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Ban Bread Quality as Affected by Low and High Viscous Hydrocolloids Gum

Hanaa M. Hemeda and Eman F. Mohamed

Faculty of Home Economics,
Department Nutrition and Food Science, Helwan University, Egypt

Abstract: The impact of some hydrocolloids agents (Arabic gum and Locust bean gum) at 5 and 10% individually and as a mixture on ban bread quality was investigated. Bread quality was evaluated according to the following physical parameters: dough fermentation time (min.), loaf height (cm), index to volumes (cm), volume (cm^3), area and degree of softness (mm/sec) before and after storage. Moreover, sensory evaluation of the product (Appearance, color, cell uniformity, moistness, odor, taste and overall acceptability) was carried out by 10 panelists and proximal composition was determined for all the fortified samples. The study showed that the highest volume was detected in fortified bread sample with mixture gum (at 5%) compared to the control and the other samples. In addition, hydrocolloids improved bread softness after the storage period (for 1 wK. at-10°C). Sensory evaluation results revealed that ban bread samples supplemented with both types of gum were acceptable. Scores given to bread fortified with Arabic gum at different levels were found to be close to that of the control sample for all the evaluated characteristics. The study concluded that gum under the present investigation improved moisture retention and maintained the overall bread quality after storage.

Key words: Ban bread · Arabic gum · Locust bean gum · Bread softness · Quality evaluation · Proximal composition

INTRODUCTION

Hydrocolloids often called gums are hydrophilic polymers, of vegetable, animal, microbial or synthetic origin, that generally contain many hydroxyl groups and may be polyelectrolytes. They are naturally present or added to control the functional properties of aqueous foodstuffs. Most important amongst these properties are viscosity (including thickening and gelling) and water binding but also significant are many others including emulsion stabilization, prevention of ice recrystallization and organoleptic properties [1]. Hydrocolloids are widely used as additives in the food industry, because they are useful for modifying the rheology and texture of aqueous suspensions [2]. Hydrocolloids are used in food products as thickeners, stabilizer, gelling agents and emulsifiers. They improve the texture of the products, retard starch retrogradation during storage, increase water retention, while enhancing lower energy value; they are often employed in low-calorie foods [3-5]. In food industries hydrocolloids exhibit some functions like controlling the pasting properties of foods, improving moisture retention and maintenance of overall product quality during storage [6, 7]. According to Yoko [8] the commercial samples of carob bean gum contain approximately 5-12% moisture, 1.7-5% acid-soluble ash, 0.4-1.0% ash and 3-7% protein. The samples of clarified carob bean gum contain approximately 3-10% moisture, 0.1-3% acid-soluble matter, 0.1-1% ash and 0.1-0.7% protein. Dagnew *et al.* [9] analyzed Arabic gum and found that moisture content of 15%, ash content of 3.56%, nitrogen content of 0.35%, protein content of 2.31% and with no tannin content. Mineral contents of the Arabic gum (g/100 g) are Ca 0.7, Mg 0.2, Na 0.01, K 0.95, Fe 0.001 and P 0.6.

Crumb firming is one of the most important attributes of bread staling, increasing opacity of crumb, toughening of crust and decreasing starch solubility. According to Toshiki and Paula [10], the most important change caused during storage is firming of bread crumb, Amylopectin recrystallization is the main cause of firming of bread crumb. Ozkoc *et al.* [11] investigated the physicochemical properties of breads baked in conventional, microwave and microwave-infrared combination ovens during storage and found that, hardness of bread samples

Corresponding Author: Eman F. Mohamed, Faculty of Home Economics,
Department Nutrition and Food Science, Helwan University, Egypt.

increased significantly with time during storage. The increase in firmness was found to associate with the decrease in moisture content. When moisture content decreases, it accelerates the starch-starch interactions, resulting in a firmer texture. Furthermore, the authors reported that the addition of xanthan-guar gum blend resulted in a significant decrease in the hardness values of samples baked, meaning that gum addition could be useful in retarding staling in terms of hardness values.

The aim of the present study was to investigate the effects of Arabic gum (low viscous) and Locust bean gum (high viscous) individually and as a mixture on ban bread quality after baking and upon storage.

MATERIALS AND METHODS

Materials: The Arabic and Locust bean gum were obtained from Elgomheria Company, Cairo, Egypt. Wheat flour (72% extraction) and other ingredients such as (yeast, salt and sugar) were purchased from local market, Cairo, Egypt.

