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THE INFLUENCE OF GUAR GUM ON TEXTURAL AND SENSORY PROPERTIES OF ROLLS MADE FROM SEMI-FINISHED FROZEN PRODUCTS

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ABSTRACT

Textural and sensory properties of rolls produced from semi-finished frozen products with additions of guar gum were assessed. A commercial wheat flour T 512, ingredients such as yeast *Saccharomyces cerevisiae,* rapeseed oil, sodium chloride were used for preparing dough and final products. Guar gum and commercial additive Trial RC2 were used as additives for production. The textural properties of rolls were measured by a TA-XT Plus Texture Analyzer. All samples were evaluated by selected assessors. A five-point hedonic scale was used for evaluation characteristics such as taste, pliancy, texture, porosity, stickiness, gumminess, crispness and quality. The obtained data showed nonsignificant difference in moisture of rolls after baking and 3 days after baking. Control sample of rolls had higher firmness in comparison to other samples with guar gum after baking. Samples of rolls with higher addition of guar gum (10 $g.kg^{-1}$ and 15 $g.kg^{-1}$) had less firmness in comparison to control sample and sample with 5 $g.kg^{-1}$ of guar gum. Sensory analysis showed negligible differences among all samples in monitored characteristics. Sensory assessors evaluated all samples as identical. Increased addition of guar gum in rolls led to the extension of shelf life (lower firmness) at unchanged sensory properties of the rolls.

Keywords: guar gum; roll; sensory analysis; texture

INTRODUCTION

The baking industry is constantly trying to offer benefits to consumers, including freshly baked breads. The partially baked frozen process provides control over the processes that are partial baking, freezing and storing of bakery products and re-baking at the point of sale or before selling to the end user **(Škara et al., 2013)**.

The redistribution of water and ice recrystallization in dough during frozen storage leads to changes in the arrangement and structure of amylopectin and amylose molecules. Other changes occur during starch gelatinization and retrogradation.

The longer dough remains in frozen conditions, the more pronounced the degree of starch retrogradation. Bread made from frozen dough also exhibits faster starch retrogradation on low temperature (4 °C) storage in comparison to bread made from non-frozen dough, causing an increase in bread firmness **(Ribotta et al., 2001, 2003; Selomulyo and Zhou, 2007)**.

The influence of frozen storage on bread dough and bread affects gradual loss of the dough strength which is related to decrease the retention capacity of CO_2 and longer fermentation time and it also reduce yeast activity. Frozen storage affects the quality of the final product by lowering of loaf volume and deterioration in the texture of the final product **(Selomulyo and Zhou, 2007)**.

Hydrocolloids are used in food products to modify their texture, control water mobility, improve moisture retention and observe overall product quality during storage **(Linden and Lorient, 1999)**. Hydrocolloids have a neutral aroma and taste thereby flavour and all recipe components are able to reflect in the taste of the product **(Kohajdová et al., 2009)**. Hydrocolloids affect the baking performance of dough and also the shelf life of stored bread **(Armero and Collar, 1998; Davidou et al., 1996; Selomulyo and Zhou, 2007)**. Hydrocolloids are able to influence gelatinization, melting, fragmentation and retrogradation processes of starch **(Fanta and Christianson, 1996)**. When used in small quantities (<10 $g.kg^{-1}$) in dough, hydrocolloids are expected to increase water retention and loaf volume, as well as to decrease firmness and starch retrogradation **(Collar et al., 1999; Kohajdová et al., 2009)**. The addition of hydrocolloids into frozen products can provide stability during freeze-thaw cycles and help to minimize the negative effects of freezing and frozen storage on starch-based products **(Ferrero et al., 1993)**. It also decreases water activity due to the competition for water by the hydrocolloids with the bread polymers like protein and starch **(Selomulyo and Zhou, 2007; Schiraldi et al., 1996)**.

