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QUALITY IMPROVEMENT FOR THE PRODUCT GINGERBREAD, CORELATIONS BETWEEN THE PRODUCT'S PHYSICAL AND CHEMICAL PROPERTIES AND THE RHEOLOGICAL CHARACTERISTICS OF DOUGHS

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Abstract

Quality management reflects on the product gingerbread by applying the Customer Orientation and the Continuous Improvement principles, also by analysing and developing the product in terms of the influence exerted by the various quantities of ingredients and the use of dough maturation.The presented study made corelations between the physical and chemical parameters of the finished products and the rheological characteristics of doughs. Dough with varying wheat and rye flour ratios were made, being left to mature for 30 and respectively 150 minutes. Corelations were made between the specific volume of the product and the rheological characteristics of the doughs. The dough's consistency measured with the farinograph after 10 minutes of mixing and the widening percentage of the gingerbread in the baking process were corelated. The variation of the dough's volume during maturation was studied after 30 minutes of maturation, respectively 150 minutes of maturation. The results obtain inform with regard to the influence that the rye flour ratio has on the distortion of the product during baking, on the consistency of the dough and on the specific volume.

Key words: *gingerbread, rheological characteristics of the dough, physical and chemical parameters, quality indicators*

INTRODUCTION

An important component in quality improvement for gingerbread is the addition of rye flour in the dough. Compared to wheat, rye is milled and used in the form of higher extraction flours, which makes these products have a higher nutritional value and improved potential to obtain functional products [9, 12]. In gingerbread manufacturing, rye flour has high applicability. The fact that the colour of rye flour is darker than that of wheat flour, at the same extraction level, is not an impediment as long as the colour of the product is darker because of the added spices. The product's strong spices cover the marked taste of rye compared to wheat.

Wheat flour represents an important ingredient for the manufacture of gingerbread, as it has low gluten content, and the forming of gluten is inhibited by the high fibre content[11]. The gluten formed by the rye flour proteins is less resilient and more plastic [10]. The formed dough has low resilience and high plasticity, as well as increased stickiness [1]. Rye flour is a very good alternative to the "dilution" of wheat flour, more specifically for the "dilution of gluten" in the wheat flour [2].

Rye flours are highly varied, differing due to their composition [3] and, therefore, due to their technological properties. As in the case of wheat flour, extraction is used to classify such flours. Medium-extraction flours are preferred because, as the extraction is higher, the proportion of the fraction made up of bran also increases, a fraction that has a stronger taste and is more bitter [8]. For this reason, semi white rye flours are preferred in the manufacture of gingerbread. According to the studies conducted by Fustier et al., insoluble wheat fibres (the tailings obtained in the centrifugal separation of starch) [5], [6], [7] have a higher impact on the product characteristics than gluten, they cause higher density and firmness of products, and they have a negative effect on the symmetry of the products. If we extend this observation to rye flour fibres, as well, it appears that low extraction rye flour is better suited for the manufacture of gingerbread, due to the lower content of hemicelluloses.

The replacement of wheat flour with rye flour leads to products having sensorial characteristics superior to the situation where the wheat flour is replaced with flours from other cereals, such as buckwheat [4].

This study aimed to identify certain corelations between the physical and chemical parameters of the finished products and the rheological characteristics of doughs.

MATERIALS AND METHODS

To obtain the gingerbread samples, wheat flour type 650 was used, having an ash content of 0.640%, 14.6% moisture, 24.6% wet gluten, and rye flour with a content of 0.950 mineral substances, moisture 13.9%. The invert sugar syrup had 64% dry matter, and the caramel 80%. Wheat flour was replaced with rye flour (in percentages ranging from 10 to 50%), and the dough obtained was left to mature for 30 and 150 minutes.

Table 1. Standard manufacturing recipe

No	Raw matter	Quantity, kg
1	Wheat flour	4.84
2	Rye flour	0.24
3	Starch	0.29
4	Sodium bicarbonate	0.071
5	Ammonium bicarbonate	0.035
6	SAPP 28 (sodium acid pyrophosphate)	0.035
7	Clove	0.019
8	Cinnamon	0.077
9	Salt	0.017
10	Lecithin	0.036
11	Hydrogenated fats	0.36
12	Sorbitol	0.29
13	Glycerine	0.048
14	Honey	0.19
15	Invert syrup	2.86
16	Caramel	0.58
	TOTAL	**10**

Source: Original.

For the study of dough behaviour upon kneading, the AACC 54-21 Farinograph Method for Flour (AACC 1995) was used, the method of the dough's constant mass.

This option was selected because the gingerbread dough is very complex, it contains a large number of ingredients which are added to a greater extent than in the bread manufacture doughs. Consequently, in order to minimize the influence of the kneaded dough mass on dough consistency, this method was preferred, where the dough mass is always of 480 grams.

