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Improving Rheological and Sensory Properties of Flour and Laboratory Cake Using Different Concentrations of Guar Gum

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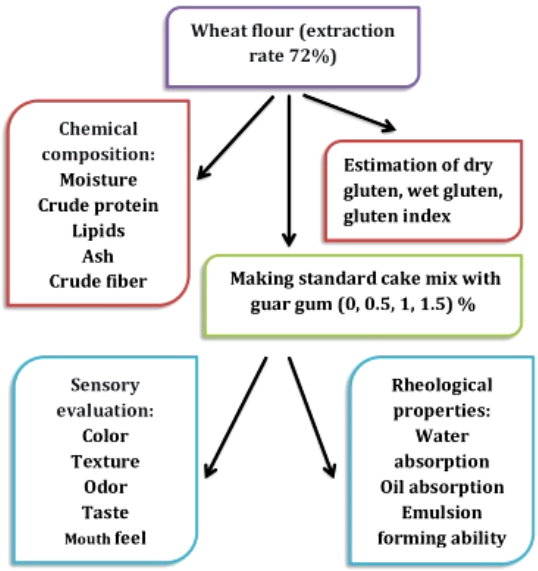
ABSTRACT

The current study was conducted to show the effect of adding guar gum on improving the rheological and sensory properties of flour and laboratory cakes. Turkish flour of the brand BESLER UN was used, guar gum was added in concentrations of 0.5%, 1% and 1.5% in treatments T1, T2 and T3, fourth treatment. T was left without addition to the control group. Chemical composition analysis of the flour was carried out before use, conforming to the Turkish and Iraqi standards for multi-purpose wheat flour. The addition of guar gum did not significantly affect the moisture and ash content, which amounted to 9.6% and 0.64%; values of dry and wet gluten and gluten index were 8,14, 24.5 and 91.4, respectively, having a clear effect on the relatively good extraction rate of flour 72%. Adding guar gum significantly affected the rheological properties of cake dough such as oil absorption and emulsification, reaching 2.66 and 2.28, compared with the control by 2.53 and 1.35. As for the water absorption of all treatments, there were no significant differences between them and the control, sensory characteristics of the cake, including taste and mouth feel, affected by the increase in the addition of guar gum, from 6.86 and 6, 57 respectively in control to 8.54 and 8.56 in T3 treatment (1.5% guar gum). The characteristics of color, texture and smell did not show significant differences from the control when adding guar gum for all treatments.

GRAPHICAL ABSTRACT



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Introduction

Cereals, including wheat in particular, occupy an important place in the human diet. Wheat flour is one of the most important grain products for global consumption, and because of its low moisture content, flour is classified among the low-perishable foods [1]. Wheat flour products represent the most consumed basic food in the food basket around the world. The forms and types of bread and bakery products are an essential feature that distinguishes people from each other, each of them has his own way and traditions in making bread and its products [2]. Therefore, bakeries use some food additives to reach the good quality, as well as to improve the qualitative properties of bread and bakery products by improving the texture and size of the product, increasing fragility and flaking, reducing the staling bread phenomenon and prolonging the shelf life [3]. The rheological properties of wheat flour depend mainly on the structure and quality of the gluten, as wheat gluten has unique elasticity and viscosity properties due to its components (gliadins and glutenins) and additives target the ability of gluten to retain water and increase the elasticity of the dough [4]. The addition of hydrocolloids is one of the most effective methods on the rheological properties of the product, which is classified as a bread improver, as it improves the taste and texture qualities while controlling moisture and texture, as well as improving the physical properties of the product and its quality in general [5]. Guar gum is a galactomannan extracted from the seed of the leguminous plant Cyamopsis tetragonolobus, belonging to the leguminous species Leguminosae, which has been grown for thousands of years in India and Pakistan as vegetables and forage crops. Some guar seeds were also discovered in the temples and burials of the ancient Egyptians. The low-concentration solutions of this gum are very viscous and are useful in thickening, stability and water binding applications. Guar gum is used in bakery products to improve mixing for making different recipes and extend the shelf life of products by retaining moisture and preventing synergy in frozen foods and pie fillings [6]. In addition, some studies indicate that foods containing guar gum are more effective than ready-made drinks containing guar granules in improving cholesterol and blood sugar control [7, 8]. This research aims to improve the rheological and sensory properties of flour and laboratory cake by using different concentrations of guar gum.

Materials and methods

Besler Un flour of Turkish origin was used, which is available in the local markets of Baghdad, guar gum, which was prepared from the company (Sigma, Aldrich, Germany), was used. The rest of the ingredients for the cake mix, which include sugar, oil, eggs, milk, baking powder, were purchased from the markets of Baghdad.