Guar gum is commonly used to improve recipe tolerance and mixing. Gums, like guar gum are able to extend the shelf life of products due to moisture retention and thus prevent syneresis in frozen foods and pie fillings **(Maier et al., 1993; Selomulyo and Zhou, 2007)**. Products were achieved with less desirable properties compared with control samples because it lowers the specific porosity and volume of bread and creates a rubbery crust with low crust thickness **(Mandala, 2005)**. **Mettler and Seibel (1993, 1995)** and **Ribotta, et al., (2001)** found that guar gum in frozen dough made a bread with more open crumb structure with higher percentage of gas cells and higher volume unlike products without added guar gum. This result was substantiated by **Ribotta, et al., (2004)**, who observed that guar gum improved the volume and texture of bread made from frozen dough frozen for 60 days, but the negative effect of frozen dough storage on the dynamic rheological parameters and microstructural damage was not avoided.

Objective of this paper is to present an analysis of the influence of guar gum on textural and sensory properties of rolls made from semi-finished frozen products.

MATERIAL AND METHODOLOGY

Materials

Dough samples were prepared from wheat flour (Mills Kojetín, Kojetín, Czech Republic, ground T 512, moisture 13.5%; ash 0.55%; gluten 34.1% as an amount of wet gluten in DM; falling number 296 s; P 71 mm H_2O; L 105 mm; P/L 0.68, W - 21.8 mJ; I_e - 49.9%;). Alveograph analysis (Chopin - Tripette & Renauld, France) was used for determination of basic characteristics according to the methods **ISO 5530-4 (2002)**. Yeast *Saccharomyces cerevisiae* (Uniferm, Paniferm, Werne, Germany), rapeseed oil (Rosa market, Kroměříž, Czech Republic) and sodium chloride (without iodine, anti-caking agent E 535 sodium ferrocyanide (Solivary Trade, Prešov, Slovakia) were used. Commercial additive for the production of leavened dough intended for freezing Trial RC2 (Irca S.r.l., Gallarate, Italy, wheat flour, malted wheat flour, mono- and diglycerides of fatty acids with tartaric acid acetal, α-amylase, ascorbic acid emulsifier) and additive guar gum (Sigma-Aldrich, Steinheim, Germany; moisture 12%, protein max. 4.5%, fiber max. 2%, fat max. 0.6%, ash max. 1.5%, arsenic max. 3.0 ppm, heavy metals max. 20.0 ppm, lead max. 5.0 ppm) were used.

Methodologies

Preparation semi-finished frozen products

All samples were prepared from 1500 $g.kg^{-1}$ wheat flour (T512), 60 $g.kg^{-1}$ of yeast, 60 $g.kg^{-1}$ of oil, 750 $g.kg^{-1}$ of water, 22.5 $g.kg^{-1}$ of salt, 22.5 $g.kg^{-1}$ of Trial RC2 and individual amount of guar gum (control product-without addition of guar gum (0 $g.kg^{-1}$) and samples with 5, 10 and 15 $g.kg^{-1}$ of guar gum, respectively). The dough samples were mixed in a spiral machine (ALBA, Hořovice, Czech Republic) for 8 min (4 min slow mix, then 4 min fast mix). Oil was added gradually in the prepared dough. The dough samples were left to rise for 10 min in environment of bakery at temperature 30 °C. After that, the dough samples were divided into pieces (60 g) in the divider (Klonek maxRED/36), left to rise for 5 min and shaped on the roll machine (T-682.0, both from ARTHOS, Újezd u Mohelnice, Czech Republic). The pieces of the dough were put into the trug on a baking tray and left to rise for 45 min at a temperature of 40 °C and at a humidity of 80% in the proofer (KA-E1V, Kornfeil, Čejč, Czech Republic). They were baked for 4 min at a temperature 245 °C and 4 min at 250 °C. The semi-finished products were left to cool down in environment of bakery for 20 min, put on a transport tray and gave into the freezer (temperature -22 °C, MTH, Fojtách, Velký Ořechov, Czech Republic). They were sorted and packed in a freezing chamber environment to special PE bags used for the storage of frozen semi-finished frozen products to prevent them from freeze drying of water from the dough and prevent them from damage gluten network. They were labeled and stored in a storage freezer for 48 hours.

Baking of semi-finished frozen products

Semi-finished frozen products were taken out from PE bags, left to stand for 30 min in environment of bakery and baked in a Rotomax rotary gas furnace (Kornfeil, Čejč, Czech Republic) for 1 min at a temperature 280 °C and 3 min at a temperature 260 °C.

