Formulation of mayonnaise recipe enriched with biological active compounds of sesame cake

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Abstract. Today, scientific schools have been formed to improve the recipe and technology of mayonnaise. In the present study, a byproduct of an oilseed source, namely sesame cake, containing unique antioxidant compounds, such as lignans, is studied as a biologically active additive that can be used in the place of starch and synthetic antioxidants in mayonnaise. Sesame seed purchased from local markets. Sesamol standard was obtained from Sigma Chemical Company (USA). The experimental results have shown that regarding the taste, color, mouthfeel, and overall acceptability, the samples containing 10% sesame cake powder obtained the highest score. It is therefore recommended to use sesame cake powder at the concentration of 8-10% in mayonnaise formulation. The findings of this research could be useful for food industries to improve their products qualitatively.

1. Introduction
Mayonnaise is an emulsion composed of fat and water, which is a fatty sauce. If we look at the history of its emergence, it consisted of eggs, vegetable oil, lemon juice and pepper. Later, the composition of mayonnaise was improved based on consumer requirements. Nowadays there are more than 300 types of mayonnaise, and their range is being further expanded by scientists. The composition, range and assortment of mayonnaise will vary depending on the region where it is consumed and produced. For example, low-fat mayonnaise is popular in Western European countries, while high-fat mayonnaise is widely consumed in Asian and
Eastern European countries [1-3]. Today, scientific schools have been formed to improve the recipe and technology of mayonnaise. Sesame is one of the main oilseeds grown in Uzbekistan since ancient times. It ranks first among oilseeds in terms of oil content in seeds [4]. Cold-pressed sesame seed oils are similar in flavor to olive oil [5]. Sesame seeds are used in the confectionery industry, medicine, as well as in the preparation of canned food [6]. Sesame seed perfectly strengthens the immune system, speeds up metabolism, has a beneficial effect on digestion and metabolic processes in the body [7] and used in the preparation of candies, oriental sweets, various halva, bakery products [8]. Sesame seeds contain 48-65% fat, 16-19% protein, 15.7-17.5% soluble carbohydrates. Moreover, it also composes of high amounts of lignan compounds: sesamin, sesamol, sesaminol, sesamolin, sesamolinol, helping inhibition of lipid oxidation [9, 10]. Cold-pressed sesame cake contains 40% protein and 8% fat, and is used in confectionery flour, halva, as well as a concentrated feed for livestock. The homeland of sesame is Africa. Sesame came to Uzbekistan through Punjab (Pakistan) and widespread in Central Asian countries [11].

Sesame is considered as an important edible oil source. This oil remarkably reveals stability despite its high unsaturation. Sesame oil - this sweet oil is rich in vitamins, calcium and zinc. It is a treatment for diseases of the cardiovascular system and osteoporosis [12, 13]. Sesame oil is known to contain healthy ingredients [14]. Due to its special structure and high nutritional value, it is one of the best edible oils [15-18].

After obtaining sesame oil, defatted cake remains. They form the basis of dietary nutrition and are not inferior in their beneficial properties to sesame oil and flour. This product is very rich in vitamins (B1, B2, F, PP, C), minerals, unsaturated fatty acids, fiber, phospholipids, cellulose, pectins, trace elements (Ca, K, Zn, Mg, Na, Fe, Cu) [19, 20]. Due to such an enriched composition of sesame oil cake, its regular use in food has a healing effect on the body. Sesame cake is used in the complex therapy of many diseases, as well as for their prevention. In some cases, this product is significantly more effective than many drugs and procedures [21]. Although sesame cake owns different types of bioactive substances and they generally used as a fertilizer, animal feed, or discarded in such production areas [22]. Sesame oil waste in oil industry is also rich in minerals [23]. Such medically related sesame cake properties have still been verified and validated by local and international researchers [24, 25].

Considering all the above, this work aimed at studying the effect of sesame seed flour, sesame oil and powder of sesame cake on the stability of mayonnaises, and characterizing their nutritional and texture features, and sensory attributes.
2. Materials and Methods

Our mayonnaise was prepared regarding the specific recipe with some modification [27]. We used different ratios of the powder of sesame (0.5%, 0.75%, 1% & 1.25%) in this paper to prepare mayonnaise with artificial antioxidants to establish a comparative study.

The recipes of mayonnaise as a control treatment and SCM (Mayonnaise with sesame cake powder) mayonnaise were given below in Table 1.

| Ingredients                  | Mayonnaise recipe as a control treatment and our proposed SCM mayonnaise |
|------------------------------|-------------------------------------------------------------------------|
|                              | Control, % | SCM, % |
| Sunflower oil                | 60         | 55-60  |
| Vinegar                      | 4          | 4      |
| Dried Egg yolk               | 5          | 5      |
| Sugar                        | 1          | 1      |
| Salt                         | 1          | 1      |
| Mustard                      | 0.3        | 0.3    |
| EDTA                         | 0.15       | -      |
| Sodium benzoate              | 0.03       | 0.03   |
| Citric Acid                  | 0.03       | 0.03   |
| Corn Starch                  | 5          | -      |
| Sesame cake powder           | 0-10       | -      |
| Water                        | 23.49      | 23.49  |

Our mayonnaise was bottled in appropriate plastic cups and then was stored at 25±5 °C. The investigation in bottled mayonnaise was performed at intervals of 0, 10, 15, 30 days to study its oxidative stability, sensory attributes and quality.

