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Scientific Research

The study of effect of different percentages of fat and Homogenization pressure on rheological, physicochemical and sensory properties of cream

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ABSTRACT

ABSTRACT: In this research, a type of cream was produced according to the standard method with different percentages of fat and different pressures of homogenization. Five treatments were prepared as follows: T_1: 25% of fat and homogenization pressure was 100 bar, T_2: 30% of fat and homogenization pressure was 100 bar, T_3: 25% of fat and homogenization pressure was 200 bar, T_4: 30% of fat and homogenization pressure was 200 bar and T_5 as a control sample: 25% of fat and homogenization pressure was 150 bar. Completely randomized design was used as a design experiment and experiments were carried out at 3 replications. The results showed that treatments with higher fat% had higher acidity (dornic) and lower pH, and treatment with less fat and homogenization pressure had higher dry matter and treatments with higher homogenization pressure showed more syneresis%. The results obtained from rheological properties, showed that with the increase of fat percentage and decrease of homogenization pressure, the rheological indices of G´and G″ increased and simultaneously with the increase of G´, the viscosity also increased, and the loss tanα decreased when G´ increased. The colorimetric test showed that samples with more fat have more yellowness than other treatments Sensory evaluation showed that samples with higher fat and higher homogenization pressure were more accepted by panelists. According to above mentioned, T_4 with 30 percentages of fat and 200 bar of homogenization pressure was the best treatments among others.

1- Introduction

Obesity has seriously threatened people's health in developing and industrialized countries. Today, one third of people in the world are considered obese. Obesity leads to diseases such as type 2 diabetes, blood clots, and certain types of cancer. Reducing the amount of fat in the diet is a good way to manage fat intake, so the demand for low-fat products is constantly increasing. (Orouji et al., 2017).Meanwhile, the production and development of dairy products with reduced fat, including cream, is of particular importance. However, consumers often perceive products with reduced fat content to be of unsatisfactory quality. Reducing the amount of fat negatively affects the rheological, organoleptic, mouthfeel and texture characteristics. Recently, studies have been conducted to produce low-fat diet products, especially diet dairy products. Cream is one of the products that have been studied to remove or reduce fat. Since fat is one of the most important and effective ingredients in cream, obese people, especially heart patients, have problems consuming it. The production of low-fat cream will provide a good market for the producers on the condition of maintaining the characteristics liked by the consumer in addition to the health aspects. But reducing fat has negative effects on the quality of low-calorie cream, so the production of low-calorie creams requires reducing or removing fat without making significant and noticeable changes in the characteristics expected by the consumer.The homogenization process can have a negative effect on the operation of the cream, causing an increase in the duration of the cream and a decrease in the volume of the final product. The reason for this phenomenon is the decrease in the tendency of the membrane of the homogenized fat globules, which are made of casein, to adsorb on the common surface of the air bubbles and the induced shear force is attributed to non-homogenized cream fat cells in comparison (Katouzian et al., 2016). Examining the rheological properties of cream is important in controlling the quality of these materials during the process, transportation and storage. On the other hand, rheological tests allow the manufacturer to produce a product with sufficient consistency and appropriate texture. Examining the dynamic rheological properties of cream is to determine parameters such as elastic modulus (G´) and viscous modulus (G″). These two parameters form another parameter called complex modulus (G*). Also, the loss tangent (tanα) is used to evaluate the quasi-liquid and quasi-solid behavior of emulsions. In this research, in order to change the rheological characteristics of breakfast cream, the effect of changing the homogenization pressure and fat percentage was studied. Therefore, the purpose of this research is the effect of fat percentage and homogenization pressure on the physicochemical, rheological, and sensory characteristics of breakfast cream.

2.Material and Methods

2-1. The method of producing breakfast cream

To produce samples of cream containing 25 and 30% fat, appropriate amounts of 2.5% milk and creams containing 30 and 36% fat were calculated and mixed together using Pearson's square. In this way, creams with fat percentage of 25 and 30% were prepared and then homogenized under the process of homogenization with pressures of 100 and 200 bar and processed under the process of pasteurization with a temperature of 90 °C and a duration of 30 seconds. After the pasteurization, the temperature of the cream was brought to 60-70 °C and it was packed in special containers, and the produced cream samples were placed in the refrigerator to perform the tests.

