



## Scientific Research

## Studying the effect of replacing sesame meal flour and corn germ flour on the physicochemical and visual properties of molded cake

Mojgan Ehsani<sup>1</sup>, Narges Rahimi<sup>2</sup>, Elham Ansarifar<sup>3</sup>, Somayeh Amani<sup>4</sup>

1 -MSc, Department of Food Science and Engineering, Islamic Azad University, Birjand Branch, Birjand.

2 -Professor, Department of Food Science and Technology, Islamic Azad University, Birjand Branch, Birjand.

3 -PhD, Assistant Professor of Food Science and Technology, Faculty of Health, Birjand University of Medical Sciences.

4- MSc, Faculty of Agriculture, Department of Food Science and Engineering, University of Tabriz, Tabriz

## ARTICLE INFO

## ABSTRACT

### Article History:

Received: 2024/04/28

Review: 2025/08/11

Accepted: 2026/04/26

### Keywords:

sesame meal,  
corn germ,  
molded cake

DOI: 10.48311/fsct.2026.83768.0

\*Corresponding Author E-

The cereal industry is a growing industry and the formulation of dietary and functional products is expanding in it. In this study, sesame meal flour in amounts of 10 and 20 percent and corn germ flour in amounts of 10 and 20 percent, and corn germ flour and sesame meal flour in amounts of 10 percent each, were used instead of wheat flour in the cake formulation. For this purpose, after preparing wheat flour and grinding sesame meal and corn germ, cake samples were produced with specific treatments. For the cake samples, moisture percentage, fat percentage, protein percentage, fiber percentage, visual properties, texturizer and also sensory properties were evaluated using the 5-point hedonic method. The test results were analyzed using Duncan's multiple range method at the time intervals of the day of production, the seventh day, and the fourteenth day at a significance level of ( $\alpha = 0.05$ ). Corn germ flour and sesame meal improved the physicochemical properties (moisture, fat, protein, fiber), sensory properties (taste, color, texture and overall acceptance) and mechanical texture measurement indices (hardness, elasticity, cohesion, chewiness) of the enriched cake. Also, according to the results, adding sesame meal flour and corn germ flour increased the average porosity of the sponge cake, which initially had a steep slope and then a gentle slope was observed. The results of evaluating the brightness index ( $L^*$ ) showed that with increasing the amount of sesame meal flour, the brightness index decreased significantly. The yellowness index also showed that the yellowness index of the cake treatments increased with increasing the amount of sesame meal and corn germ flour. With increasing the yellowness index ( $b^*$ ), the redness index ( $a^*$ ) in the treatments decreased. In general, the results of the research showed that the use of sesame meal and corn germ flour in the formulation of cake treatments can have the characteristics of ideal cakes despite increasing the protein content.

## 1- Introduction

Nowadays, the tendency of consumers to consume ultra-beneficial food products such as baking products is increasing. Multipurpose foods have beneficial effects on the host's health and in addition to their nutritional value, they also reduce the risk of chronic diseases.(Saarela et al., 2002). The generation of super-beneficial foods was proposed based on enrichment with vitamins and minerals. Beneficial compounds often include probiotics, prebiotics, polyunsaturated fatty acids, omegas3, conjugated linoleic acid, plant antioxidants, vitamins, minerals, some proteins, peptides and amino acids(Sangwan et al., 2011). Cereal products in Iran and many other countries form a major part of people's consumer goods basket. Considering that most of the products produced in our country are made of wheat flour and considering that wheat protein is not rich in nutrients due to the imbalance of amino acids including lysine, therefore, in recent years, many studies related to The nutritional deficiencies of these products have been compensated (end of 2018).

Cake is one of the snacks that has become a snack and its nutritional value is also considered important in the food basket of families. Many of the reforms and changes made in the cake formulation are done with the aim of improving the quality and nutritional value of this product. In general, the cake making industry has developed rapidly in recent years and all over the world, and since the change and manipulation of raw materials to improve the nutritional value of the product is a powerful tool in the hands of producers, so far many studies have been conducted in the field of reforming and changing the ingredients. The composition of the cake has been made(Aghamohammadi et al., 2012). So far, most of the enrichments in this field have been by vitamins, minerals, and recently bran and different fibers, and little research has been done in relation to the enrichment by substances with high protein value. Therefore, the use of materials with high protein value

together with other nutrients can improve the quality of the product, increase the nutritional value, attract more customers and finally compensate for the deficiencies in the society and the country..(Pinarli et al., 2004) Due to the increase of diseases caused by improper diet, the use of healthy foods with desirable functional characteristics has been taken into consideration and many food producers have become interested in the production of beneficial food products, especially from edible plants. Compounds containing salts, vitamins, protein and fiber are used to enrich products and produce useful food. The spread of foods rich in plant materials that contain various vitamins, minerals and antioxidants can play a major role in ensuring good health (Kiriimi et al., 2017).Among plant sources, sesame is considered one of the best sources of micronutrient compounds and is used as a beneficial food in many countries, especially in Asia. The purpose of this research is to investigate the possibility of using sesame flour or meal as a food supplement for improvement The characteristics of layer cake and compensation for the deficiencies in this food item through enrichment and also production It is a food product with desirable characteristics in terms of texture, chemical characteristics, taste, sensory properties and nutritional value.. Sesame flour is a solid product obtained from sesame seeds, which oil has been removed by cold pressing method. Sesame flour contains 35.6% protein, 7.6% crude fiber, 11.8% ash and 83.2% dry matter. Therefore, it seems that the flour of nuts like sesame can be a suitable source for enriching bakery products. Considering the high production of sesame oil around the world, which is estimated at a total of one million tons per year, the production of sesame flour is very high.(FAO, 2011) is up. The corn germ makes up about 12% of the corn grain, which is much more in corn than in other grains. Corn germ protein is composed of albumin and globulin, and it is quantitatively and qualitatively superior to endosperm proteins, and the limitation of some amino acids (especially lysine and methionine) in corn

protein is related to the proteins of its endosperm part. In other words, corn germ protein has a better amino acid pattern compared to its endosperm. In other words, corn germ, which is one of the materials used in flour, starch and corn oil production factories (Payan, 2010). It is rich in minerals and proteins and contains the essential amino acid lysine, the amount of which in corn germ is twice that of corn flour and wheat flour. Flour is corn germ.

## 2-materials and methods

### 1-2- Materials

All the materials needed for the project, including cake ingredients, sesame flour and corn sprouts, were purchased from the market. Also, the chemicals used in this research were purchased from reputable representatives of Merck.

### 2-2- The method of making cake mold

First, the raw ingredients of the cake (including: flour prepared from Razavi Flour Factory, sugar, eggs, baking powder, vanilla, oil and milk) are prepared, and then two types of alternative flour, which include sesame flour (0%, 10%, 20%) and corn germ flour (0%, 10%, 20%), were used in the formulation. First, mix 3 eggs and 1 glass of sugar in a bowl and mix with an electric mixer until it becomes elastic. Then we add half a glass of liquid oil and 1 glass of milk. Mix two and a half glasses of flour and 1 tablespoon of baking powder in another bowl and sift it over the egg mixture. Mix the cake batter with a whisk, heat the oven and pour the batter into a greased mold. Bake the cake in the oven for 40 to 50 minutes, then test it with a toothpick and remove it from the oven if it is cooked. After cooling, remove the cake from the mold. The prepared samples were examined and sampled after preparation on the first day.

