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The evaluation of egg replacement with soy flour and guar gum in oil cake

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Abstract

Cake as a source of calories ranks between bread and biscuits and has considerable popularity among various strata of society. Many researchers now seek to produce a variety of dietary cakes and find suitable substitutes for the sugar, oil, and eggs present in the product. The aim of this study was to investigate the effect of adding soy flour (at 25%, 50%, and 75%) and guar gum (at levels of 0%, 0.3%, and 0.5%) on the qualitative and quantitative properties of eggless cake. The results showed that by increasing the levels of soy flour and guar gum in eggless cake, the moisture content was significantly increased. However, by increasing the amount of soy flour in the cake formulation, the value of L* was increased and a* and b* were decreased. The results of image processing showed the L* and b* values were increased and the a* value was reduced by increasing the amount of guar gum in the formulation of eggless cake. Furthermore, the results clearly showed that the samples containing 50% soy flour and 0.3% guar gum had the highest levels of specific volume and porosity and the lowest levels of firmness and overall acceptability.

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Introduction

Eggs are the most costly ingredients in some cakes. In yellow cakes, eggs are a significant source of cholesterol. The use of vegetable proteins for partial or total substitution of eggs in cake formulations appears, therefore, to be an interesting objective, especially for people with specific dietary needs or restrictions (vegans, vegetarians, those with high cholesterol, etc.). The almost unique foaming, emulsifying, and heat coagulation properties of egg proteins confer them a very important functional role in the definition of cake characteristics, namely volume and texture. This makes it extremely difficult to successfully replace eggs in cakes with a different source of proteins, even with the use of several types of additives, such as hydrocolloids. Good results have been obtained using bovine blood plasma as a substitute for egg whites at various levels (Lee CC *et al*,. 1991, 1993; 4, and Raeker MO *et al*,. 1995). Other protein sources, such as egg white, egg yolk, skimmed milk, whey powder, and a soy protein isolate, have been employed in the study of volume and textural characteristics of rice cakes (Mohamed S *et al*,. 1998). On the other hand, other studies have suggested the use of xanthan gum to partially replace egg white content in cakes (Miller LL *et al*,. 1983). In some cases, the cakes obtained after including xanthan gum in the batter formulation showed similar or better characteristics in terms of volume, height, and shrinkage than those of the control cakes (Miller RA *et al*,. 1993). Vegetal proteins isolated from lupine (Lupinus albus) seeds have demonstrated good foaming and emulsifying properties (Franco JM,. 1998 *et al*; Leon, A. E. 2004). The aim of this work was to analyze the possibility of total substitution of egg proteins in small ratio yellow cakes with this lupine protein isolate. The optimum leavening agent, emulsifiers, and xanthan gum levels in this system were also studied.

Materials and methods

Materials

Star flour with an 83% extraction rate was purchased from Golmakan factory (Mashhad, Iran). Other materials required in experiments including sugar, vegetable oil, and baking powder were bought from a pastry supplier of raw materials; fresh eggs were purchased one day before the sample was taken and were stored in a refrigerator. Invert sugar syrup was also prepared according to the national standard No. 8025 adopted in 1383. Guar gum brand MEYPROTM GUAR (E412), vanilla brand RHOVANILLA (Rudya companies, France), and soy flour was purchased from Soy Sun Company (Iran, Tehran).

Preparation of cake batter and production

The basic formula (control) of cake batter contained 100% wheat flour, 25% sugar, 25% oil, 36% eggs, 12% invert sugar syrup, baking powder 2%, and 0.2% vanilla and water (Torabi *et al*., 2008). The sample cakes were made without eggs, soy flour at three levels of 25%, 50%, and 75%, and guar gum at three levels of 0.1%, 0.3%, and 0.5% based on flour weight; egg substitutes were available in the original formulation. To prepare the cake, the oil, sugar, and eggs were mixed with an electric mixer (Electra EK-230M, Japan) at a speed of 128 revolutions per minute for a 6-minute period until cream containing air bubbles was created. Then invert syrup and water was added to this cream and stirring was continued for 4 minutes. Baking powder and vanilla were added to the flour, and the mixture was gradually added to the cream. Then, 55 g of the prepared batter was poured into the cake mold using a cloth funnel (Lebensmittelecht, Germany) and baked in the oven for laboratory operations battalions with hot air (Zuccihelli Forni, Italy) at a temperature of 170°C for 20 minutes. After cooling, each sample was packaged in a polyethylene bag and kept at room temperature in order to assess its quantitative and qualitative characteristics.

