INFLUENCE OF CORN AND POTATO STARCH ON THE GINGERBREAD CHARACTERISTICS

MARIA LIDIA IANCU , MONICA MIRONESCU , VIONELA MIRONESCU

"Lucian Blaga" University of Sibiu,Faculty of Agricultural and Food Engineering , Department of Food Biotechnology

Abstract: In order to determine the changes induced by the replacement of wheat flour with starch and the maximum allowable limit of starch addition to gingerbread dough, a study on dough consistency, water content in the final product and sensory properties was realised. Two starch types (corn and potato starch) and three concentrations (5, 10 and 15%) were analysed. The results showed that the replacement of wheat flour with starch modifies the dough consistency, the modification being dependent on the starch type and concentration. The water content in the final product increases with the increase of starch percent. Water loss decreases at the addition of both starch types with the increase of starch content, improving the shelf-life of gingerbread. Sensory properties changes at the addition of starch, colour and porosity being improved, whereas brittleness and general aspect are reduced. For obtaining of gingerbreads with sensory characteristics similar with the traditional product but with improved shelf-life, the replacement of wheat flour with 5% to 10% potato starch or 5% corn starch is recommended.

Keywords: corn starch, potato starch, ginger bread, consistency, quality.

INTRODUCTION

As a multifunctional and user-friendly ingredient, starch is widely used in the food industry. Its hydrophilic action is a feature that makes it a colloidal stabilizer (Nashed et al., 2003), thickening and water retention agent (Singh et al., 2005), giving it valuable coating and surface properties (Averous et al., 2001) (Shamekh et al., 2002). Its hydrophilic properties given by the molecule with high hydroxylation degree, recommends it for softness and for maintaining the keeping period of “porous” products (Petersen et al., 2001). Its utilization is ideal especially where a sponge structure is desired (cakes, bakery products), where softness and shelf-life are improved (Murat Karaoglu et al., 2001).

In most bakery products, the primary starch source is wheat flour, where gluten contributes to the specific structure and texture. One of the modern orientations is to replace flour with starch. Native or modified starches are used as alternatives to wheat flour for gluten-free baked goods, in batters and breading products (Taggart, 2000). The added starch can range from 3 – 4.5% depending on the desired texture (Luallen, 2000).

Gingerbread is a typical product for Romania, obtained by baking dough obtained from wheat flour, sugar, honey, glucose syrup, eggs, oil and aroma.
In order to study the influence of starch addition on the gingerbread characteristics, in this work the effect of two native starches (corn and potato starch) on the bread processing characteristics and final physical and sensorial properties is investigated. Three concentrations (5, 10 and 15% reported to flour concentration) for each starch type are tested.

MATERIALS AND METHODS

Materials

For the obtaining of gingerbread dough, wheat flour, corn and potato starch, sugar, honey, glucose were used. Their main characteristics are presented in tables 1, 2 and 3.
The other materials, added in very small amounts compared to the above ones has standardised qualitative properties.

Table 1. Characteristics of corn and potato starch

Physical and chemical characteristics	Values	
	Corn starch	Potato starch
Humidity , %	12	18
Acidity , cm^3 NaOH 0,01 N	1.8	1.9
Ash , %	0.2	0.1
Proteins , %	0.7	0.1
Fat , %	0.2	0.06

Table 2. Characteristics of wheat flour 480

Physical and chemical characteristics	Values
Farinographic absorption , %	58
Humidity , %	13.8
Ash / s.u. , %	0.48
Acidity, grade	1.8
Wet gluten , %	25

Table 3. Physical and chemical characteristics of glucose syrup, sugar and honey

Physical and chemical characteristics	Values		
	Corn glucose	Honey	Sugar
Humidity , %	17.9	21	0.09
Total sugar, %		5	99.03
Reduced substances, expressed as dextrose	36	-	-

Gingerbread obtaining

The receipt for gingerbread preparation was: 92,8% flour; 4,3% sugar; 1,4% honey; 1% glucose syrup; 0,3% egg; 0,16% bicarbonate; 0,03% sunflower oil; 0,01% aroma compounds. In order to analyse the influence of starch addition on the gingerbread characteristics, samples where the wheat flour was replaced with corn or potato starch (5%, 10% and 15%) were prepared.
The dough was made through the direct method, using a laboratory mixer with 2 speeds. The baking was realised in a direct heating oven at 160°C.

