ACTA SCIENTIARUM POLONORUM Acta Sci. Pol., Technol. Aliment. 7(2) 2008, 43-49

INFLUENCE OF HYDROCOLLOIDS ON QUALITY OF BAKED GOODS*

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Abstract. The effect of different hydrocolloids (arabic gum, guar gum, xanthan gum and methyl 2-hydroxyethyl cellulose) on the rheological properties of composite flour dough and final quality of baked goods was investigated. Addition of these compounds concluded in higher water absorption capacity (from 60.5 to 68.3%) and dough stability (from 6.5 to 14 min). The incorporation of hydrocolloids into the loaves also influenced volume, cambering and sensory acceptance of final products in different ways. Baked goods shelf life evaluated during 72 h storage period through bread firmness values showed, that loaves prepared with hydrocolloids extent products contained celullose derivate were softened when control sample. In conclusion, guar gum could be recommended as improver in the bread-making performance owing to its good rheological, sensory and crumb softening effects.

Key words: wheat, spelt, hydrocolloids, quality, shelf life

INTRODUCTION

Nowadays, the use of additives has become a common practice in the baking industry. The objectives of their use are to improve dough handling properties, increase quality of fresh bread and extend the shelf life of stored bread [Rosell et al. 2001].

Hydrocolloids are multifunctional ingredients that add flexibility, functioning as fat replacer, water binders, texturizers and adhesives [Gurkin 2002]. Hydrocolloids due to their high water retention capacity confer stability to the products that undergo successive freeze-thaw cycles [Lee et al. 2002, Sanderson 1996]. They have also been used in oil uptake reduction in cereal product [Albert and Mittal 2002, Lucca and Tepper 1994]. The most well know and applied in the industry polymers included in this kind of substances are alginates, carrageenans, agar, guar gum, arabic gum, methycellulose and

* This work was supported by following grants: VEGA (grant no. 1/0570/08), APVT (grant no. 20-002904), AV (grant no. 4/0013/07) and APVV (grant no. 031006).

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carboxymethylcellulose [Gómez-Díaz and Navaza 2003]. Several studies have been carried out showing the potential use of hydrocolloids in the baking industry. An improvement in wheat dough stability during proofing can be obtained by the addition of hydrocolloids, namely sodium alginate, k-carrageenan, xanthan gum and HPMC [Rosell et al. 2001]. Schiraldi et al. [1996] reported the use of guar gum and locus bean for improving the fresh bread quality, although did not find an evident antistaling role. A similar study with locus bean, xanthan gum and alginate revealed a softening effect of those hydrocolloids, due to the high water retention capacity in the case of locus bean, or for hindering the gluten-starch interactions in the case of xanthan gum and alginate [Davidou et al. 1996].

The present study was done to examine the effect of selected hydrocolloids on the quality of baked goods and their potential use in retarding the staling process at room temperature.

MATERIAL AND METHODS

Dough preparation. A wheat flour T650 (containing 0.73% ash in dry matter, 12.2% proteins and 35.6% wet gluten in dry matter) and wholemeal spelt flour (containing 1.82% ash in dry matter 16.5% proteins and 43.2% wet gluten in dry matter) of local origin was used in the study. Blend flour was obtained mixing of wheat and wholemeal spelt flours in ratio 85:15. The hydrocolloids used were: guar gum (G) (Kroner, Slovakia), gum arabic (A) (Vaja Ltd., Hungary), xanthan gum (X) (type FN, Jungbunzlauer, Austria) and methyl 2-hydroxyethyl cellulose (M) (SIGMA-ALDRICH CHEMIE Germany). The dough was prepared according to formulation, which was 100% blend flour, salt 2%, sugar 1%, yeast 4%, sunflower oil 2.5%, hydrocolloid 1% on flour weight basis and water to farinographic consistency 400 BU (Brabender Units). As a control, no hydrocolloid was added to the formulation (S). The ingredients were mixed during 6 minutes in farinographic mixing bowl. After 20 min fermentation, the dough was divided into 100 g loaves, formed on dough former, proofed 45 min and baked in an electric oven during 12 min at 230°C. Baking trials were performed in triplicate.

