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Effects of Some Sweeteners on Gingerbread Properties – Textural Properties

Anca Tulbure[1*] and Ioan Danciu[2]

[1]*Extra Sib SA, Alba Iulia Av., 70th, Sibiu, Romania*
[2]*Faculty of Agricultural Sciences, Food Industry and Environmental Protection*

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Abstract

Texture, water activity and moisture sorption of gingerbreads depend on theirs composition. Gingerbreads with different sweeteners and humectants were prepared in lab. The texture of samples was evaluated at 0.590, 0.630 and 0.710 value of water activity by cutting with a blade. Hardness, maximum forces for cutting and other textural characteristics were analysed. The textural parameters were moisture content dependent. The samples with high moisture content were softer than the dryer ones. The glucose syrup and sugar, with a low water affinity, lead to harder gingerbreads when were used in formulations. The maximum force registered during cutting are more suitable for textural analysis than the hardness, the force registered at the end of blade's travel.

Keywords: gingerbread, hardness, texture, sucrose, honey, sorbitol, invert syrup

1. Introduction

Food texture is a very important aspect in food evaluation by consumers. Lawless and Heymann [14] define texture as "all the rheological and structural (geometric and surface) attributes of the product perceptible by means of mechanical, tactile, and where appropriate, visual and auditory receptors". This definition reveals how diverse is observed and appreciated food products and how many human sense are involved for a complete picture. A comprehensive work on the sensory perception of texture is presented by Foegeding et all [11]. The sensory evaluation of texture is very difficult and imprecise while human senses are used. Many efforts were spent to develop method and instruments which may describe appropriately the food texture. These methods were validated by researchers as Varela et al. The Textural Profile Analysis was developed by Bourne, [3,4].

This method describes a textural test and terms which are still used in recent works. Other methods were developed as long different aspects of texture were more suitable for food characterisation. As many other bakery products gingerbreads is sensory evaluated by consumers and the softness, brittleness, dryness and crumbliness are among the textural characteristics evaluated. For bread and biscuits were developed textural methods. These are used now. Gingerbread is a relatively small product, with a low moisture content which should be soft. The stale gingerbread is associated with a hard product. No study on textural properties of gingerbreads was finding by authors. The texture of biscuit and cookies (which are most similar to gingerbread) was studied in many articles [1, 6, 9, 16, 17].

Corresponding author: *e-mail:* anca.tulbure@extrasib.ro

Few studies were performed on sorption properties of gingerbreads, Cervenka et al.[8], Tulbure et al. [18].

These studies showed a very close relation between formulation and sorption properties of gingerbreads. Cervenka et al. [8] find that the water content of Czech gingerbread vary between 12 and 15% while the water activity lies between 0.6 and 0.65. These study and other works showed that by modifying the composition could be influenced water activity of products [7]. In the recipe of gingerbread could be introduced different ingredients, with a higher water affinity, like sorbitol, glycerol, honey, invert sugar. To compare the water affinity of different materials these are compared with sucrose's water affinity. The sucrose equivalent for glycerine, sorbitol, invert sugar and salt is 4.0, 2.0, 1.4 and respective 11.0 [7, 10]. By including these raw material in recipe it is possible to increase water affinity (to reduce water activity) of product.

This work represents the second part of an experiment which aim is to observe the effects of different common sweeteners used in gingerbread's formulation. The first part of the experiment (in press) investigated how different sweeteners modify the water sorption. In our previous works we notified (sensorial analysis) that the hardness of gingerbreads is very water content dependent, the gingerbreads become very hard due drying. For a more accurate study we decide to use a device for texture analysis and to control the water content of samples by placing the samples in closed vessel with controlled relative humidity till reach the equilibrium. For more accurate observations of the effects of water the gingerbreads must have the same water content but these state it is very hard to achieve. If we consider that during the storage all products will have the same water activity, equal with relative humidity of storage house, the results of this experiment are very relevant to describe the behaviour of gingerbreads with different formulations. Water sorption and desorption during the storage are important process because, during the storage, the gingerbread could adsorb or lose moisture in a humid or, respectively, dry air. The dried gingerbreads become hard, resistant and crumbly, become stale, and the consumers will reject them as stale.