### 2-3- Research tests

#### 1-3-2- Density measurement

The density of the cake was measured by measuring the ratio of weight to volume of the cake by pycnometric method (Coker et al. 2006).

#### 2-3-2- Measurement of specific volume

The specific volume of the cake was measured by calculating the ratio of the weight of 240 ml of cake batter to the weight of 240 ml of water (Lin et al. 2003; Lee et al. 2008).

#### 3-3-2- Measuring the moisture content of the cake

Moisture content of samples by method (AACC 44-151999) It is measured. for this purpose 10 hot From the crushed sample in plates with a specific weight and duration 3 Hour in the oven with temperature 105 Celsius is placed. The samples are dried until they reach a constant weight. So After drying and cooling in the desiccator, the plates are weighed and the humidity is from the following relationship the next day Baking is calculated.

$$= \text{moisture percentage } B-C/B-A * 100$$

A: Weight of the empty plant: B Sample weight with container before drying: C Weight of sample with container after drying

#### 4-3-2- Fat measurement

To measure fat using the method (AACC 30 - 10 2010) is used First, about 15 grams One of the samples was weighed on filter paper, then poured into the cartridge and covered with cotton and is connected to the fat extraction device. A container for fat that has already been heated and weighed containing diethyl ether and welding stone, connected to the device and by turning on the device (150 degrees Celsius), the extraction process begins and after four hours, the extraction process is completed and the dilator is collected. The device is turned off and after it cools down, the fat container is removed from under the device. The excess dilator was separated by the rotary evaporator and the container containing the fat was heated in the oven at

105 degrees Celsius for 30 minutes and after cooling down in the desiccator, weighing and Then the following equation is used to calculate the total fat percentage

$$= \text{percentage of total fat } A-B/C * 100$$

:AWeight of balloon with fat:BWeight of empty balloon:CThe weight of the consumed sample

### 5-3-2- Protein measurement

Protein measurement by method 46-13AACC (2010) And it was done using microcaldal. In this way, one gram of the sample was weighed on filter paper and placed in the digestion tube. 10 grams of potassium sulfate, one gram of copper sulfate and 20 ml of concentrated sulfuric acid were added to the digestion tube. The digestion tube was connected to the Keldal digestion device connected to the suction device containing tanks with 10% soda solution and distilled water, and the digestion tube was heated for 15 minutes by turning on the thermal oven at medium temperature. The temperature was increased to the maximum (430°C) until the solution inside the digestion tube turned clear green. Then the thermal oven is turned off and the digestion tube is cooled. The digestion tube was transferred to the distillation apparatus and by running the relevant program for 6 seconds, boric acid was placed inside the Erlenmeyer containing a few drops of methyl red reagent, and in the relevant place, distilled water and 32% sodium chloride were poured into the digestion tube for 7 seconds. And after 3.5 minutes, the distillation stage ended. The content of Erlenmeyer was titrated with 0.1 normal sulfuric acid tetrazole until the yellow color of the solution changed to purple. The purple color is the end of the titration process. The conversion factor of nitrogenous compounds into protein was considered to be 6.25.

### 6-3-2- Examining the texture of the mold cake

TestTPA and the hardness of the layered cake using the machineAnalyzer Texture It was

done at 10°C. for the testTPA Using a 6 mm cylinder probe at speeds/mm 0.5 to a depth of 4 mm was done. For the pressure test, first the cut wire probe is connected to the device and after The cake cut in square shapes so that its dimensions are slightly larger than the width of the cutting probe was placed in the sample place (Hajlaoui et al., 2010).

### 7-3-2- Image processing

Image processing method was used to measure porosity and color parameters. For this purpose, the cake samples were first carefully divided into two halves lengthwise using a sharp knife to measure the porosity. Imaging was done using a CANON Eos 1000D camera in a special room with black walls. The captured images were transferred to Photoshop CS5 software and the desired part was cut, and after removing the layer from the background, the image was saved in JPG format. Then the image was transferred to Image J software.

### 1-7-3-2- Porosity

D: To check the porosity of the Kim samples using the method of Naushad et al. (2022) and using an image of the cake cross section (Figure 1) and the softwareimage J Version 2/14 was used. The amount of porosity was calculated as a percentage, which was the result of the ratio of the total surface of the air holes to the total surface of the cake.

### 2-7-3-2- color parameters

In the image processing, to investigate the effect of different treatments on the surface color changes of the cake samples, it was done as follows: one thousand. Imaging system: This systemIn general, it consists of 4 componentswhich include Light sources, cameras, computer hardware and software.

one thousand.in this research For uniform lighting, it needs a dark room. In a dark room, a box with black wallsis (to minimize the background light), a string of lampsLED It was the supplier of light. The samples were placed

on the white screen and the mobile camera (Apple, pro13) vertically and at a distance of 10 cm from the sample. All pictures were taken with the lens in manual mode and the lens aperture at full size 4 and the speed was set to one tenth of a second. Finally, the pictures with the mentioned digital camera 3888×2592 Pixel taken with port USB Transferred to the computer and formatted JPEG Images saved.

B. Image preprocessing: intersection<sup>1</sup> Pictures (Separating the real image of the cake samples from the background) using Photoshop software (Adobe, v.8.0) It was done and the photos are formatted BMP were saved.

C. Changing the color space from RGB To L\*a\*b\*: Because the color parameters L\*a\*b\* It is not dependent on the measuring instrument, it provides uniform color regardless of output or input (Yam and Papadakis, 2004), the obtained images to the color space L\*a\*b\* were converted. An example of image conversion from color space RGB To L\*a\*b\* in the form (2) is brought. In this study, image processing using software Image J<sup>2</sup> prescription r43/1 Done. L\* It is a light indicator that is between zero values (equivalent to black) and 100 (Equivalent to full reflection of light) is. While positive values a\* The indicator is red and negative is equivalent to green. Positive values component b\* The indicator is yellow and negative values are equivalent to blue (San, 2008).

8-3-2- Sensory characteristics of mold cake  
Sensory features of the baked cake such as color, taste, texture and overall acceptability

are evaluated by 10 evaluators using the 5-point hedonic method. The samples are coded before the test. Then it is available to the evaluator for evaluation and scoring. The score given by each evaluator is reported (Shakri et al., 2017).

### 9-3-2- Statistical features

In this research, after designing the treatments (with the aim of replacing cake flour with these types of flour) according to the different percentages of replacing two types of sesame flour (0%, 10%, 20%) and corn germ flour (0%, 10%, 20%) %, the obtained experimental data will be analyzed with spss software version 26.

## 3-Discussion and results

### 1-3- The results of humidity measurement test

According to the diagram in Figure 1-3, the highest percentage of moisture was related to the control sample on the first day of the experiment and the lowest was related to the sample containing 10% sesame flour and 10% corn germ flour on the fourteenth day of the experiment. Sadeghizadeh et al. (2019) obtained similar results in the study of the use of sesame and pineapple flour on the properties of sponge cake. They found that with the increase in the use of sesame flour due to the increase in the percentage of fiber and the ability to retain moisture, the moisture content of the cake increased first. also This result is in accordance with the research of Agha Kashipour et al. (2013) in adding fennel powder to pasta, who reported a decrease in the moisture content of the product with an increase in the percentage of fennel powder.