Analyses

The dough consistency was measured by determining the resistance to penetration using the "Valenta" device (Mironescu and Mironescu, 2000). The results were expressed in time units necessary to the device head (300 mm) to penetrate the dough at the appliance of a weight of 351 g.
The water content, expressed as humidity, was determined gravimetrically using an analytical balance.
The freshness degree, aspect, colour texture, elasticity and adherence at mastication were determined sensorial, using a specialised analysts team with 12 members.

RESULTS AND DISCUSSION

Matching the right starch type in foods requires a multitude of criteria to be considered. These include functional or sensory properties, shelf-life expectations (Taggart, 2000). The dough consistency was considered to be a significant functional property influencing the manufacturing process and was measured. In Figure 1, the dough consistency for all the studied samples, expressed in time units (sec x 10^{-1}), is presented.

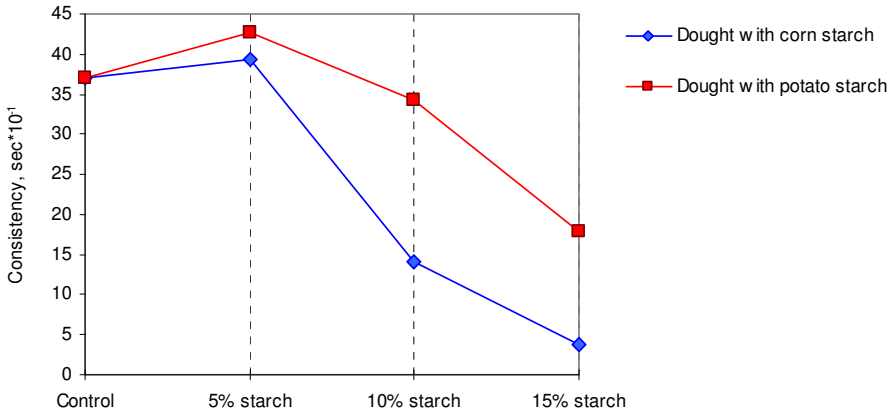

Figure 1. Variation of dough consistency in dough formulated without and with different corn and potato starch concentrations.

For the same value of weight applied, the penetration time varies according to the dough consistency. In the case of control sample, the value is 370 sec. When 5% potato or corn starch is added, the consistency increases over the control sample value, having close values for dough prepared with the two starch types. This result agrees with other literature data, which show that the consistency increases at the addition of starch (Taggart, 2000), especially in the case of potato starch (Bergtaller, 2000). This behaviour is probably due to the formation of starch gel-like structure, which improves the consistency.
When wheat flour is replaced with 10% and 15% starch, the dough consistency decreases drastically, compared with the control sample and with dough where 5% of wheat flour were replaced with starch. The decrease could have as main reason the decrease of gluten content in the mixture, which modifies the dough texture and consistency. Because the starch quantity is very high compared with the water content, the gel-like structure is not formed.
The decrease of dough consistency is more obvious when using corn starch. This behaviour could be due to the better retention of water by potato starch because of its composition in phosphate groups. Water affects the texture of this kind of product by plasticizing and softening the starch/protein matrix, which alters the strength of the product (Katz and Labuza, 1981).
It can be concluded that the starch nature and quantity influences the dough consistency. This characteristic is very important at designing and choosing the adequate mixer and mixing speed for dough preparation. The addition of

maximum 5% potato or corn starch improves the, dough adherence. The increase of starch content to 10% or 15% give doughs easier to be processed (mixed).

