TECHNOLOGICAL ASPECTS OF THE ADDITION OF SEVERAL TYPES OF HYDROCOLLOIDS IN BREAD

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Abstract: In this research, the hydrocolloids xanthan, alginate, cellulose and guar gum were used in breadmaking. The rheological properties of dough and the properties of loafs supplemented with hydrocolloids were analysed. At low levels of gums the properties of dough and loafs weren't change so much but at high levels of gums the rheology of dough were change dramatically as the properties of loafs. The gums which form very viscous solutions, xanthan and alginate increased very significant the development time and stability of dough. At 3% and even 5% of gums added the breads properties were slightly improved but at 10% hydrocolloids the porosity and elasticity of crumb decreased at unacceptable levels, porosity at about 80% and elasticity under 80%. The breads volume decreased from 290 ml/100 g of control sample to 175 and a00 ml/100 g for samples with 10% xanthan and respective alginate.

Keywords: bread, dietary gums, xanthan, guar, alginate, carboxymetilcelullose

INTRODUCTION

Bread and cereal products should represent the most important quantitative part (about 30%) from total daily food consumed (W.H.O., 2005). Wheat bread actual consumed is prepared from low extraction flours with a low dietary fiber content and nutritive values lower than high extraction flours. From this reasons we should work to improve the nutritionally properties of bread. We can add diverse products in wheat bread to obtain healthier breadstuff. Some products which can be added are the gums (soluble dietary fiber) from different sources. The addition of fiber (or any other product) modifies the technological properties of dough and properties of breads, positively or negatively (Ang et all, 2005)(Cauvain et all,2001)(Shradanant et all, 2003) .

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The most of hydrocolloids, or also named gums, are considered from nutritional point of view soluble fibers. Its have the properties to bind large quantities of water which will dilute the final products (Asghar, 2005). The products will be much moist, with reduced levels of dry maters and reduced caloric values (Ognean et all, 2006).
Xanthan gum is produced by *Xanthomonas campestris* and is a exogenous material which protect the cells. Xanthan has a backbone chain identical to that of cellulose. A trisaccharide side chain is attached to alternate D-glucosyl units at the O-3 position. This side chain consists of a D-glucuronosyl unit between two D-mannosyl units. Approximately 50% of the terminal mannosyl units contain a pyruvic acid moiety as a 4,6-cyclic acetal, and the nonterminal mannosyl units are substituted at the O-6 position with an acetal group. The net result is a helix when the xanthan molecule is in solution. The molecular weight of xanthan is about 3,000,000. Xanthan is a pseudoplastic hydrocolloid. It is not degraded by shear, and it recovers its original "at rest" viscosity upon cessation of shear. What makes xanthan unique is that it holds a constant viscosity over a wide range of temperatures, while most gums thin as their solutions are heated. Xanthan is stable at pH 1–9, which includes all food systems (Philips et all, 2000).
Sodium alginate is extracted from brown seaweeds in which it is a structural component of the cell walls. The alginate polymers are composed of β-D-mannuronopyranosyl and α-L-guluronopyranosyl units. These units occur in blocks of one or the other uronic acid and are referred to as M-blocks and G-blocks, respectively. There also can be regions of the alginate molecule that consist of alternating mannuronic and guluronic acid monomers, which are referred to as MG-blocks (Philips et all, 2000).
On each glucopyranosyl unit in the chain of cellulose are three hydroxyl sites that are capable of etherification to carboxymethyl groups (CMC). Most CMC used commercially has a DS of 1.5 or less. The cellulose derivative hydrocolloids (and CMC) are optically transparent in solution, while most other gums are not. They make pseudoplastic solutions provided that the substitution is evenly distributed along the molecule. The CMC solution thins when heated and thickens again when cooled (Philips et all, 2000).
Guar gum is obtained from the seed of the guar plant. Guar consists of a chain of (1-4)-linked β-D-mannopyranosyl units with single α-D-galactopyranosyl units connected by (1-6) linkages, on average, to every second main chain unit. Guar gum is soluble in cold water. Because it is composed of neutral sugars, guar is less affected by salts than most anionic hydrocolloids. Like most hydrocolloids, guar gum shows pseudoplastic, or

“shear thinning,” behavior in solution. Guar gum solutions do not possess a yield point (Philips et all, 2000).
This work intends to investigate in which manner these properties are modified when several gums are added to dough.