Lipids of all mayonnaise samples were totally extracted using the proposed procedure [28]. Our mayonnaise was then gently mixed before to conduct sampling processes. 30 g mayonnaise was poured into the 50 ml tubes of polypropylene centrifuge. Mayonnaise samples were brought to freeze at -20°C for 24 hours, and then, thawed for 2 hours at 4°C when the emulsion broke. 2 ml of water was poured and the mixtures were centrifuged at 5,000 rpm for 20 minutes. Potential lipid mass was separated from the emulsion residue and closely stored in glass flasks at - 40°C until our analysis.

The sensory evaluation in our study was performed on mayonnaise samples after day storage at room temperature. Potential panellists composed of ten specialized people -selected based on their interest and availability, and evaluated the sensory characteristics of mayonnaise such as color, appearance, texture, odor, taste, and overall acceptability.

Sensory attributes in this experiment were evaluated by a ten point scale with 1 – the lowest or extremely disliked and 10 – the highest or extremely liked. Within
this period, all mayonnaise samples were coded randomly and brought to the panellists placed on white plates at room temperature.

3. Results and discussion
The chemical composition of sesame seed, sesame cake and sesame oil is presented below in Table 2. The data in Table 2 show that the minerals, proteins, fiber and carbohydrates in sesame seeds remain in the sesame cake. This ensures that the nutritional value of the cake is almost the same as that of the seed.

Table 2. Chemical composition of the sesame cake, sesame oil and sesame seed

| Proximate compositions (%) | Sesame seed | Sesame cake | Sesame oil |
|----------------------------|-------------|-------------|------------|
| Moisture                   | 6.1         | 7.2         | 0.02       |
| Fat                        | 48.53       | 18.64       | 99.93      |
| Minerals                   | 9.11        | 13.06       | 0.05       |
| Protein                    | 20.36       | 31.68       | -          |
| Fiber                      | 5.61        | 10.35       | -          |
| Carbohydrates              | 10.29       | 19.07       | -          |

Table 3 shows that sesame seed and its byproducts contain bioactive substances such as lignan, tocopherol and minerals. In sesame seeds, some of the lignans are converted into oil during the extraction process. But most of them stay in the cake. Tocopherols and minerals, on the other hand, remain mostly in the cake and are almost insoluble in oil. This means that the sesame cake has a relatively high content of antioxidants (lignans and tocopherols) and has antioxidant properties.

Table 3. Possible variations in the components in sesame seed, cake and oil

| Bioactive components | Sesame seed | Sesame cake | Sesame oil |
|----------------------|-------------|-------------|------------|
| Lignans, mg/g        | 15.9        | 13.4        | 8.66       |
| Tocopherol, μg/g     | 800         | 430         | 0.9        |
| Minerals             | 11.02       | 15.2        | 0.05       |

The samples of mayonnaise were prepared by different quantities of sesame cake powder which were analyzed for its sensory parameters as taste, color, mouth feel, texture and overall acceptability. The results of these samples analysis were presented in Table 4.

In the control mayonnaise used corn starch as a stabilizer. In the invited mayonnaise formulation instead of starch used sesame cake powder. Corn starch and sesame cake powder are not similar each other by their facilities, but they are both powders and may be used as stabilizers. So, the sesame cake powder used in mayonnaise effects sensory evolution of final product.
Scores of sensory evaluations for mayonnaise enriched with sesame cake powder samples are shown in Table 4. As the amount of sesame cake powder increases, the taste and mouth feel scores of mayonnaise also improves. The color score of mayonnaise samples decreases. The taste and mouth feel scores of SCM5 mayonnaise samples were higher than the others. This sample obtained the lowest score for color and overall acceptability. The SCM1 sample obtained the lowest score for texture.

Table 4. Sensory attitudes of mayonnaise samples

| Content of mayonnaise and recipe | Control | SCM1 | SCM2 | SCM3 | SCM4 | SCM5 |
|---------------------------------|---------|------|------|------|------|------|
| Sesame cake powder, %           | 0       | 5    | 5.15 | 6    | 8    | 10   |
| Sunflower oil, %                | 60      | 60   | 60   | 59.15| 57.15| 55.15|
| EDTA, %                         | 0.15    | 0.15 | -    | -    | -    | -    |
| Corn Starch, %                  | 5       | -    | -    | -    | -    | -    |
| Water and other ingredients, %  | 34.85   | 34.85| 34.85| 34.85| 34.85| 34.85|
| Sensory parameters              |         |      |      |      |      |      |
| color                           | 9.0     | 8.8  | 8.8  | 8.7  | 8.6  | 8.6  |
| taste                           | 8.8     | 8.2  | 9.1  | 9.1  | 9.2  | 9.4  |
| mouth feel                      | 8.8     | 8.6  | 8.9  | 9.1  | 9.1  | 9.2  |
| overall acceptability           | 8.5     | 8.1  | 8.4  | 8.5  | 8.4  | 8.3  |
| texture                         | 8.6     | 8.0  | 8.2  | 8.3  | 8.6  | 8.7  |

Figure 1. Peroxide concentration of mayonnaise (ml. equiv. O2/kg) stored at 30 °C.
Mayonnaise samples containing various amounts of vegetable oil were given according to Table 4. These mayonnaise samples were taken by diminishing the concentration of sunflower oil from 60% to 55%.