2-2. pH measurement

The pH of the cream samples was determined by Iranian standard method No. 2852 at a temperature of 20 °C (INSO-2852, 1987).

2-3. Measurement of acidity (Dornic)

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The acidity test was performed according to the national standard of Iran No. 2852, to determine the acidity and pH of milk and its products. 10 ml of the samples were titrated with phenolphthalein reagent and 0.1 normal sodium hydroxide until a pink color appeared and the results were reported in terms of lactic acid percentage (INSO-2852, 1987).

2-4. Dry matter measurement

First, a glass or stainless steel container was dried in an oven at 105 degrees Celsius for 20 hours and cooled after being transferred to a desiccator containing a moisture absorbent. After cooling, the container was weighed with a scale with an accuracy of 0.001 grams, and about 3 grams of fully mixed cream sample was weighed in it. The container was transferred to the oven with a temperature of 105 degrees Celsius and after 3 hours it was cooled in a desiccator and weighed. This work was done in 20-minute intervals after 3 hours to reach a constant number after weighing twice (INSO-11328, 2008). Then, according to equation 1, the percentage of dry matter was calculated.

Equation 1: (primary weight-secondary weight)/ (sample weight) x 100 = percentage of dry matter

2-5. Measurement of cream fat

Cream fat concentration was determined according to Iranian National Standard Method No. 191 (INSO-191, 2010).

2-6. Measurement of syneresis

To measure the syneresis and stability of the cream emulsion in relation to two phases, 10 ml of the cream sample was poured into a graduated laboratory tube and placed in a Heraeus centrifuge, Germany, at a speed of 4000 rpm for 15 minutes. Phase volume the water separated from the cream was presented as a percentage. This test can be performed at 20 degrees Celsius (Siamak & Jafarpour, 2022).

2-7. Cream rheological tests

Measurement of viscosity and rheological properties including storage modulus G′, loss modulus G″, loss tangent tanα and viscosity μ after adding the cream and reaching the maximum increase in volume by rheometer (Bohlin Gemini HRNano, Malvern, England) with parallel plate number 5 became. The tests were performed at a temperature of 10°C. To measure the viscosity and rheological properties, about 10 ml of whipped cream was placed on the plate of the rheometer and the rheological properties of the samples were measured (Katouzian et al., 2016).

2-8. Color evaluation

To evaluate the color of the samples, the cream samples were placed in a box with white walls with dimensions (50x50x350 cm). Inside the box, a low-consumption fluorescent lamp with a power of 20 watts with white light was used. The distribution of light inside the box was completely uniform and photography was done by a digital camera (Cannon power shot A 540 model, Japan) with a distance of 30 cm from the sample and perpendicular to it inside the box. The obtained images were transferred to Photoshop 8 software and their color components (a*, b* and L*) were obtained, color component L* represents brightness, a* represents the amount of green and red, and color component b* represents the amount of blue and shows yellowness (Siamak & Jafarpour, 2022).

2-9. Sensory evaluation

Evaluation of sensory characteristics was done by 15 evaluators, for whom the desired sensory characteristics were explained. The characteristics of the test include color, texture, taste and general acceptance. The test was designed on a five-point hedonic scale and based on a scoring method of 1 to 5. A score of 1 is the worst sample, 2 is a poor sample, 3 is an average sample, 4 is a good sample, and 5 is a very good sample. It is good (Siamak & Jafarpour, 2022).

2-10. Evaluation of cream microstructure

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The evaluation of the microstructure of the cream was done by scanning electron microscope (SEM) (model ΠVEGA, manufactured by TESCAN, Czech Republic). To prevent changes in the sample, the samples were dried in a vacuum dryer and coated with gold for 300 seconds in a gold sputtering machine (gold coating machine, K450X, made by EM Technologies LTD, England) after Placing the samples inside the microscope and creating a vacuum, electron bombardment was done with 3KV and images were prepared with a magnification of 1000 (Baghdadi et al., 2017).

