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QUALITY IMPROVEMENT FOR THE PRODUCT GINGERBREAD, A STUDY REGARDING THE INFLUENCE OF RYE FLOUR ON THE PRODUCT'S TEXTURAL CHARACTERISTICS

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Abstract

In view of obtaining high-grade and competitive products, food industry manufacturers, as well as others, place the client, the consumer, at the top of the quality pyramid. The application of the Customer Orientation principle is essential. For the product "gingerbread", the subject of this work, textural analysis is used as a survey method, to improve the quality of the product. Gingerbread manufacturers, aiming to satisfy the clients' requirements, study the behaviour of the products developed by using various ingredients, in different proportions, with various maturation times and with water activities originating from different moisture levels of the product. Such values are intended to particularize the product and to assign it better quality and preservability during the validity term. Thus, in this survey, wheat flour was replaced with rye flour in different percentages, and the dough obtained was left to mature for 30, and respectively 150 minutes. The textural properties of the finished product were analysed, having an impact on the consumer, namely hardness, strength, and resilience. These parameters subject to analysis can be considered quality indicators for gingerbread. It was determined that the replacement of wheat flour with rye flour to a certain percentage leads to minimum toughness of the product. Corelations were made with maturation times, as well as with the moisture of the product. Maturation processes are complex, and the effects of the various factors considered are contradictory.

Key words**:** *gingerbread, rye flour, textural characteristics, quality indicators.*

INTRODUCTION

Gingerbread is a product that is difficult to obtain as part of industrial continuous flow processes, because of the characteristics of sticky doughs and of the technology used to obtain the dough pieces. Wire cutting is used for simple gingerbread, and coextrusion for gingerbread having various filling proportions. The compromise occurs because of the doughs' ability to be processed when they are formed.

Instead, it is important to analyse the hardness of the product, its strength and resilience, parameters representing textural quality indicators for the finished product [11].

The presence of rye flour in the doughs is responsible for this sticky consistency, the doughs are less cohesive, but they have positive effects on the textural characteristics of the finished products, which become softer, they attain a superior, more tender texture [2], [3], [9]. This aspect is due to the lower quantities of gluten proteins in the dough with added rye flour and also to the limited development of gluten during kneading, because of the pentosans present in large quantities [1], [5], [4].

An in-depth study on the sensory perception of texture was conducted by Foegeding et al [6]. The assessment of product quality involves more than an analysis of appearance, smell, and taste [8]. Rye flour has an influence on tthe quality of the final product and also on its physical and chemical properties [1].

In view of elaborating the most accurate tests possible, which are closest to the consumer's perception, it is necessary to explain the sensorial perception and the discovery of the mechanical aspects of sensorial analysis, to identify the parallels with the instrumental textural evaluation [7], [10].

This study monitored the effect which the replacement of wheat flour with rye flour has on the products' textural characteristics. Wheat flour was replaced in the basic recipe, which contained 100% wheat flour, with rye flour percentages ranging from 0 to 50%. The dough was matured for 30 and 150 minutes.

MATERIALS AND METHODS

Ordinary raw materials were used to obtain the product: white wheat flour, rye flour, sodium bicarbonate, ammonium bicarbonate, sodium acid pyrophosphate (SAPP), cloves, cinnamon, salt, lecithin, sorbitol, glycerine, honey, invert sugar syrup, and caramel. The product was derived industrially.

To prepare the dough, white wheat flour type 650 was used. 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).

For texture tests, the TexVol TVT-300XP/XPH texture meter manufactured by the company Perten Instruments, Sweden, was used. The instrument was equipped with a 15 kg load cell. The test device employed was the blade version, a device imitating the bite, the shearing of the product between the incisors (Figure 1).