<sup>1</sup> Segmentation

<sup>2</sup> ImageJ

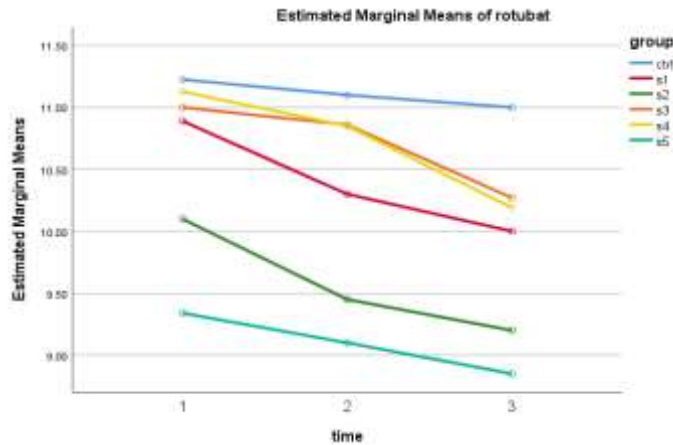


Chart 1-3. The results of checking the humidity of the treatments (percentage).

2-3- The results of the fat measurement test

According to the results of graph 2-3, the highest percentage of fat was related to the sample with 10% sesame flour and 10% corn germ starch on the first day of the experiment, and the lowest percentage was related to the control sample on the fourteenth day of the experiment. In general, one of the reasons for observing such changes is that the percentage of remaining oil in sesame flour is low and the fat percentage of corn germ flour has no significant differences with fat and only in the

amounts of 10% of sesame flour and 10% Corn germ flour, few significant changes were observed with the control treatment, which was not far from the expectation. In this regard, there was also a similar research. In a study Rouhanian et al.(2018) used sesame flour and tangerine peel flour on the physicochemical and sensory characteristics of dark chocolate and found that sesame flour had no significant effects on the fat percentage of chocolate, which is in agreement with the findings of the present study. It was an agreement.

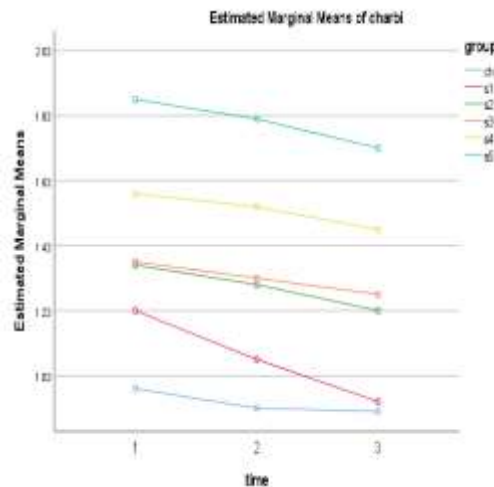


Diagram 2-3. The results of the treatment fat analysis (percentage).

3-3- Protein measurement test results

According to the results of Figure 3-3, It was observed that there were significant differences between the amount of protein

percentage of the cake treatments in the amounts of sesame flour and corn germ flour of 10 and 20% compared to the control treatment. The use of sesame flour and corn germ flour in the formulation of cake treatments significantly increases the amount of protein content, which is the highest percentage. The protein of the sample containing 10% of sesame flour and 10% of corn germ starch on the first day of the experiment and the lowest of the control sample on the fourteenth day of the experiment. In a study by Aloba in 2001, similar results were obtained during a study on

the use of sesame seed flour on the characteristics of millet biscuits. They found that the use of sesame flour significantly increased the protein percentage of biscuit treatments, which was in agreement with the findings of the present study. Makinde and Akinoso (2014) in a study on the physical, nutritional and sensory properties of bread samples prepared with wheat flour and black sesame acknowledged that the use of sesame flour increased the protein content of the bread treatments, which is in line with the findings of the current research in It was an agreement.

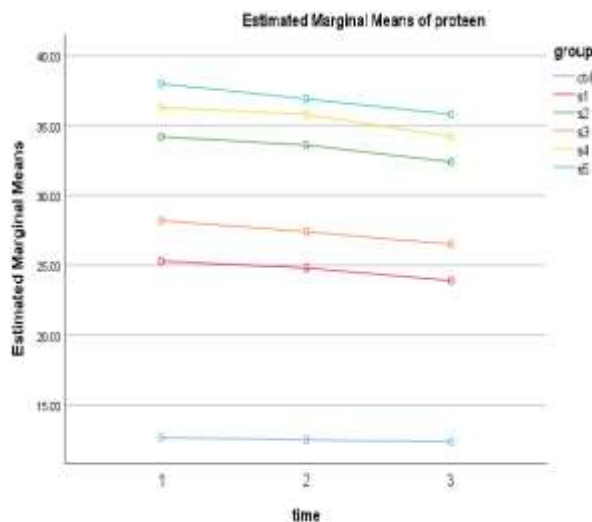


Diagram 3-3. The results of protein analysis of the treatments (percentage).

#### 3-4- The results of the cake textural properties test

According to the results of examining the textural properties of the cake in graphs 3-4, it was observed that the effect of treatment, time and the interaction effects of treatment in time on the hardness index of cake treatments were significant at the significance level of 0.05 ( $0.05 \geq p$ ). According to the table, it was observed that there are significant differences between the hardness index of the cake treatments in the amount of using 10% and 20% sesame flour, 10% and 20% corn germ flour, and 10% sesame flour treatment and 10% germ flour. There was no corn compared

to the control treatment ( $0.05 \geq p$ ). According to the table, it was observed that the use of sesame flour in the formulation of cake treatments increases the stiffness index significantly ( $0.05 \geq p$ ). So that the highest level of texture stiffness was observed in the cake treatment with 20% sesame flour flour ( $0.05 \geq p$ ). In general, during the storage time, the hardness index of cake treatments increases significantly ( $0.05 \geq p$ ). The highest hardness index was observed on the fourteenth day of storage and the lowest on the day of production for the control sample ( $0.05 \geq p$ ).

According to the results of examining the textural properties of the cake in charts 3-5 to

3-8, it was observed that the effect of treatment, time and the interaction effects of treatment in time in the index of elasticity of cake treatments were significant at the significance level of 0.05 ( $0.05 \geq p$ ). According to the table, it was observed that there are significant differences between the amount of elasticity index of the cake treatments in the amount of using sesame flour at 10% and 20%, and corn germ flour at 10% and 20% and the treatment of 10% sesame flour and 10% flour. There was no corn sprout compared to the control treatment ( $0.05 \geq p$ ). According to the table, it was observed that the use of sesame flour and corn germ in the formulation of cake treatments increases the elasticity index significantly ( $0.05 \geq p$ ). So that the highest level of tissue elasticity was observed in cake treatment with 10% corn germ flour treatment ( $0.05 \geq p$ ). In general, during the storage time, the amount of elasticity index of cake treatments decreases significantly ( $0.05 \geq p$ ). The lowest amount of elasticity index was observed on the fourteenth day of storage for the control sample and the highest on the production day for the 10% corn germ flour sample ( $0.05 \geq p$ ). According to the results of examining the textural properties of the cake in graphs 3-6, it was observed that the effect of treatment, time, and the interaction effects of treatment in time in the continuous index of cake treatments were significant at the significance level of 0.05 ( $0.05 \geq p$ ). According to the table, it was observed that there are significant differences between the consistency index of the cake treatments in the amount of using sesame flour at 20% and corn germ flour at 20% compared to other treatments ( $0.05 \geq p$ ). According to the table, it was observed that the use of sesame flour and corn germ in the amount of 20% in the formulation of cake treatments increases the consistency index significantly ( $0.05 \geq p$ ). So that the highest level of tissue cohesion was observed in cake treatment with 20% corn germ flour treatment ( $0.05 \geq p$ ). Also, during the storage time, the continuity index of the cake treatments increases significantly ( $0.05 \geq p$ ). The highest amount of consistency