2. Materials and Method

The gingerbreads were baked in lab, with different formula. We varied the sweeteners, the proportion between them and we prepared some gingerbread with humectants, as glycerol and sorbitol. One sample was prepared with an industrial premix, which contains flour, sorbitol, sugar, condiments, baking agents in unspecified proportions. The recipes (baker's percentage) are presented in the Table 1. All recipes, excerpt sample 8, were tailored for the same content (dry mass) of sugars, including sorbitol. The ratio of sugars shown in sample 8 is typical for an industrial recipe. In the others recipes was used different sugars to observe the effects of them on sorption properties of gingerbreads. In the experiment the gingerbreads were prepared without glaze.

Water content of samples was determined by drying at 105 °C till constant weight. Water activity was determined with LabMaster, Novasina; at 25°C, 4 minutes temperature stability and 3 minutes stability for water activity (a_w) [15]. Before textural testing the gingerbreads were placed for seven days in desiccators with H_2SO_4 solutions, until equilibrium water activity was reached, similar to Bajpai et all. [2]. Were used different H_2SO_4 solutions, final a_w were 0,590, 0,630 and respectively 0,710.

For the textural test was used a texture analyser TexVol TVT-300XP/XPH, developed by Perten Instruments, Sweden, equipped with a 15 kg cell load. For the test we used a heavy duty stand and a blade-probe. We preferred this probe because at low a_w the hardness registered with a 1 inch spherical compression probe was out of measuring range of load cell. Test parameters were: test mode – single cycle; test speed 10 mm/s; compression 10 mm; trigger force – 5g; data rate 300 pps. At least six tests were performed for each sample.

Table 1. Gingerbreads recipes (baker's percentage)

Sample	PM	P1	P2	P3	P4	P5	P6	P7	P8
Flours (wheat and rye)	100	100	100	100	100	100	100	100	100
Premix	-	-	-	-	-	-	-	-	22,1
Baking agent	2,7	2,7	2,7	2,7	2,7	2,7	2,7	2,7	-
Condiments	1,8	1,8	1,8	1,8	1,8	1,8	1,8	1,8	-
Salt	-	0,3	0,3	0,3	0,3	0,3	0,3	0,3	-
Fat	7,4	7,4	7,4	7,4	7,4	7,4	7,4	7,4	-
Caramel	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	-
Sorbitol	5,4	-	5,4	-	5,4	5,4	-	-	-
Glycerol	0,9	-	0,9	-	-	0,9	-	-	-
Honey	3,5	-	-	-	-	-	50,9	-	7,4
Invert sugar	53,2	-	-	63,6	57,6	57,6	-	-	63,6
Sucrose	-	40,5	36,8	-	-	-	-	-	26,7
Glucose syrup DE 64	-	-	-	-	-	-	-	49,4	-

3.Results and Discussion

For the single cycle texture test, one of the most important parameters used to describe texture is hardness. The hardness is defined as the force registered when the desired compression is achieved. For our experiment the hardness represents the force registered when the cutting blade cut 10 mm in the gingerbread. In the Figure 1 are presented the variation of hardness during the testing. The hardest sample was sample P7, prepared with glucose syrup. The hardness of the gingerbreads was higher at low water activity and lowest at high water activity. The absorbed water softened the samples. Between the samples big differences were observed at low water activity. As long the water activity is increased the differences become not so obvious. The gingerbreads hardness was higher than the control (PM) when sucrose and glucose syrup were used. Glucose syrup had the highest hardening effects. Replacing sucrose with sorbitol and adding glycerol to recipe reduce the hardness of gingerbread. The hardness of gingerbreads increased when invert sugar syrup was replaced with an equivalent quantity of sorbitol and of glycerol was added.

The previous researches showed us that the addition of glycerol and replacing invert sugar had very little effects on water sorption.