2-11. Statistical Analysis

The experiment is factorial and in the form of a completely random design, to determine the significance of $P<0.05$ or non-significance of $P>0.05$, one-way analysis of variance was used. Comparison of averages was done with Duncan's test at the 5% level and three repetitions were considered for each sample. The treatments used in the research are as follows: The treatments include, T1: containing 25% fat and homogenization pressure equivalent to 100 bar, T2: containing 30% fat and homogenization pressure equivalent to 100 bar, T3: containing 25% fat and homogenization pressure equivalent to 200 bar, T4: containing 30% fat and pressure equal to 100 bar Homogenization equivalent to 200 bar and T5 as a control treatment: containing 25% fat and homogenization pressure equivalent to 150 bar

3.Results and discussion

3-1. Changes in pH of cream with different fat percentage and homogenization pressure

The highest pH related to treatment T4 containing 30% fat and homogenization pressure equivalent to 200 bar and the lowest pH related to treatment T1 containing 25% fat and homogenization pressure 100 bar and T3 containing 25% fat and homogenization pressure 200 bar and T5 containing 25% fat and homogenization pressure 150 load, and in terms of pH values, treatments T1 and T3 are the same as the control treatment (T5) (Table 1). The pH of produced creams is caused by free fatty acids and lactose fermentation of milk and lactic acid production, as a result of the pasteurization process and the removal of lactose-fermenting microorganisms, lactic acid production stops, and on the other hand, with increasing homogenization pressure, due to the negative effect of high pressure On the natural microorganisms present in the cream, the power of lactic acid production decreases. In this study, the treatments containing 30% fat had higher acidity than the treatments containing 25% fat, which is due to the concentration of fatty acids in these treatments. Results this research was consistent with the results obtained by Orouji et al. in 2016. These researchers attributed the increase in cream acidity to the increase in cream fat percentage (Orouji et al., 2017). Another reason can be attributed to the fact that the dispersion of the fat phase increases as the temperature increases and the viscosity decreases, finally the hardness of the cream decreases and this change is to some extent unfavorable for the texture of the cream and causes an increase in the serum of the cream and as a result some It was removed from the acids in the fat bed and caused a relative drop in acidity and an increase in the pH of the samples (Katouzian et al., 2016).

3-2. Changes in acidity

The highest acidity according to Dornick corresponds to treatment T1 (11.03) containing 25% fat and homogenization pressure 100 bar, and the lowest acidity according to Dornick corresponds to treatment T2 and T4 (10.56) containing 30% fat and homogenization pressure 100 bar and 200 bar, respectively. The closest treatment to the control treatment is the T3 treatment containing 25% fat and 200 bar homogenization pressure. Along with the changes in pH, acidity also changed (Table 1). The reason for the higher acidity of T1 treatment with fat and lower homogenization pressure is that in high pressure homogenization, small globules of fat are formed. As the temperature increases, the dispersion of the fat phase increases and the

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viscosity decreases. Finally, the hardness of the cream decreases and this change is to some extent unfavorable for the texture of the cream and causes an increase in creaming, and as a result, some of the acids in the fat bed are released and cause the relative decrease in acidity and increase in pH of the samples (Katouzian et al., 2016).

3-3. Changes in percentage of dry matter

The highest percentage of dry matter among different treatments related to treatment T2 containing 25% fat and homogenization pressure of 100 bar is 38.13% and the lowest percentage of dry matter related to control treatment T5 containing 25% fat and homogenization pressure of 150 bar and the closest In terms of dry matter percentage, T1 treatment contains 25% fat and 100 times homogenization (Table 1). The dry matter contains fat, protein, lactose and minerals. Among the studied treatments, treatment T2 has the highest percentage of dry matter despite the 25% fat and the homogenization pressure equal to 100 bar, because the lower the homogenization pressure, the hardness of the cream increased, because larger globules are formed. The size of the particles increases, it causes the viscosity of the cream to increase, and this factor makes the texture of the cream more stable and prevents the serum from leaving. Obviously, with an increase in fat percentage, we expect that the percentage of dry matter will increase, but the homogenization pressure is more effective on the transfer of cream components by the serum phase as it affects the stability and consistency of the cream (Katouzian et al., 2016). The result of this research was consistent with the result of the research conducted by Katouzian et al. in 2015 (Katouzian et al., 2016).

3-4. Changes in fat percentage

The highest percentage of fat related to T2 and T4 treatments (10.56) contains 30% fat and homogenization pressure of 100 bar and 200 bar, respectively, and the lowest percentage of fat related to T1, T3 and T5 treatments contains 25 percent fat and homogenization pressure of 100 bar, 200 bar, and 150 bar. Treatments T1 and T3 were similar to control treatment T5 in terms of fat percentage. Fat percentage was considered as a preset and standardized parameter (Table 1). Obviously, the treatments varied in terms of fat percentage based on the samples supplied to the market were investigated and the factor that changes the amount of fat was not considered.