Preparation of laboratory cake treatments

The standard cake mix was prepared in the laboratory using 250 g. of wheat flour, 75 g. of sugar, 3 eggs, 130 mL of milk, 70 mL of corn oil, 10 g of baking powder. Concentrations of 0.5, 1, 1.5% of guar gum were added to the treatments and a sample was left Control without addition, distribute the dough in small molds and bake in the oven at 180 °C for 25 minutes.

Chemical composition

Moisture, ash, crude fiber, fat and nitrogen were calculated in wheat flour using the methods mentioned in another study [9]. The protein percentage was calculated by multiplying the nitrogen value by 0.70, fats were extracted using a Soxhlet apparatus by using *n*-hexane as a solvent, and total carbohydrates were calculated by subtracting the sum of the previous values out of 100. According to the equation:

% carbohydrate = 100 – (% fat + % protein + % ash +% dietary fiber + % moisture).

Rheological properties

Calculation of gluten, water and fat absorption and ability to emulsify

The wet and dry gluten and flour gluten index were calculated using a device (AB type 2200 No. 005092, Huddling, Sweden) according to the method described by another previous study [10]. The effect of guar gum on the absorption of water and fats and the ability to emulsify was determined by following the methods mentioned

earlier in the literature [11]. Water absorption percentage was calculated by weighing 2 g of flour sample with addition of 15 mL of distilled water placed samples in glass tubes for a centrifuge previously weighed, fat and emulsifying ability, by following the previously applied methods [11]. Water absorption percentage was calculated by weighing 2 g of flour sample with the addition of 15 mL of distilled water; samples were placed in glass tubes for a centrifuge that were previously weighed. The liquid was mixed with the resulting suspension using vortex for one minute, placed in a centrifuge at 300 rpm for 30 minutes. The supernatant liquid was removed from the top and the tubes were placed at a tilt in an air oven at 50 °C for 25 minutes to dry the samples. It was placed in a desiccator as soon as it came out of the oven, left to cool and subsequently weighed; water absorption capacity was expressed as the amount of water retained by 100 g of flour or protein. As for the ability to emulsify, it was calculated at room temperature by placing 2 g of flour in a clean glass tube, followed by adding 23 mL of distilled water, and mixing the samples with a low speed mixer to produce a suspension. The corn oil was gradually added to the burette at a rate of 0.45 mL oil/sec. by stirring until reaching the breaking point of the emulsion when separated into two layers; the emulsify ability was expressed as 1 ml of oil per gm. of flour or protein.

Sensory evaluation

A previously applied method [12] was followed in assessing the sensory characteristics of the laboratory cake, so 10 trained persons from the professors and employees of the Market Research and Consumer Protection Center at the University of Baghdad assessed the characteristics of color, texture, odor, texture and mouth from 10 degrees where 1 signifies poor and 10 signifies excellent; the residents were provided with drinking water to clean the taste cells in the mouth between treatments.

Data analysis

Statistical Analysis System (SAS) [6] was used to analyze the data and to study the effect of adding guar gum on the studied characteristics of flour and cake according to a complete random design (CRD), and the significant differences between the means were compared with the test of the least significant difference (Lest Significant) difference-LSD.

Results and discussion

Chemical composition of wheat flour

Table 1 shows the chemical composition of Turkish flour of the brand BESLER UN used in the experiment, with an extraction rate of 72%, depending on the dry weight, with a moisture rate of 9.6%, dry protein 10.5%, fat 1.05%, ash 0.64%, fiber 0.93 % and carbohydrates 77.28%. The chemical composition was in conformity with the Turkish specification for flour [13, 5], matching also with the Iraqi specification for multi-use wheat flour. A difference in the percentages of flour extraction from wheat grains grown in several regions of Turkey has been indicated, ranging from 70% to 76%, and the moisture content ranged between 14% to 15% [13]. It has been stated that the difference in the extraction rate and the ash percentage in wheat flour is due to genetic and environmental restrictions and determinants that accompany the cultivation of wheat grains and clearly affect the ability to fill the grain during maturity, which leads to changes in grain weight and ash content [14].

Chemical properties

Table 2 shows the effect of adding guar gum on the chemical properties, the most important of which is the moisture and ash ratio of the flour treatments used in the experiment. When adding guar gum the moisture content was not affected by concentrations of 0.5, 1, and 1.5% to the flour, which amounted to 9.7, 9.7, 9.8%, respectively, compared with the control treatment (9.6%), as well as the percentage of ash which was also not affected by the addition of guar gum; it was recorded at 0.65, 0.64 and 65.0, respectively, for the three concentrations compared to the control treatment of 0.64. Adding guar gum to Iranian flour used in making Barbari kind bread did not significantly affect the moisture and ash content of the flour [15].

