Available online at www.scholarsresearchlibrary.com

Scholars Research Library

Annals of Biological Research, 2012, 3 (3):1629-1635
(http://scholarsresearchlibrary.com/archive.html)

ISSN 0976-1233
CODEN (USA): ABRNBW

Rheological Characteristics of Chapatti Bread Containing Guar and Carboxy Methyl Cellulose Gums

Mehrmah Vafaei[1], Sara Movahhed[1*]

[1]*Department of Food Science, Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran*

ABSTRACT

There has been the production and consumption of flat breads in Iran from very ancient times and now it also has a major role in the diet of the most of Iran's population. Chapatti bread is one of the most widely consumed breads in the Middle East, as fresh it has a soft and flexible texture, but during a short-term maintenance it has a rigid and inflexible texture, while adding in some gums to its formulation can cause to maintain quality and to improve the rheological characteristics. In this study, the effect of adding guar and carboxy methyl cellulose gums on the rheological characteristics was studied. The mentioned gums was used as separated and combined in two different concentrations of 0.25 and 0.5 percent (by weight-weight, based on flour) and the effects of its different levels on the rheological characteristics. The results showed that the treatment with 0.5% of carboxy methyl cellulose gum (G4) had the highest amount of water absorption and the treatment with 0.5% of guar gum (G2) had the higher rank in terms of dough development time, stability and volumetric time and according to the results of extensograph test the dough samples of the treatment with 0.5% of guar gum (G2) had higher advantage than control samples and other samples in terms of resistance to dough stretching (in each time period) and energy (in times of 45 and 135 min).

Key words: Chapatti Bread; Guar; Carboxy Methyl Cellulose; Rheological Characteristics

---

INTRODUCTION

Bread is one of the most important foods that used by people in the most parts of the world. In addition, the bread as the cheapest source of energy and protein has a vital role in the diet of a large part of the world's people. The studies of FAO showed that the people of Middle East supply almost 70% of their daily energy requirements with the bread and other wheat products [4, 9].The production of thin and flat bread in Iran has a high diversity and Chapatti bread is the new types of these breads that can be used in this country. The mentioned bread is flat, round and non-fermented with a diameter of 15 to 20 cm that the whole wheat flour, water, some salt and oil are used in its production [7, 13].

Chapatti bread is one of the most common flat breads in the world and the major parts of India, Bangladesh, Mongolia. For example, in India almost 90% of the total wheat in the production of Chapatti bread and the other 10% in the production of other baking products (cakes, biscuits, etc) are used. Chapatti bread recently baked is soft, elastic and flexible but its storage, even for a few hours, at ambient room temperature, cause to decrease its freshness and it almost becomes rigid and inflexible [14].

Hydrocolloids are the carbohydrate biopolymers (such as gums) that can absorb large amounts of water in its structure and thereby causing the useful functional properties in the food systems. The most important of these applications including giving consistency and gelingl, stabilizer for colloidal food systems, texture improvement, crystallization control, preventing product launch, film formation, the flexibility, deterrence against absorption of oils, water binding, tissue formation and making adhesion were used in the food [4]. The guar gum is a kind of Long-chain Galactomanan that is obtained from the endosperm of the plant, "Cyamopsis Tetragono lobus". This gum consists of units of β-D- manopiranozil that is connected to bonds 1→4 and these units as alternate are connected to a unit of D-Galactopiranozil with the bonds α (6 → 1) [5]. The application of guar gum in food industry is very diverse and is usually considered as an agent of gelling, viscosing, increasing consistency, additive concentration, clouding, adhering agent and stabilizing in the product. The gum is used in the flour and baking products to retain moisture and increase the product storage period [10]. In addition, carboxy methyl cellulose gum is other one of the most applied gum that used in the food industry that is produced as the sodium salt and consist of two units of D-Glucopyranose 2-O- (carbony methyl)- Monosodium salt β-D Glucose-β that is connected to each other by the beta-glucoside binding (1→4) and is distributed as non-random in all macromolecular. The gum is produced by the reaction of cellulose with alkali and acid or sodium salt of mono-colouristic [3]. Among the functional characteristics of carboxy methyl cellulose gum can be referred to giving concentration, emulsifying and retaining and absorbing water, stabilizer agent and the agent of keeping the (rheological) shape and appearance. The given gum also has various applications in the floury products such as emulsifying, controlling the gel viscosity without gelling, stabilizing, concentrating, water retention, bulking, preventing the growth of crystals, fixing, adhering, making strength, maintaining the colloidal state, high solubility in the cold water and making viscosity during heating and modifying the structure and texture [5,6]. Mettler and Seibel (1995) studied the effect of the addition of carboxymethyl cellulose and guar gums to the bread made of rye and the research results indicated that the qualitative properties of the breads had improvement compared to the control bread (no gum). Rosell et al., (2005) reported that the HPMC, guar and pectin gums have favorable impacts on the quality of wheat bread so that had a large role in improvement of the rheological properties of pastes obtained, while the given effects were increased as a result of their combined addition [15]. Asghar et al., 2005 studied the effect of carboxymethyl cellulose and Arabic gums on the frozen dough stability. The results indicated that the qualitative properties of the resulting breads have improved compared to the control bread [3].