Characterization studies of oil cake

Oil cakes were analyzed for humidity, aw, specific volume, and texture according to AACC International Standards (2000).

Colorimetric measurements

The color characterization of different treatments in this study was carried out using a Hunter Lab Color

Flex 45/0 spectrophotometer and measured by describing L*, a*, and b* indexes. L* value showed the lightness of the product and ranged from 0 (pure black) to 100 (pure white). A* value showed red and green and ranged from -120 (pure green) to +120(pure red). b* value was blue and yellow and ranged from -120 (pure blue) to +120 (pure yellow). To measure these indicators, a piece of cake was first prepared. Images were taken by an HP Scanjet G3010 and measured by Image J (Sun D *et al.*, 2008).

Sensory evaluation

Sensory evaluation was carried out using a hedonic scale consisting of 5 points (1-5), where 5 = excellent, 4 = very good, 3 = good, 2 = fair, 1 = poor (Sidel & Stone, 1993). An internal panel of ten expert members of the Technical and Engineering Researches Section, Agricultural and Natural Resources Research Center, Mashhad, Iran evaluated the products for crust color, crumb color, aroma, texture, taste/flavor, and overall acceptability.

Statistical analysis

The samples were prepared in three replicates, and the results were analyzed by Mstat–C, version 1.42. Using a 2 x 2 element factorial design, samples included soy flour in three levels (25%, 50%, and 75%) and guar gum in three levels (0.1%, 0.3%, and 0.5%) of 100% wheat flour. A multiple comparison procedure of the treatment means was performed using Duncan's New Multiple Range Test. The significance of difference was defined as $P<0.05$. All diagrams were drawn by Excel.

Results and discussion

Characterization studies of oil cake

Humidity

The results of egg replacement with soy flour and guar gum on the moisture of produced samples showed that samples containing 25% soy flour and 0.1% guar gum with a moisture content of 0.20 ± 18.90 percent minimum and 75% soy flour samples containing 0.5% guar gum with a moisture content of 0.15 ± 27.73 had the highest moisture content. It seems that the reason for the increased moisture seen in the produced samples with increased soy flour and guar gum in the eggless cake is the presence of high amounts of protein and fiber in the soy flour and hydrophilic groups in guar gum (Mc Carthy, D F *et al.*, 2005), (Fig. 1).

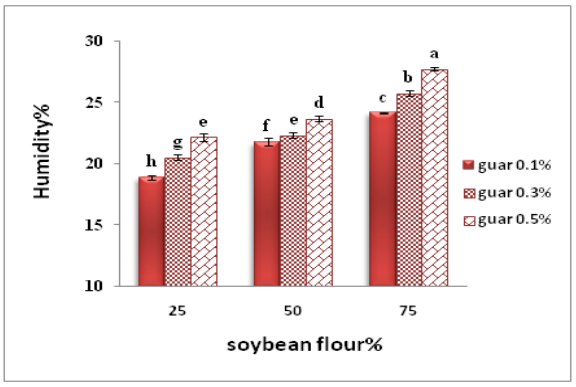

Fig. 1. The effect of Interaction between soy flour and guar gum on the oily cake moisture content.

aw

The results of replacing eggs with soy flour and guar gum on the moisture of produced samples showed that increasing soy flour and guar gum in the formulation caused no significant difference between the samples ($P<0.01^{**}$) (Fig. 2).

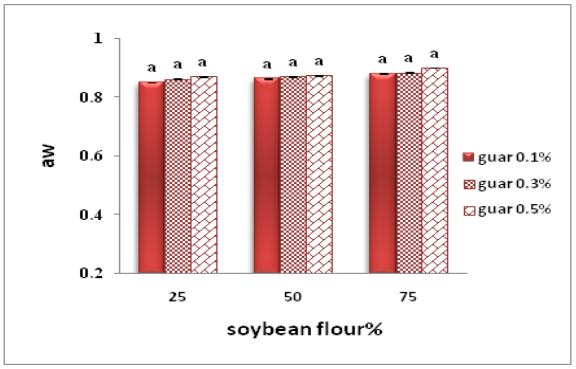

Fig. 2. The effect of Interaction between soy flour and guar gum on the oily cake aw content.