Methods: Bread product was prepared according to Food Technology Research Center, Agricultural Research Center [12]. Basic dough formula was presented in Table 1. Bread flour was partially replaced with Arabic and Locust bean gum individually (at 5% and 10% of flour weight) and as a mixture at the same ratios as presented in Table 2.

Preparation of the Fortified Ban Bread:

Quality Evaluation of Fortified Ban Bread with Gum: Water uptake (ml) of both Arabic gum and Locust bean gum (5 gm) upon soaking in 100 ml water for (3 h.) at three different temperatures (25 ,40 and 60 °C) each individually was determined. Dough water uptake during preparation was recorded (ml), weight after baking for each treatment was recorded (gm) and percent change (%) in weight was calculated according to the following equation:

$$\text{Change in weight \%} = \frac{\text{Wt. before baking - Wt. after baking}}{\text{Wt. before baking}} \times 100$$

Bread fermentation time (min.), was determined (twice), height (cm), index to volumes (cm) was measured, while volume (cm^3) was determined by rapeseed displacement method according to Penfield and Camphell [13]. The area of the slice from each of the prepared samples was measured by using the planimeter apparatus.

Table 1: Ingredients of standard recipe of the Ban bread

Ingredients	Amounts (gm)
All flour purpose	220.0
Dry yeast	5.0
Sugar	2.5
Salt	2.5
Butter	7.5
Sugar	7.5

Table 2: Levels of gum added for ban bread preparation as percentage of flour weight.

Flour (gm)	Replication ratio (%)	Different hydrocolloid (gm)
220	5	11
220	10	22

Degree of softness (mm/sec) before and after storage (for 1 wK. at-10°C) was done by using penetrometer apparatus (Model H-1240 with serial number 99101240 specs Ast M. Humbeldt MFG. Co. USA) and following the methodology reported by Penfield and Camphell [13].

Sensory Evaluation: Sensory evaluation was carried out by (10) trained panelist from department of Nutrition and Food Science using semi-structured scales scoring (1 = lowest quality to 5 = highest quality) according to Penfield and Camphell [13]. The evaluated characteristics included visual appearance, color, cell uniformity, moistness, odor, taste and overall acceptability.

Proximal Composition: Proximal composition of ban bread samples prepared with each type of gum at two different levels individually and as a mixture was subjected to chemical analysis. Moisture, ash, protein, fat and fiber were determined according to AOAC [14]. Total carbohydrates were calculated by difference. Sodium, calcium, magnesium and potassium were determined by atomic absorption spectrophotometer (Type Unicom-929) according to the methods of AOAC [15].

Statistical Analysis: The obtained results of sensory evaluation and Tenderness were statistically analyzed according to statistical analysis system, SAS User's Guide [16].

RESULTS AND DISCUSSION

The amount of water uptake of both Arabic gum and Locust bean gum upon soaking for 3 hr. in (100 ml) of water at three different temperatures each individually are

Table 3: Water uptake (ml) of both Arabic gum and Locust bean at three different temperatures.

Treatments	Temperature	Water uptake of Arabic Gum (ml)	Water uptake of Locust bean Gum (ml)	Water uptake of Locust bean + Arabic Gum (ml)
1	Room temperature 25°C	40.0	30.0	45
2	Water bath at 40°C	32.5	47.5	35
3	Water bath at 60°C	25.0	50.0	28

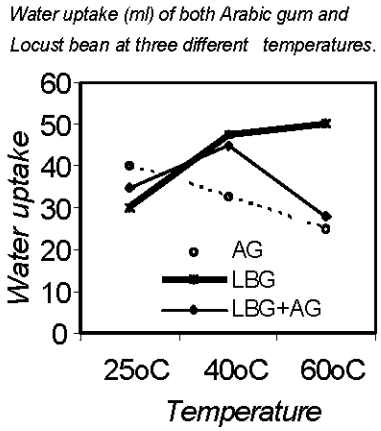

Fig. 1: Water uptake (ml) of both Arabic gum and Locust bean at three different temperatures

illustrated in Table 3 and Fig. 1. It was found that water uptake of Arabic gum tended to decrease as the temperature raised. While, water uptake of Locust bean gum tended to increase at 60°C and decrease at 40°C. However, when mixture of the two types was added to water that led to increase in water uptake at 40°C and decrease at 60°C.