index was observed on the fourteenth day of storage for the sample with 20% corn germ flour and the lowest was observed on the day of production for the control sample ( $0.05 \geq p$ ). According to the results of examining the textural properties of the cake in graphs 3-7, it was observed that the effect of the treatment, time and the interaction effects of the treatment in the time on the chewability index of the cake treatments were significant at a significance level of 0.05 ( $0.05 \geq p$ ). According to the table, it was observed that there are significant differences between the amount of chewability index of the cake treatments in the amount of using 20% sesame flour and 20% corn germ flour compared to other treatments ( $0.05 \geq p$ ). According to the table, it was observed that the use of sesame flour and corn germ in the amount of 20% in the formulation of cake treatments significantly reduces the chewability index ( $0.05 \geq p$ ). So that the highest level of tissue chewing ability was observed in the control treatment ( $0.05 \geq p$ ). Also, during the storage time, the chewability index of cake treatments decreases significantly ( $0.05 \geq p$ ). The highest amount of chewability index was observed on the first day of storage for the control sample and the lowest on the fourteenth day of storage for the control sample ( $0.05 \geq p$ ). Protein content in the formulation of bakery products, especially the cake, which needs a relatively weak network to create the desired volume, by increasing the strength of the dough and its structure, in maintaining and accepting the air bubbles entering the dough during stirring. creates that as a result, many of the technological characteristics of the final product, such as the volume and porosity decrease, and the compactness and stiffness of the tissue increase (Naghypour et al., 2013). Also, In-Hara and colleagues (2010) also reported an increase in texture by adding lentil flour (protein source) to the cake formulation. These researchers found the reason for the changes in the internal structure of the cake due to the difference in the amount of starch present in the formulation. Also, in this regard,

Luo et al. (2010) and Gomez et al. (2008) pointed out in their study that increasing the viscosity of the production samples increased the amount of force required for chewing, which was consistent with the previous results. The results of these researchers were such that by increasing the replacement of wheat flour with green tea powder and

chickpea flour, the force required to chew the cake increased and the cakes made with white flour had a more gummy state compared to the cakes made with wholemeal flour. As a result, the force required to chew them increased (Gómez et al., 2008; Lu et al., 2010).

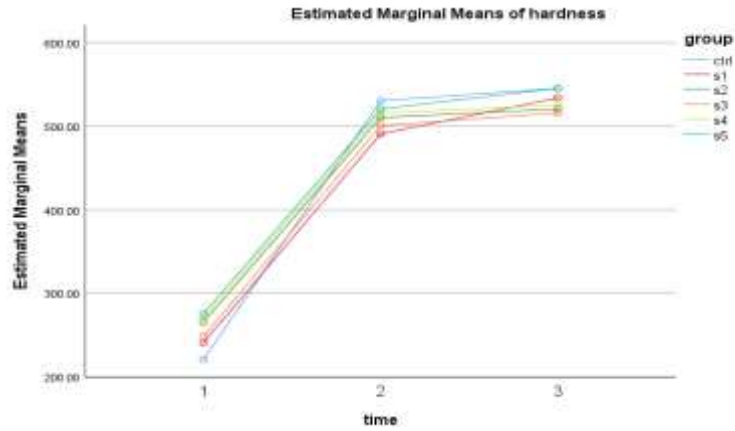


Diagram 5-3. The results of cake texture hardness index investigation.

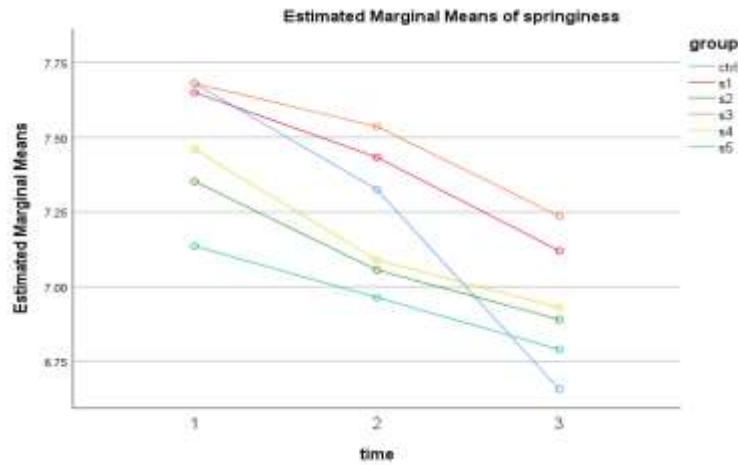


Diagram 6-3. The results of checking the cake texture elasticity index.

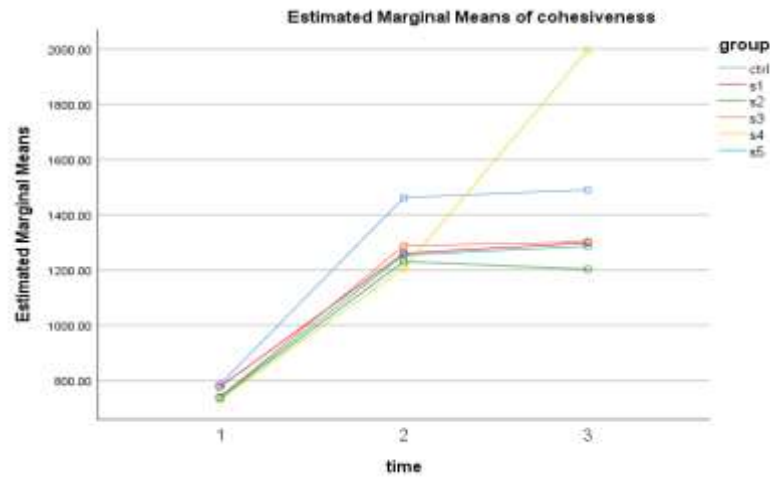


Diagram 7-3. The results of checking the adhesion property index of the cake texture.

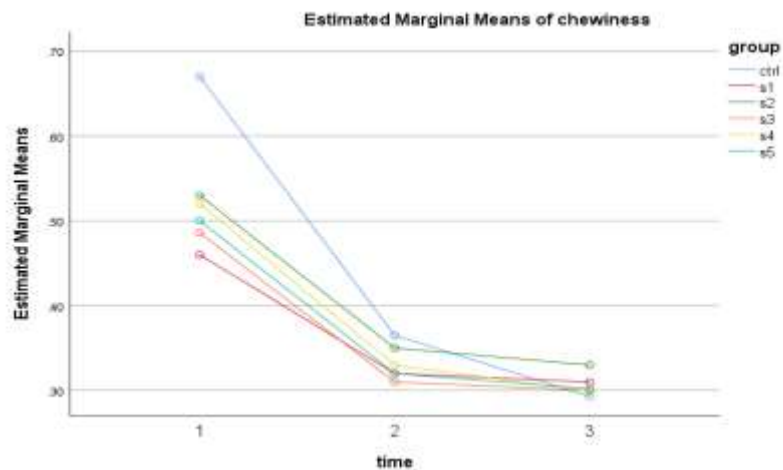


Diagram 8-3. The results of cake texture chewability index investigation.