To prepare the doughs, the reference recipe from Table 1 was used.

RESULTS AND DISCUSSIONS

The maximum consistency of the doughs made with various rye flour proportions was analysed in comparison with the widening, the H/D ration, and the products' specific volume. All trend curves had regression coefficient values of less than 0.4000, which indicates that no correlations can be established between dough consistency and the physical-chemical characteristics of the products. This is somewhat expected, as the considered consistency was not the maximum value, but rather the consistency after 60 minutes of mixing, as the maximum consistency could not be attained according to the farinograph in the 60 mixing minutes, and the dough's consistency increased too much, threatening the proper operation of the instrument.

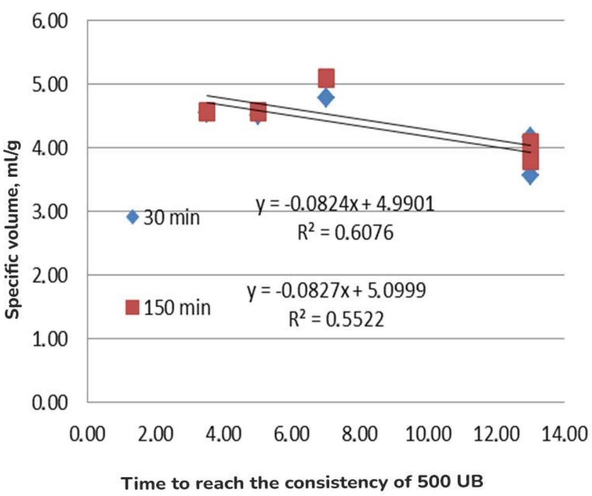

Fig. 1. Corelations between the specific volume and the rheological characteristics of doughs with various rye flour proportions
Source: Own results in the laboratory.

Much better characteristics were obtained when the physical and chemical characteristics of gingerbread were placed in relation with the time needed to reach the consistency of 500 UB. When analysing the specific volume of the samples, linear regression factors of 0.76 and 0.78 were noticed (Figure 1). These two values, even though they seem low, are considered to be significant for the experimental rheology tests.

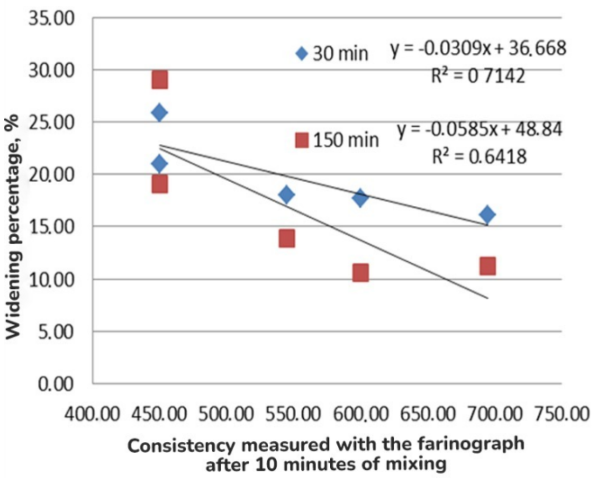

Fig. 2. Corelations between the consistency measured with the farinograph after 10 minutes of mixing and the widening percentage of the gingerbread during baking
Source: Own results in the laboratory.

Another parameter considered for the characterization of the farinograph curves specific for the mixing of gingerbread doughs was the consistency of the dough after 10 minutes of mixing. Significant values for the linear regression factors were only noted when the widening of the dough pieces in the baking process was considered. We can note in Figure 2 that these regression factors had values of 0.7142 and respectively 0.6418 for matured doughs, for 30 and respectively 150 minutes. These values confirm that, to widen gingerbreads, the consistency of the dough is important. When increasing the farinograph mixing time, the values of the linear regression factors became increasingly lower.

The variation of dough volume during maturation

During the maturation process, decomposition of the chemical aerating agents occurs as a result of the reaction between the sodium and ammonium bicarbonate and the acidifiers employed. Gas evolution led to high porosity of the dough, which made it less dense and easier to handle. The rate of decomposition of the gases depends on temperature and on the type of acidifiers employed. The higher the temperature of the dough, the higher the quantity of formed gas, as the speed of reaction is higher at high temperatures. The temperature of the dough also conditions the solubilisation rate of acidifiers. In recipes for manufacturing, various acidifiers may be employed, depending on the time when the gas release is intended, whether during kneading, during fermenting, in the first part of the baking or towards the end of the baking cycle.