In Figure 2 the humidity of the final product is presented. At the formulation of gingerbread where 5% of wheat flour was replaced with starch, no significant changes in the water content of samples is obtained. When the amount of added starch increases, the gingerbread humidity increases too, due to the better capacity of starch to retain water.

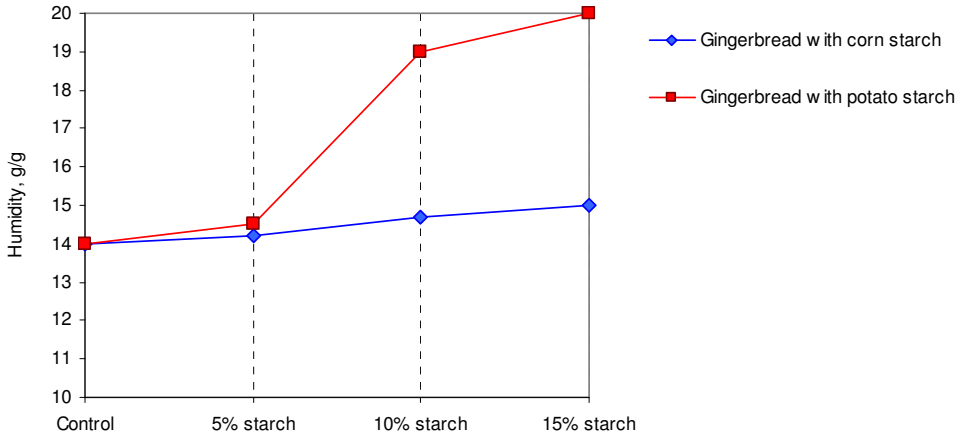

Figure 2. Variation of gingerbread humidity in sample formulated without and with different corn and potato starch concentration

The water retention capacity of potato starch is much higher as in the case of corn starch, this behaviour being due also to the phosphate groups in the composition of potato starch (Bergtaller, 2000).
The greater the starch percentage, the greater is the humidity of the final product. So, starch can be used in formulation of foods where the water content has to be increased. The bonding mode of water is different in the presence of starch, this aspect being also influenced by the other ingredients in the gingerbread specific receipt.

The shelf-life of this kind of product is a very important parameter. It depends on the storage conditions, but also on the product characteristic. The influence of starch content on the loss of water, expressed as humidity, in gingerbread is presented in Figure 3. The loss of humidity was measured as

percent from the initial product humidity after 5 days of storage at 20°C in air with 75%relative humidity.

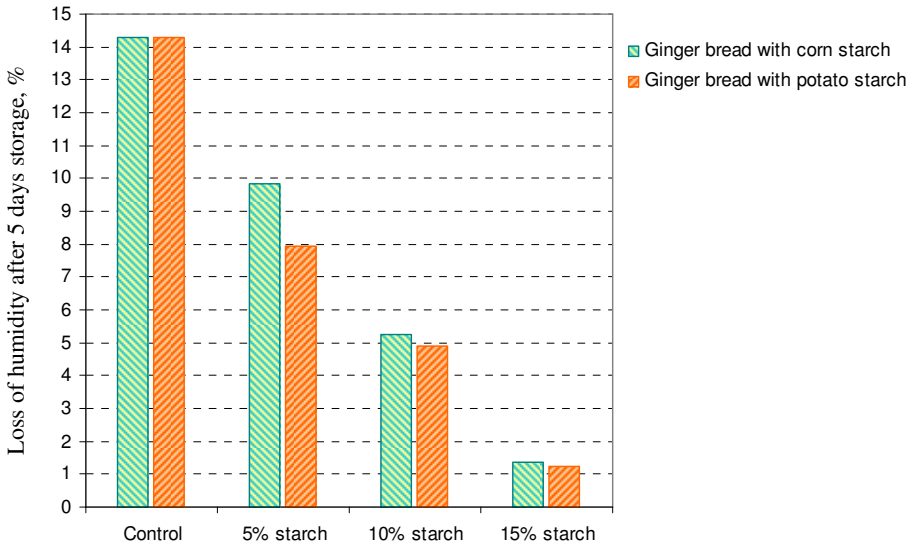

Figure 3. Variation of gingerbread humidity during storage in samples formulated without and with different corn and potato starch concentrations

