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Scientific Research

Influence of the mucilage and chia seed (*Salvia hispanica* L.) oil addition on the physicochemical and sensory properties of yoghurt during storage time

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ABSTRACT

The aim of the present study was to investigate the physicochemical and sensory properties of yogurt fortified with chia seed mucilage and oil, as a rich source of omega-3 fatty acids. For this purpose, mucilage (0.213%), free and encapsulated oil (3.41%) were added to the yogurt formulation. The prepared sampleswere compared in terms of some physicochemical (pH, titratable acidity, syneresis, dry matter, peroxide values and color attributes) and sensory properties with control (without oil and mucilage) during storage for 30 days at refrigerator temperature (4 °C).The results showed that the addition of mucilage and chia seed oil in a free and encapsulated forms caused a significant increase in water holding capacity (decrease in syneresis), acidity (decrease in pH) and dry matter during storage ($p<0.05$). In addition, the sample containing mucilage and encapsulated oil showed the lowest color difference (ΔE) with the control. Furthermore, this sample showed an increase in whiteness index (*WI*) and a decrease in yellowness index (*YI*) compared to the sample containing free oil. The amount of peroxide value in the samples containing free and encapsulated oil after 30 days of storage was 3.19 and 1.16 meq / kg of oil, respectively, which indicates the protective effect of encapsulation process against oxidation of samples. Evaluation of sensory attributes showed that the addition of mucilage and encapsulated chia seed oil did not have significantly effects on the sensory properties of fortified yogurt samples ($p>0.05$).

1. Introduction

Dairy products are considered as one of the most consumed food products in the world, and among them, fermented dairy products, especially yogurt, have a special place.1[. Over the past years, due to the continuous demand of the market and due to the preference of consumers for a healthier lifestyle that includes healthy foods with high nutritional value, yogurt has become a popular product.Due to the expansion of the production and the increasing consumption of all types of yogurt, the enrichment of this product with useful compounds, including fibers and oil sources containing essential fatty acids, has received much attention.]2- 6[.

mountain[1] A plant from the Lamiaceae family[2] And the sage genus is native to southern Mexico and northern Guatemala. But today some of Its species are cultivated and used in many parts of the world due to their nutritional properties and beneficial effects on human health [7]. Edible chia seeds have about 25 to 50% oil, which are a plant source rich in alpha-linolenic acid, and nowadays they have received much attention from researchers [7, 8, 9, 10 and 11]. On the other hand, chia seeds contain approximately 30-34% dietary fiber, which has the ability to produce mucilage by absorbing approximately 27 times its weight in water. Fibers prevent blood pressure, high fat, diabetes followed by obesity and the risk of cardiovascular diseases and stroke. In the food industry, these compounds are also used as foam stabilizers[3], suspension factor[4], texture improver and coating formation are widely used in various foods [9]. Chia seeds as ingredients or additives in some foods such as muesli[5], dairy drinks, fruit smoothies or salads, as well as thickeners in soups and sauces, breakfast cereals [12], cakes and cookies [13], fruit juice and types of yogurt [11], pasta [14 and 15], cheese [16] , ice cream [17], sausage, ham and margarine [18] and mayonnaise [19] have been used.

Therefore, the purpose of this research is to investigateThe effect of adding mucilage and chia seed oil on the physical, chemical and sensory properties of yogurt during storagein temperatureIt was a refrigerator. But due to the sensitivity of chia seed oil to high temperature and oxygen, first Its oil is made using sodium alginate and chia seed mucilage using internal emulsification-gelation method.[6] It was covered. ThenPhysical and chemical properties (LevelpH, titratable acidity, watering, dry matter, color and peroxide) and sensory (taste, texture, color, smell and overall acceptability) samples of yogurt containing mucilage and free and microcoated oil were compared with the control sample (without oil and mucilage) during 30 days of storage at refrigerator temperature.

1. Divide
2. Lamiaceae
3. Foam stabilizer
4. Suspending agent
5. muesli

2- Materials and methods

2-1- Materials

High-fat pasteurized milk (Mihen, Iran) and 3% high-fat yogurt (Mihen, Iran) were obtained from the local market. Chia seeds were purchased from one of the local abattoirs. All materials and culture media used were obtained from Merck (Germany) with analytical purity.

2-2- Mucilage extraction from chia seeds

In order to extract mucilage, first, chia seeds and water were mixed with a ratio of 1 to 20 (weight/volume) and continuously stirred at a temperature of 50±2 degrees Celsius for 45 minutes by a magnetic stirrer at a speed of 100 rpm. The final mixture was placed in a refrigerator (4 degrees Celsius) for 8 hours. Then the seeds along with the mucilage were poured into metal trays and placed in the oven at 50 degrees Celsius for 24 hours to dry completely. Then, the dried material was sieved through a filter with 25 mesh. The obtained powder was kept at room temperature and in closed glass containers until the next tests [9].

