SORPTION PROPERTIES OF SOME ROMANIAN GINGERBREAD

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Abstract: Water activity of gingerbread is very important for keeping the product freshness and shelf life. Water activity is influenced by composition, water content and temperature. The water content of gingerbread could vary according with storage condition. i.e. rH. 11 gingerbread samples were analysed. The water content and water activity lies between 7.0 and 12.6% and respectively 0.590 and 0.715. The sorption isotherms were determined at 30°C by gravimetric method. The moisture sorption is influenced by composition, especially sweeteners and humectants. Honey and invert sugar have the same impact on gingerbread hysteresis.

Keywords: water activity, moisture, sorption isotherm, gingerbread

INTRODUCTION

Gingerbread is a bakery product with a very complex recipe and composition. We can summarize that these products have relative low water content (10-15%), higher than regular biscuits and cookies but lower than cakes; the sugar content is high. The water and sugar content is very important because the textural properties of gingerbread are very dependent of these. At low water content sugars crystalize and products become hard,

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resistant to bite and crumbly, so the products will be rejected by consumers. Related with water content but more relevant for product behaviour during storage is the water activity. Water content and composition of gingerbread influenced the water activity. Some authors (Crevenka et al, 2008) analysed gingerbread and water content was between 12 and 15% while the water activity 0.6-0.65. Water activity is very important from the point of view of microbiological keeping quality but also this influenced other process during storage as: nonenzymatic browning and lipid autoxidation (Couvain, Young, 2000), (Troller, 1989) and, very important for gingerbread, the sorption and desorption of water. Despite their low water content gingerbread are susceptible to some xerophilic fungi (Vytrasova et al., 1989).

The sorption-desorption process during storage is related with air rH (relative humidity) and water activity of products. Water activity of products could be influenced by modifying their composition (Mathlouthi, 1989).

To reduce the water loss during storage in dry places the manufacturers include in product recipe raw material with higher affinity for water as glycerine, sorbitol and honey. By comparison with sugar for glycerine, sorbitol, invert sugar and salt is 4.0, 2.0, 1.4 and respective 11.0 (Couvain, Deiler, 1992). By including these raw material in recipe it is possible to increase water affinity (to reduce water activity) of product.

It is very important for manufacturers to create products which will keep their properties during storage, till their consumption. The aim of this work is to analyse how the composition of gingerbread influenced the water activity of gingerbread and, more important the water sorption. We chose some gingerbread with different recipes and manufacturing date and we analysed their water content and water activity. The sorption isotherms were determined in order to see how the ingredients influenced sorption properties of gingerbread.

MATERIALS AND METHODS

We selected 11 samples of gingerbread produced by ExtraSib factory, with different recipe or different manufacturing date. All of them were kept in the same storage room, with no control of temperature or rH. The recipes are presented in the Table 1. The premix composition wasn't known but contains baking agents, condiments and some humectants.

Water content of samples was determined by drying at 130 °C till for 60 minutes. Water activity was determined with LabMaster, Novasina; at 25°C, 4 minutes temperature stability and 3 minutes stability for water activity

(Novasina, 2007). 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 (Bajpai, Tiwari , 2013). The salts were replaced with H₂SO₄ solution with 80%, 70%, 60%, 50%, 40%, 30%, 20%, 10% and 5% w/w. After 48h 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 3 minutes.

Table 1. Recipes of selected gingerbread

Sample	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11
Flours(wheat and rye fours, starch)	55.5	55.5	55.5	50	45	50	50	50	54	50	50
Gingerbread premix	-	-	-	5	10	5	5	5	-	5	5
Powder sugar	-	-	-	25	25	25	25	25	-	25	25
Glucose	-	-	-	-	-	-	10	-	-	-	-
Self-made caramel, 80% d.w.	6	6	6	-	-	-	-	-	6	-	-
Invert sugar, 64% d.w.	29.5	29.5	29.5	2	2	-	-	-	6	-	-
Honey, 80% d.w.	2	2	2	8	8	10		10	20	10	10
Glycerine	0.5	0.5	0.5	-	-	-	-	-	0.5	-	-
Sorbitol	3	3	3	-	-	-	-	-	3	-	-
Lecithin	0.37	0.37	0.37	-	-	-	-	-	0.38	-	-
Hardened vegetable fat	3.7	3.7	3.7	0	0	0	2.5	0	3.6	0	0
Baking powder	1.48	1.48	1.48	0	0	0	0	0	1.48	0	0
Condiments	1	1	1	0	0	0	0	0	1.26	0	0
Flavours	-	-	-	-	-	-	-	0.19	0.19	0.19	0.19
Dried orange zest	-	-	-	-	-	-	-	5	5	-	-
Salt	0.18	0.18	0.18	-	-	-	-	-	0.18	-	-