Dough rheological characteristics. For farinographic determination farinograph Brabender (Düsseldorf, Germany) was used. The following parameters were determined: water absorption capacity, dough development time, dough stability, mixing tolerance index and degree of softening after mixing dough for 12 min after reaching the optimum. All farinographic tests were repeated three times and the values presented are means of three replications.

Sensory evaluation. The loaf quality and sensory attributes were evaluated after cooling for 2 h at room temperature. Sensory evaluation was accomplished by the 4-point hedonic scale determination by 9 assessors. The assessors evaluated: shape of product, crust colour and thickness/hardness, crust/crumb odour and taste, crumb: elasticity, porosity, colour, resistance to the bite and adhesion to palate (on longer chewing).

Quality of baked goods. Evaluation of loaf quality included: the loaf volume (cm^3), specific loaf volume (cm^3 per 100 g of loaf), cambering (loaf height/width ratio). Millet seeds were used to measurement of loaf volume.

Crumb hardness. Crumb hardness was measured on freshly baked loves (2 h after baking) and on loaves that were stored for 24, 48 and 72 hours at ambient temperature using a manually operating penetrometer AP 4/1 (Feinmess, Germany) when 1 penetrating unit (PJ) represented 0.1 mm.

Statistical analysis. Data were evaluated by analysis of variance with t tests at a confidence interval of 95% using the Origin Version 5 (Northamton USA).

RESULTS AND DISCUSSION

Rheological characteristics reflect the dough properties during processing and the quality of the final product [Shahzadi et al. 2005]. The effect of hydrocolloid addition on dough rheology is summarised in Table 1. Rao et al. [1985, 1992] reported increases on water absorption by wheat flour with various hydrocolloids. Water absorption was increased by addition of applied hydrocolloids and ranged from 60.5 to 68.3%. These results were expected due to the hydroxyl groups in the hydrocolloid structure, which allow more water interactions through hydrogen binding. The dough development time decreased with all hydrocolloids expect xanthan gum, when the slightly increasing effect was observed. The observed effect agrees with the increased dough development time found by Rossel et al. [2001] when they added xanthan gum in wheat dough. The stability of dough is an indicator of the flour strength, with higher values suggesting stronger doughs [Rosell et al. 2001]. Stability of studied doughs was clearly positively affected by hydrocolloids, while mixing tolerance index was practically not affected by the presence of these additives. Elasticity of the dough was reduced with incorporation of hydrocolloids expect guar gum, when this parameter was not affected.

Table 1. The effect of different hydrocolloids on farinograph characteristics
Tabela 1. Wpływ różnych hydrokoloidów na charakterystykę farinograficzną

Sample – Próbka	S	A	G	X	M
Water absorption, % Absorpcia wody, %	59 ±0.50	60.5 ±0.40	63.3 ±0.80	68.3 ±1.00	68.2 ±0.80
Dough development time, min Czas rośnięcia ciasta, min	6 ±0.20	2.5 ±0.05*	4 ±0.10	7 ±0.10	1.75 ±0.04*
Degree of softening, BJ Stopień zmiękczenia, BJ	80 ±2.00	80 ±1.50	40 ±0.70*	50 ±0.50	20 ±0.30*
Dough stability, min Stabilność ciasta, min	5.5 ±0.20	6.5 ±0.30	13.5 ±0.50*	9 ±0.30*	14 ±0.40*
Mixing tolerance index BJ Wskaźnik tolerancji mieszania, BJ	50 ±0.40	50 ±0.80	50 ±0.80	30 ±0.70*	50 ±0.50
Elasticity, BJ Elastyczność, BJ	70 ±1.00	60 ±0.80*	70 ±1.50	60 ±1.00*	60 ±0.70*

*Means are significantly different from control sample at $\alpha = 0.05$.
*Wartości są statystycznie istotne dla próby kontrolnej na poziomie $\alpha = 0,05$.

