

## IMPROVING THE QUALITY OF THE PRODUCT “GINGERBREAD”, A STUDY ON THE INFLUENCE OF RYE FLOUR ON THE PRODUCT’S PHYSICOCHEMICAL PROPERTIES

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### Abstract

*The variety of the assortments of gingerbread existing on the market originates from the applied technology, from the quality and diversity of the ingredients used, as well as from the application of quality management: customer orientation and continuous improvement. Upon adding rye flour, an improvement in the quality of the finished product was ascertained. Different quantities of wheat flour were replaced with rye flour, and the doughs were matured for 30, respectively 150 minutes. An analysis was performed regarding the behaviour of the dough, as well as the features of the finished product (shape effect, height/diameter ration, and specific volume), which correspond to the consumer’s requirements. These parameters subject to analysis can be considered quality indicators for gingerbread.*

**Key words:** gingerbread, rye flour, physicochemical properties, quality indicators

### INTRODUCTION

The product “gingerbread” is a leavened dough cake (using baking soda or another chemical substance), made of flour, honey, and various spices (cinnamon, nutmeg, cloves, anise, and even pepper), coated in thick syrup and baked in the oven [9].

In view of improving the quality of the traditional product “gingerbread”, ingredients with a positive impact on quality indicators are often used.

Rye flour is widely used in obtaining gingerbread and, in numerous manufacturing recipes, rye flour is seen in various proportions, in combination with wheat flour.

Wheat flour, due to its gluten protein content, helps in obtaining a cohesive, springy, dry dough, which is easily processed, but the products become hard. Rye flour provides for the manufacture of products with a superior, softer texture, but the dough is more difficult to process, it is stickier, less cohesive [1], [8], [7].

This study monitored the effect which the replacement of wheat flour with rye flour has

on the products’ physicochemical characteristics [2].

Wheat flour was replaced with rye flour in different percentages and the dough obtained was left to mature for 30 and 150 minutes.

### MATERIALS AND METHODS

To manufacture gingerbread, the raw materials (Table 2) used in industrial manufacturing were employed, as well.

To prepare the dough, white wheat flour type 650 was used. The characteristics of the flour are presented in Table 1.

Table 1. Technological characteristics of the wheat flour used in the experiment

Ash content, %		0.640
Moisture content, %		14.6
Wet gluten content, %		24.6
Alveograph characteristics	P (mm H <sub>2</sub> O)	68
	L (mm)	80
	G	19.9
	W (J)	0.0179
	P/L	0.85
Ie (%)		50.8

Source: Own results in the laboratory.

Rye flour had a mineral content of 0.950 % and a moisture content of 13.9%.

The inverted sugar syrup and the caramel syrup were industrially manufactured (64% dry matter and respectively 80% dry matter).

Table 2. Gingerbread manufacturing recipe

Raw material	P1	P2	P3	P4	P5	P6
Wheat flour, kg	2.69	2.42	2.15	1.88	1.61	1.34
Rye flour, kg	-	0.27	0.54	0.81	1.08	1.34
Rye flour ratio, %	0	10	20	30	40	50
Sodium bicarbonate, kg	0.04	0.04	0.04	0.04	0.04	0.04
Ammonium bicarbonate, kg	0.02	0.02	0.02	0.02	0.02	0.02
SAPP 28, kg	0.02	0.02	0.02	0.02	0.02	0.02
Clove, kg	0.01	0.01	0.01	0.01	0.01	0.01
Cinnamon, kg	0.04	0.04	0.04	0.04	0.04	0.04
Salt, kg	0.01	0.01	0.01	0.01	0.01	0.01
Lecithin, kg	0.02	0.02	0.02	0.02	0.02	0.02
Vegetable fat, kg	0.18	0.18	0.18	0.18	0.18	0.18
Sorbitol, kg	0.15	0.15	0.15	0.15	0.15	0.15
Glycerin, kg	0.02	0.02	0.02	0.02	0.02	0.02
Honey, kg	0.10	0.10	0.10	0.10	0.10	0.10
Inverted syrup, kg	1.43	1.43	1.43	1.43	1.43	1.43
Caramel, kg	0.29	0.29	0.29	0.29	0.29	0.29

Source: Own results in the laboratory.

## RESULTS AND DISCUSSIONS

During the course of the study, dough behaviour, as well as the characteristics of the finished product were monitored.

After mixing, the dough was left to rest between 30 and 150 minutes before processing. During the course of processing, the aspect of the dough was monitored. Thus, the dough without rye flour addition, after a 30-minute rest, has a homogeneous, non-sticky aspect, it was easily processed. These characteristics remained similar after 150 minutes of rest as well, the dough was denser and drier to the feel. As the rye flour proportion increased, the dough became stickier, having a viscous appearance.

The doughs which were allowed 150 minutes of rest were more consistent. These notes are in agreement with the other rheological experiments, indicating that, with the increase

of rest time, dough consistency increases due to the absorption of water by the flour components. A reduction in the quantity of gluten in the dough by diluting wheat flour with rye flour leads to less cohesive and stickier doughs.