Water Uptake During Dough Preparation: During dough preparation of fortified bread, water uptake (ml) of different percentages (5 and 10%) of Locust gum, Arabic gum and mixture of them are shown in Table 4. It was found that water uptake (ml) was decreased during preparation of fortified dough with Locust gum and Arabic gum either individually or as a mixture (at 10%) as compared to control (147 ml). While water uptake is increased in dough fortified with 5% mixture of both gum (150 ml) as compared to control. Meanwhile, dough prepared with mixture gum had increased water uptake than other dough followed by dough with Arabic gum and Locust gum. Increase of water of the final product may depend on different factors such as temperature and gum level and the ingredients of the recipe [17]. The present results disagreed with the findings of other investigators. Kohajdová and Kohajdová [18] reported that the effect of hydrocolloid addition (Arabic gum, guar gum, xanthan gum and methyl 2-hydroxyethyl cellulose)

Table 4: Water uptake (ml) during dough preparation as affected by the addition of gums (individually and as a mixture)

Treatments	Uptake of water (ml)
Control (wheat flour)	147
Locust gum	
5%	100
10%	110
Arabic gum	
5%	120
10%	125
Mixture gum	
5%	150
10%	133

Table 5: Dough fermentation time (min.) as affected by addition of the two types of gum

Samples	1st fermentation time (min)	2nd fermentation time (min)
Control	30	20
5% Locust gum	90	60
10% Locust gum	90	60
5% Arabic gum	90	70
10% Arabic gum	60	45
5% Mixture gum	60	40
10% Mixture gum	50	45

on dough rheology reported increases on water absorption by wheat flour with various hydrocolloids. Water absorption was increased by addition of applied hydrocolloids. These results were expected due to the hydroxyl groups in the hydrocolloid structure, which allow more water interactions through hydrogen binding.

Fermentation Time: Fermentation time of each sample is shown in Table 5. The first fermentation time of dough fortified with Locust bean gum (5 and 10%) and Arabic gum (5%) increased by 60 min. while, increased by 30 min. with both Arabic gum (10%) and mixture gum (5%), while increased by 20 min. with 10% mixture gum as compared to the control (30 min). Also, the second fermentation time (min) increased in all the fortified samples as compared with the control (20 min). The addition of the gums had a great effect on dough performance and quality of the final product.

Table 6: Percent change in weight of ban bread after baking and relative to control as well as baking time.

Simples	Wt. before baking (gm)	Wt. after baking(gm)	Change in weight %	Relative to control %	Baking time (min.)
Control	375	310	17.33	-	25
5% Locust gum	375	270	28.00	161.57	15
10% Locust	375	250	33.33	192.32	15
5% Arabic gum	375	300	20.00	115.41	50
10%Arabic gum	375	200	46.67	269.30	35
5% Mixture gum	375	323	13.87	75.01	55
10% Mixture gum	375	345	8.00	46.16	30

Table 7: Physical properties of ban bread fortified with tested hydrocolloids.

		Arabic gum		Locust gum		Mixture gum	
Samples	Control	5%	10%	5%	10%	5%	10%
Volume (cm^3)	950	850	840	750	760	1030	770
Height (cm)	6.7	5.6	4.9	3.8	3.8	5.80	4.9
Index to volume (cm)	7.4	6.5	5.8	4.9	5.0	7.14	5.9
The area (cm^2)	46.7	40.5	33.1	25.2	25.7	45.20	35.93

Gums at all tested concentrations reduced fermentation activity of yeast and prolonged the rising time of dough. The present results are in agreement with the findings of Dodić *et al.* [19]. A great improvement in dough stability during fermentation was achieved by adding hydrocolloids as reported by Rosell *et al.* [20].

Bread weight as (%) relative to control is presented in Table 6. There was a decrease in weight after baking with each increment of Locust or Arabic gum. This decrease might be due to more retention of gas as indicated previously from Table 5. While the lowest reduction in weight was detected in bread with mixture gum (5 and 10%) which might be due to less retention of gas as compared to the effect of each type individually. In addition, there was an extend in baking time for bead samples fortified with Arabic gum at the two levels and the mixture which can be explained by higher water holding capacity of this gum.

Physical Properties of Ban Bread: Physical properties of ban bread are shown in Table 7. Loaf volume is regarded as the most important bread characteristic since it provides a quantitative measurement of baking performance. The volume of fortified ban bread with gum ranged from 750 to 1030 (cm^3). Bread with Arabic and Locust gum had smaller loaf volumes than the control sample. The mixture addition of gums (5 %) promoted the greatest volume as compared to the control and the other samples.