MATERIALS AND METHODS

The whole wheat flour by Varamin flour industries, guar by Sigma Company, carboxy methyl cellulose by DOW Chemical Company and also other materials (salt and oil by Hedie and Behshahr companies) were prepared. In all tests, the control treatment with the code G, the treatment with 0.25% guar with the code G1, the treatment with 0.5% guar with the code G2, the treatment with 0.25% carboxymethyl cellulose with the code G3, the treatment with 0.5%

carboxy methyl cellulose with the code G4 and the treatment with 0.25% guar and 0.25% carboxy methyl cellulose with the code G5 were determined.

Chemical tests of wheat flour

Chemical tests performed on whole wheat flour used in the research included the moisture (according to standard method of AACC, No. 44-16), ash (standard method of AACC, No. 08-01), pH (standard method of AACC, No. 02-52) and sedimentary units (standard method of AACC, No. 116), determination of the wet gluten (according to the standard method of ICC, No. 38-11) and protein (the standard method of ICC, No. 46-12).

Method of Chapatti bread production and how to bake it

At first, the raw materials for baking chapatti bread including whole wheat flour, oil and salt, were prepared. In order to form the dough of a loaf of Chapatti bread, 100 g wheat flour, 1.5 g salt, 5 ml of oil and some water that was measured by farinograph, were used. Also, based on flour weight, some improver (0.1%) was used. Then the guar and carboxy methyl cellulose gums with the amounts of 0.25% and 0.5% were added as separated and combined and after the entire mixture were added into the mixer. Next the other ingredients (salt, oil and water) were added to the mixer and the stirring continued for 5 min with the rate of 80 rpm. Then the dough produced at room temperature (30±2°C) was rested for 30 min and finally after dividing dough into 25g loafs was flattened with a diameter of 15cm and a thickness of approximately 2mm, and was placed in the industrial oven with a temperature of 280°C for 1 min for baking. Finally the resulting hot Chapatti bread was placed on the wooden column for 5min and after cooling were weighed and then stored in the polyethylene package.

Dough rheological tests

In order to determine some rheological characteristics of control dough samples and the dough containing gums, the farinograph test (according to the international standard of AACC 54-21) and the extensograph test (according to international standard of AACC No. 54-10) were conducted.

Method of statistical analysis

For the statistical tests of variance analysis, Duncan's multiple-range test and SPSS software, version 16, were used.

RESULTS

In table 1 is referred to the results of the chemical properties of whole flour used in Chapatti bread production and also in tables 2 and 3 are referred to the results of farinograph and extensograph tests of Chapatti bread dough samples, respectively.

Table 1. Chemical properties of wheat flour

flour	Wet %	Ash %	Protein %	Wet Gluten%	Zeleny number	pH
wheat flour	9.8	1.41	12	28.32	23	5.8

Table2. Comparison of results Farinography test on cake dough containing gums and emulsifiers