MATERIALS AND METHODS

Materials

For experiments a commercial flour from Baneasa Mill, type 650 (0.65% ash) was used, with wet gluten content 28.9%, the deformation index 6 mm, Falling Number 265 s. Fresh yeast was commercial type too, with a dry content at 28% and fermentation power 12 minutes, determined through dough ball method.
The gums investigated were: xanthan gum (Pre-Hydrated® TICAXAN® Rapid-3), sodium alginate (Pre-Hydrated® Colloid 488 “T”), cellulose gum (Pre-Hydrated® TICALOSE® CMC 15) and guar gum (Pre-Hydrated® Nutriloid® 010) from TIC GUMS. Three, five and ten percent on flour basis are investigated.

Methods

To investigate the influence on the bread quality, some loafs adding the hydrocolloids in 3, 5 ant 10%, expressed at flour basis were prepared. The recipes are presented in table 1.

Table 1. Bread formula

Sample / Ingredients	Control	Xanthan*			Alginate*			CMC*			Guar*		
		X3	X5	X10	A3	A5	A10	C3	C5	C10	G3	G5	G10
Wheat flour, g	300	300	300	300	300	300	300	300	300	300	300	300	300
Fresh yeast, g	9	9	9	9	9	9	9	9	9	9	9	9	9
Salt, g	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Water, ml	190	253	324	353	256	317	572	216	274	759	223	233	271
Gums, g	0	9	15	30	9	15	30	9	15	30	9	15	30

*The samples noted with 3, 5 and 10 were prepared with gums in ratio 3, 5 and respectively 10% based on flour weight.

The dough was prepared using a lab mixer, the water was added until the desired consistency (the same for all samples) was achieved. Bulk fermentation last hour, after that the dough was molded, place into a pan and keep at 30ºC for proofing and than it was baked at 200ºC without steam.

The loaf volume of the loaves was determined by rapeseed displacement. The porosity of crumb was determined measuring the volume of oil displaced by piece of crumb pressed very well in some ball. The volume determined was reported to known initial crumb volume.

The elasticity of crumb was determined by pressing a crumb cylinder at half of initial height and keeping them one minute and measuring the final height after another minute. The final height was reported to initial height of crumb cylinder. The moisture of crumb was determined too.

External and internal sensorial characteristics were evaluated by 25 students from bread making laboratory and score on a scale of 1 (least favorable) to 10 (most favorable). Products were considered acceptable if their scores were above 5 (the score for the lowest level of acceptability).

The effects of gum supplementation on rheology of dough were evaluated farinographic in accordance with Farinograph Method for Flour AACC Method 54-21, constant flour Weight Procedure. Some important characteristics were determined:

- Dough Development Time (DDT), the time required for the curve to reach the maximum consistency;
- Stability (S), the time difference (in minutes) between point where top of curve first intersects and point where top of curve leaves the line who define dough consistency;
- Tolerance Index (TI), difference (in BU) between the maximum of curve at peak to top of curve measured at 5 min. after peak is reached;
- Degree of Softening (DS), difference (in BU) betweens the maximum of dough consistency and the dough consistency reached after 12 min from consistency peak;
- Dough Consistency (C), line range which passes through the middle of the curve at the maximum consistency;
- Dough Elasticity (E), the curve width at the maximum consistency range.

RESULTS AND DISCUSSION

The results of hydrocolloids addition on the farinographic characteristic are showed in figure 1. Both xanthan gum and sodium alginate and both guar gum and cellulose gum have similar behaviors. The Farinograph absorption at 3 and 5% addition of xanthan gum and sodium alginate increases with about 20%, related to the control sample. The tolerance index decreases from

110 BU for control sample too little than 10 BU at 3 and 5% xanthan gum and sodium alginate addition. The dough development time increases very much, from 1.5 minutes to more than 15 minutes. The stability of dough increases from 4 minutes for control sample to 25 and 19 minutes at samples with 3% xanthan gum and respectively sodium alginate and for sample with 5% gums couldn't be determined (more than 30 minutes). 3, 5 and10% cellulose and guar gum addition have increased Farinograph absorptions with about 10, 20 and respectively 45%.