2-3- Chia seed oil extraction

Chia seed oil was extracted using a cold hydraulic press with a pressure of 20 MPa, at room temperature and for 15 minutes. In order to minimize oxidation, the resulting oil was stored in dark containers at a temperature of 4 degrees

6. Emulsification-internal gelation method

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Celsius until use [16].

2-3-1- Determining the fatty acid profile of chia seed oil

First, to prepare the samples, the process of derivatization (methyl esterification) of fatty acids was carried out. For this purpose, 2 ml of normal hexane solvent and 300 microliters of methanolic potassium hydroxide solution were added to 0.5 g of each extracted sample and stirred vigorously for 5 minutes. Then the samples were centrifuged for 5 minutes at a rotation speed of 4500 rpm and finally the upper phase was collected for injection into the gas chromatography machine. Then, in order to determine the profile of fatty acids, a gas chromatography device equipped with a capillary silica column (thickness 2.56 micrometers, with a length of 10 meters and an internal diameter of 0.53 millimeters) was used. The initial temperature of 50 degrees Celsius was chosen, which was kept constant for 3 minutes. Then the temperature increased by 2 degrees Celsius per minute to 175 degrees Celsius and was kept at this temperature for 25 minutes. The injection valve temperature was 230 degrees Celsius and the detector temperature was 270 degrees Celsius and the nitrogen gas flow rate was set at 1.2 milliliters per minute. The injection was done as a split with a ratio of 1 to 20 and an injection volume of 1 microliter [11].

2-4- Chia seed oil microcoating process

The microcoating process was carried out by the method of Zandi et al with some modifications [20 and 21].ToFor this purpose, after mixing chia seed mucilage powder and sodium alginate with (1 to 1 ratio)in a ratio of 2 to 100 (weight/volume) dDistilled water and stirring for 2 hours at ambient temperature, water was removed in the refrigerator for one day and night. In the following 30 grams of the mixture and 10 grams of chia seed oil were stirred at a speed of 3000 rpm for 6 minutes and the resulting emulsion was slowly and drop by drop added to the calcium chloride solution (1% by weight/volume) and after formingThe microcoatings were washed with 0.05 M calcium chloride solution. The formed microcoatings were separated with the help of nitrocellulose filter and Millipore glass vacuum system and washed with distilled water. Finally, micro-coatingsIt was poured into distilled water at a ratio of 1 to 9 and kept at 4 degrees Celsius until use.

2-5-preparation of yogurt samples

In order to prepare yogurt samples, first pasteurized milk was heated in a hot water bath to a temperature of 45 degrees Celsius. Then 3% of yogurt was added to it and 3 samples of yogurt were prepared; Sample 1: without additives, sample 2: containing 41.3% of uncoated (free) oil and 0.213% of mucilage, and sample 3: containing 41.3% of microcoated oil and 0.213% of mucilage. Next, in order to form a gel network and produce yogurt, the milk samples were placed in an oven with a temperature of 45 degrees Celsius. Finally, after reaching pH = 4.5 (about 3 hours), the samples were kept at 4 degrees Celsius for 24 hours.

6-2- Evaluation of our quality features

2-6-1- The amount of acidity and pH

The acidity and pH of yogurt was done in accordance with the national standard of Iran (2015) No. 2852 [22].

2-6-2- Dry matter

To measure dry matter, mass (m_1) Some of the yogurt samples were dried in a hot water bath with a temperature of 100 degrees Celsius. Then the remaining water in the oven with a temperature of 105 ± 2 degrees Celsius until a constant weight is reached (m_2) was evaporated and the amount of dry matter in percent was obtained using equation 3 [23]:

Total amount of dry matter (percentage)= $\frac{m_2}{m_1}$ m_2/m_1 ×100(3)

2-6-3- Amount of watering (water storage capacity)

Yogurt water content or water holding capacity was measured according to the method of Tamjidi et al. (2011) [2]. The amount of 30 grams of yogurt was placed on filter paper for 1 hour at 10 degrees Celsius and the percentage of water or serum removed was calculated from equation 4:

percentage of irrigation= The amount of serum has been removed/The initial amount is yogurt ×100