The results prove that when starch is added, the duration for preserving the freshness increases and the weight losses during keeping decreases. Weight loss during storage of the control sample is relatively high (14.2%). When starch is added, the humidity decreases during baking are much smaller for gingerbreads prepared with corn or potato starch. The high the starch content the smaller the water losses. This decrease is more probably due to the complex structure formed in the presence of starch, which limits the humidity loss, water being entrapped inside the structure.
Only for products with 5% starch the starch type shows a significant influence on the humidity loss during storage. In this case, the decrease of water content in gingerbreads prepared with potato starch is more pronounced as in final products obtained with corn starch.
In samples with more than 5% starch (Figure 3), water losses during storage are quite similar for both starch types.

Starch addition leads also to modifications of colour, aspect and texture of the final product. These changes are presented in Table 4.

Table 4. Sensory characteristics of gingerbread formulated with different corn and potato starch concentrations

Sample	**Colour**		**Aspect**		**Textural characteristics**	
Control	Braun - red		Smooth surface, glowing and half good ripe. Uniform coating		Rubbery with resistance at mastication	
With replacement of flour with starch :	Corn starch	Potato starch	Corn starch	Potato starch	Corn starch	Potato starch
5% starch	Yellow , yellow – red	Yellow white	Dry aspect , with smooth surface ripped uniformly		Characteristics identical with the control sample	
10% starch	Yellow	Yellow	Easy rough surface	Uniform aspect	Rubbery with resistance at mastication	Rubbery and porous in section
15% starch	Yellow	Yellow - brown	Deformed, flat	With rough surface	Easy elasticity , non-brittle	Loss of brittleness

For the control sample, the brown colour is given by the Maillard reactions between the aminoacids contained in flour and the reducing sugars and to the the formation of melanoidins at high temperatures (Mironescu, 1998). The addition of starch leads to colour lightening due to reduction of Maillard reactions (a smaller amount of aminoacids participating at these reactions).
The aspect is also strongly influenced by the starch addition, the products becoming flatted at the replacement of wheat flour (which contains 25% gluten) with starch.
The textural characteristics change in gingerbreads with starch addition. For example, the resistance to mastication (combined with loss of brittleness) increases with the starch content increase.
Some sensory properties are improved: the colour and the porosity. Other sensory properties (the dimension and the texture) are not improved by the addition of starch. The increase of starch content gives flat and with rough surface, resistant to mastication, non-brittle products.

CONCLUSIONS

The gingerbread processing properties and the final product characteristics are influenced by the quality and properties of ingredients. At the replacement of wheat flour with starch the changes are significant, depending on the starch type (corn or potato) and quantity (5% to 15%):

- The dough consistency is influenced by the presence and type of starch. Small amounts of starch increase consistency, whereas higher starch concentrations decrease the consistency. The decrease of consistency is higher in samples with corn starch. The consistency change implies the modification of dough processing, especially mixing.
- The water content of final products is higher and the humidity losses during storage are smaller when starch percentage increases.
- Sensorial properties changes at the replacement of wheat flour with corn or potato starch. Starch added in maximum 5% does not lead to major modifications of the textural properties. The increase of the starch content decrease friability and increase the elasticity of the samples, which become lighter in colour. The porosity and pore distribution are positively influenced by the addition of starch in higher quantities.

So, for obtaining of gingerbreads with sensory characteristics similar with the traditional product but with improved shelf-life, the replacement of wheat flour with 5% to 10% potato starch or 5% corn starch is recommended.

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