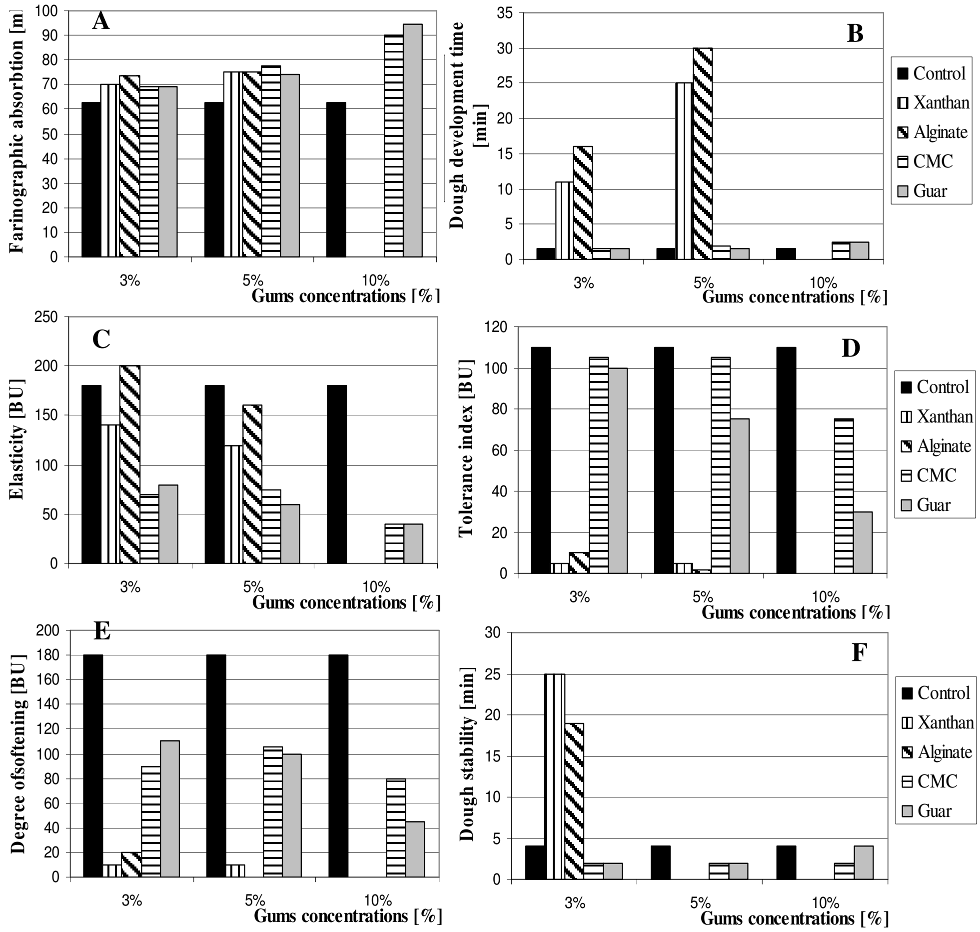

Figure 1. The farinographic characteristic of dough prepared with 3, 5 and 10% hydrocolloids (xanthan, alginate, CMC and guar)(A-water absorption, B-time of dough development, C-dough elasticity, D-tolerance index, E-degree of softening and F-dough stability)

The dough development time shows very little changes at 3 and 5 % cellulose and guar gums and increases from 1.5 minutes for control sample to 2 minutes for samples with 10% gums. The dough elasticity decreases very much probably because water and gums act as plasticizer. The dough softening is lower for samples with cellulose and guar gums than for control sample, lowest for the higher level of gums addition.

Xanthan and alginate and respective CMC and Guar gum had similar pattern of farinographic curve. The dough prepared with xanthan showed two maximum corresponding to the complete hydration point of flour and hydrocolloids. The consistency curves of dough prepared with xanthan and sodium alginate were formed by multiple peaks (minimums and maximums) that indicate a very sticky dough. In the light of these facts maybe the elasticity of dough prepared with xanthan and alginate weren't so great as were measured (the curve width at the maximum consistency range).