Treatment	Water absorption %	Dough development time (min)	Dough stability time (min)	Doug softening after 10 minutes (B.U)	Doug softening after 12 minutes (B.U)	Farinograph quality
G	30.58^{e}	1.75^{d}	2.708^{c}	65^{a}	90^{a}	48^{c}
G1	10.59^{d}	1.8^{d}	3.5^{b}	35^{c}	85a^{b}	51^{b}
G2	59.55^{c}	4.125^{a}	5^{a}	25^{d}	77.5^{b}	56^{a}
G3	60.45^{b}	2.875^{b}	3.25^{bc}	60^{a}	85^{ab}	51^{b}
G4	61.55^{a}	2.875^{b}	3.5^{b}	60^{a}	58^{ab}	51^{b}
GC	60.25^{b}	45^{b}	2.75^{c}	2.625^{c}	77.5^{b}	51^{b}

In each column mean that at least one letter in common, according to Duncan's test not significant at the 1% level

Table3. Comparison of results Extansography test on cake dough containing gums and emulsifiers

Treatment	Energy (cm^2)			Resistance to stretch (B.U)			Ability to stretch (mm)			(Resistance stretch / Ability to stretch)		
	45	**90**	**135**	**45**	**90**	**135**	**45**	**90**	**135**	**45**	**90**	**135**
G	46.5^{d}	45^{d}	34.67^{c}	165^{c}	185^{d}	167.5^{d}	155^{a}	142.5^{a}	157.5^{a}	1.073^{c}	1.293^{d}	1.340^{e}
G1	60.5^{b}	54.5^{b}	47.3^{a}	250^{a}	260^{b}	275^{b}	141.5^{cd}	129^{d}	139.5^{b}	1.743^{a}	2.013^{b}	2.23^{b}
G2	60.5^{b}	60^{a}	48.5^{a}	275^{a}	285.5^{a}	297.5^{a}	146.5^{bc}	129^{d}	113.5^{d}	1.733^{a}	2.207^{a}	2.62^{a}
G3	0.54^{c}	45.5^{c}	38.5^{b}	190^{b}	215^{c}	197.5^{c}	151^{b}	132.5^{c}	136^{b}	1.257^{b}	1.607^{c}	1.437^{de}
G4	65.5^{a}	62.5^{a}	47^{a}	230^{a}	265^{b}	275^{b}	143^{cd}	135.5^{b}	133^{c}	1.603^{a}	1.937^{a}	2.12^{c}
GC	52^{c}	43^{cd}	37.5^{c}	190^{b}	215^{c}	200^{c}	140^{d}	131^{cd}	132^{c}	1.353^{b}	1.630^{c}	1.17^{d}

In each column mean that at least one letter in common, according to Duncan's test not significant at the 1% level

DISCUSSION

Rheological tests of Chapatti bread dough samples

The results of the average comparison of farinograph test of Chapatti bread dough samples (Table 2) shows that there is significant difference (P<0.01) between all treatments and control treatment in terms of water absorption. In addition, its highest amount was in the treatment of G4 and then in G3, GC, G2 and G1 and the lowest amount was in control. In other words, using different levels of guar and carboxy methyl cellulose gums as separated and combined has played a role to increase water absorption of samples compared with the control sample. Increasing water absorption is due to the presence of hydrophilic groups in the structure of given gums in the Chapatti bread dough. The Researches have shown that the presence of different hydrophilic groups such as OH and COOH in the structure of gum or hydrocolloids serves as hydrophilic groups and causes more hydrogen bonds and thus more exchange with water and therefore increases the rate of water absorption [15]. The results from the research is consistent with the results obtained from the research of Mandala et al in 2005 that reported that adding CMC, xanthan, pectin, agarose and HPMC gums to formulation of breads from Egyptian rice flour increase the amount of water absorption and its reasons were attributed to the hydrophilic structure of the polymer [11]. Also it is consistent with the results obtained from the research of Ghodke Shalini et al in 2007 which reported that among the carrageen an, CMC, K-HPMC and guar gums, CMC has the highest water absorption and its high water absorption ability is due to carboxyl groups in the hydrocolloid structure. These groups cause more water absorption through a hydrogen bond with water [8]. The average comparison results of dough development factor of samples in Table 2 indicate that all treatments except for treatment of G1 have significant difference (P<0.01) with control. In addition, the treatments of G2 and then G3 and