3-5. Changes in synersis percentage

The highest percentage of syneresis related to T2 and T4 treatments contains 30% fat and homogenization pressure of 100 and 200 bar, respectively. The lowest percentage of syneresis related to T1 treatment contains 25% fat and 100 bar homogenization. In terms of syneresis percentage, the closest treatment to the control treatment is T3 treatment containing 25%. The fat and homogenization pressure is 200 bar (Table 1). One of the most important issues in cream production is the amount of rehydration after production, which lowers its acceptability and usability. With the reduction of fat in the cream formulation, the rehydration amount increased, which is related to the reduction of the mechanical resistance of the protein network. Enrichment with dry matter as well as adding hydrocolloids is a common method to prevent water loss. Reducing the homogenization pressure due to the creation of a texture with high stability and appropriate consistency acts as a water absorber and with Water trapping prevents water from escaping. At higher homogenization pressures, because the size of the fat globules is smaller, the stability of the texture is weaker, and as a result, the water level increased.

Table 1. Changes in physicochemical of cream with different percentages of fat and homogenization pressure**

Physicochemical properties					Treatment
Synersis%	Fat %	Dry matter%	Acidity(Dornic)	pH	
0.86^{b}	25.00^{b}	33.13^{c}	11.03^{a}	6.7^{ab}	T1

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1.06^{a}	30.00^{a}	38.13^{a}	10.56^{b}	6.71^{a}	T2
0.9667^{a}	25.00^{b}	33.13^{c}	11.00^{a}	6.7^{ab}	T3
1.06^{a}	30.00^{a}	38.00^{b}	10.56^{b}	6.72^{a}	T4
1.00^{a}	25.00^{b}	33.00^{d}	11.00^{a}	6.70^{ab}	T5(Control)

** Treatments prepared as follows: T_1: 25% of fat and homogenization pressure was 100 bar, T_2: 30% of fat and homogenization pressure was 100 bar, T_3: 25% of fat and homogenization pressure was 200 bar, T_4: 30% of fat and homogenization pressure was 200 bar and T_5 as a control sample: 25% of fat and homogenization pressure was 150 bar. Different letters in each column indicate significant differences at p<0.05 level.

3-6. storage modulus or G´

The highest amount of storage modulus in terms of pascal is related to T2 treatment containing 30% fat and homogenization pressure of 100 bar and the lowest amount of storage modulus related to T1 and T3 treatment containing 25% fat and homogenization pressure of 100 and 200 bar respectively. The closest treatment to the control treatment in terms of modulus, the reserve treatment is T1 and T3 (Figure 1). Increasing the percentage of fat and decreasing the homogenization pressure synergistically increases the storage modulus G'. In fact, as the percentage of fat increases and the homogenization pressure decreases, the viscosity value also increases. The homogenization pressure caused the formation of globules with a larger diameter in the cream matrix, which both reduced the water content and increased the hardness, and finally increased the viscosity and increased the storage modulus G'. The results of this study showed that with increasing the fat percentage and decreasing the pressure Homogenization increased the hardness of the samples. This change is favorable for the texture of the cream to some extent and causes a decrease in cream cream. Rheologically, the cream has a weak gel system in which the proteins create a false gel network by absorbing the interface of oil and water. (Brooker, 1990). The natural structure of the solid state is enhanced by the degree of reaction between serum components such as fat-fat, protein-protein and protein-carbohydrate with water (Ihara *et al*., 2015).