2-6-4- number of peroxide

5 grams of the yogurt sample was thoroughly mixed with 30 ml of glacial acetic acid-chloroform solution (with a ratio of 2:3 (v/v)) and after adding 0.5 ml of saturated potassium iodide, it was placed in a dark environment for 10 minutes. given. Next, add 30 ml of distilled water and 1 ml of 1% starch glue to the sample. After stirring, the mixture was titrated with 0.01 M sodium thiosulfate and the amount of peroxide number was calculated from equation 5 and the results were reported as milliequivalents of active oxygen per kilogram of lipid [2]:

$$\frac{N(S-B)}{W} \times 1000 \quad (5)$$

PV= N(S-B) / W× 1000

S: volume of sodium thiosulfate used for the sample, B: volume of sodium thiosulfate used for the control, N: normality of sodium thiosulfate and W: weight of the sample

2-6-5- Determination of color indicators

Surface imaging of our samples in an image processing chamber with two SMD lamps[7] (with an angle of 45 degrees) and was done with the help of a Canon camera (EOS 70D). In the pre-processing stage after image segmentation and using a median filter with a radius of 2 pixels, the color indices of our samples are*(a*, b* and (L**and color difference (compared to the control sample, ΔE), whiteness index (*WI*(and jaundice index)*DO*) from their images and with the help of Image J software (g 1.40, United States of America) were obtained from relations 6, 7 and 8, respectively [40].

$$\Delta E=\sqrt{(L^*-L^*_0)^2+(a^*-a^*_0)^2+(b^*-b^*_0)^2}$$

$$\sqrt{(L^*-L^*_0)^2+(a^*-a^*_0)^2+(b^*-b^*_0)^2} \quad (6)$$

$$WI=100-\sqrt{(100-L^*)^2+(a^*)^2+(b^*)^2}$$

$$\sqrt{(100-L^*)^2+(a^*)^2+(b^*)^2} \quad (7)$$

$$DO= b^*\times 142.86/ L^* \quad (8)$$

2-6-6- Sensory evaluation

Sensory evaluation of yogurt samples, including taste, texture, color, smell and overall acceptance, by 15 evaluators and based on a 5-point hedonic test as very good: 5 points, good: 4 points, average: 3 points, bad: 2 points and very bad : Score 1 done.

7. Surface mounted device (SMD)

2-6-7- Statistical analysis

The statistical analysis of the data was done with the help of SPSS software (version 26, USA) and using the analysis of variance (ANOVA). In order to compare the averages, Duncan's multiple range test was used at the 95% confidence level.

3. Results and Discussion

3-1- Checking the fatty acid profile of chia seed oil

Considering that dairy products are not rich in essential fatty acids, it is possible to increase the amount of these compounds in dairy products by adding compounds rich in essential fatty acids [24]. According to the chromatogram results of chia seed oil (Figure 1), adding this oil to yogurt can increase the amount of alpha-linolenic acid.

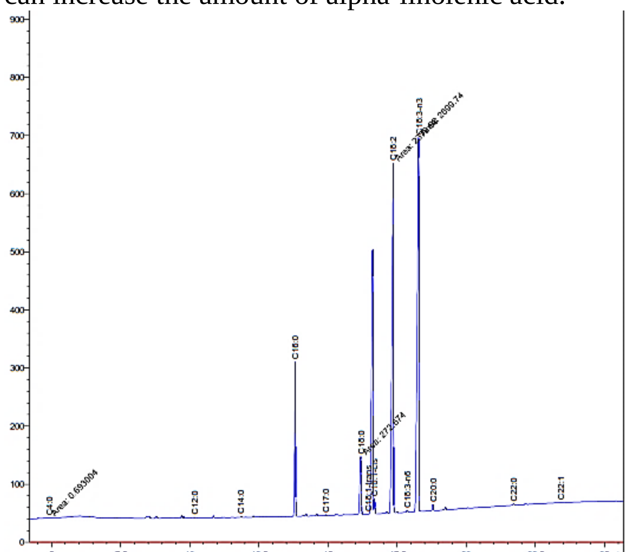

Fig 1 Chromatogram of fatty acids profile of chia seed oil

2-3- Changes in the qualitative and sensory characteristics of yogurts during the storage period

3-2-1- pH and acidity changes

The results of changes in pH and acidity of the control sample and yogurt samples containing mucilage and free and microcoated oil, stored for 30 days at refrigerator temperature at 15 day intervals are shown in Figures 2 and 3, respectively. According to the results, the pH value of all samples was in the range of 4.64-4.59 and the range of acidity was between 0.80

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and 1.19% of lactic acid during the storage time. In addition, according to the results of Figures 2 and 3, with the passage of time, the pH and acidity of the samples decreased and increased significantly ($p<0.05$). The cause of this phenomenon can be the proliferation of initiator bacteria, especially*Lactobacilli*And the continuation of the fermentation process by them during the storage time is relevant. Similar results reported by other researchers confirm this [26-31].