In Table 2 it is shown that there are lignans and tocopherol in the sesame seed and its byproducts. These substances are natural antioxidants. In the next experiments the antioxidant efficacy of sesame cake powder in mayonnaise protection is studied during storage time.

Figure 1 and 2 display the PV developments within the mayonnaise storage enriched with sesame cake powder samples at 60 °C for three months. Additional treatments included EDTA (control).

![Image of PV developments](image)

**Figure 2.** $p$-Anisidine value of mayonnaise stored at 30 °C

Mayonnaise without the sesame cake powder in control group reached the maximum PV of 14.3 ml. eq/kg after 90 days of storage. However, a significant difference in the PV was detected between the control and the offered mayonnaise. This is due to the presence of sesame cake powder in mayonnaise, which slowed the rate of peroxide formation. Thus, the PV of offered mayonnaise with 5, 5.15, 6, 8 and 10 % of sesame cake powder were 16.2, 15.7, 12.9, 10.4 and 9.8 respectively.

It is known that the $p$-anisidine value represents the amount of secondary oxidation products formed during the oxidative degradation of the oil. Changes in $p$-anisidine value of mayonnaise are shown in Fig. 2. Besides that, the formation of secondary oxidation products increased throughout the storage period. The $p$-anisidine concentration of the control variant reached its maximum of 17.6 ml from an initial value of 2.7 ml after 90 days of storage. The $p$-anisidine value of
mayonnaise with 5, 5.15, 6, 8 and 10% of sesame cake powder were 19.0, 18.6, 12.6, 13.4 and 12.8 respectively. The PV and p-anisidine value of mayonnaise that contained the sesame cake powder were significantly higher than that of the control, which clearly showed the marked antioxidant effect of the sesame cake powder in mayonnaise protection.

Sensory parameters of mayonnaises are change during storage time. Sensory analyses of five mayonnaise samples and control are studied during 90 days of storage. Changes in sensory parameters of mayonnaise samples are shown in Fig. 3. Color, taste, mouth feel, texture and overall acceptability of mayonnaise are decreased during storage. Sensory parameters of control decreased faster than SCM samples 90 days of storage. For example, the taste and color are decreased from 8.8 and 8.3 to 6.1 and 6.0 respectively after 90 days of storage. The scores of taste and color of SCM samples are varied after 90 days of storage depending on the quantities of sesame cake powder in mayonnaise.

![Figure 3. Sensory evolution of mayonnaise before storage](image)

From the data in Figure 3 and 4, it can be seen that during the 90-day storage period, the sesame cake powder was not negatively affected to sensory parameters of mayonnaise, but rather reduced the decline. Fig. 3 shows that, as the amount of sesame oil cake powder in mayonnaise increased, its quality slightly decreased. However, after 90 days of storage, the quality of the mayonnaise containing sesame cake powder did not change much compared to the control. It can be seen from the data in Figure 4.
4. Conclusions

Many researchers have found that synthetic antioxidants in foods are harmful. That's why research on the use of natural antioxidants is always relevant. Due to the high content of unsaturated fatty acids in vegetable oils, mayonnaise contains antioxidants to increase its shelf life. Instead of the synthetic antioxidant in mayonnaise, the natural antioxidant of sesame has been proposed. To do this, lignin can be extracted from sesame seeds or sesame cake and added to mayonnaise. This requires additional processes and costs. A study suggested adding sesame powder instead of starch to enrich mayonnaise with natural antioxidants. The results showed that when 8-10% sesame cake powder was added to the mayonnaise, the PV and Anisidine values of the obtained mayonnaise changed less than the control during the 90-day storage period. The sensory properties of mayonnaise have also improved.

Our study was denoted to re-design the samples of mayonnaise formulated with sesame cake powder because of its high calories and evaluated the sensorial, physical, and rheological properties of proposed and produced mayonnaise. Our findings revealed that a potential increase in sesame cake powder components led to an increase in values of consistency coefficient, viscosity and stability of mayonnaise samples. Our experiment-based results also showed that in regards to the color, taste, mouthfeel, and overall acceptability, the mayonnaise samples, containing 10% sesame cake powder, achieved the highest score. Thus, we highly recommend using sesame cake powder at the concentration of 8-10% in mayonnaise recipe formulation.

Figure 4. Sensory evolution of mayonnaise after 90 days storage
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