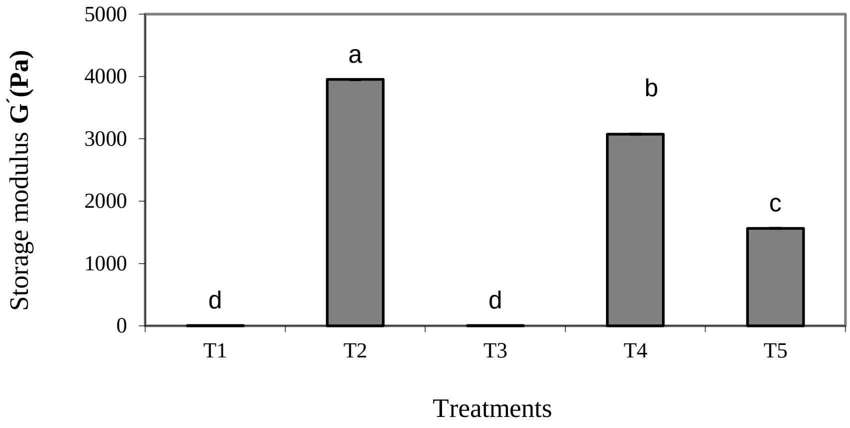

Figure 1. Changes in storage modulus G´ of cream** with fat percentages and different homogenization pressures

3-7. Loss modulus G″

The highest amount of drop modulus related to T2 treatment containing 30% fat and homogenization pressure of 100 bar and the lowest amount of drop modulus related to T1 and T3 treatments containing 25% fat and homogenization pressure of 100 and 200 bar respectively. The closest treatment to the control treatment in terms of drop modulus of T1 and T3 treatments. (Figure 2). Creams show

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a weak gel system. Ihara *et al*. (2015) showed that the increase of casein peptides in the continuous phase of cream along with low molecular weight emulsifiers caused a greater increase in the storage modulus compared to the loss modulus. And the ability of the cream to maintain its original shape increased during one day of storage at 4 degrees Celsius compared to the sample without these compounds (Ihara et al., 2015). The mechanism of action of these substances is justified by the absorption of casein peptides on air bubbles and their stabilization. Low molecular weight emulsifiers also increase the stability of fat cells in the mixture (Ihara et al., 2015). It should be mentioned that the process of beating and aerating causes the bubbles to enter the solution and increase the storage modulus and loss modulus (Clement & Prins, 1987). The results of this research showed that the increase of the storage modulus was more than the loss modulus. The durability of the bubbles is related to The stabilizing effect of casein micelles and proteins is to hold the beta-casein film by increasing the thickness and hardness of their interfacial surface (Smith et al., 2000). As mentioned earlier, increasing the percentage of fat and decreasing the homogenization pressure increases the fat-fat interaction and increases the hardness of the cream and increases the viscosity of the continuous phase and finally increases the viscoelastic moduli. G″ showed an increasing trend in all samples, which can somehow indicate the rearrangement of the bonds of the cream network in parallel with the increase in the time of applying stress. In all samples, the values of G' and G″ were higher in all frequencies, which indicates the superiority of the behavior. Elastic over viscous behavior (Orouji *et al*., 2017).

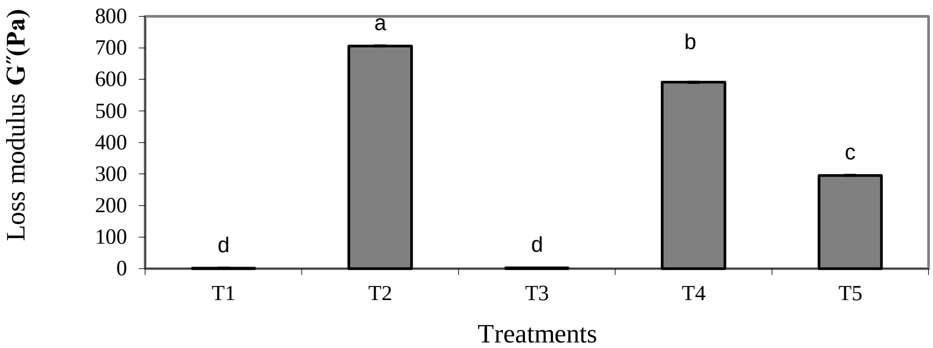

Figure 2. Changes in loss modulus G″ of cream** with fat percentages and different homogenization pressures.

** Treatments prepared as follows: T_1: 25% of fat and homogenization pressure was 100 bar, T_2: 30% of fat and homogenization pressure was 100 bar, T_3: 25% of fat and homogenization pressure was 200 bar, T_4: 30% of fat and homogenization pressure was 200 bar and T_5 as a control sample: 25% of fat and homogenization pressure was 150 bar. Different letters on the histograms indicate significant differences at the $p<0.05$ level.