Chemical and sensory analysis of rolls after baking and 3 days after baking

Moisture of rolls was determined according to **ISO 712 (1998)**. Each sample was measured five times and all measurements were repeated twice. All samples were evaluated by „15 selected assessors“ (employees of bakery Topek, Topolná, Czech Republic) trained according to **ISO 8586-1 (1993)**. The samples (sample A without guar gum, samples B - D with 5, 10 and 15 $g.kg^{-1}$ guar gum) were coded and served anonymously at room temperature (25 ±1 °C). A five-point hedonic scale was used for the taste, pliancy, texture, porosity, stickiness, gumminess, crispness and quality.

Texture analysis of rolls after baking and 3 days after baking

The texture of the rolls was evaluated by a TA-XT Plus Texture Analyzer (O.K. SERVIS BioPro, Prague, Czech Republic), and conducting a ”measure force in compression” test with an AACC 36 mm cylinder probe with radius (P/36R) using 5 kg load cell. The rolls were divided into five slices of 25 mm thick and subjected to texture analysis after baking and 3 days after baking. The rolls were kept in plastic bags at room temperature for three days. The analyzer was set at a ”return to start’ cycle”, a pre-test speed of 1 $mm.s^{-1}$, a test speed of 1.7 $mm.s^{-1}$, a post-test speed 10.0 $mm.s^{-1}$ and a distance of 10 mm. Firmness F - power which is necessary for achievement of deformation or penetration of the product (initial strength), Firmness A - total force which is necessary for deformation (total strength) were measured in duplicate.

Statistical data analysis

The results of the basic chemical analyses (moisture), the texture and the sensory analyses were statistically evaluated by STATISTICA CZ (Statsoft, Inc., Tulsa, USA), ver. 9.1. The results of sensory analyses were statistically evaluated by means of non-parametric analysis of variance (Kruskal-Wallis test), Friedman test **(Agresti, 1984)**. Differences had to achieve $P < 0.05$ to show significance in all cases.

RESULTS AND DISCUSSION

Chemical and textural analysis of rolls after baking and 3 days after baking

Insignificant differences were found among individual samples in moisture of rolls after baking and 3 days after baking ($P > 0.05$). Additions of guar gum did not influence moisture of rolls, but it decreased within three days as can be seen in Table 1.

Table 1 Moisture of rolls made from semi-finished frozen products after baking and 3 days after baking.

Value (unit)	Day	Samples with guar gum (g.kg^{-1})			
		A	**B**	**C**	**D**
Moisture (%)	0	27.7 ±2.2[a]	28.1 ±1.2[a]	28.5 ±2.1[a]	27.8 ±3.8[a]
	3	25.4 ±2.1[a]	26.0 ±1.7[a]	25.8 ±1.9[a]	26.2 ±1.8[a]

* Day after baking
A-samples without guar gum, B-D samples with 5, 10 and 15 g.kg^{-1} of guar gum superscripts expressing diversity (b, c; b, a) or identity (a, a) between samples; samples were compared with each other in rows

Our results are in agreement with authors **Ribotta, et al., (2001, 2003)** and **Selomulyo and Zhou (2007)** who find that bread made from frozen dough exhibits faster starch retrogradation, but they are in disagreement with those of **Maier, et al., (1993)** who stated that guar gum is used to extend the shelf life of products through moisture retention. Figure 1 showed that samples of rolls with additions of guar gum (5-15 g.kg^{-1}) had less firmness (A, F) in comparison to control sample of rolls after baking. 3. days after baking, control sample of rolls and sample with the lowest addition of guar gum had higher firmness (A, F) in comparison to samples of rolls with higher addition of guar gum (10 g.kg^{-1} and 15 g.kg^{-1}) (Figure 2). This agree with the statement that guar gum improved the volume and texture of bread made from frozen dough **(Ribotta et al., 2004)** and with the findings that small quantities (<10 g.kg^{-1} in flour) of hydrocolloids decrease firmness and starch retrogradation **(Collar et al., 1999; Kohajdová et al., 2009)**. It was partially confirmed that hydrocolloids are used in food products to modify texture and improve moisture retention **(Linden and Lorient, 1999)**.