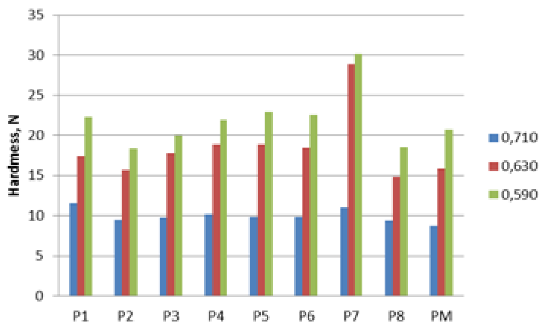

Figure 1. Hardness of gingerbread with different formulation, at 0.590, 0.630 and 0.710 a_w

In the Figure 2 could be observed that the maximum force could be registered not at the end of the test. Some samples are brittle and they could be destroyed mechanically, and after that point the necessary force for cutting will be lower. For that reason in the Figure 3 are presented the maximum force registered during the cutting test.

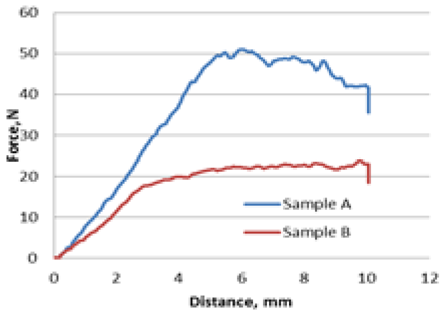

Figure 2. Gingerbreads with different behaviour during cutting (Sample A- maximum force registerede during the cutting; Sample B – maximum force required for cutting at the end of testing).

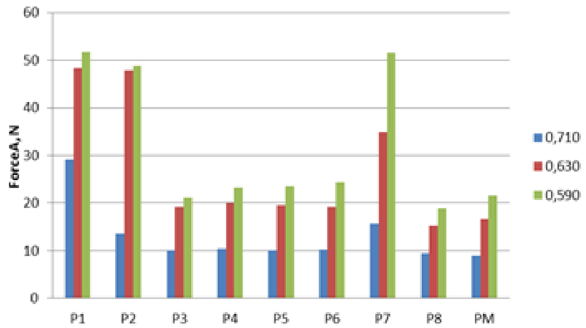

Figure 3. Maximum force (ForceA) registered during the cutting

The differences between the gingerbread samples were much obvious when maximum force were analysed. The samples with sucrose and glucose syrup needed the highest force for cutting. When sorbitol and glycerol were introduced in the recipe (P2) the maximum force decreased when the samples adsorbed moisture and reached 0.710, value of water activity. The samples prepared with invert sugar syrup or honey, with or without sorbitol or glycerol added (P3-P6), had similar resistance to cutting, similar to control samples (PM) or samples with premix. The samples with premix were the softest.

The samples with the highest ForceA had the highest hardness and also the ForceA wasn't the same as the hardness. The maximum force was registered by the testing instrument before the end of the cutting test. The distances to reach the ForceA are presented in the Figure 4. The samples with sucrose and glucose syrup seems to be more brittle, theirs internal structures were destroyed mechanically and after that lower forces were necessary to cut. When the product are moisture they are les brittle. All the samples seems to be less brittle when were moist (at high a_w).