The dough prepared with CMC showed very interesting behaviors. The dough with 3% CMC at 11 minutes after water addition the consistency arrived at the minimum and was observed an easy increase of consistency and elasticity. The same increase of consistency and elasticity is observed at 14 minutes after water addition in the dough with 10% CMC.

The properties of breads with different gums added are presented in figure 2. The wet contents of samples with gums are higher than the wet content of control sample, higher for the samples with higher contents of gums and higher for samples with xanthan and sodium alginate gums than samples with cellulose and guar gums. Despite the level of water in the samples with gums the moistures of samples were significant higher than in the control samples the moisture of samples with gums weren't so different. This because the time needed for baking was greater and the loss at baking and the loss at cooling were greater due the higher levels of water.

The crumb elasticity decreases at gums addition, the lowest elasticity is revealed at samples with maximum content of gums. Probably the gums interfere with the starch and protein matrix of crumb and made them weaker.

The crumb porosity of samples with 3 and 5% gum addition is better than crumb porosity of control sample but the 10% gum addition determined decreasing that. The addition of gums in 3 and 5% proportions shows little modifications of loaf volume but addition of 10% xanthan or sodium alginate gums determines a severe reduction of that.

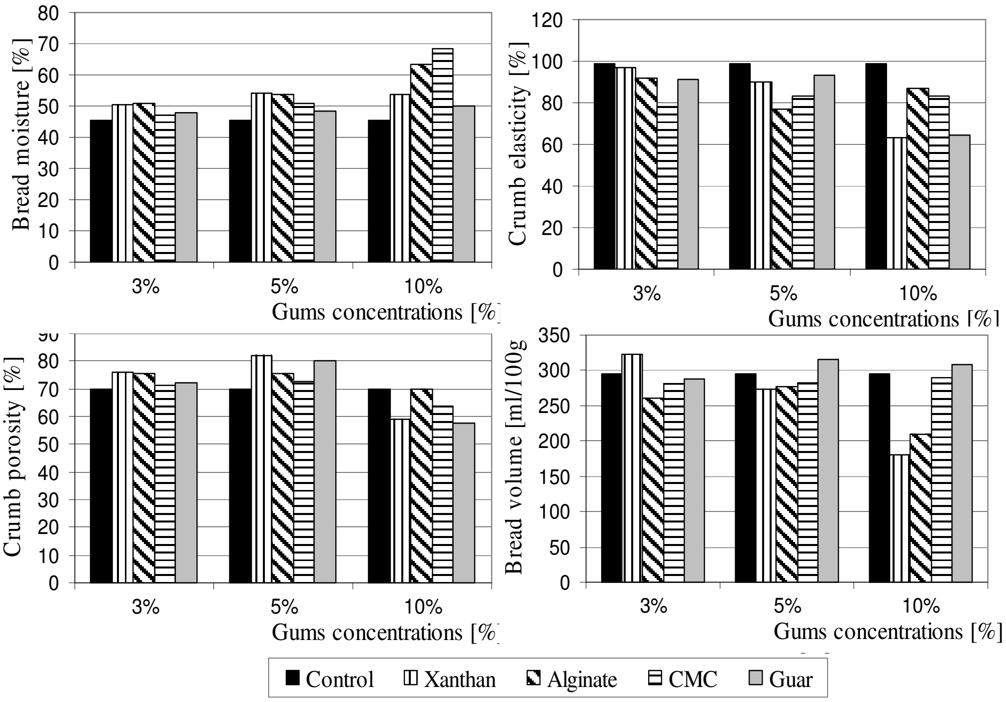

Figure 2. The bread moisture, crumb elasticity and porosity and bread volume of samples with 3, 5 and 10% hydrocolloids compared with the control sample

CONCLUSIONS

The addition of hydrocolloids in minor proportion has little effects on the technologically properties of dough and bread.

At high proportions of gums with high viscosity, these properties are severe modified. Little effects present gums with low viscosity. The gums with high viscosity lead to dough very sticky and the low viscosity gums lead to dough more plastic.

The bread propertied were approximative constant at different levels of gums when we used CMC and guar, probably because its form solution with very low viscosities so the influence on the water level is lower. The xanthan show adverse effect on bread volume probably because it is able to maintain its viscosities during baking while the others gums didn't have this properties.

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