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Effects of Some Sweeteners on Gingerbread Properties – Water Sorption

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Abstract

Water activity and moisture sorption of gingerbreads are important and depend on theirs composition. The ingredients which have the higher influence on these properties are sugars, and could be improved, also, by inclusion of humectants in recipe. The gingerbread samples were prepared with sucrose, honey, invert sugar and glucose syrup. In some recipes were included glycerol and sorbitol, as humectants. The sorption properties of gingerbreads were improved by replacing sucrose with honey and invert syrup. Honey and invert syrup had the same influence on moisture sorption. The water sorption decreased by replacing sucrose with glucose syrup (DE 65). glycerol The water uptake increased very little by adding 0.9%. The sorption properties of gingerbreads were slightly improve through replacing 8.8% of sweeteners with sorbitol.

Keywords: gingerbread, sorption isotherm, sucrose, honey, sorbitol, glycerol, invert syrup

1. Introduction

Gingerbread produced in Romanian factory is tributary to the German product and it is very similar, despite they differ in fragrance. Ginger is rarely used in Romanian product, cinnamon and clove are more common used as condiments. The main ingredients are flour (wheat and rye flour), honey or other sweeteners, raising agent and condiments. Gingerbread is commonly consumed during the Christmas and Easter but it is consistently consumed during the whole year. Romanian gingerbread is similar to a soft cookie, usually covered with sugar or chocolate glaze. The gingerbread must be soft, not hard and crumbly.

Due the low moisture and high sugar content the gingerbread has a long shelf life and it is a challenge to keep the product moist and fresh for a long time. Because the low relative humidity of air from the storage spaces the moist from the product is lost and its became hard.

The moist could be kept in the product by the control of relative air humidity, the use of moist barrier package and using different materials with a high affinity for water. In a previous research (in press) we have been studied the sorption properties of some gingerbreads produced with different recipe. These researches reveal us that some products, according with their composition, have higher sorption properties than others. The gingerbreads from experiment were prepared industrially, without a precise control of recipe. The water activity and water sorption of gingerbreads could be influenced through water content and composition. Cervenka et al. [3] analysed different gingerbread and water content lied between 12 and 15% while the water activities lied between 0.6 and 0.65.

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Water activity is very important for the microbiological keeping quality but, also, influenced other process during storage, as: nonenzymatic browning and lipid autoxidation [4,9] and, very important for gingerbread, the sorption and desorption of water. Despite their low water content gingerbread are susceptible to some xerophilic fungi [10].

The sorption-desorption process during storage is related with air's relative humidity and water activity of products. By modifying their composition could be influenced water activity of products [7].

Among the raw materials for gingerbread production salt and baking agent have the higher affinity for water, followed by sugars. The level of baking agent and salt could not be increased so, to reduce the water loss during storage in dry places, the manufacturers include in product recipe raw material with high affinity for water as glycerine, sorbitol and honey. The sucrose equivalent for glycerine, sorbitol, invert sugar and salt is 4.0, 2.0, 1.4 and respective 11.0 [5]. By including these raw material in recipe it is possible to increase water affinity (to reduce water activity) of product.

Water sorption and desorption 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 it. The aim of this study is to find which sweetener improve better the water sorption and if the levels of glycerol and sorbitol are effective as humectants. In the second part of this study on the effectiveness of different sweeteners in gingerbread we will test the textural properties of the gingerbreads with different sugars, at different water activities.

2. Materials and Methods

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 [8]. For the sorption isotherms the samples were crushed in a mortar, dried at 65°C overnight. The sorption isotherm was determined at 30°C, by gravimetric method, as described by Bajpai [1]. The salts were replaced with H_2SO_4 solution with 80%, 70%, 60%, 50%, 40%, 30%, 20%, 10% and 5% w/w concentration. After 96 hours the mass of samples remained constant and water activity was measured for each sample. The time for the stability of water activity was set at 10 minutes while the temperature stability remained constant for 3 minutes. The water sorption is expressed as the water uptake of the samples reported to the dry weight of the samples, in percent (w / dw).