d.w.- dry weight

RESULTS AND DISCUSSIONS

In the Figure 1 are presented the values of water activity in relation with the water content of gingerbread samples selected. No correlation could be established between water activity and water content of gingerbreads analysed. This is normal because the product had different composition, according to theirs recipes. The product with lowest moisture didn't have the lowest water activity. Nevertheless, the product with highest water activity had the highest water content. The behaviour of product is complex and we must consider the hysteresis of sorption-desorption curve. The sorption – desorption curve of gingerbread is type C (Couvain, Demertzis, 1993). Because no control of air's rH during storage many cycles of sorption and desorption could have been occurred.

Figure 1. Water activity and water content of selected gingerbreads

The samples analysed had different behaviour during water sorption. The highest affinity for water, and higher sorption was observed for samples P1 and P9, which were sweetened with invert sugar and honey, with higher sucrose equivalent than sugar. The samples P5, P6, and P7, with no invert sugar, sorbitol and glycerine in recipe, had the lowest water sorption. Major differences could be observed between samples. In figures 2 are presented the sorption isotherms of samples P1 and P6.

At 0.65 a_w (water activity) sample P1 had 13% moisture while sample P6 just 7%. This aspect is very important because if the gingerbreads are kept at the same rH, after a while its will have the same a_w but different moisture. The product with lower sorption characteristics will have lower water content and, consequently, higher hardness and crumbier texture. These have been observed during sensorial evaluation, data not showed. For the same products, with different package (different moisture barrier properties), the products with higher water loss became harder, crumbier, with a higher resistance to bite. At 12% water content the a_w of samples P1 and P6 were 0.620 and respectively 0.715. For these kinds of gingerbreads the 12% water content is typical and ensures good textural behaviour. For the sample 1 the water activity is low enough to ensure microbiological stability while the water activity of samples P6 allow proliferation of osmophilic microorganisms (Couvain, Young, 2000).

Figure 2. Sorption isotherm of gingerbread samples P1 and P6

The ingredients from recipe influenced the water sorption. Even for products with the same recipe differences could occur. The samples P1, P2 and P3 were prepared after the same recipe but their behaviour was different (Figure 3). Despite the recipes were identically some raw ingredients disturbed the gingerbread properties. We suspected the caramel and invert syrup which

were self-made and during the preparations because the variances of working parameters insufficient monitored the composition wasn't the same.

In reverse, gingerbreads with different recipe could have the same water uptake profile. The sample P1 and P9 had similar water uptake (Figure 4). Both of them were prepared with similar amounts of flours (55,5 and respectively 54 % - baker's percentage). Gingerbread P1 was prepared with 2% honey and 29.5% invert sugar while sample P2 was prepared with 20% honey and 6% invert sugar syrup. The sorption uptake was similar and sugar amount (as dry sugar) was close to. Minor differences were between the rests of recipes. Consequently, the invert sugar and honey are very similar from the point of view of water sorption.

Figure 3. Sorption isotherm of gingerbread samples P1, P2 and P3

Figure 4. Sorption isotherm of gingerbread samples P1 and P9

The sorption isotherm could be used to compare the efficiency of raw material to increase the gingerbread higroscopicity. In figures 5 are presented the sorption isotherms of samples with P4 and P5. Despite the samples P5 had a double amount of gingerbread premix the curves were very similar. This demonstrated that the gingerbread premix had no impact on product higroscopicity.

CONCLUSIONS

Sorption isotherms are very efficient instrument in the analysis process of storage behaviour for product very sensitive to water content changes, as is gingerbread. It is very important to understand the factors which influence the product higroscopicity. An equilibrium must be established between the

water content needed to ensure good texture properties and microbiological stability. The use of raw ingredients with a high affinity for water guarantees a stable product with water content high enough to preserve the texture of gingerbread.

In the process of tailoring recipes for gingerbread invert sugar syrup could be used with success to replace the more costly honey if the dry sugar content remain constantly. It is very import to have the same parameters during manufacturing for each batch to ensure consistent properties.

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