Dry and wet gluten and gluten index

The values of dry and wet gluten and gluten index of wheat flour used in the experiment were 8.14, 24.5 and 91.4, respectively (Table 3). These results are similar to those of a previous study [3], finding them by 9, 29 and 28,64 and 91.3, respectively, for Egyptian flour with an extraction rate of 72%, while a comparison the comparison between the chemical properties of four types of Lebanese wheat flour used in bread indicated that the dry gluten ranged between 13,30-13, 92 and the wet gluten 38, 98-43,98 and the gluten index of -54 68, with low extraction rates that ranged between 60, 1-67.6% [16]. The difference in dry gluten and gluten index is attributed to the fact that the value of the latter decreases in the wheat crop when it is grown in relatively warm weather conditions, while the value of dry gluten rises in the same conditions and their values differ inversely in cold rainy weather conditions.

Table 1: Proximate chemical composition of wheat flour 72% extraction (% based on dry weight)

Chemical composition	Wheat flour (72% extraction)
Moisture	9.6
Crude protein	10.5
Lipids	1.05
Ash	0.64
Crude fiber	0.93
Total available carbohydrates	77.28

Table 2: Effect of adding guar gum on the chemical properties of the flour treatments used in the experiment

Treatments with guar gum	Moisture (%)	Ash (%)
T (0%) control	9.6	0.64
T1 (0.5%)	9.7	0.65
T2 (1%)	9.7	0.64
T3 (1.5%)	9.8	0.65

Table 3: Dry gluten, Wet gluten and gluten index in wheat flour

Dry gluten	8.14
Wet gluten	24.5
gluten index	91.4

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Effect of gum on rheological characteristics

The results of the study showed the values of water and oil absorption and the ability to emulsify during dough preparation. Table 4 shows the values of water absorption percentage of cake dough, which amounted to 64.5, 65.2, 66.5 and 67.4%, respectively, for the parameters T, T1, T2 and T2. T3, respectively; there were no significant differences between them at ($P \leq 0.05$), and these results are in agreement with those of previously reported research [15], in which when adding guar gum to Iranian flour used in bread, water absorption ratio was 55.59, 56.2, 57.7, 58.5, respectively, for the control and treatments 0.5 and 1 and 1,5% guar gum, while it has been indicated that the value of water absorption by flour when adding guar gum to it increased with the increase in the percentage of added gum [3, 17], so it was recorded in the first research for Egyptian flour 6, 7 and 61, 8, 62.5 and 64.2, for the control and the treatments with addition ratios of 0.5, 1 and 1.5 % guar gum, in the second study of Italian flour 61.9, 64.4, 68.6 , 73.3, for the control and the treatments with the addition ratios of 0.5, 1 and 1.5 % guar gum, which was attributed to the fact that the increase in the proportion of colloids by the addition of flour during the preparation of dough leads to an increase in its ability to absorb water due to the presence of hydroxyl groups that enhances its interaction with water through the hydrogen bond.

Table 4 shows the percentage of oil absorption by the flour during the preparation of cake dough, its value in the control treatment and the treatments with addition ratios of 0.5, 1; 1.5 % guar gum reached 2.53, 2.57, 2.60, and 2, 66, and significant

differences appeared at (P≤0.05) between the treatments with the increase in the percentage of added gum. Comparing our results with those of past research [18] revealed that the absorbability of oil in cakes made from wheat flour with different percentages of corn flour here was 2.31% in the treatment 100% wheat flour, while it amounted to 2.56% in treatment 85:15, corn to wheat; it has been indicated that the cake prepared with different concentrations of jojoba seed oil extract increased the oil absorbability in it from 1.94 to 3.44 % [12]. The increase in the ability of cakes and pastries to absorb oil is an important property and a vital function of protein in diets because it binds fats as a flavor stabilizer and enhances the qualities of tenderness and mouth feel for food [19].

Cake treatments with different concentrations of guar gum recorded significant differences at (P≤0.05) among them (Table 4). The highest emulsification rate was 2.28 in T3 (1.5%) compared with 1.35 in control treatment. The results from another study [20] with the same approach as this study showed that the emulsify ability of rice cake treatments with guar gum increased from 1.23 in the control to 2.19 in the 3% guar gum treatment, which was attributed to the fact that adding types of gum such as xanthan, guar and carrageenan to the cake mixture helps reduce its apparent viscosity, allowing the dough to swell more and form a fragile texture. It has been stated that adding jojoba oil extract has a clear effect on increasing the ability to emulsify in cake treatments from 1.27 in the control treatment to 3.42 in the 1% jojoba oil treatment [12].