Sensory analysis of rolls made from semi-finished frozen products after baking and 3 days after baking

Insignificant differences were found among samples of rolls (P >0.05) in Table 2.

Sensory assessors evaluated all samples as identical in

Table 2 Results (expressed as median) of the sensory analyses of the tested rolls (samples A-D) after baking and 3 days after baking.

Characteristics	Samples							
	After baking				3 day after baking			
	A	**B**	**C**	**D**	**A**	**B**	**C**	**D**
taste	2[a]	2[a]	2[a]	2[a]	2[a]	2[a]	2[a]	2[a]
pliancy	3[a]	2[a]	2[a]	3[a]	2[a]	2[a]	2[a]	3[a]
texture	3[a]	3[a]	4[a]	4[a]	3[a]	2[a]	3[a]	2[a]
porosity	2[a]	2[a]	2[a]	2[a]	3[a]	3[a]	2[a]	3[a]
stickiness	3[a]	3[a]	3[a]	4[a]	4[a]	4[a]	4[a]	4[a]
gumminess	3[a]	3[a]	3[a]	3[a]	4[a]	4[a]	5[a]	4[a]
crispness	2[a]	3[a]	3[a]	3[a]	2[a]	3[a]	2[a]	2[a]
quality	3[a]	2[a]	2[a]	2[a]	2[a]	2[a]	2[a]	2[a]

Hedonic scales used: Taste: 1-very good to 5 very bad. **Pliancy:** 1-very high to 5 very low. **Evaluation of texture:** 1-very high to 5 very low. Porosity: 1-very porous to 5 small porosity. Stickiness: 1-very sticky to 5 not sticky. **Gumminess of crumb:** 1-very high to 5 hardly noticeable. **Crispness:** 1- little flexible, rather crisp to 5 very tough. Quality: 1-excellent to 5 very bad, unacceptable.

** Median values having the same superscript letter in each row are not significantly different (*P* ≥0.05); each group was evaluated separately. Refer to Table 1 for samples A-D monitored characteristics (taste, pliancy, texture, porosity, stickiness, gumminess, crispness and quality). Our results disagree with those of **Selomulyo and Zhou (2007)** who found that effects of frozen storage on bread include lowering of loaf volume and deterioration in the texture of the final product.

CONCLUSION

Semi-finished frozen products allows easier and more profitable baking, as bread can be made available in few minutes, reducing labour and production costs while facilitating transportation. However, the quality of final bakery products is not good, especially flaking and crackling crust is very often after freezing for several