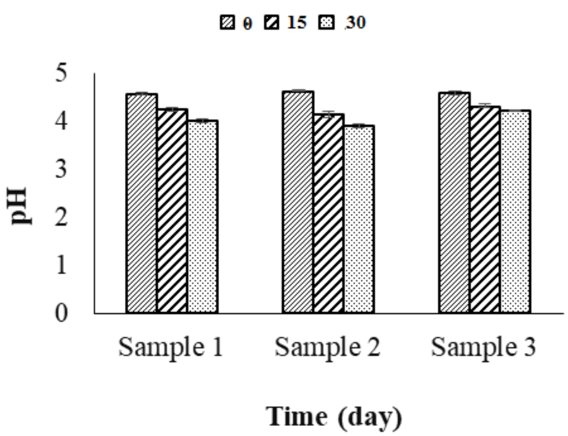

Fig 2 Effect the type of prepared yogurts and storage time on pH changes (sample 1: without additives, sample 2 containing 3.41% free oil and 0.213% mucilage and sample 3 containing 3.41% encapsulated oil and 0.213% mucilage)

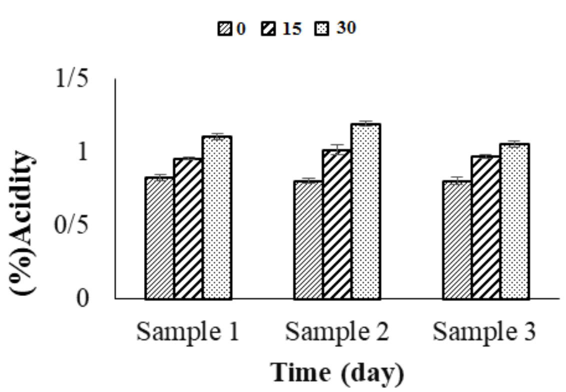

Fig 3 Effect the type of prepared yogurts and storage time on acidity (%) changes (sample 1: without additives, sample 2 containing 3.41% free oil and 0.213% mucilage and sample 3 containing 3.41% encapsulated oil and 0.213% mucilage)

3-2-2- Changes in irrigation and water storage capacity

One of the major quality problems of yogurt is the wateriness, which actually refers to the appearance of serum or yogurt water on its surface. Curdling in yogurt occurs due to the shrinking of the three-dimensional structure of the protein network, which leads to a decrease in the binding power of serum proteins to the clot and their exit from the yogurt [32]. Stabilizers such as hydrocolloids, mucilages, and gums can be used to reduce waterlogging and increase water retention capacity. Examining the changes in hydration of the samples kept at refrigerator temperature during 30 days of storage (Figure 4), it was determined that time and the interaction effect of type of yogurt-time have a significant effect ($p<0.05$) on the amount of hydration of the samples. The addition of mucilage and chia seed oil microcoatings has significantly reduced the amount of watering ($p<0.05$). So that during the storage period, the samples containing free and finely coated oil have the lowest amount of water drop and the sample without oil has the highest amount of water drop.

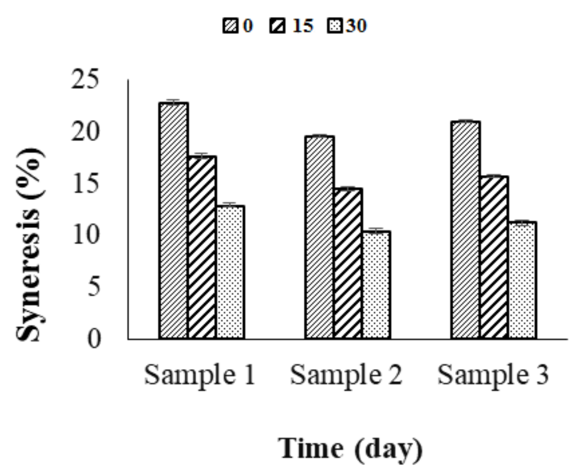

Fig 4 Effect the type of prepared yogurts and storage time on the percentage of syneresis (sample 1: without additives, sample 2 containing 3.41% free oil and 0.213% mucilage and sample 3 containing 3.41% encapsulated oil and 0.213% mucilage)