According to Lazaridou *et al.* [21] when the polymers added alone to the formulation, the bread volume were reduced to the range of 150-220 (cm^3/100 g) which similarly to our findings and with further rise of the polymer level (hydrocolloid) the loaf volumes decreased. The hydrocolloids increased the specific volume, moisture retention, water activity and reduced the firmness of bread crumb as reported by Rosell *et al.* [20]. Height, area and index to volume was decreased by increasing level of gum except for the bread with 5 and 10% of Locust gum which had approximately the same values which was the lowest values among the prepared products. While, the best values of ban bread were obtained upon fortification with 5% mixture gum and 5% Arabic gum respectively. 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 as stated by Kohajdová and Kohajdová [18]. Ali *et al.*[22] found that peak height percentage was higher in the treatment having 3% Arabic gum, also the use of Arabic gum and CMC at the level of 3% on flour weight basis can improve the frozen dough pizza (FDP) quality. Moreover, Dodić *et al.* [19] found that addition of hydrocolloids resulted in higher specific volume of loaves compared to the specific volume of control sample loaves and the decrease in specific volume of frozen bread is less in the samples with hydrocolloids compared to the decrease in the control sample. Degree of softness (mm/se) of ban bread prepared with some hydrocolloids (Locust bean gum and Arabic gum) at different ratios is presented in Table 8. The results indicated that degree of softness values decreased significantly ($P \leq 0.05$) in fresh sample fortified with Locust bean gum at (5%),

Table 8: Degree of softness (mm/sec.) of ban bread fortified with different kinds of gum according to penetrometer apparatus.

Samples	Fresh bread tenderness	Bread tenderness after storage for 1 week at (-10 C°)
Control	182.5±10.62^{b}	25.67±1.7^{c}
Locust 5%	75.25±20.68^{c}	65±16.31^{ab}
Locust 10%	232.5±11.37^{a}	62.33±25.62^{ab}
Arabic gum 5%	162.25±18.05^{b}	51.33±4.11^{abc}
Arabic gum 10%	171.5±5.12^{b}	42±10.03^{bc}
Mixture 5%	237.5±22.01^{a}	60.67±6.13^{ab}
Mixture 10%	173.5±13.67^{b}	44±2.94^{bc}

Table 9: Nutritive value of ban bread as affected by some hydrocolloid

		Arabic gum		Locust gum		Mixture gum	
Proximal composition	Control	5%	10%	5%	10%	5%	10%
Protein	11.40	11.32	11.71	11.64	12.79	11.35	11.61
Carbohydrate	52.06	56.04	52.42	57.70	51.44	52.63	48.32
Fiber	1.07	1.35	1.75	2.05	4.77	2.58	3.00
Lipids	2.63	5.37	5.69	2.30	2.95	2.87	5.49
Moisture	31.02	23.72	25.54	24.96	26.49	29.03	29.37
Ash	1.82	2.20	2.89	1.35	1.56	1.54	2.21
Minerals (mg / 100 gm)							
Sodium (Na)	342.65	409.40	485.05	235.85	298.15	226.95	356.0
Calcium (Ca)	48	74	88	51	59	83	116
Magnesium(Mg)	36	37	61	38	40	47	58
Potassium (K)	140.76	145.76	189.72	169.32	179.52	196.86	215.73

while there were increases in softness of ban bread samples fortified with Locust bean gum at (10%) and the sample fortified with (5%) mixture gum as compared with the control. This increase may be due to water holding capacity of gum at the percentage added and its ability to retain moisture and increase freshness. According to Rosell *et al.* [20], gums are able to modify starch gelatinization and retard starch retrogradation by interacting with starch components, amylase and amylopectin. In this respect Guarda *et al.* [23] reported that, Locust bean revealed a softening effect due to high water retention capacity of it.