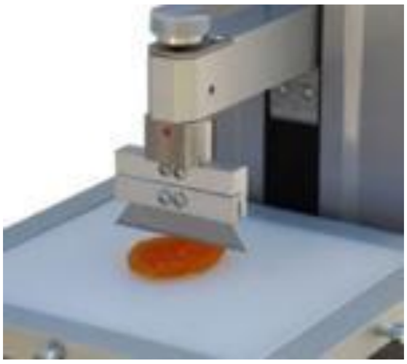


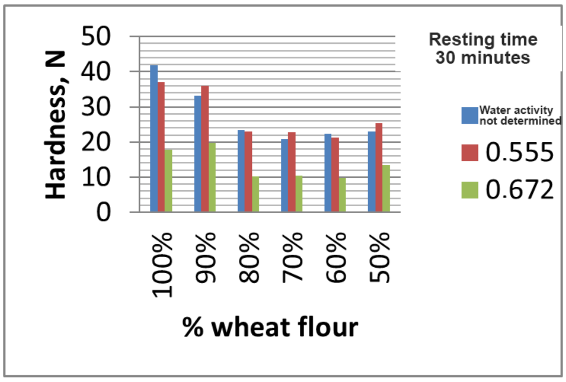
Photo 1. Blade device used for testing
Source: Original from laboratory.

RESULTS AND DISCUSSIONS

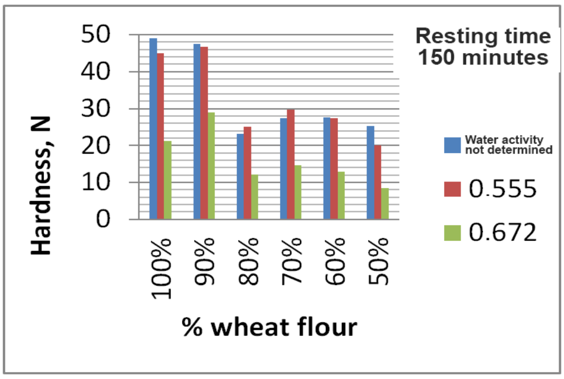
Gingerbread, after a 60-day preservation, was analysed in terms of texture, by cutting with the texture meter's blade device. Given that product dehydration occurred during storage, it was resorted to rehydration by placing it in a controlled relative humidity environment. Two water activities were provided, 0.555 and 0.672. The products stored in the warehouse were also analysed, and their water activity was not determined.

Figure 1 provides a graphic presentation of the values obtained for gingerbread hardness. Maximum hardness and force represent the same characteristic, namely the force needed to advance the device, in this particular case a blade, into the product. The hardness was recorded when the device penetrated the sample for the established distance

As the device was still advancing into the product, the recording was continued for compression tests, as well, with the maximum force occurring in this portion. For this reason, the maximum force was also analysed. The gingerbread prepared with different resting times were tested, 30 and respectively 150 minutes of rest.



a. Hardness by % wheat flour at 30 minutes by % of wheat flour



b. Hardness by % wheat flour at 150 minutes by % of wheat flour

Fig. 1. Hardness of the gingerbread made with various rye flour proportions, at different dough resting times and different water activities (N)
Source: Own results in the laboratory.

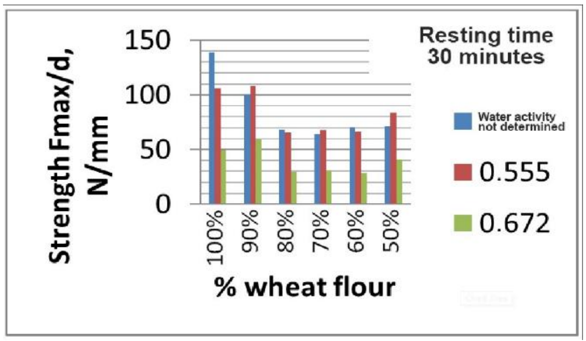
Figure 1 indicates that the added rye flour radically influenced the textural characteristics of the gingerbread. The higher the rye flour proportion, the more significant the reduction in hardness, in the resistance upon insertion of texture meter's cutting knife. The lower hardness was visible starting from the recipe where wheat flour was replaced with rye flour to a 20% rate. A replacement rate of only 10% led to slight increases in hardness. The most visible decrease was noted for the 20% replacement ratio. Upon increasing the rye flour ratio above 20%, the changes are quite low.