G4 had the highest dough development time and the control had the lowest. In other words, using both guar and carboxy methyl cellulose gums in the formulation of Chapatti bread dough could increase the dough development time compared to control sample. On the other hand, using more levels of guar gum and also both levels of CMC gum played a role for more increase of the dough development time of samples compared to the their combined addition (GC) that the results obtained is quite equal to the results of Mettler et al., 1995 which stated that in the formulation of making bread from Egyptian rice flour with the addition of individual gums, dough development time increased [12]. According to the average comparison results obtained from Table 2, it is determined that the highest time of dough stability belonged to the treatment of G2 and had significant difference with the other treatments (P<0.01) and then belonged to the treatments of G1 and G4, and the lowest belonged to the control. In other words, all treatments with the control except GC had significant difference. It means that guar and CMC gum used played a role in improving the flour structure and increasing the dough stability obtained from it, especially the addition of high amounts of guar increased the stability of Chapatti bread. It should be note that based on the characteristics of farinography in evaluating the dough, dough stability time showed a very poor dough quality between 0-2 minutes, poor dough quality between 2-4 min, medium-strong dough quality between 4-7 minutes, high dough quality between 7-10 minutes and very high dough quality between 10-15 min [15]. According to such evaluation, all treatments were of a poor quality except the treatment of G2 that had moderate-strong quality. Furthermore, according to the average comparison results obtained from Table 2, it was determined that in terms of the degree of loosening up the dough after 10 min, the control and then the treatments of G4 and G3 had the highest amounts of its and G2 had the lowest amount. In addition, there was significant difference between all treatments and control (except G3 and G4) in terms of this factor (P<0.01). In other words, the results show that the addition of gums cause to strengthen the dough structure compared to control and reduce the degree of loosening the dough, and the difference observed is significant in the treatments containing different levels of guar gum and combined treatment of guar and CMC gums compared to control. The strong structure of dough and reduction of its loosening is probably due to the structure of given additives and their strong bond with the wheat flour components. In other words, the lipophilic part of given compounds are connected with the hydrophobic part of wheat proteins and by making a strong negative charge in complex, lead to accumulate proteins and strengthen the dough gluten network [8]. Also the average comparison results obtained from Table 2 determined that in terms of the degree of loosening up the dough after 12 minutes, the results obtained are relatively equal to the results obtained from being loose dough after 10 minutes so that the control treatments had the highest level of this factor and the treatments of G2 and GC had the lowest, while there was no significant difference (P<0.01) in terms of this trait between two given treatments and other treatments (except control). According Table 2, the highest volumetric amount is related to G2 and has significant difference with other treatment and the lowest amount belongs to control treatment (P<0.01). In all samples of Chapatti bread in which the gums are used, volumetric unit is increased compared to the control sample. Also there was significant difference between all treatments and control in terms of this factor (P<0.01).

Also the average comparison results of extensograph tests in Chapatti bread dough samples (Table 3) determined that the treatment of G2 at the fermentation time of 45 and 135 min and treatment of G4 in the fermentation time of 90 min had the highest amounts of energy and control had the lowest amount of this factor in all three time periods. Furthermore, there was a significant difference (P<0.01) between given treatments and control at all times of the fermentation. Generally, the effect on the amount of energy is different depending on the type and amount of additive (gum). The research results show that the addition of carboxy methyl cellulose and guar gums can increase the amount of energy in the dough compared to the control dough (no gum). It seems that it is because of making strong complexes between flour starch and