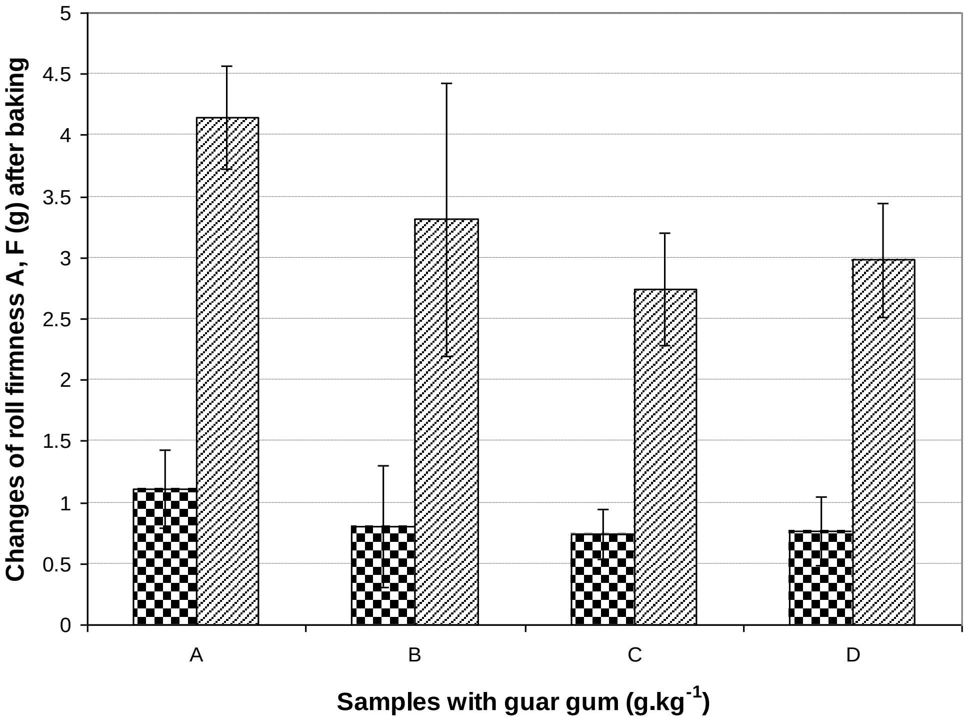

Figure 1 Firmness A, F of rolls after baking

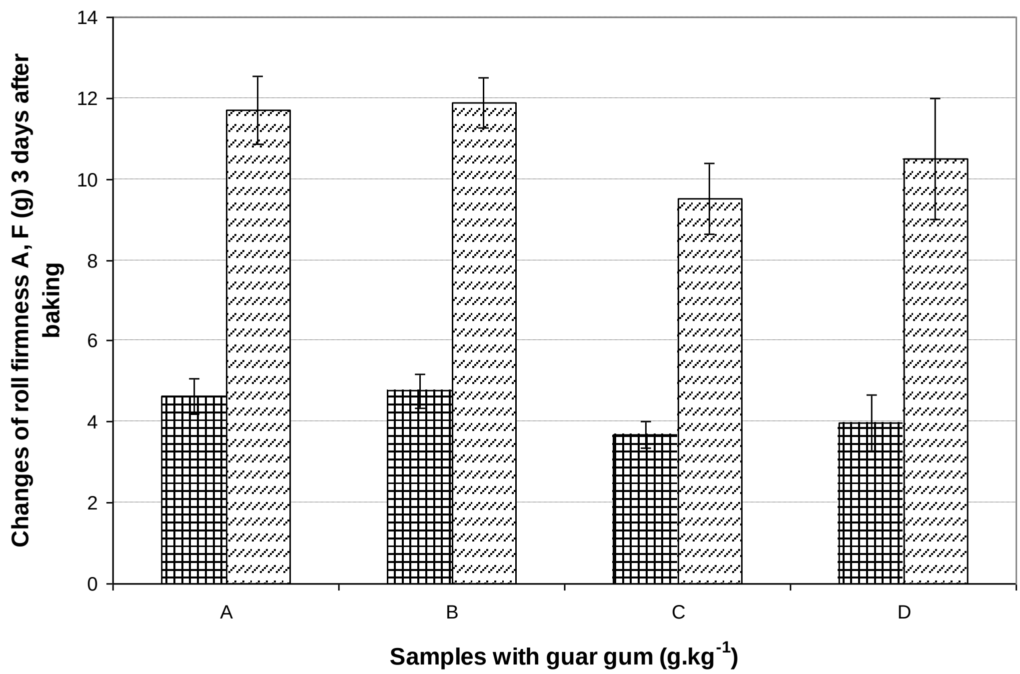

Figure 2 Firmness A, F of rolls 3 days after baking

months. Therefore it is very important to eliminate these problems associated with freezing and frozen storage, thus, the guar gum have been used in individual amount to improve the baking quality and extend the shelf life of bakery products made from semi-finished frozen products. Results of chemical analysis showed no significant differences in moisture of rolls after baking and 3 days after baking. Measurement of texture properties, firmness A and firmness F, showed that samples of rolls with additions of guar gum had lower firmnesses (A, F) in comparison to control samples of rolls after baking. But 3 days after baking, samples of rolls with higher additions (10 and 15 $g.kg^{-1}$) of guar gum had lower firmness (A, F) in comparison to control sample and rolls with the lowest addition of guar gum. Sensory analysis showed that sensory assessors evaluated samples of rolls as the same in all monitored characteristics. But visual assessment of rolls showed that rolls with lower additions of guar gum (5 and 10 $g.kg^{-1}$) had better surface of crust and porosity of crumb and they have a longer shelf life. Solution of problem as a flaking and crackling crust or irregular porosity of crumb may be the guar gum. Moreover, lower additions of guar gum did not increase the final price of the bakery product so much.

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