This can be due to the enrichment of yogurt with mucilage and microcoating, which creates a gel with high strength, lower permeability, creates a strong protein network, and reduces water loss. Also, the results of Figure 4 showed that the percentage of watering in all samples decreased significantly with the passage of time ($p<0.05$). The lowest and highest amount of watering in all samples was related to Siam day and first day of storage, respectively. The decrease in water content during storage can be due to the evaporation of water and the increase of dry matter in yogurt samples [4]. In addition, at lower temperatures, the bonds between the gel particles become stronger or their number increases, which can be caused by the swelling of the gel particles or their joining together. Gurbanzadeh et al. (2017) during a study on the effect of enriching yogurt with fish oil nanoliposomes during 21 days of storage at 4 degrees Celsius reported that the decrease in pH during storage had a contraction effect on the casein micelle network and can cause more water in yogurt. 4 [. Because in the present study, the samples containing mucilage and micro-coated oil had a higher pH than the control sample (Figure 4), so they also showed a lower water content. Akalin et al. (2012) also reported the reduction of water loss due to the addition of sodium calcium caseinate and whey protein concentrate to yogurt during 28 days of storage at 4 degrees Celsius compared to the control sample [29 and 4]. Similar results have been reported by Noor Mohammadi and colleagues during the enrichment of yogurt with spirulina coating [34].

In addition, the addition of mucilage and chia seed oil in a free form can also cause a decrease in water absorption compared to the control sample. Grossi et al. (2011), in the study of the effect of enriching yogurt with phytosterol during 28 days of storage at refrigerator temperature, concluded that in enriched yogurt, the increase in dry matter stabilizes the gel network and increases the water binding capacity, and reduces water in the enriched samples. It is possible [33].

3-2-3- Evaluation of dry matter changes

According to the results of Figure 5, During 30 days of storage at 4 degrees Celsius, the type of yogurt, the storage time and the interaction between type of yogurt and time have a significant effect on the changes in the dry matter of the yogurt samples ($p<0.05$). The addition of oil, oil coating and chia seed mucilage increased the dry matter in the enriched samples compared to the control sample. The results also revealed that with the increase in storage time, the amount of dry matter increases significantly ($p<0.05$), which can be due to the absorption of water in samples containing free and finely coated oil and the increase in water evaporation in all samples during this period [4, 33] and 35 [.

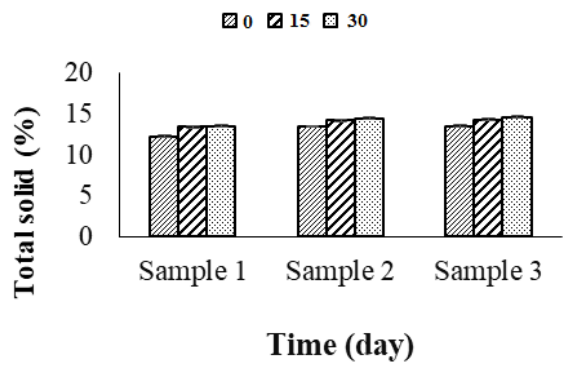

Fig 5 Effect the type of prepared yogurts and storage time on total solid (%) changes (sample 1: without additives, sample 2 containing 3.41% free oil and 0.213% mucilage and sample 3 containing 3.41% encapsulated oil and 0.213% mucilage)

3-2-4- The rate of changes in the peroxide number

According to Figure 6, the type of yogurt and storage time have a significant effect on the peroxide changes of yogurt samples ($p<0.05$). The peroxide value of the control sample was 0.1, 0.16, and 0.33 milliequivalents of active oxygen per kilogram of oil on days 0, 15, and 30, respectively.

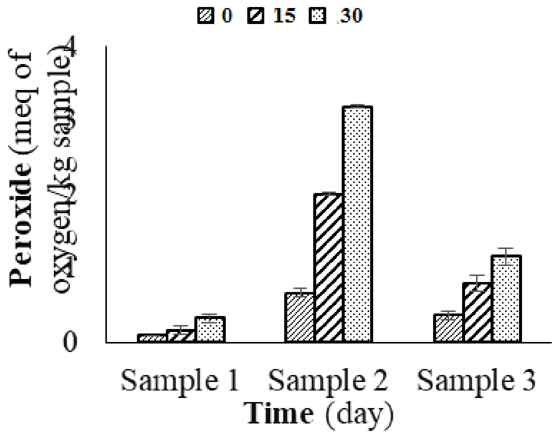

Fig 6 Effect the type of prepared yogurts and storage time on peroxide value changes ((sample 1: without additives, sample 2 containing 3.41% free oil and 0.213% mucilage and sample 3 containing 3.41% encapsulated oil and 0.213% mucilage)