### 5-3 Examination of sensory characteristics

According to graphs 3-9 to 3-11, it was observed that the effect of treatment, time and interaction effects of treatment in time in the amount of sensory index of appearance color of cake treatments was significant at the significance level of 0.05 ( $0.05 \geq p$ ). According to the results, it was observed that the evaluators did not detect significant differences in the sensory desirability of the cake treatments between the control treatment and the pasta treatment containing 10% sesame flour ( $0.05 > p$ ). However, based on

the results of the sensory evaluation of the apparent color of the evaluators in amounts of 20% sesame flour and 10% and 20% corn germ flour and 10% corn germ flour and 10% sesame flour, the sensory desirability of the cake treatments was significantly reduced ( $0.05 / 0 \geq p$ ). During the storage time, the sensory desirability of the appearance color of the cake treatments was significantly reduced, and at the end of the fourteenth day of storage, the lowest desirability of the appearance color was observed compared to the seventh day and the production day ( $0.05 \geq p$ ). According to graph 3-10, it was observed that the effect of treatment, time and the interaction effects of

treatment in time on the sensory index of taste and taste of cake treatments were significant at a significance level of 0.05 ( $0.05 \geq p$ ). According to the graph, it was observed that the evaluators did not recognize significant differences in the sensory desirability of the cake treatments between the control treatment and the pasta treatment containing 10% sesame flour ( $0.05 > p$ ). But based on the results of the sensory evaluation of the taste of the evaluators in the amounts of 20% sesame flour and 10% and 20% corn germ and 10% corn germ flour and 10% sesame flour, the sensory desirability of the cake treatments significantly decreased. became ( $0.05 \geq p$ ). During the storage time, the sensory desirability of the pasta treatments decreased significantly, and at the end of the fourteenth day of storage, the lowest sensorial desirability of taste and taste was observed compared to the seventh day and the production day ( $0.05 \geq p$ ). According to graph 3-11, it was observed that the effect of treatment, time and interaction effects of treatment in time in the sensory index of overall acceptance of cake treatments was significant at a significance level of 0.05 ( $0.05 \geq p$ ). According to the table, it was observed that the evaluators did not recognize significant differences in the sensory desirability of the overall acceptance of the

cake treatments between the control treatment with the pasta treatment containing 10% sesame flour and the treatment containing 10% corn germ flour and 10% sesame flour ( $0.05 > p$ ). However, based on the results of the sensory evaluation of the overall acceptability of the evaluators in the amounts of 20% sesame flour and 10% and 20% corn sprouts, the sensory desirability of the overall acceptance of the cake treatments was significantly reduced ( $0.05 \geq p$ ). During the storage time, the sensory desirability of the overall acceptance of the pasta treatments was significantly reduced, and at the end of the fourteenth day of storage, the lowest sensory desirability of the overall acceptance was observed compared to the seventh day and the production day ( $0.05 \geq p$ ). Animashaunet al. (2017) obtained similar results in a study on the preparation of pasta with roasted sesame flour. They found that high percentage of sesame flour significantly reduces the taste of pasta treatments, which was in agreement with the findings of the present research. In a study by Rouhanian et al. They used the physico-chemical and sensory characteristics of dark chocolate and found that sesame flour in amounts above 10% had the desirability of chocolate texture, which was in agreement with the findings of the present research.

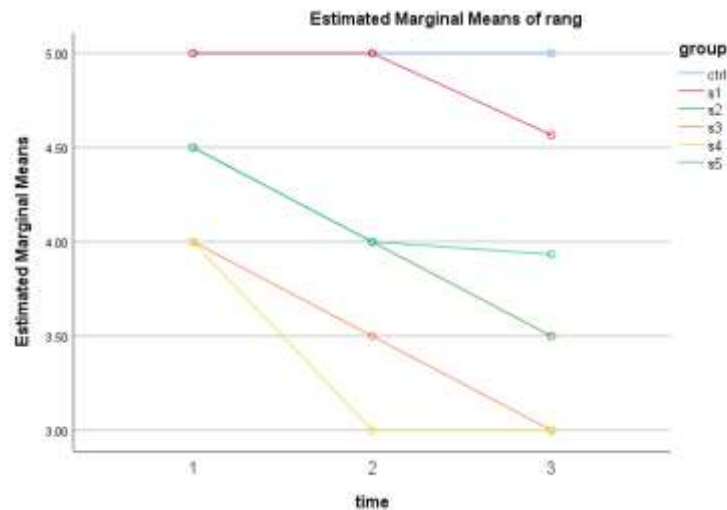


Diagram 9-3. Investigating sensory characteristics of treatments (color index).

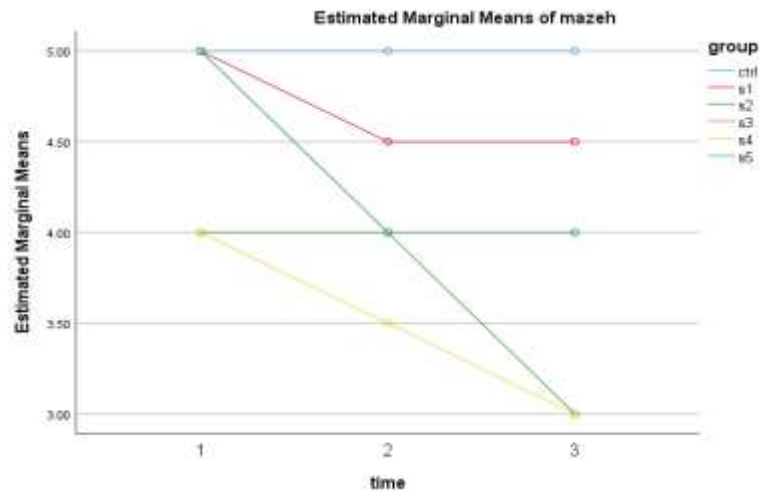


Diagram 10-3. Investigating sensory characteristics of treatments (taste index).

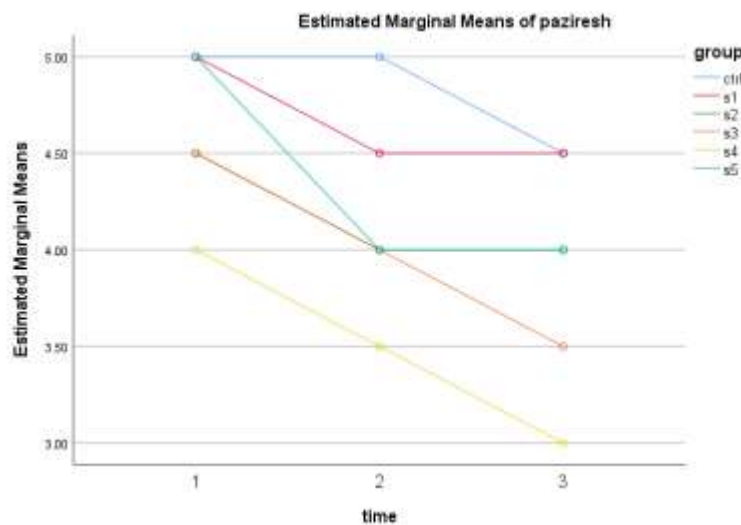


Diagram 11-3. Investigating sensory characteristics of treatments (general acceptance index).