3.Results and Discussion

The sorption curves, for the samples with premix and control, are presented in Figure 1. No significant differences were observed between the sorption curves. The sample P8 had a higher content in sugars than control but was prepared without glycerol and sorbitol. Some amount (unspecified by manufacturer) of humectant (sorbitol) was present in the premix. Due the higher amount of honey and invert sugar syrup the water absorbed by sample P8 was greater than the control sample. It is difficult to judge which ingredient was more effective in the improvement of the sorption properties.

To compare the efficiency of different sugars to bind water are presented, in Figure 2, the sorption curves for samples P1, P3, P6 and P7, prepared with sugar, invert syrup, honey and, respective, glucose syrup.

The figure revealed that the samples prepared with honey and invert syrup were, practically, identic and

very similar to the control. Invert sucrose syrup, through his main composition of glucose and fructose, is very similar in composition and technological functions with bee honey.

Those two sweeteners were the same effective in sorption and binding moisture from the dump air. Very small differences were observed between the control sample and samples with inverted sucrose or honey because the samples had the same amount sweeteners with similar sucrose equivalent. The recipe for control contained glycerol and a fraction of honey and inverted sucrose was replaced with sorbitol, with a higher sucrose equivalent. The sorption property of control was slightly improved towards samples P1 and P5.

Sucrose and glucose syrup shown a reduced affinity for the moisture from the air and the water sorption was lower than the cases of samples prepared with sucrose invert syrup, honey or control. The affinity of sucrose for water is low. The sucrose equivalent [5] of glucose syrup with DE 64 is 0.9. According to Belitz et al. [2] glucose syrup with 64 DE contain only 39% glucose. The other sugars are maltose (35%), DP3 (11%) and DP4+ (15%). This explain why the samples prepared with glucose syrup shown the worst affinity for water.

Table 1. Gingerbreads recipes (baker's percentage)

Sample	**Control**	**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	-

Table 2. Water uptake (%) of gingerbread samples prepared with invert sugar (P3); invert sugar and sorbitol (P4); invert sugar, sorbitol and glycerol (P5)

aw / Samples	**0,022**	**0,078**	**0,175**	**0,362**	**0,558**	**0,740**	**0,845**	**0,915**	**0,931**
P3	0,06	0,57	1,67	5,20	10,31	19,91	31,84	48,34	56,27
P4	0,10	0,56	1,59	5,08	10,25	20,06	32,26	50,03	57,58
P5	0,10	0,58	1,73	5,24	10,47	20,48	32,71	49,38	57,53

In food industry some ingredients are used to improve water sorption, as humectants. Glycerol and sorbitol are among them. One aim of the experiments is to verify that the sorbitol and glycerol are efficient as humectants.

We prepared gingerbread sweetened only with sucrose (P1) and gingerbread with sucrose, sorbitol and glycerol, as indicated in Table 1. In Figure 3 are presented the sorption curves of these samples.

