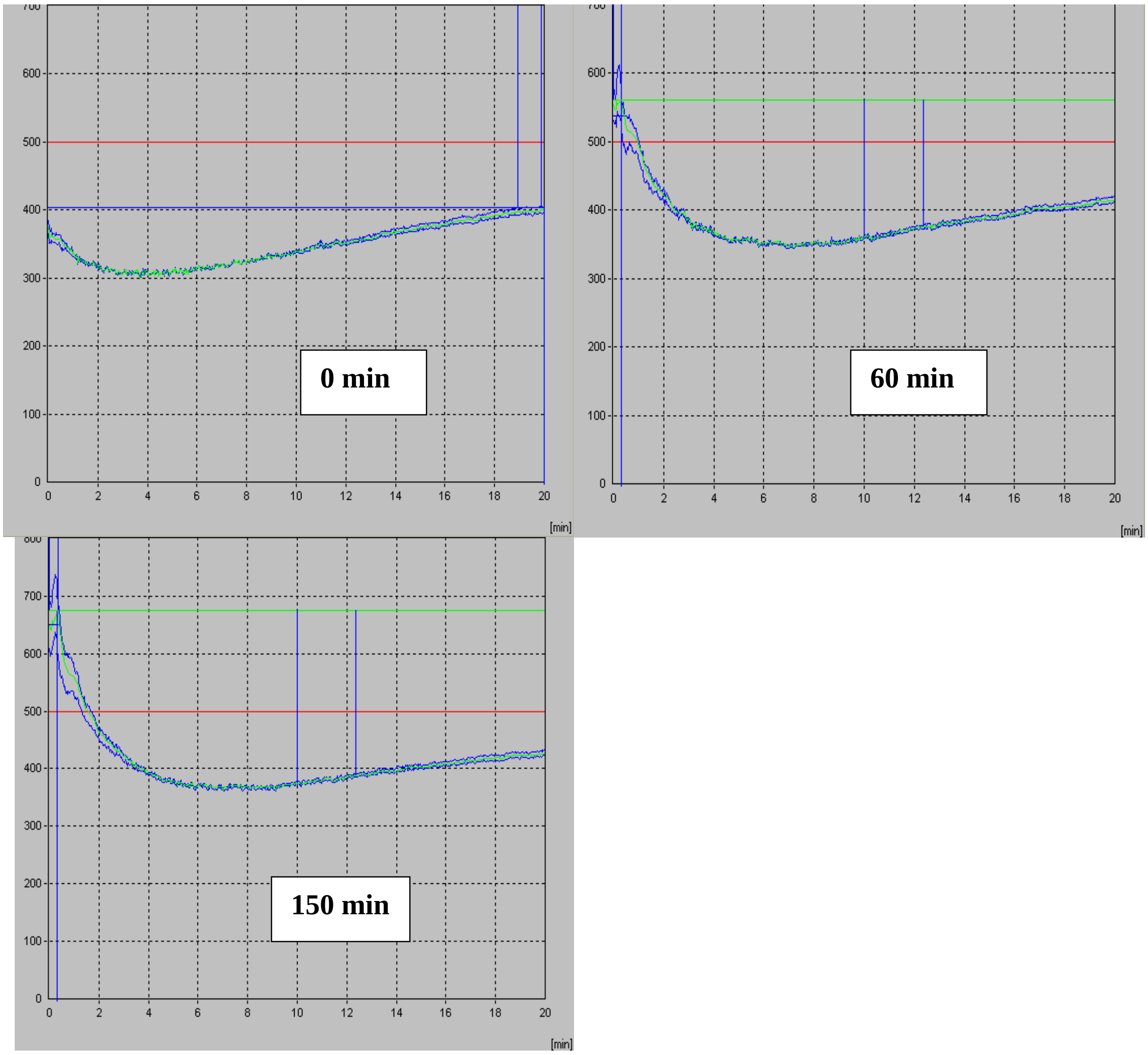

Fig. 4. The mixing curve of plant gingerbread dough with 0 minutes, 60 minutes and 150 minutes resting

CONCLUSION

The rheology of gingerbread doughs is very complex. The high level of sugars inhibited the flour hydration and gluten development. Dough rheology was improved by replacing wheat flour with rye flour. Rye flour components adsorb water easily so development time was reduced. The gluten lack of rye flour reduced the dough consistency and development time. The kneading time must be shorter than the time necessary for a complete development of dough.

During the resting time the water adsorption continued and the dough become harder and dryer. Longer time of resting leaded to more consistent doughs.

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