Also, a lightening in the colour of the dough was noticed as the proportion of wheat flour increases.

### The shape effect

Due to the release of gas during baking, the product's volume changes. Initially, the viscosity of the dough decreases in the first baking stage, due to the release of water by the proteins, followed by an increase in viscosity, due to the jellification of the starch [3], [5], [6],[10].

As a result, a product widening process occurs, cumulated with a rising process, due to the release and retaining of gas [4].

Figure 1 presents the change in diameter during baking. The widening percentage was calculated, as a difference between the initial value and the final value in relation to the initial diameter. At the time of their insertion into the oven, the samples had the same dimensions, respectively a diameter of 3.1 cm and a height of 2 cm; later, due to the different rye flour ratios in their composition, the baking behaviour was very different.

With the increase of rye flour proportion, we note that the widening of products upon baking is increasingly reduced.

The differences between samples having differing textures are lower for the 30-minute maturation time.

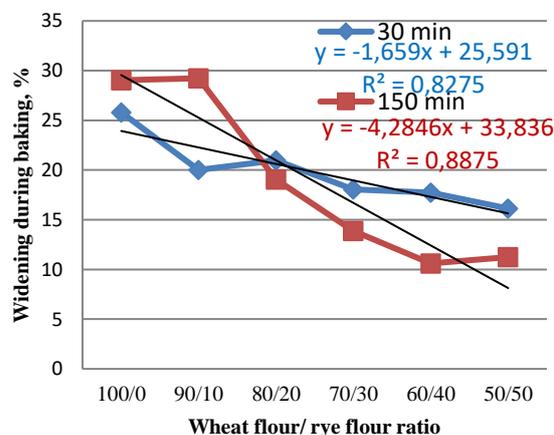


Fig. 1. Widening of cookies during baking

Source: Own results in the laboratory.

The widening of the cake obtained exclusively from rye flour was of 25.8%, whereas for the cake made with 50% rye flour, the widening percentage was 16.1%.

The same samples, after 150 minutes of relaxation had a widening of 29, respectively 11.3%. Apparently, the use of rye flour induced lower widening of the products during baking. The lower jellification temperature of the starch in the rye flour probably induced a faster stabilization of the structure and a reduced flow.

If the results obtained are statistically analysed, a rather good correlation is noticed between the widening of gingerbread and the proportion of used rye flour. In the case of dough allowed a 30-minute maturing time, the linear regression coefficient has a lower value, 0.8275, whereas for cookies prepared from matured dough for 150 minutes, the linear regression coefficient has a greater value, 0.8875. If we also take into account the fact that doughs, as they mature, become harder, more consistent (according to the sensorial observations), we can draw the conclusion that a decisive factor for the widening of gingerbread cookies is the consistency of the doughs. The higher the rye flour ratio, the greater the dough consistency, which leads to lower widening of dough pieces.

However, it has been noted that the gingerbread cookies, although processed in a similar manner, did not have the same mass. The gingerbread cookies prepared with wheat flour had an initial mass of 18.4 grams, whereas the cookies with 50% rye flour had an initial average mass of 15.55 g. If the fact is taken into account that the widening, the flow is conditional upon the weight of the piece of dough, it is very possible that this widening also depends on the mass of the pieces. In order to verify this, the percentage-wise widening of dough pieces was related to the average mass of the samples. The results are graphically illustrated in Figure 2.

The rate of the curves does not change, which indicates the fact that weight has a more reduced role on widening, and that it depends much more on the rheological modifications of dough.

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

The linear regression factor increased slightly, from 0.8875 to 0.9143.

In the case of doughs with only a 30-minute rest, the correlation is weaker.

#### Height/Diameter (H/D) ratio

The height/diameter ratio is a parameter characterising baked goods from a geometrical viewpoint. When the products contain chemical raising agents, this parameter is used to define the development of products during baking (mostly vertically, horizontally, or in both directions) [8].

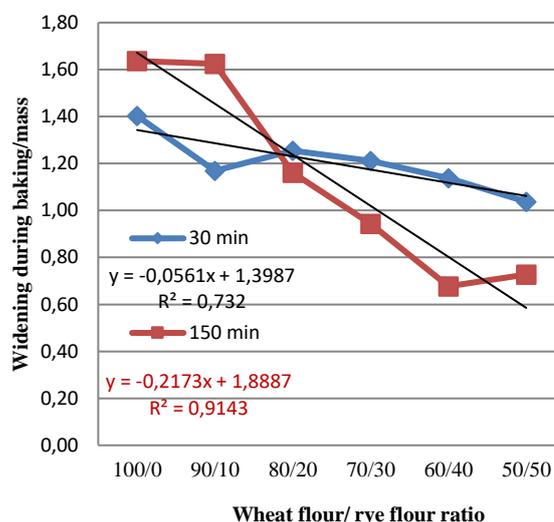


Fig. 2. Widening of cookies in relation to the cookies' average mass

Source: Own results in the laboratory.