Loaf volume is regarded as the most important bread characteristic since it provides a quantitative measurement of baking performance [Tronsmo et al. 2003]. Influence of applied hydrocolloids on volume of final products is presented in the Table 2. Only

Table 2. Effect of hydrocolloids on loaf volume and cambering of products
Tabela 2. Wpływ różnych hydrokoloidów na objętość i wypukłość pieczywa

Sample Próba	Loaf volume Objętość pieczywa cm^3	Cambering Wypukłość
Control	269 ±5.00	0.50 ±0.02
A	322 ±5.50*	0.48 ±0.02*
G	325 ±4.50*	0.60 ±0.01*
X	223 ±4.00	0.50 ±0.03
M	210 ±3.50	0.42 ±0.01*

*Means are significantly different from control sample at $\alpha = 0.05$.
*Wartości są statystycznie istotne dla próby kontrolnej na poziomie $\alpha = 0,05$.

addition of arabic and guar gum positively affected this parameter. It was observed increase of loaf volume about 19.7% and 20.8% respectively in comparison to control sample. Schober et al. [2002] stated that shape and cambering of loaves are an important qualitative parameters because spelt bread tends to become flat. Cambering of wheat-spelt loaves was markedly influenced by guar gum. Addition of xanthan gum non-affected cambering of final products (Table 2).

From the sensory evaluation resulted that bakery products contained arabic gum and xanthan gum were characterised by less even porosity and loaves with xanthan gum and celullose derivate showed lower crumb elasticity in compare with control samples (Fig. 1). Baked goods with celullose derivate were also presented as products with compact and closely grain structure. Loaves with gum arabic had the darker crust colour as other loaves. Addition of hydrocolloids non-affected odour and taste of final products. Sensory analysis showed that addition of guar gum improve sensory properties of baked goods, giving higher degrees of sensory parameters than control samples.

Firming of bread crumb during storage is a common phenomenon and leads to a crumbly texture, and lower consumer acceptanc [Ji et al. 2007]. This parameter is the preferred parameter used to evaluate staling development [Ribotta and Le Bail 2007]. All from applied hydrocolloids expect methyl 2-hydroxyethyl cellulose reduced firmness, given softer crumb than the fresh or stored samples (Fig. 2). Although it was found that cellulose derivates are able to retard the migration of moisture to the bread surface and thus retard its staling process during storage [Armero and Collar 1996, Bárcenas and Rosell 2006], in this study, conversely, the addition of methyl 2-hydroxyethyl derivate of cellulose increased the firmness of baked goods crumb that could be the consequence of the thickening effect on the crumb walls surrounding air spaces. Loaves with guar gum were shown as softer than products containing arabic and xanthan gum not only in case of fresh products but also during 72 h of storage. The softening effect of this hydrocolloid can be due to a possible inhibition of the amylopectin retrogradation, since guar gum preferentially binds to starch. This may be because addition of guar gum may affect only the amylose network avoiding the formation of spongy matrix [Shalini and Laxmi 2007]. It was also concluded that the most softening effect of hydrocolloids was observed after 24 h of storage.