3-8. Changes in of tanα

The highest amount of tanα corresponds to treatment T3 containing 25% fat and homogenization pressure of 200 bar, and the lowest amount of tanα corresponds to treatment T2 containing 30% fat and homogenization pressure of 100 bar. Fat percentage and homogenization pressure are 100 bar and 200 bar (Figure 3). The drop tangent of the ratio of

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lost energy to stored energy during a stress cycle is fluctuating during the test, Compared to the quasi-liquid, in the sense that the storage modulus is higher than the drop modulus and the samples showed viscoelastic solid behavior (Katouzian et al., 2016). The greater drop tangent means that the material is less elastic, however, any formulation that behaves predominantly elastically, the value of the drop tangent is less than one and shows the dominant elastic behavior, and if the drop tangent is greater than one, it indicates it gives viscous behavior.

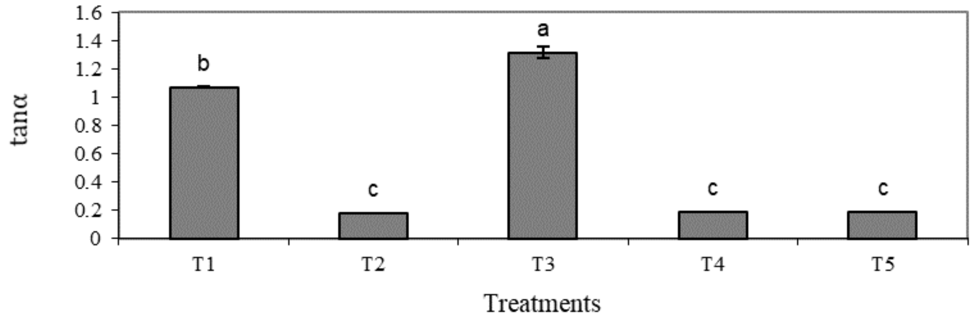

Figure 3. Changes in tanα of cream** with fat percentages and different homogenization pressures

** Treatments prepared as follows: T_1: 25% of fat and homogenization pressure was 100 bar, T_2: 30% of fat and homogenization pressure was 100 bar, T_3: 25% of fat and homogenization pressure was 200 bar, T_4: 30% of fat and homogenization pressure was 200 bar and T_5 as a control sample: 25% of fat and homogenization pressure was 150 bar. Different letters on the histograms indicate significant differences at the $p<0.05$ level.

3-9. Changes in viscosity

The highest amount of viscosity related to treatment T2 containing 30% fat and homogenization pressure 100 bar, and the lowest amount of viscosity related to treatments T1 and T3 containing 25% fat and homogenization pressure 100 and 200 bar, respectively, and the closest treatment in terms of viscosity to the control treatment is T1 and T3 treatments. (Figure 4). Viscosity provides a measure of the hardness of the total volume. By increasing the percentage of fat and decreasing the homogenization pressure, the viscosity increases. The cause of this phenomenon can be attributed to the accumulation of fat globules and the formation of a gel-like network. In fact, it can be said that the cause This discharge accumulation phenomenon means the disintegration of the membrane of fat cells during the whipping process, the addition of substances such as phospholipids and emulsifiers, which leads to the improvement of the mixing characteristics of the cream. These compounds in the cream increase the viscosity of the serum and cause the stability of the emulsion The higher the viscosity of the emulsion, the movement of fat globules and the collision between globules decreases. The increase in consistency may be due to the increase in Brownian motion in the system because new connections are formed that strengthen the cream network (Korhonen *et al*. 2001).

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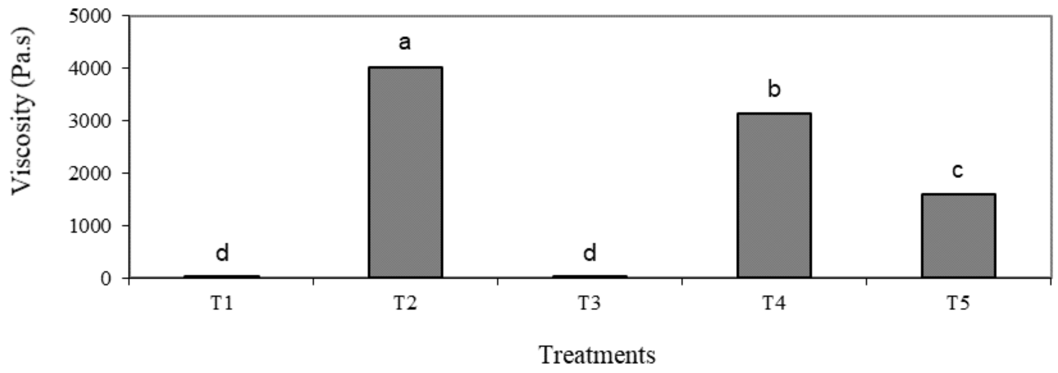