In the yogurt sample containing free oil and mucilage, the amount of peroxide during storage was 0.66, 2.01, and 3.19, respectively, and in the sample containing microcoating and mucilage, it was 0.36, 0.8, and 1.16 milliequivalents of oxygen, respectively. Active per kg of oil was obtained. The peroxide number in the sample containing microcoated oil was significantly increased compared to the sample without oil during 30 days of storage ($p<0.05$). But it should be noted that compared to the sample containing free oil, the amount of peroxide was lower. The presence of more free fatty acids or higher acidity (Figure 2), in the sample containing free oil, can be one of the main reasons for the increase in oil oxidation during the storage period. Therefore, microcoating is a suitable method to prevent oil oxidation, followed by a change in taste and a reduction in the nutritional value of the product. Tamjidi et al. (2011) also reported that the process of microcoating prevents oil oxidation compared to the free state [2]. Gurbanzadeh et al. (2017), in the enrichment of yogurt with finely coated fish oil, also witnessed a decrease in the peroxide index in the samples during the storage period compared to the samples containing free oil [4]. Faraji et al. (2019) also achieved a similar result in enriching yogurt with Iranian shallot nanoemulsions [36].

3-2-5- Changes Color

Table 1 color indices($^*L$ ، $^*a$ ، $^*b$, *YI, WI and ΔE*) shows yogurt samples during storage time. According to the results of Table 1, the effect of type of yogurt on the index $^*L$ (brightness level) during storage time is significant ($p<0.05$). Because microcoatings are white and bright, they can increase the surface areas that scatter light in yogurt [2, 34] and then increase the brightness of the yogurt sample.Contains micro-coated oil compared to the sampleContains free oil, compared to the sample, which indicates the success of the microcoating process in covering the color of chia seed oil (pale yellow). Investigating the effect of adding flax seeds on the index $^*L$ Yogurt samples during 21 days of storage at refrigerator temperature also showed a decrease in the brightness index due to the increase in the amount of flax seeds compared to the control sample [7]. Also, the results of Table 1 showed that the type of yogurt caused a significant difference in the index $^*a$ ($p<0.05$). But the storage time has no significant effect on this index ($p>0.05$). Positive values in the index $^*a$ It means increasing the amount of redness and decreasing the amount of green. Microcoatings of oil and chia seed mucilage increase the index $^*a$ And the reduction of greens in Our examplesContains micro-coated oil have become insignificant but significant ($p<0.05$). But oil in free form causes the index to decrease $^*a$ In the exampleContains free oilbecame

According to the results of Table 1, there is a significant difference in the type of yogurt, time and the interaction effect of the type of yogurt-time in the index $^*b$ It was observed during 30 days of storage at 4 degrees Celsius ($p<0.05$). Amounts $^*b$ In the exampleContains free oilpositive and in control samples andContains micro-coated oil A negative result was obtained, which means that the enrichment can reduce the yellowness index in the samples. The examination of the whiteness index in Table 1 showed that the type of yogurt, time and the interaction effect of the type of yogurt - time had a significant effect on the whiteness index ($p<0.05$). Addition of oil in a free form decreased the whiteness index in the samples and the microcoating process decreased the difference with the control sample in the whiteness index. According to the results of

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Table 1, adding oil freely has increased the yellowness index in the samples. Yoghurt type, time and mutual relationship between yogurt and time had a significant effect on yellowness index ($p<0.05$) and the results with the amount of changes**b* And*DO* In yogurt containing free oil, it was proportional. In the study of Ardebilchi et al. (2020), the increase in the amount of flax seed powder caused an increase**b* And*DO*And the decrease in brightness level was observed in yogurt samples containing flax seeds compared to the control sample [37]. According to the results of Table 1, type of yogurt, time and interaction effect of type of yogurt - time in color changes*(ΔE)* made a significant difference ($p<0.05$). But among the samplecontaining free and microcoated oil, SampleContains micro-coated oil It showed a smaller difference with the control sample, which again showed the success of the microcoating process in maintaining and improving the color characteristics.