As a result of gas evolution during maturation, an increase in volume occurred, as these gases were retained in the dough. The increase in volume was not proportional to the quantity of released gas, just as the quantity of released gas was not proportional to the quantity of aerating agents that reacted. Such disproportionalities are due to the physical properties of the doughs. As a result of the chemical reaction of aeration agent decomposition, CO_2 and NH_3 are released at a constant rate. These substances are released in a constant manner but, in a first stage, they are dissolved in the liquid stage of the dough. When the saturation concentration is reached, the substances will reach the gaseous stage and will start to accumulate, leading to an increase in volume. Several types of pressure act on the gas present in the dough, leading to gas compression. The more cohesive the dough, the higher the pressure exerted on the gas and, as a result, the volume growth will be lower. Strong flours make strong doughs, which do not allow for volume growth.

In the study performed, the only variable was the proportion between rye flour and wheat flour, which means that the evolution rate of gas is identical in all these. If differences occurred in terms of gas evolution, they were due to the various retention capacity of gases, as well as to the pressure exerted on them.

Figure 3 presents the dynamics of dough volume changes during maturation for the doughs made with varying rye flour proportions, after 30 minutes of maturation.

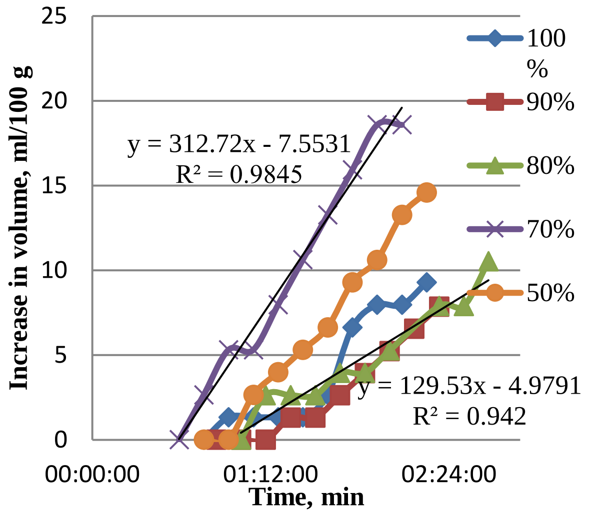

Fig. 3. Variation of the dough's volume during maturation after 30 minutes of maturation
Source: Own results in the laboratory.

The figure indicates that the development of doughs with a higher rye flour proportion was more effortless, their volume increased faster. As the production of gas was similar due to the identical quantity of aeration agents and to the identical working conditions, the differences may only be ascribed to the fact that doughs with more rye flour have better extensibility. Due to the lower pressure, the gases diluted more.

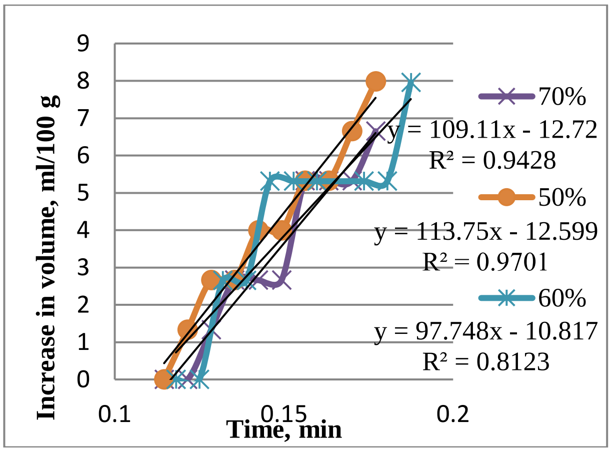

Fig. 4. Variation in the dough's volume during maturation after 150 minutes of maturation
Source: Own results in the laboratory.

After 150 minutes of maturation, the differences between the curves were lower (Figure 4). Also, the trend line slope was reduced, indicating a lower gas formation rate. As SAPP 28 was used for aeration, it may be that the part having low granulation and fast dissolution had already reacted, and only the coarser and lower-dissolving component reacted with the bicarbonates and released gases.

CONCLUSIONS

The higher the rye flour ratio in the dough, the lower the widening of the products during baking. The differences between the samples having various rye flour ratios were lower for the 30-minute maturation time.

The higher the rye flour ratio, the greater the dough consistency, which led to lower widening of the dough pieces. The weight of the dough piece also played a lesser role in terms of widening, as the latter depended to a much higher extent on the rheological changes of the dough.

Also, when weighting the widening of the cookies with their initial mass, the best correlation was noticed in the case of doughs matured over a longer period of time.

During baking, the doughs with a higher wheat flour ratio were more fluid, with a higher widening tendency.

Maturation time had no effect on the products' specific volume. The specific volume depended on the rye flour ratio within the mixture. However, there are other factors which influence the samples' specific volume, as linear regression factors were not very high. During maturation, certain processes take place, which influence the specific volume, as the linear regression factor for the trend curve corresponding to the samples having a 150-minute maturation time is low, namely 0.558.

The doughs with a greater rye flour ratio had better extensibility.

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