Specific volume

The interactions between soy flour and guar gum indicated that samples containing 75% soy flour and 0.5% guar gum (4.80±0.10 ml/g) had the lowest specific volume and samples containing 50% soy flour and 0.3% guar gum (2.60± 0.10 ml/g) had the highest specific volume. Increasing the amount of soy flour in the formulation increased the thickness of air bubbles and resulted in a decrease in specific volume (Ribotta, P D *et al.*, 2004), (Fig. 3).

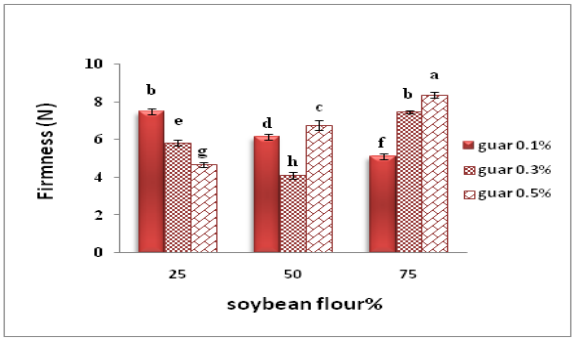

Fig. 3. The effect of Interaction between soy flour and guar gum on the oily cake specific volume.

Texture

Firmness 2 hours after cooking

As a result of the interaction between the egg substitute of soy flour and guar gum in the eggless cake formulation, the sample containing 75% soybean flour and 0.5% guar gum (8.37 ± 0.15 N) had the highest level of firmness and the sample containing 50% soy flour and 0.3% guar gum (4.10 ± 0.20 N) had the lowest level of firmness 2 hours after cooking. The interaction between egg substituted with soy flour at different levels of guar gum in the formulation of oil-cake was also investigated, and the results showed that when 25% soy flour is used, the best percentage of guar gum to produce soft tissue is 0.5%. However, when increasing the percentage of soy flour in the formulation, the levels of guar gum should be decreased in order to obtain an acceptable texture. For example, the sample containing 50% soy flour with 0.3% guar gum and the sample containing 75% soy flour with 0.1% guar gum had the best texture compared with other samples (Fig. 4).

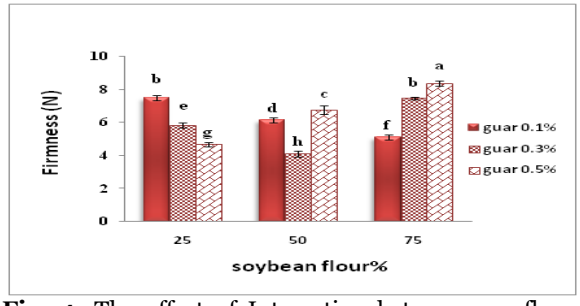

Fig. 4. The effect of Interaction between soy flour and guar gum on the oily cake firmness within 2 hours after cooking.

Firmness 1 week after cooking

Results indicated that the effect of replacing egg with soy flour and guar gum in different levels on the textural properties of oil cake after 2 hours and 1 week were the same. When increasing the percentage of soy flour in the formulation, the levels of guar gum should be decreased in order to produce an acceptable texture. The sample containing 50% soy flour with 0.3% guar gum and the sample containing 75% soy flour with 0.1% guar gum had the best texture (softer) compared with other samples (Fig. 5).

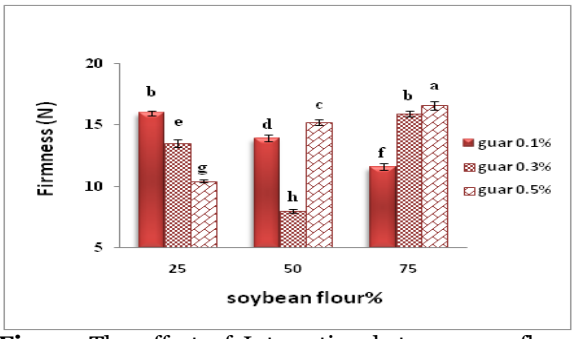

Fig. 5. The effect of Interaction between soy flour and guar gum on the oily cake firmness within 1 week after cooking.

*Crust color components (L *, a *, and b *)*

*L * value*

The results of the interaction of soybean flour and replacing eggs with guar gum showed that the sample containing 75% soybean flour and 0.5% guar gum (53.37 ± 0.52) had the highest rate of crust L * component and the sample containing 25% soybean flour and 0.1% guar gum (38.95±0.64) had the lowest rate of crust L * component (Fig. 6).