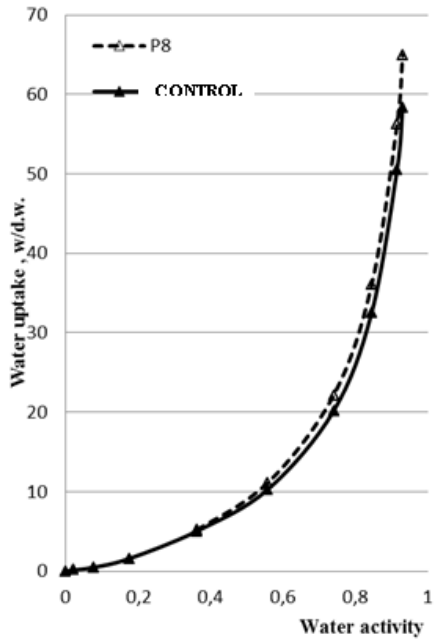

Figure 1. The sorption curves of control sample and sample prepared with premix

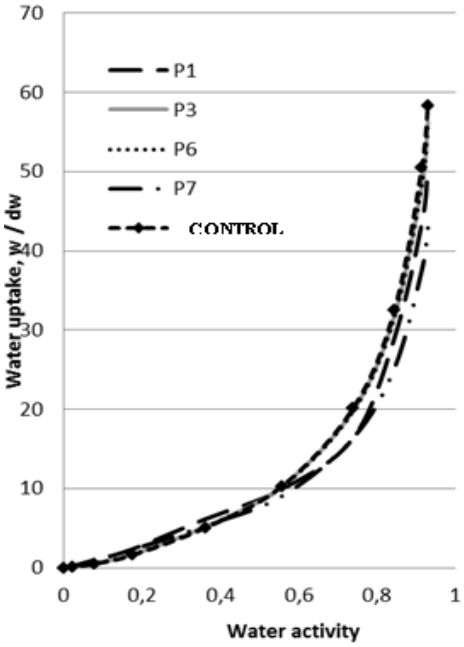

Figure 2. The sorption curves of control sample and sample prepared with sucrose, glucose syrup, invert syrup and honey

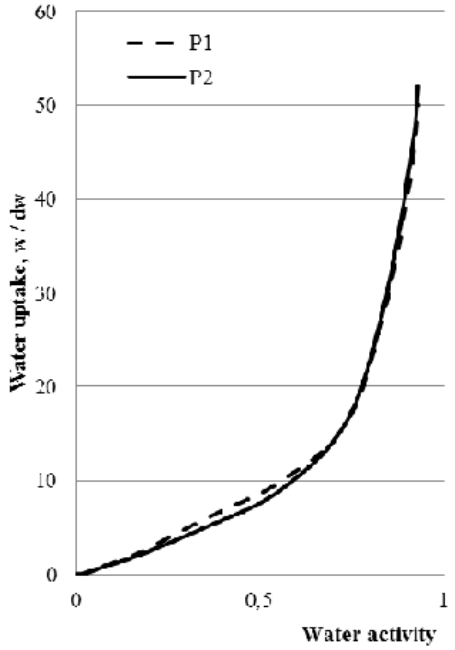

Figure 3. The sorption curves of samples prepared with sucrose (P1) and sucrose, glycerol and sorbitol

The gingerbread water sorption was only slightly improved due including of glycerol consequently with replacing a part of sugar with sorbitol. The high amount of sugar and other ingredients counterbalanced the sorption properties of sorbitol and glycerol. At air's relative humidity of 0.740 the water uptake of sample with just sucrose added was 16.56% (w / d.w.) while de sample with sucrose and sorbitol adsorbed 16.39% water. The water uptake of control sample was 20.18%, at the same relative humidity of air.

This effect was observed also in the case of gingerbread prepared with sugar invert. The differences are very small and practically the sorption curves overlapped. The small differences could be observed better in the Table 2. Could be observed that the replacing of invert sugar with sorbitol increase water sorption. Glycerol inclusion increased sorption even more, but not very much.

The desorption curves are needed for a complete description of gingerbread's properties. The hysteresis effects [6] will influence the water content of samples at desorption. This effect must be

considered because during the storage the relative humidity isn't controlled very strictly.

4.Conclusions

The recipe for gingerbread must be tailored very carefully to retain the water inside the product during storage, to maintain the initial property of gingerbreads all long theirs shelf life.

The use of honey and invert sugar syrup to retain water are the same effective. No significant differences were observed between the samples prepared with honey or invert sugar, so, we considered that honey could be successfully replaced with invert sugar if we keep in mind just this aspect. The similar behavior is due the very similar composition.

Glucose syrup had the worst effect on water uptake due the low sucrose equivalent, 0.9 [5]. A better water sorption showed the samples prepared with sucrose but the water sorption was lower than that showed by samples with honey or invert sugar.

The addition of glycerol improved slightly the water uptake during the humidification, when it is added at a level of 0.9%. The real concentration of glycerol is even lower as this level is expressed in baker's percentage.

Also, replacing 8.8 % d.w. of sugars from the recipe with an equivalent quantity of sorbitol slightly increases water sorption during humidification.

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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 and/or animal subjects (if exists) respect the specific regulations and standards.

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