strengthened wheat gluten network in the presence of gums that caused the strength and the stability of dough and the increase of dough energy to stretch that the results obtained from this research is consistent with the research of Rosell et al., 2005 which reported that adding different gums to the bread was involved in the strengthening, strength, and increasing energy of dough samples [15]. Moreover, the average comparison results of the factor of resistance to stretch of the samples in Table 3 showed that all treatments in each three time periods had significant difference (P<0.01) with the control. G2 had the highest levels of resistance to stretch during each three fermentation times of 45, 90 and 135 min and control had the lowest. The dough samples containing gum (CMC and guar with both concentrations) were more resistant than the control dough against the changes and passing of time and had the highest level of resistance compared to the control dough without both gum. Also the average comparison results of the factor of the ability to stretch dough samples in Table 3 determined that the highest ability to stretch the dough in each three fermentation times of 45, 90 and 135 min was related to the control and has significant differences with other treatments (P<0.01). Among the samples containing gum in 45 min, respectively, the treatments of G3, G2, G4, G1 and GC had the highest amounts for this factor, in the 90-min the treatments of G4, G3, GC, G1 and G2 and in 135 min, the treatments of G4, GC, G3, G1 and G2 had the highest amount of this property. Results of the study is consistent with the results of Rosell et al., (2005) which reported that the addition of gums such as guar and HPMC cause the relative increase in stretchiness of dough, but this increase is not as the control sample [15]. The effect of factors of resistance to stretching and the ability to stretch the dough on the coefficient numerical value is defined as the ratio of resistance to stretching to the ability to stretch. The average comparison results in Table 3 determined that the addition of gums increase above-mentioned coefficient. On the other hand, there was significant difference between all treatments and the control (except G3 in the time period of 135 min) in terms of this property (P<0.01). The highest coefficient numerical values in fermentation time of 45 min belonged to the treatments of G1 and then G2 (with significant differences with the treatments of GC and G3) and in the fermentation time of 135 and 90 min belonged to the treatment of G2 (with significant differences with other treatments).

CONCLUSION

The overall conclusion indicated that the whole wheat flour used was ideal and suitable for the production of Chapatti bread in terms of the measured parameters (moisture, ash, protein, wet gluten, sedimentation unit and pH). Also the positive relationship was observed between the addition of gums and farinography properties so that the water absorption in the samples containing guar and carboxy methyl cellulose gums increased in comparison with the control sample and the results obtained from the farinograph test of the dough samples showed that the treatment with 0.5% of carboxy methyl cellulose gum (G4) had the highest amount of absorbed water compared to the control treatment and other samples. There was a positive and direct relationship between the increase of the time of dough development and resistance and volumetric unit by adding gums so that these parameters were improved compared to the control sample, especially in the presence of 0.5% of guar gum (G2). Considering the results of extensograph test, except the factor of ability to stretch the dough, all samples containing guar and CMC gums had more favorable effects than the control sample (without gum) and these results indicated that the dough samples containing 0/5% of guar gum (G2) had higher rank than the control samples and other samples in terms of resistance to stretch dough (in each time period) and energy (in time of 45, 135 min).

REFERENCES

[1] Anonymous1, **2000.** American Association of Cereal Chemists (AACC). Approved Methods of American Association of Cereal Chemists
[2] Anonymous2, Standard Methods of International for Cereal Chemistry. (ICC).
[3] A. Asghar, F. M. Anjum; *Food Hydrocolloids*., **2005,** 29, 237-241
[4] E. Armero, C. Collar; *J. Cereal Sci*., **1998,** 28, 165-174
[5] H. Belitz, W. Grosch; Polysaccharides. In: Belitz, H., Grosch, W.(Eds), *Food Chemistry*. Springer, Berlin, **1999,** PP.237-318
[6] J. N. BeMiller, R. L. Whistler; Carbohydrates. In: Fennema, O.R. (Ed.), *Food Chemistry*. Marcel Dekker Inc., New York, **1996,** pp.206_218
[7] S. Davidou, M. Le Meste, E. Debever, D. Bekaert; *Food Hydrocolloids*., **1996,** 10, 375-383
[8] K. Ghodke Shalini, L. Ananthanarayan Laxmi; *Food Hydrocolloids*., **2007,** 21,110-117
[9] A. Guarda, C. M. Rosell, C. Benedito, M. J. Galotto; *Food Hydrocolloids*., **2004,** 18, 241-247
[10] H. Maier, M. Anderson, C. Karl, K. Magnusinm; Guar, locustbean, and fenugreek gums. In: whistler, R.L., Bemiller, J.N. (Eds.), Industrial Gums. Polysaccharides on their Derivatives. Academic Press, New York, **1993,** PP. 182-205
[11] I. G. Mandala; *J. Food Eng*., **2005,** 66, 291-300
[12] E. Mettler, W. Seibel; *Cereal Chem*., **1995,** 72, 109-115
[13] V. Octtaviani, Z. Weibiao; *J. Cereal Sci*., **2006,** 45, 1-17
[14] J. Raghavan; Small farming in central India. Dclhi: sharda publishing.,**1994.**
[15] C. Rosell, A. Guarda; *Food Hydrocolloids*., **2003,** 18, 241-247