Table 1 Changes in color attributes during storage time

Storage time (day)	**Sample**	***L****	***a****	***b****	***ΔE***	***WI***	***DO***
0	1	0.07 ^{a} ± 98.19	^{b} 0.08± 8.47	0.04 ^{a} ± 0.36-	-	0.09 ^{a} ± 91.32	0.52 ± 0.05 ^{a}
	2	0.14 $^{It is}$ ±92.02	0.09^{d} ± 6.93	0.23 ^{g} ± 3.04	0.25 ^{d} ± 6.56	0.19 ^{c} ± 89.56	3.67±0.34 ^{c}
	3	0.1 ^{c} ± 97.77	0.14 ^{a} ± 8.79	0 ^{c} ± 0.27 -	0.23 ^{a} ± 0.58	0.15 ^{b} ± 91.0	0.40±0.08 ^{a}
15	1	0.09 ^{a} ± 98.01	0.03 ^{b} ± 8.5	0.01 ^{b} ± 0.33 -	-	0.05 ^{a} ± 91.30	0.45±0.02 ^{a}
	2	0.11 ^{f} ± 91.99	0.12 ^{b} ± 6.92	0.2 ^{h} ± 4.32	0.06 $^{It is}$ ± 7.74	0.09 ^{d} ± 88.56	6.70±0.3 ^{d}
	3	0.06 ^{d} ± 97.15	0.07 ^{a} ± 8.72	0.01 ^{d} ± 0.19 -	^{b}0.05 ± 0.90	0.06 ^{b} ± 90.82	0.28±0.08 ^{b}
30	1	0.03 ^{b} ± 97.92	0.03 ^{c} ± 8.33	0.01 $^{It is}$ ± 0.12 -	-	0.03 ^{a} ± 91.38	0.16±0.05 ^{b}
	2	0.17 ^{g} ± 90.26	0.09 $^{It is}$ ± 7.12	0.18 ^{i} ± 5.14	0.14 ^{f} ± 9.37	0.13 $^{It is}$ ± 86.7	8.13 ±0.28 $^{It is}$
	3	0.06 ^{d} ± 97.02	0.08 ^{a} ± 8.79	0.01 ^{f} ± 0.07 -	0.05 ^{c} ± 0.99	0.09 ^{b} ± 90.71	0.81±0.03 ^{b}

* Numbers with different letters in each column have a significant difference at the level of 0.05.

Sample 1: without additives, sample 2 containing 3.41% free oil and 0.213% mucilage and sample 3 containing 3.41% encapsulated oil and 0.213% mucilage.

3-2-6- Sensory characteristics

According to Figure 7, the analysis of sensory evaluation results showed that the effect of type of yogurt and the effect of time on changes in sensory characteristics were significant.(05/0 p<). The highest score of taste and smell is related to samples without oil andContains micro-coated oil On day zero, there was no statistically significant difference (0.05p>). But in the exampleContains free oil The specific taste related to chia seed oil decreased the desirability of the taste characteristic of this sample. This indicates the success of the microcoating process in protecting the taste and smell of chia seed oil so that its smell and taste could not be detected by consumers. A decrease in the taste and smell score during the storage period is possible due to the increase in acidity, which causes a significant change($p<0.05$) inThe taste and smell of the product will be.

Texture is one of the most important primary evaluations of yogurt quality by consumers. Therefore, its investigation is of great importance. According to the results of Figure 7, the addition of chia seed oil microcoating and mucilage has a significant effect on texture characteristics. The results obtained from the sensory evaluation of the texture were in full agreement with the results obtained from the water immersion of the samples (Figure 4). So that the addition of chia seed oil and its mucilage has increased the firmness of the texture and with the increase of time, the consistency score has also increased. The reason for the upward

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trend of the consistency score during the storage time can be attributed to the effect of adding mucilage and water evaporation and increasing the amount of dry matter. Due to its high hydrophilic property, mucilage has a strong interaction with water, and by trapping the free water in the structure of yogurt, it has improved its texture and increased its consistency [39].

In terms of evaluating the appearance of samples, control samples andContains micro-coated oil There was no significant difference from each other (0.05).p>). But the addition of oil freely caused a decrease in the appearance score from the point of view of consumers. General acceptance is the evaluation of all sensory indicators. Considering that all the investigated sensory indicators, except the texture, decreased with increasing time, the decrease in overall acceptance of the product during storage was expected. But no significant change was observed in samples containing chia seed oil coating and mucilage and control during storage. (05/0p>). In general, the addition of chia seed oil microcoating and mucilage increased the sensory evaluation score in enriched yogurt samples and improved taste, smell, texture, color and overall acceptance. In addition, the addition of mucilage and micro coating of chia seed oil did not have an adverse effect on the sensory characteristics of yogurt compared to the control sample.Gurbanzadeh et al. (2017) also reported that yogurt samples containing fish oil nanoliposomes were almost similar to the control sample in terms of sensory characteristics. But the samples containing free oil obtained the lowest sensory score compared to the control sample [4]. Noormohammadi et al. (2020), also in enriching yogurt with free and microcoated spirulina, found that the microcoating process improves the flavor of the samples [33]. But,Faraji et al. (2019), during a research on the effect of enriching yogurt with Iranian shallot nanoemulsions during 21 days of storage at refrigerator temperature, concluded that the increase in concentration of nanoemulsions did not have a significant effect on sensory scores.] 36[.