The figure also indicates that maturation time influenced the characteristics of the products. Surprisingly, with large proportions of wheat flour, resting time led to significant increase in product hardness. If we refer to the hardness of the product without conditioning (without humidification), using the same rye flour proportion, we noted, in almost all case, increases in hardness in proportion to the increase in resting time. A pattern for such growths could not be noticed, which proves that the transformations that occurred in the dough during maturation were complex and it is very likely that some of them had contradictory effects.

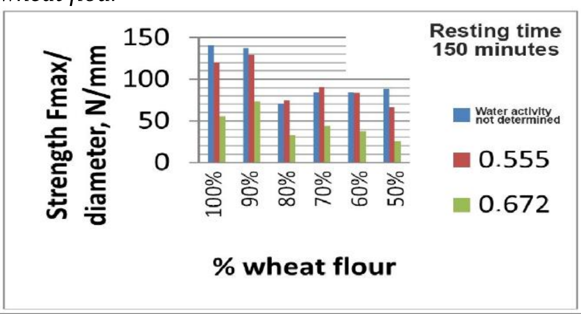
The situation is difficult to analyse without also considering the effect of humidification. The previous experiments led to the finding that hygroscopicity highly influenced the behaviour of gingerbread during storage. For this reason, humidification was employed for gingerbread, enabling its comparison by taking into account all the factors that may influence the process. The data obtained confirmed the fact that gingerbread moisture influences the textural characteristics of products to a great extent. The differences between the conditioned gingerbread and the gingerbread unconditioned up to a water activity level of 0.555 were not significant. Subsequent laboratory assessments confirmed that water activity for these samples was very close to that of the conditioned samples (between 0.480 and 0.560). Much greater differences were noticed when the conditioning was achieved up to a water activity level of 0.670.

With the increase in resting time, sample hardness increased for almost all samples. A significant exception was noted for the gingerbread where 50% of the flour was replaced with rye flour, its hardness decreasing by 21, respectively 37%, compared to the hardness of the gingerbread where only the resting time varied.

Where the hardness of conditioned gingerbread was analysed up to a water activity level of 0.555 and 0.670, prepared with a 30-minute resting time, it was noticed that for a water activity of 0.555 hardness decreased, as compared to the 100% wheat flour sample, insignificantly for gingerbread with 10% rye flour, but with values between 31.5 and 42.3% for gingerbread in which the rye flour proportion increased from 20 to 50%. If the same reference is maintained in the case of a water activity increase up to 0.670, hardness decreased even more, with values contained between 46.5 and 73.8%. In principle, a decrease in hardness by almost half was noticed in the case of samples which were moistened to a higher rate (Figure 2).



a. Strength by % wheat flour at 30 minutes by % of wheat flour



b. Strength by % wheat flour at 150 minutes by % of wheat flour

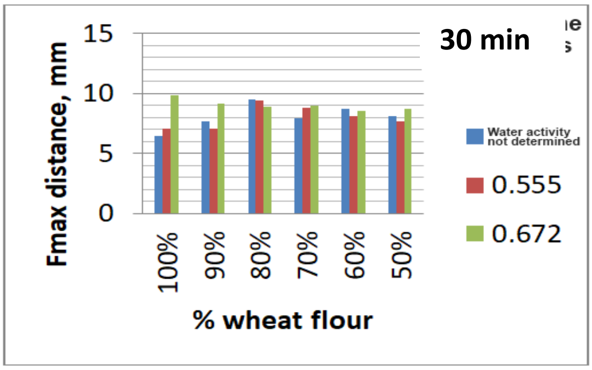
Fig. 2. Strength of the gingerbread made with various rye flour proportions, at different dough resting times and different water activities (N/mm)

Source: Own results in the laboratory.