Table 4: Rheological characteristics of dough contained different concentration of guar gum

Treatments with guar gum	Water absorption (%)	Oil absorption (%)	Emulsifying capacity
T (0%) control	64.5 ±3.07 a	2.53±0.015 a	1.35 ±0.017 a
T1 (0.5%)	65.2 ±2.33 a	2.57±0.023 b	1.39 ±0.011a
T2 (1%)	66.5 ±2.84 a	2.60±0.031 bc	2.16 ±0.014 b
T3 (1.5%)	67.4 ±2.81 a	2.66±0.024 cd	2.28 ±0.024 c
LSD value	4.904 NS	0.721*	0.733 *
Means with different letters in same column differed significantly. * (P≤0.05).			

Sensory evaluation

The results of evaluating the sensory characteristics of the treatments of cake with guar gum under study (Table 5) showed that there were no significant differences at (P≤0.05) in the characteristics of color, texture and odor among the treatments compared with the control, while the characteristics of taste and mouth fell recorded significant differences between the treatments, values of the taste character gradually increased with the increase in the percentages of added gum from 68.6 in the control to 8.54 in the T3 (1.5%) treatment. Besides the characteristic of mouth fell, its evaluation scores increased to 8.56 in T3 treatment (1.5%) compared with 6.57 in control group. It has been indicated that adding guar gum to bread at rates of 0.5, 1, and 1.5% does not significantly affect the evaluation of color and taste characteristics, while the values of texture and flavor gradually increases to reach 19.0 and 18.3 respectively, in the treatment 1.5% guar gum compared with the control 17.5 and 17.6, respectively. It has been mentioned that the addition of guar gum to taftoon type of Iranian bread raises the degrees of sensory evaluation of color and texture characteristics from 1.5 in control to 2.75 in treatment 1.5% for color and from 1.75 to 2.75 in treatment 3% Guar gum for the texture [4].

In a study [19], in which annatto dye was added to the cake, it was found that the texture, color, smell, taste and sensation in the mouth increased when assessing sensory, reaching 7,29, 7,81, 7,57, 8,23 and 7,45, respectively, compared with the control one, while the addition of jojoba oil extract to cake treatments in another study [12] negatively affected the characteristics of color, texture, smell and taste to decrease to 8,77, 9,05, 8,63 and 8,23, compared with the control which scored 9 , 11, 9, 12, 9, 24 and 9, 14. They explained that the increase in the proportion of

jojoba oil in the treatments of 15% and 20% negatively affected the sensory characteristics of the cake compared with the proportions of 5% and 10%, which were somewhat acceptable sensory. The addition of ginger powder to bread was studied at rates of 2%, 4%, 6% and 8% and they explained that the increase in ginger addition negatively affected the sensory evaluation scores for all treatments, which decreased gradually with the increase in the addition compared with the control, except for the 2% addition treatment, which was sensually acceptable [1]. It is attributed to the fact that ginger has a strong and spicy taste that leads to consumers' rejection of the product when the percentage of addition increases, despite its being a natural extract that has great benefits in various nutritional and therapeutic fields.

Table 5: Sensory characteristics for cakes treatments with guar gum

Treatments with guar gum	Color	Texture	Odor	Taste	Mouth feel
T (0%) control	8.11 ±0.32 a	7.92 ±0.29 a	6.52 ±0.37 a	6.86 ±0.43 b	6.57 ±0.33 b
T1 (0.5%)	8.55 ±0.57 a	8.30 ±0.45 a	6.87 ±0.56 a	7.21 ±0.59 b	7.53 ±0.61 ab
T2 (1%)	8.63 ±0.55 a	8.64 ±0.51 a	6.55 ±0.39 a	7.90 ±0.62 ab	7.91 ±0.58 a
T3 (1.5%)	8.66 ±0.42 a	8.66 ±0.57 a	7.04 ±0.53 a	8.54 ±0.63 a	8.56 ±0.68 a
LSD value	0.794 NS	0.844 NS	0.591 NS	1.071 *	1.247 *
Means with different letters in same column differed significantly. * (P≤0.05).					

Conclusion

The results of this study showed that adding guar gum to the cake mix enhanced the rheological properties of the dough, as it increased the ability to absorb oil and the ability to form and stabilize emulsions, thus enhancing its desirable sensory qualities such as taste and sensation in the mouth, and the treatment with the addition of 1.5% guar gum was the best in enhancing the qualitative characteristics of the cake product in general. In addition to improving the rheological and sensory properties, the results showed that the use of guar gum generated good properties of the product that can be applied in the future and developed as improvers for bread and pastries, which requires conducting more studies on the effect of adding hydrocolloids on the quality of bakery products.

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Authors' contributions

All authors contributed toward data analysis, drafting and revising the paper and agreed to responsible for all the aspects of this work.

Conflict of Interest

We have no conflicts of interest to disclose.

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