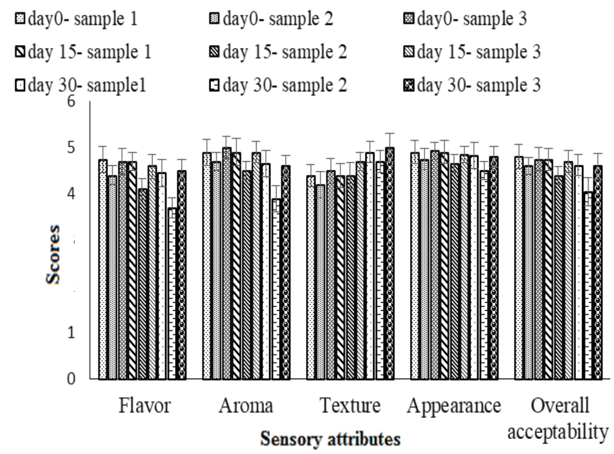

Fig 7 Effect of prepared yogurts and storage time on sensory changes (sample 1: without additives, sample 2 containing 3.41% free oil and 0.213% mucilage and sample 3 containing 3.41% encapsulated oil and 0.213% mucilage).

4- General conclusion

The present study was conducted to investigate the effect of adding chia seed oil and mucilage on the qualitative, nutritional and sensory characteristics of yogurt during 30 days of storage at refrigerator temperature. The results showed that the addition of mucilage and chia seed oil in a free and microcoated form caused a significant increase in the storage capacity of water and dry matter during the storage period ($p<0.05$). In addition, in terms of color indices of the sample containing microcoating, the lowest color difference (ΔE) with a witness sample. Also, the microcoating process increases the whiteness index (*WI*(and reducing the jaundice index)*DO*) compared to the sample containing oil in the free state. The evaluations of the measurement of peroxide during the storage period showed the protective effect of the coating from the oxidation of free fatty acids. The analysis and sensory evaluation showed that the microcoating process was effective in preserving the taste and smell of chia seed oil and increased the score of taste, smell and appearance of the sample containing microcoating compared to the control.

5- Resources

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مقاله علمی_پژوهشی

اثر افزودن موسیلاژ و روغن دانه چیا (*Salvia hispanica* L.) بر ویژگی‌های فیزیکی‌وشیمیایی و حسی ماست طی زمان نگهداری

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چکیده

هدف از پژوهش حاضر بررسی ویژگی‌های فیزیکی‌وشیمیایی و حسی ماست غنی‌شده با موسیلاژ و روغن دانه چیا، به‌عنوان منبع غنی از اسید چرب امگا ۳ بود. برای این منظور ابتدا موسیلاژ و روغن آزاد و ریزپوشانی‌شده به ترتیب به میزان ۰/۲۱۳ و ۳/۴۱ درصد به فرمولاسیون ماست اضافه شدند. نمونه‌ها طی ۳۰ روز نگهداری در دمای یخچال، از نظر برخی از ویژگی‌های فیزیکی‌وشیمیایی (میزان pH، اسیدیته قابل تیتر، آب‌اندازی، ماده خشک، رنگ و پراکسید) و حسی با نمونه شاهد (بدون روغن و موسیلاژ) مقایسه شدند. نتایج نشان داد که افزودن موسیلاژ و روغن دانه چیا به صورت آزاد و ریزپوشانی شده، باعث افزایش معنی‌دار در ظرفیت نگهداری آب (کاهش در میزان آب‌اندازی)، اسیدیته (کاهش pH) و ماده خشک طی نگهداری شد (p<۰/۰۵). به‌علاوه، نمونه حاوی روغن ریزپوشانی‌شده کمترین اختلاف رنگ (EΔ) را با نمونه شاهد داشت و شاخص سفیدی (WI) آن بیشتر و شاخص زردی (YI) نیز کمتر از نمونه حاوی روغن آزاد بود. میزان پراکسید نمونه¬های حاوی روغن آزاد و ریزپوشانی‌شده پس از ۳۰ روز نگهداری به‌ترتیب ۳/۱۹ و ۱/۱۶ میلی اکی‌والان اکسیژن در کیلوگرم روغن به دست آمد که بیانگر اثر حفاظتی ریزپوشش در برابر اکسایش نمونه‌ها بود. ارزیابی ویژگی‌های حسی نیز نشان داد که افزودن روغن دانه چیا ریزپوشانی‌شده و موسیلاژ آن تاثیر معنی‌داری بر ویژگی¬های حسی ماست نداشته است (p>۰/۰۵).