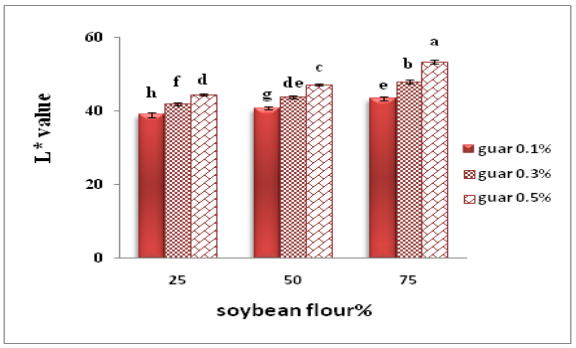

Fig. 6. The effect of Interaction between soy flour and guar gum on the oily cake L * value.

a value*

Results indicated that the sample containing 75% soybean flour and 0.5% guar gum (6.79 ± 0.11) had the highest rate of crust a* component and the sample

containing 25% soybean flour and 0.1% guar gum (4.40±0.17) had the lowest rate of crust a* component (Fig. 7).

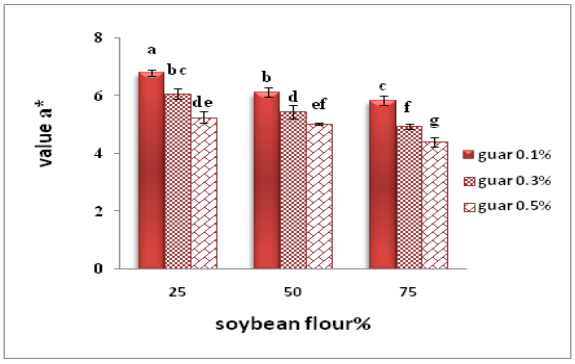

Fig. 7. The effect of Interaction between soy flour and guar gum on the oily cake a* value.

b value*

Results indicated that the sample containing 25% soybean flour and 0.5% guar gum (28.48 ± 0.19) had the highest rate of crust b* component and the sample containing 25% soybean flour and 0.1% guar gum (22.41±0.16) had the lowest rate of crust b* component. Therefore, it can be concluded that the reduction in the rate of b* value when the amount of soy flour was increased in the formulation due to the presence of the lipoxygenase enzyme caused the decomposition of xantofil contained in wheat flour and was effective in reducing the amount of component b* in the samples (Fig. 8).

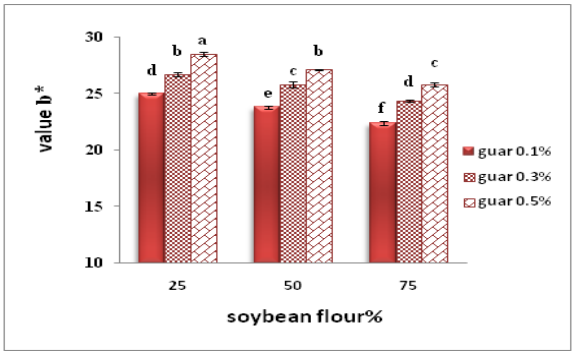

Fig. 8. The effect of Interaction between soy flour and guar gum on the oily cake b* value.

Sensory evaluation

Results indicated that samples containing 75% soybean flour and 0.5% guar gum received the lowest score in sensory analysis. On the other hand, samples containing 50% soybean flour and 0.3% guar gum received the highest score in total acceptance (Gujral H *et al.*, 2004) (Fig. 9).

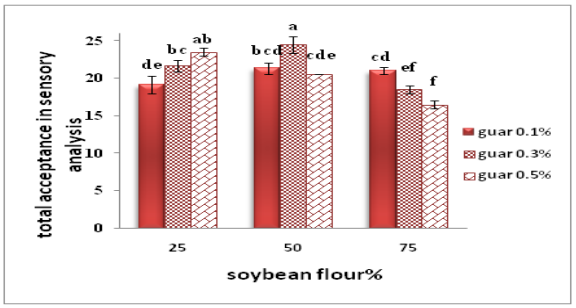

Fig. 9. The effect of Interaction between soy flour and guar gum on the oily cake total acceptability in sensory analysis.

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