6-3 fiber treatments

According to the results mentioned in chart 3-12, the lowest percentage of fiber was related to the control sample on the first day of the experiment and the highest was related to the sample containing 10% sesame flour and 10% corn starch on the fourteenth day of the experiment. Animashaun et al. (2017) in a study on the preparation of pasta with roasted sesame flour achieved similar results that the

use of sesame flour in pasta formulation reached similar results. They found that sesame flour significantly increases the crude fiber percentage of pasta treatments, which was in agreement with the findings of the present study. Also, the obtained results were consistent with the results of Mohed et al. in 2016, that the amount of fiber in muffin samples enriched with orange fiber increased

significantly. Madadi and Azizi (2018) also investigated the percentage of fiber in pasta samples with corn flour and came to the conclusion that the percentage of fiber in the

samples with corn flour has a significant difference with the control sample, which was in line with the results of the present study.

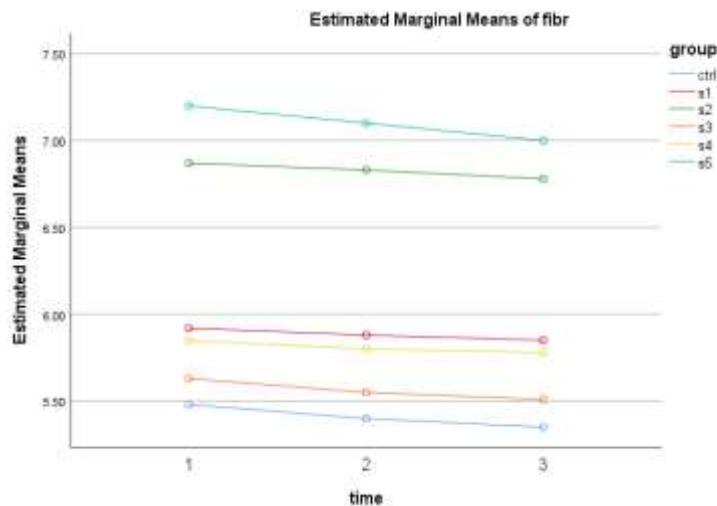


Diagram 12-3. Investigating the properties of the amount of fiber in the treatments (percentage).

### 3-7 Checking the color of the shell and core

The review of the color evaluation results is given in chart 3-13. According to the results of the brightness index ( $L$  (by increasing the amount of sesame flour in the formulation of cake treatments, the amount of brightness index)  $L$ ) decreases significantly, which is due to the increase in the accumulation of fiber particles and the decrease in cell space, as well as the decrease in the volume of air bubbles, which causes a decrease in the amount of reflection of air bubbles. Therefore, increasing the amount of fiber also increases the brightness index.  $L$  in treatments with 20% of sesame flour effectively reduces it more than other treatments. Abd El-Aziz *et al.*, 2012 in investigating the effect of using ginger extract in the formulation of soft cheese, reached similar results. They found that increasing the amount of ginger root fiber significantly decreased the brightness index of cheese treatments, and the amount of this decrease had a significant relationship with the amount of ginger root fiber, which was in agreement with the results of the present study. Also, Nasahi *et al.*'s research (2013) also reached

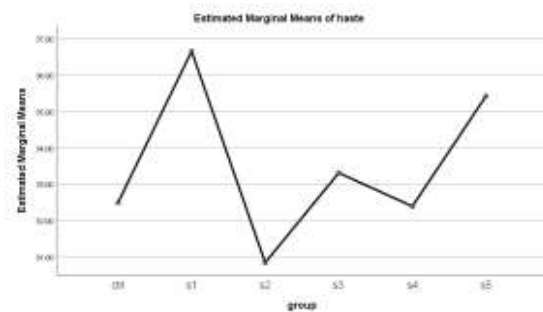
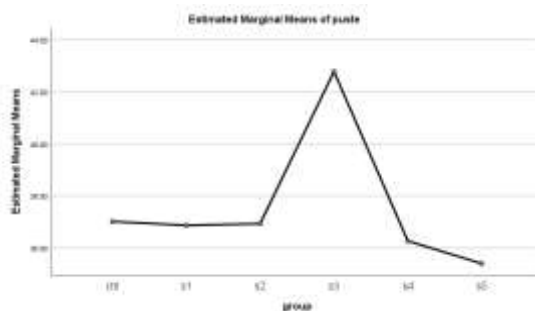
similar results in investigating the effect of gluten on the characteristics of spaghetti containing whole soy flour. They found that increasing the use of soybean flour significantly decreased the brightness index ( $L$ ) were treated with whole soybean flour, which was in agreement with the results of the present study.

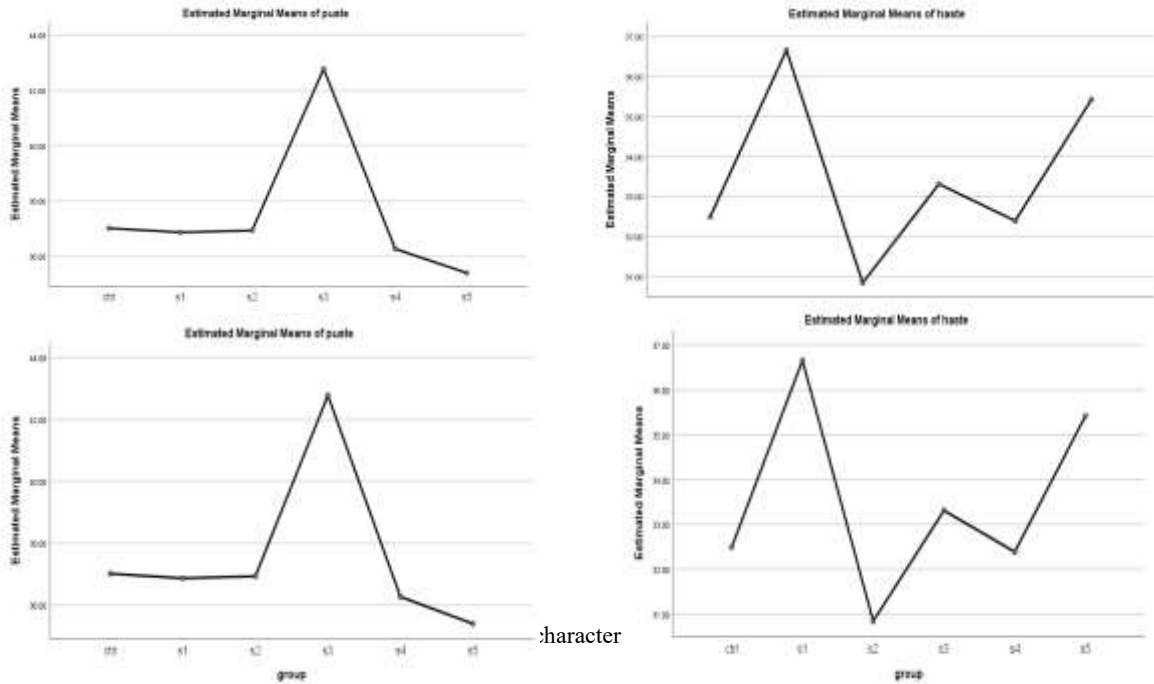
Examining the results of evaluation of the yellowness index also showed that the amount of yellowness index of cake treatments increases with the use of sesame flour and corn germ flour, which seems to be due to the color of sesame flour and corn germ flour as well as the presence of xanthophyll pigments. contained in them, which increases jaundice  $b$  (and by increasing the amount of sesame flour and corn germ used on the amount of yellowness index)  $b$  is significantly increased compared to the control treatment. In this regard, there was a similar research. Also, during the storage period of the yellowness index ( $b$  (due to the oxidation of beta-carotene in the formulation of cake treatments, slightly on the amount of yellowness index)  $b$ ) treatments are increased,