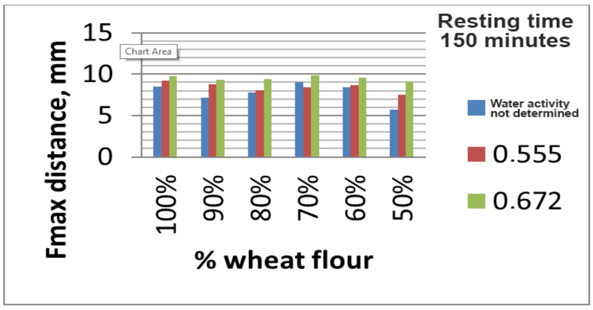
Similar behaviour was also noticed in the case of gingerbread prepared with 150 minutes of rest.

The graphs in Figure 2 were analysed, obtained for gingerbread strength, in parallel with the ones for hardness, and no major differences were noted, which led to the conclusion that the samples were relatively homogenous.

The distance where maximum force was recorded is another important parameter for the textural characterization of the samples. Figure 3 provides the average values for this parameter.



a. Distance by % wheat flour at 30 minutes by % of wheat flour



b. Distance by % wheat flour at 150 minutes by % of wheat flour

Figure 3. Distance for $F_{max.}$ in the case of the gingerbread made with various rye flour proportions, at different dough resting times and different water activities (mm)

Source: Own results in the laboratory.

It can be noticed that, with the increase in water activity, for samples with 30-minute rest and for the ones with 150-minute rest, a growth in cutting depth occurs, for which maximum force is registered. To understand this parameter, we have to specify and emphasize the fact that the gingerbread was not sectioned in whole, but rather only for a 10 mm depth. As the knife advanced into the gingerbread, it could cut directly if the tested sample was not compressible or, if it was compressible, then the sample was compressed before cutting, and the compression of the layers led to higher hardness. If the maximum force was reached at a smaller penetration distance, this indicates that the product was crumblier. Upon reaching maximum force, the product is mechanically destroyed along the knife advancement line, which renders lower the resistance after reaching this point.

When we interpret this parameter in view of this reasoning, we can say that the products having lower rye flour content were crumblier and that, with the increase in water activity, product brittleness decreased.

This observation was also confirmed by the aspect of the curves recorded by the texture meter and presented in Figure 4.

It was noticed that, for small water activities, the curves start suddenly, reaching a maximum, and then the registered values decreased until the maximum cutting depth was attained.

The lower the water activity, the more cohesive and compressible the product, which makes the maximum force to increase gradually and to reach the maximum cutting depth.

For products with 50% rye flour, this finding is even more obvious. Upon increasing resting time, an inversion was noted.

Products with rye flour were crumblier than the ones where only wheat flour was used.

Resilience is associated in terms of texture with the ratio between the areas below the texturometric curve upon advancement of the testing device and those upon withdrawing the testing device, respectively.

The analysis of Figure 4 capitalizes and clarify the notes based on the interpretation of the maximum distance variation mode and in the texturometric curves. Resilience is first of all influenced by resting times, as well as by water activity. The analysis of these figures indicates that it is not a possible resilience of samples that determines the increase in the distance for attaining maximum force.