In the otherwise there are no significant ($P< 0.05$) differences between bread samples fortified with Arabic gum at different ratios and bread sample fortified with mixture gum at 10% as compared to control sample. Moreover, hydrocolloid addition increases degree of softness after storage (7 days). There was noticeable significant ($P\leq 0.05$) increase in degree of softness of bread with all ratios (65±16.31 and 62.33±25.62) of Locust bean gum and bread fortified with mixture gum at 5% (60.67±6.13) as compared with control sample (25.67±1.7). Meanwhile, there is no significant ($P\leq o.05$) differences among bread samples fortified with different hydrocolloids. Davidou *et al.* [24] reported that both degrees of crumb firmness and the rate of staling during storage were reduced by addition of Locust bean gum. These results agreed with the findings of Rosell *et al.* [20] and Guarda *et al.* [23] who reported that the softening effect of hydrocolloids should be attributed to their water retention capacity, a possible inhibitor of the amylopectin retrogradation during storage. Sharadanant and Khan [25] reported that the levels of gum Arabic 0.1% and 0.2% and 0.3% Locust bean gum decreased bread firmness values obtained by texture analyzer as compared to control. Also, Bread shelf-life through bread crumb moisture and bread firmness values showed that Locust bean gum retained moisture to a greater extent and were softer when compared with the frozen control. According to Sharadanant and Khan [26], Locust bean gum, gum Arabic and CMC improved bread characteristics to varying degrees.

Therefore, the present study, hydrocolloid addition reduces the dehydration rate of crumb samples during storage. Also texture properties and softness degree for bread can be improved with using Arabic and Locust bean gum by binding water and decreasing its availability.

Nutritive Value of Fortified Bread Samples: Nutritive value (per 100 g) of bread samples with different types of gums as compared to the control values are illustrated as (%) in Table 9. It was clearly noticed that there were increases in minerals content (Ca, Mg and K) in all fortified samples with tested gums as compared to control sample. Also, tested gums increased bread composition of fiber, lipids, moisture and ash.

Table 10: Characteristics of bread fortified with different percentage of Arabic and Locust gum represented as average score given by panel test.

Character Groups	Appearance	Color	Cell uniformity	Moistness	Odor	Taste	Overall acceptability
Control	4.667^{a} ± 0.211	4.500^{a} ±0.224	3.667^{ab} ± 0.422	3.167^{ab} ± 0.307	3.500^{ab} ± 0.428	3.667^{a} ± 0.494	3.667^{a} ± 0.422
5% Locust	2.500^{b} ± 0.342	2.167^{b} ±0.401	2.500^{bd} ± 0.342	2.167^{b} ± 0.477	3.054^{ab} ± 0.447	2.467^{ab} ± 0.401	2.333^{ab} ± 0.333
10% Locust	2.667^{b} ± 0.333	1.833^{b} ±0.307	2.333^{bd} ± 0.333	2.000^{b} ± 0.365	3.000^{ab} ± 0.516	2.260^{ab} ± 0.365	2.167^{ab} ± 1.169
5% Arabic	4.667^{a} ±0.211	4.833^{a} ±0.167	4.000^{a} ± 0.365	4.333^{a} ± 0.333	4.167^{a} ± 0.307	3.896^{a} ± 0.211	4.000^{a} ± 0.258
10% Arabic	3.833^{a} ± 0.401	4.333^{a} ±0.333	3.333^{ad} ± 0.494	3.667^{a} ± 0.558	4.167^{a} ± 0.307	3.666^{a} ± 0.817	3.500^{a} ± 0.428
5% mixture	2.333^{b} ±0.615	1.667^{b} ±0.333	2.333^{bd} ± 0.715	3.167^{ab} ± 0.477	2.850^{bc} ± 0.633	2.276^{ab} ± 0.258	1.500^{b} ± 0.224
10% mixture	2.167^{b} ±0.167	1.667^{b} ±0.211	2.167^{cd} ± 0.654	3.167^{ab} ± 0.601	2.730^{bc} ± 0.633	2.207^{ab} ± 0.167	1.667^{b} ± 0.333

Organoleptic Properties of Bread Samples: Sensory evaluation results of fortified bread with gums are presented in Table 10. It was found that no significant ($P \leq 0.05$) differences between the all organoleptic properties of control sample and samples with Arabic and Locust bean gum at different ratios except with regard to appearance and color which were significantly ($P \leq 0.05$) lower in ban bread with Locust bean gum and the same results were observed in samples with mixture gum. In addition, the scores given for all properties of fortified bread with Arabic gum at different ratios were found to be close to that of the control sample. As was previously found by Abo-Ghoush [27], the addition of gums did not show a detrimental effect on Arabic bread and the addition of gums to Arabic flat bread improved quality and extended shelf life. Therefore, Locust bean in combination with surfactant gels improved the bread making quality of wheat flour to a maximum extent as indicated by Azizi and Rao [28].

The overall results of the present investigation showed that the addition of each of the tested hydrocolloid affected in a different way the pasting properties of bread. Food industries should be encouraged to use hydrocolloids as ingredients in the bread making process in a proper percentage for improving the quality of bread and to extend bread shelf life.

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