but due to the fact that sesame and corn sprouts have a strong antioxidant composition, so the increase in yellowness index in treatments with higher amounts of sesame flour and corn sprout flour is less. Also, Nasahi et al.'s research (2013) also reached similar results in investigating the effect of gluten on the characteristics of spaghetti containing whole soy flour. They found that increasing the amount of soybean powder significantly increased the yellowness index of spaghetti, which was also consistent with the results of the present study. Abbasi and Mahdikhani (2019) investigated the effects of using sesame flour and locust bean gum on the characteristics of chicken nuggets and acknowledged that the use of sesame flour increased the amount of yellowness index (\*b) significantly increased chicken nugget treatments, which was in agreement with the findings of the present study.

The reason for the reduction of the redness index (\*a) due to the increase in the amount of jaundice\*b) It is because these two have the opposite relationship with the increase of yellowness index.\*b), the amount of redness index\*a) should be reduced. In this regard, there was also a similar research. Tuan et al. (2016) investigated the effect of sesame flour on the characteristics of Berber bread and found that the use of sesame flour reduced the redness index, which is due to the increase in

yellowness caused by the presence of a small amount of residual oil in sesame flour. which increases the amount of yellowness index in Berber bread formulation. According to the results, the addition of sesame flour and corn germ flour caused an increase in the average number of holes in the sponge cake, which was observed at first with a steep slope and then with a gentle slope. According to the results, the addition of sesame flour and corn germ flour up to 10% caused an increase in the average number of holes in the sponge cake. The porosity of the production samples is influenced by the uniform distribution of the air bubbles entering the cake dough and their number. Now, the greater the porosity, the greater the amount of air bubbles, or in other words, the greater the number of holes in the dough, and on the other hand, sesame flour has foaming and emulsifying properties, and corn germ flour also contains a protease enzyme (an enzyme that loosens the cake dough helps and facilitates the diffusion of incoming air bubbles) the diffusion of air bubbles has been done better and more, which in turn has been effective in increasing the average number of holes per square millimeter (Avaz-Sufiyan et al., 2014). Fazel et al. (2017), by examining the image characteristics of sponge cake with sesame flour and pineapple, concluded that the increase of sesame and pineapple flour caused an increase in the average number of holes in the sponge cake.





character

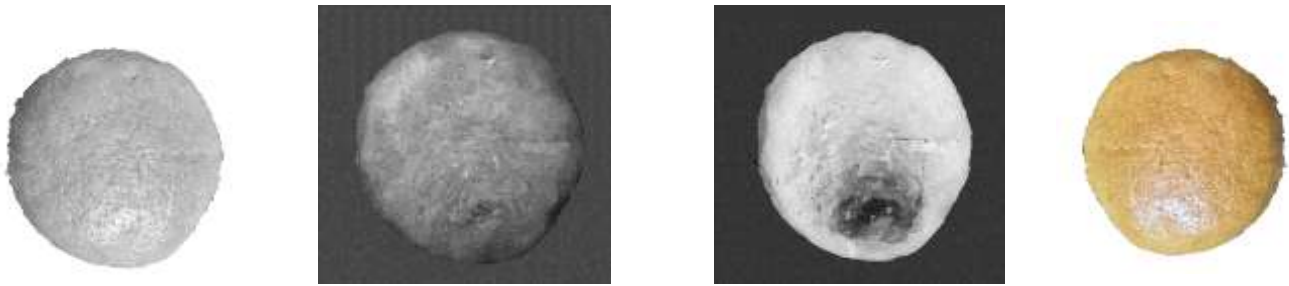


Image conversion from RGB color space to L\*a\*b\*

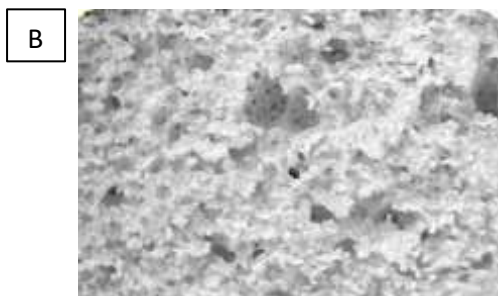


Figure 1-3. Cross-section image of the cake (a), binary image (b)

### 4-Conclusion

Corn germ flour and sesame flour improve the properties Physicochemical properties (moisture, fat, protein, fiber) of enriched cake to be Over time (regardless of different

groups), there is a significant difference between the average of the studied variables (moisture, fat, protein and fiber). But different sources indicate that the interaction between time and group is significant only for moisture and protein ( $p < 0.05$ ). This result shows the

effectiveness of different percentages of corn germ flour and sesame flour on cake moisture and protein.

For the variables of fat and fiber, the significance level for the interaction of time and group is greater than 0.05, which shows that the average fat and fiber in different cakes with different percentages of corn germ flour and sesame flour over time is significantly different from They don't have either. Corn germ flour and sesame flour improve the properties Sensory (taste, color, texture and overall acceptance) of the cake is enriched to be It shows that over time (regardless of different groups) there is a significant difference between the average of the studied variables (taste, color, texture and overall acceptance). Also, various sources indicate that the interaction between time and group is also significant for all four variables ( $<0.05$ ). p). This result shows the effectiveness of different percentages of corn germ flour and sesame flour on the taste, color, texture and overall acceptance of the cake. feature Technological (image processing) in different combinations of corn germ flour and sesame flour have a significant difference. The significance level of the group variable for shell color and core color variables has been reported as 0.999, which is more than 0.05, and this shows that the average scores of these two variables in the six studied groups are not significantly different. Corn germ flour and sesame flour improve the parameters of the device texture (hardness, elasticity, cohesion, chewability) of the enriched cake. to be It shows that over time (regardless of the different groups) there is a significant difference between the average of the studied variables (hardness, elasticity, consistency and chewing ability). Also, various sources indicate that the interaction between time and group is also significant for these four variables ( $p>0.05$ ). This result shows the effectiveness of different percentages of corn germ flour and sesame flour on the firmness, elasticity, consistency and chewability of the cake.

## Funding

The author declares that he / she has not received any funding.

## Author Contributions

All activities were carried out by the author.

## Competing Interests

The author confirms that he / she has no financial conflicts of interest or competing interests in this study.