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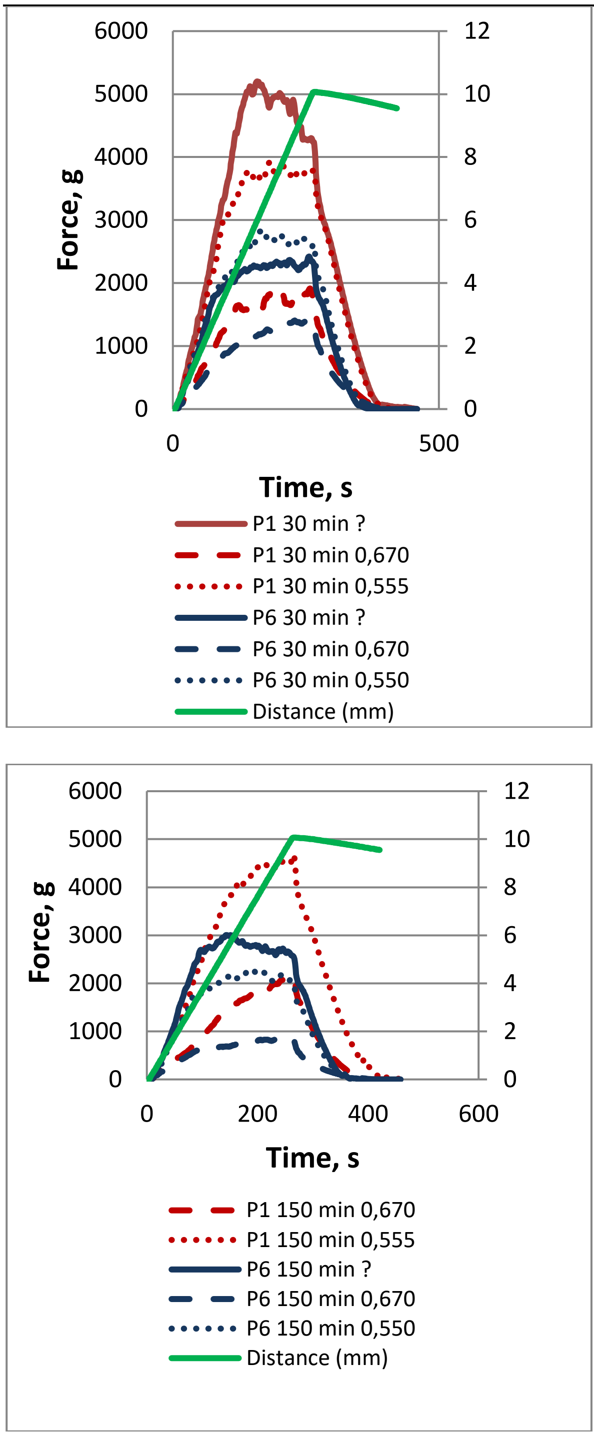

Fig. 4. Texturometric curves for the gingerbread made with 100% and 50% rye flour, at 30 and 150 resting minutes for the dough.
Source: Own results in the laboratory.

This parameter is influenced by product brittleness. It can be noticed that the curves with high distance for attaining the maximum force have a more regular aspect, whereas the other ones are more irregular, due to small fractures occurring in the product.

The resilience of products with smaller rye flour proportion is greater for lower dough resting times and for low water activity. As water activity increases, resilience decreases. Gingerbread with 50% rye flour and more moisture were more resilient than the dry ones. The increase in resting time led to lower resilience values, particularly for those conditioned at higher moisture (Figure 5).

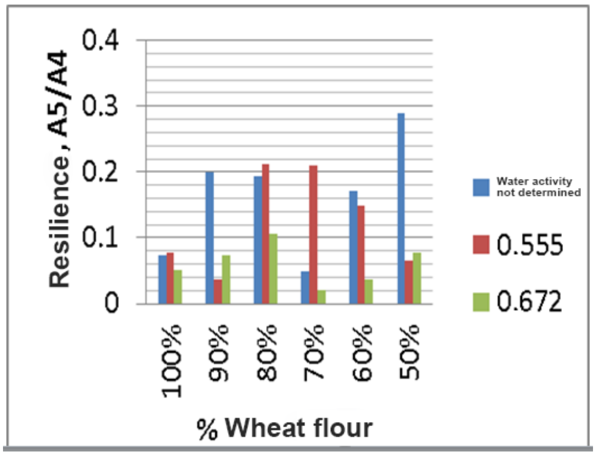

Fig. 5. Resilience of the gingerbread made with various rye flour proportions, at different dough resting times and different water activities.
Source: Own results in the laboratory.

CONCLUSIONS

Products with a lower rye flour content are crumblier and, as water activity increases, product brittleness decreases.

Surprisingly, with large proportions of wheat flour, resting time led to significant increase in product hardness.

If we refer to the hardness of the product without conditioning (without humidification), using the same rye flour proportion, we noted, in almost all case, increases in hardness in proportion to the increase in resting time.

A pattern for such growths could not be noticed, which proves that the transformations occurring in the dough during maturation are complex and it is very likely that some have contradictory effects.

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