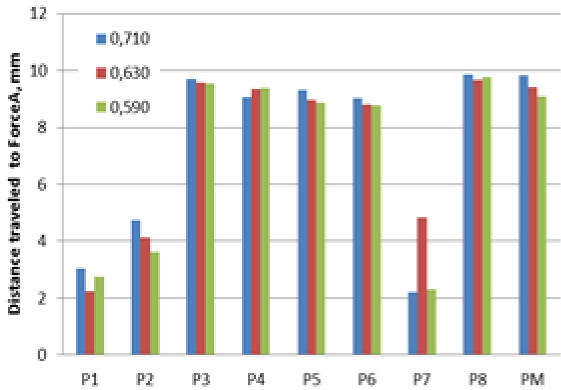

Figure 4. The distance that the probe travelled to reach ForceA

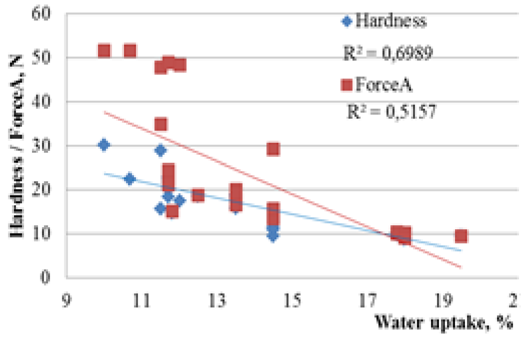

Figure 5. Hardness dependence with water content of gingerbreads

The hardness is very moisture dependent. We used the sorption curves obtained in previous work to find the moisture of samples tested at different a_w and we used the data to find if any correlations exist between the moisture content and hardness (Figure 5). Very weak correlation was observed. The low coefficient of regressions showed that the hardness of the gingerbread were not dependent only with the water uptake. Other factors, as the composition, influence the texture of gingerbreads. When we analysed samples with the same composition (recipe) the correlation between the hardness and the moisture was much higher, with regression coefficient R^2, higher than 0.95. The date are not presented because the low number of cases, one case for each a_w.

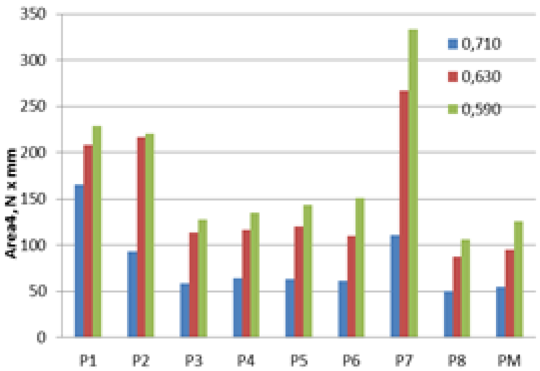

Figure 6. Area4 registered for gingerbreads with different sweeteners

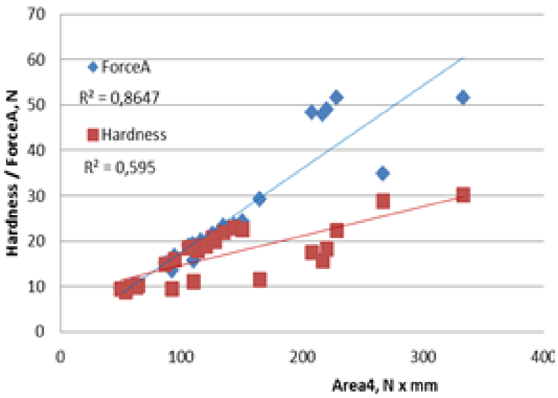

Figure 7. Correlations between Hardness, ForceA and Area4

When the textural curves are analysed the area between the curve which describe the variance of cutting force and cutting distance are analysed (Area4). If we consider that the energy are the obtained by multiply the force with the distance that this area could be considered as the energy necessary to compress or cut the sample. This area describe better the textural properties of the gingerbread because consider the force necessary for cutting in every moment of test, not just at the end or when the maximum are reached. In Figure 6 are presented the value of Area4 for the prepared gingerbreads, at different water activity. As in the case of hardness or maximum force, the samples with sugar or glucose syrup had needed a higher energy for cutting. By increasing the moisture the energy for cutting was lowered. Good correlation was observed, R^2=0.8647 between the Area4 and ForceA (Figure 7). We considered that the maximum force registered for cutting is better parameter to describe gingerbread texture than hardness.

4.Conclusions

The textural properties of gingerbreads are strongly related with their water content. A good correlation was observed between the water content and gingerbread's hardness. The hardness of gingerbreads was influenced also by the ingredients used in the formulation. The samples with sugar and glucose syrup were the hardest samples. The glucose syrup used, with DE 65 and a relative low content of glucose [3], has a poor water sorption. Glucose syrups with higher glucose content could show better results in gingerbread formulation.

The study confirms that as moist are the gingerbreads as soften they are. The ingredients with higher water affinity sobbed higher quantity of water and they become softer.

The maximum force registered during testing are a better textural parameter than Hardness, the force registered for cutting at the end of the knife travel. Also, Area4 are a very valuable textural parameters while quantify the energy necessary for cutting during the entire test, not just at a specific moment. The distance that the probe travelled to reach ForceA offered information about the brittleness of the samples.

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Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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