## 5-References

- [1] Wang, H., Wei, C. X., Min, L., & Zhu, L. Y. (2018). Good or bad: gut bacteria in human health and diseases. *Biotechnology & Biotechnological Equipment*, 32(5), 1075-1080.
- [2] Olivares-Tenorio, M. L., Orrego, D., Klotz-Ceberio, B. F., Palanca, C., & Tortajada-Serra, M. (2022). Galactooligosaccharides: Food technological applications, prebiotic health benefits, microbiome modulation, and processing considerations. *JSFA Reports*, 2(12), 578-590.
- [3] Payan, Rasool (2008). *Technology of Cereal Products*, No Pardazhan Publications.
- [4] Catzeddu, P., Fois, S., Tolu, V., Sanna, M., Braca, A., Vitangeli, I., ... & Roggio, T. (2023). Quality evaluation of fresh pasta fortified with sourdough containing wheat germ and wholemeal semolina. *Foods*, 12(14), 2641.
- [5] Slade, L., Kweon, M., & Levine, H. (2021). Exploration of the functionality of sugars in cake-baking, and effects on cake quality. *Critical Reviews in Food Science and Nutrition*, 61(2), 283-311.
- [6] AOAC. Official methods of analysis. Association of official analytical chemists, 15<sup>th</sup> ed. Washington, DC; University of Alabama, 1990.
- [7] AACC. 2003, Approved methods of the american association of cereal Chemists.
- [8] AACC. 2000. Approved Methods of the American Association of Cereal Chemists, 10th Ed., Vol. 2. American Association of Cereal Chemists, St. Paul, MN.

- [9] Sadeghi, S. M., Tayefe, M., Eshkiki, L. F., & Ghiasvand41, K. (2023). Evaluation of Changes in Some Textured and Qualitative Properties of Cake Enriched with Wheat Germ. *Iranian Food Science and Technology Research Journal*, 19(5), 607-616.
- [10] Karimi M, Sheikhol-Islami Z, Sahraian B, Qayafe Davoudi M, Naghipour F. Application of sesame flour in gluten-free baguette bread (rice-corn) containing guar gum and carboxymethyl cellulose to produce a profitable product. *Food sciences and industries*.
- [11] FAO. 2011. Faostat. Food and Agricultural Organization of the United States (<http://www.fao.org>).
- [12] Sadeghizadeh Dehkordi, A., Najafabadi, M., Abbasi, H., (2016). Investigating the technological and image characteristics of sponge cake containing sesame and pineapple flour and determining the optimal level of these two nutrients. *Iran food science and industry*, 14th volume, number 69, pp. 268-225.
- [13] Naghipour, F., Mazaheri Tehrani, M., Sahraiyani, B., Sheikholeslami, Z., and Soleimani, M. 2013. Replacing eggs with soy flour and mixing with wheat flour with wheat germ for oil cake production. *Iranian Journal of Nutrition Sciences & Food Technology*, 8(2): 211 -220 [in Persian]
- [14] Park, B. G., Lee, S. Y., & Lee, M. H. (2017). Quality and antioxidant properties of sponge cake added with flaxseed powder. *Culinary science and hospitality research*, 23(3), 207-215.
- [15] Gómez, M., Oliete, B., Rosell, C.M., Pando, V., and Fernández, E. 2008. Studies on cake quality made of wheat –chickpea flour blends. *LWT - Food Science and Technology*, 41: 1701 - 1709.



بررسی تاثیر جایگزینی آرد کنجاله کنجد و آرد جوانه ذرت بر ویژگی‌های فیزیکوشیمیایی و تصویری کیک قالبی

مژگان احسانی<sup>۱</sup>، نرگس رحیمی<sup>۲</sup>، الهام انصاری فر<sup>۳</sup>، سمیه امانی<sup>۴</sup>

۱- فارغ‌التحصیل کارشناسی ارشد، گروه علوم و مهندسی صنایع غذایی، دانشگاه آزاد اسلامی، واحد بیرجند، بیرجند.

۲- استاد، گروه علوم و صنایع غذایی، دانشگاه آزاد اسلامی، واحد بیرجند، بیرجند.

۳- دکتری تخصصی، استادیار علوم و صنایع غذایی، دانشکده بهداشت، دانشگاه علوم پزشکی بیرجند.

۴- فارغ‌التحصیل کارشناسی ارشد، دانشکده کشاورزی، گروه علوم و مهندسی صنایع غذایی، دانشگاه تبریز، تبریز.

اطلاعات مقاله

چکیده

تاریخ های مقاله :

تاریخ دریافت: ۱۴۰۳/۰۲/۰۹

تاریخ داوری: ۱۴۰۴/۰۵/۲۰

تاریخ پذیرش: ۱۴۰۵/۰۲/۰۶

کلمات کلیدی:

کنجاله کنجد،

جوانه ذرت،

کیک قالبی

صنعت غلات از صنایع رو به رشد بوده و فرمولاسیون محصولات رژیمی و فراسودمند در آن رو به گسترش می باشد. در این تحقیق از آرد کنجاله کنجد در مقادیر ۱۰ و ۲۰ درصد و آرد جوانه ذرت در مقادیر ۱۰ و ۲۰ درصد، و آرد جوانه ذرت و آرد کنجاله کنجد هر کدام ۱۰ درصد، به جای آرد گندم در فرمولاسیون کیک استفاده گردید. برای این منظور پس از تهیه آرد گندم و آرد کردن کنجاله کنجد و جوانه ذرت نمونه‌های کیک با تیمارهای مشخص تولید شد. برای نمونه های کیک آزمون های درصد رطوبت، درصد چربی، درصد پروتئین، درصد فیبر، خصوصیات تصویری، بافت سنجی و همچنین با روش هدونیک ۵ نقطه ای نیز ارزیابی خصوصیات حسی انجام شد. نتایج آزمون ها با روش دانکن در بازه های زمانی روزتولید، روز هفتم و روز چهاردهم در سطح معنی داری ( $\alpha=0/05$ ) تجزیه و تحلیل شد. آرد جوانه ذرت و کنجاله کنجد سبب بهبود ویژگی‌های فیزیکوشیمیایی (رطوبت، چربی، پروتئین، فیبر)، ویژگی‌های حسی (طعم و مزه، رنگ، بافت و پذیرش کلی) و شاخص‌های سنجش بافت دستگاهی (سفتی، قابلیت ارتجاع، پیوستگی، قابلیت جویدن) کیک غنی شده گردید. همچنین طبق نتایج افزودن آرد کنجاله کنجد و آرد جوانه ذرت باعث زیاد شدن میانگین حفرات کیک اسفنجی شد که در ابتدا شیب تند و سپس شیب ملایم مشاهده گردید. بررسی نتایج ارزیابی شاخص روشنایی ( $L^*$ )، نشان داد با افزایش میزان آرد کنجاله کنجد، شاخص روشنایی به طور معنی‌داری کاهش یافت. بررسی شاخص زردی نیز نشان داد که میزان شاخص زردی تیمارهای کیک با افزایش میزان استفاده از کنجاله کنجد و آرد جوانه ذرت افزایش یافت. با افزایش شاخص زردی ( $b^*$ )، میزان شاخص قرمزی ( $a^*$ ) در تیمارها کاهش یافت. به طور کلی نتایج تحقیق نشان داد که استفاده از آرد کنجاله کنجد و آرد جوانه ذرت در فرمولاسیون تیمارهای کیک می تواند علیرغم بالا بردن محتوی پروتئینی خصوصیات کیک ایده آل را داشته باشد.

DOI: 10.48311/fsct.2026.83768.0

\* مسئول مکاتبات:

n.zamindar@iauo.ac.ir