Figure 3 presents an analysis of this aspect conducted on the samples having various rye flour percentages. Insignificant differences were noted between the two maturing times. When the proportion of rye flour was enhanced, the height/diameter ratio also increased.

These values are in agreement with the mode in which the diameter of the products changes during baking.

Doughs having a more fluid consistency widened more during baking, these being the ones having a higher wheat flour ratio.

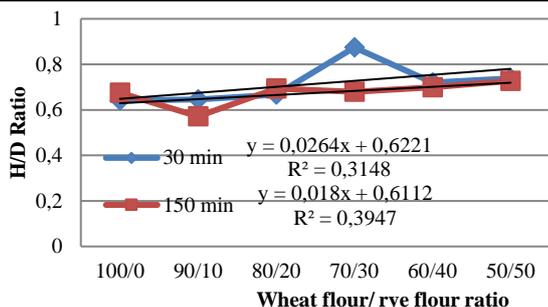


Fig. 3. Height/Diameter Ratio  
Source: Own results in the laboratory.

Although constant growth in the H/D ratio is noticed as the rye flour ratio in gingerbread doughs increases, the correlation is very weak, and linear regression factors have values of less than 0.4000. The linear trend slope is very low, 0.026 and, respectively, 0.018. This indicates low variability, we can practically see a preservation of proportions, of the shape of the products, although an obvious widening was noticed, of 11 and 29%. The almost unchanged preservation of the height-diameter ratio indicates that samples with greater widening also suffered an appropriate height increase.

**Specific volume**

Specific volume is important for a bakery product from several points of view. First of all, visually, the effect upon a consumer is stronger. If the product is perceived to be bigger, the consumer satisfaction level is higher [9]. Another aspect is that of texture. Bakery products with a larger specific volume have better porosity, the walls are less thick, and, upon pressing, the product feels softer [10]. Consequently, the consumer will perceive the product to be fresher and more pleasant. Another important aspect related to the specific volume is the one concerning the product's dimensions. A too large specific volume will not allow the products to fit in the package provided for them, and a specific volume which is too low will not fill the package sufficiently, the excess space will be too large, and it will allow for an ampler movement of the product in the packaging, which will lead to its damaging during transport and handling.

With regard to gingerbread, these aspects related to specific volume are also valid, just

like in the case of other bakery products. Even if the product is eaten occasionally, and the consumer's visual perception is not sufficiently enhanced and refined, the specific volume influences the mode in which the consumers assess the products. Figure 4 presents the variation of the products' specific volume as the proportion of rye flour increases.

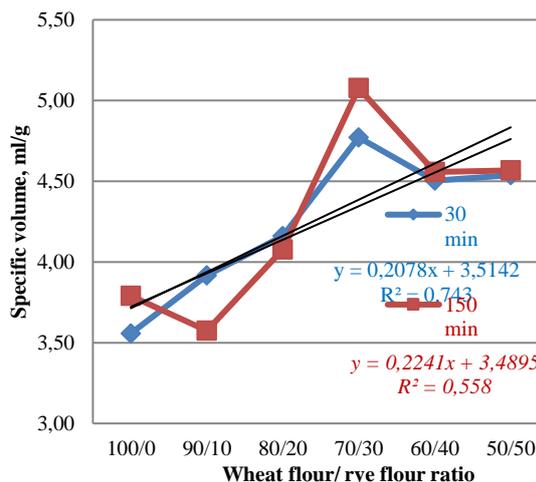


Fig. 4. Specific volume of gingerbread cookies prepared with various proportions of rye flour  
Source: Own results in the laboratory.

The tendency is for the specific volume of products to grow with the increase of the rye flour percentage. We can note a certain abnormality in the figure, a deviation of the graph when adding 30% rye flour. Normally, this could be regarded as a work error, as an inconsistency in preparing the samples. However, in the experiments performed as part of the rheological study, a similar inconsistency was noticed, also in the doughs prepared with rye flour to a 30% rate. The dough prepared with 30% rye flour had the lowest consistency and it needed the most time to attain the consistency of 1,000 UB.

If curve rates for the two series of results are traced, corresponding to the 30 and 150 minutes of mixing, we notice that these are almost identical, which indicates that maturation time has no effect in the products' specific volume. The specific volume depends on the rye flour ratio within the mixture. However, there are other factors which influence the samples' specific volume, as linear regression factors are 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 with a 150-minute maturation time is low, namely 0.558.

## CONCLUSIONS

As the rye flour ratio increases, the widening of the products upon baking is increasingly reduced. The differences between samples having differing textures are lower for the 30-minute maturation time.

The higher the rye flour ratio, the greater the dough consistency, which leads to reduced widening of dough pieces, weight has a lower impact upon widening.

Also, when weighting the widening of the cookies with their initial mass, the best correlation can be noticed in the case of doughs matured over a longer period of time; During baking, the doughs with a higher wheat flour ratio are more fluid, they tend to widen more.

Maturation time has no effect on the products' specific volume; the specific volume depends on the rye flour ratio within the mixture. However, there are other factors which influence the samples' specific volume, as linear regression factors are not very high.

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