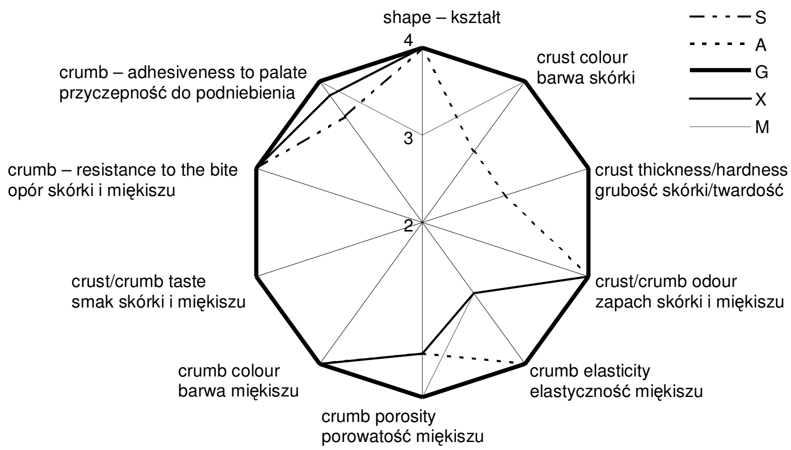

Fig. 1. Effect of hydrocolloids on sensory parameters of baked goods
Rys. 1. Wpływ hydrokoloidów na charakterystykę sensoryczną wypieków

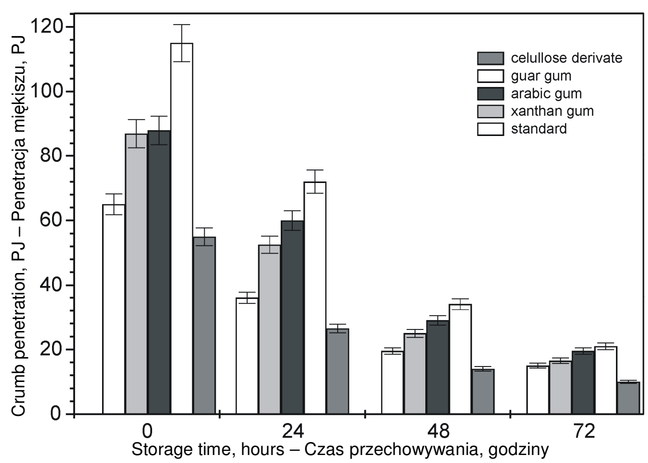

Fig. 2. Effect of hydrocolloids on crumb penetration
Rys. 2. Wpływ hydrokoloidów na penetrację miękiszu

CONCLUSION

In the baking industry hydrocolloids are of increasing importance as bread making improvers [Rosell et al. 2001]. Usually, the addition of hydrocolloids to dough improves its stability and quality criteria such as increased water absorption, specific loaf volume and the viscoelastic properties [Tavakolipour and Kalbasi-Ashtari 2006]. From this study concluded that all from examined hydrocolloids positively affected dough stability and proved higher water absorption capacity. These compounds also affected sensory properties of final products in different ways. For instance when looking for the reduction of the staling, guar gum is the best additive due to both its softening and retarding the firming of the baked goods crumb effects. As a consequence of the great variation in the effect promoted by the different hydrocolloids, a systematic study is necessary about the influence of a range of hydrocolloids in the quality of wheat bread [Guarda et al. 2004].

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WPŁYW DODATKU HYDROKOLOIDÓW NA JAKOŚĆ PIECZYWA

Streszczenie. Zbadano wpływ wybranych hydrokoloidów (guma arabska, guarowa, ksantanowa oraz metyl 2-hydroksyceluloza) na właściwości reologiczne zarówno ciasta, jak i gotowego pieczywa. Dodanie tych substancji wpływało na zwiększenie absorpcji wody (od 60,5 do 68,3%) oraz stabilności ciasta (od 6,5 do 14 min). Wykorzystanie tych koloidów w produkcji chlebów w zróżnicowanym stopniu powiększało ich objętość, oddziaływało na zmianę sklepienia oraz zmianę oceny sensorycznej. Zmieniało się również odczucie świeżości chleba podczas jego 72-godzinnego przechowywania. Można więc wnioskować o korzystnym wpływie dodatku gumy guarowej.

Słowa kluczowe: pszenica, orkisz, hydrokoloidy, jakość, trwałość

Accepted for print – Zaakceptowano do druku: 14.04.2008

For citation – Do cytowania: Kohajdová Z., Karovičová J., 2008. Influence of hydrocolloids on quality of baked goods. Acta Sci. Pol., Technol. Aliment. 7(2), 43-49.