Figure 4. Changes in viscosity of cream ** **with fat percentages and different homogenization pressures**

** **Treatments prepared as follows: T_1: 25% of fat and homogenization pressure was 100 bar, T_2: 30% of fat and homogenization pressure was 100 bar, T_3: 25% of fat and homogenization pressure was 200 bar, T_4: 30% of fat and homogenization pressure was 200 bar and T_5 as a control sample: 25% of fat and homogenization pressure was 150 bar. Different letters on the histograms indicate significant differences at the $p<0.05$ level.**

3-10. Colorimetry test

The intensity of colors were determined using Hunter's parameters in terms of brightness (L*), red-green (a*) and yellow-blue (b*).

3-10-1. L* (Lightness index)

The highest color index L∗ corresponds to treatment T3 containing 25% fat and homogenization pressure 200 bar, and the lowest color index L∗ corresponds to treatment T2 containing 30% fat and homogenization pressure 100 bar, and the closest treatment in terms of color index L∗ to the control treatment is treatment T3 It contains 25% fat and homogenization pressure of 200 bar (Figure 5). Homogenization by reducing the size of fat globules prevents the process of milk coagulation and the color of the products becomes whiter and the resulting light scattering depends on the size and number of particles in the sample. Therefore, the treatment with less fat and higher homogenization pressure showed a higher brightness index, and vice versa, the samples with more fat and lower homogenization pressure showed more yellowness and a lower L* lightness index. The results of this research were consistent with the results of other researchers (Ghoreishi Rad *et al.*, 2011).

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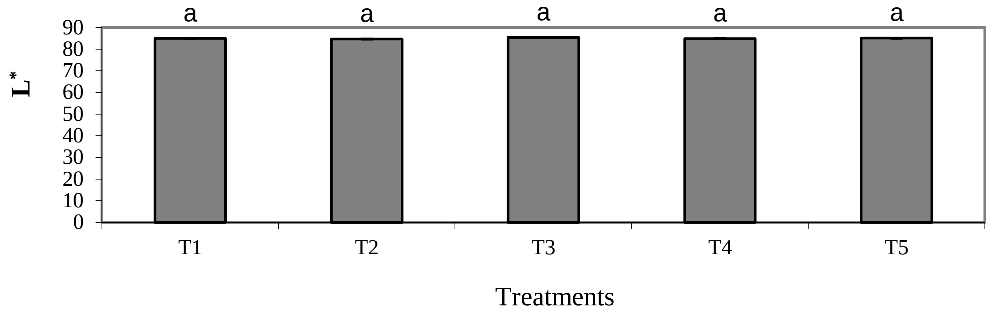

Figure 5. Changes in L* Lightness index of cream** with fat percentages and different homogenization pressures
** Treatments prepared as follows: T_1: 25% of fat and homogenization pressure was 100 bar, T_2: 30% of fat and homogenization pressure was 100 bar, T_3: 25% of fat and homogenization pressure was 200 bar, T_4: 30% of fat and homogenization pressure was 200 bar and T_5 as a control sample: 25% of fat and homogenization pressure was 150 bar. Different letters on the histograms indicate significant differences at the p<0.05 level.

3-10-2. Yellow-blue color index (b*)

The highest color index b∗ corresponds to T2 treatment containing 30% fat and homogenization pressure 100 bar, and the lowest color index b∗ corresponds to T3 treatment containing 25% fat and homogenization pressure 200 bar. And the closest treatment in terms of color index b∗ to the control treatment, T4 treatment contains 30% fat and 200 bar homogenization pressure (Figure 6). The data of the yellow-blue index increased with the increase of fat percentage and the decrease of homogenization pressure, and this has been confirmed. The increase in the size of fat globules reduces the amount of light reflection and increases the yellow color index. The results of this research are in agreement with the results of other researchers. It was consistent (Ghoreishi Rad et al., 2011).

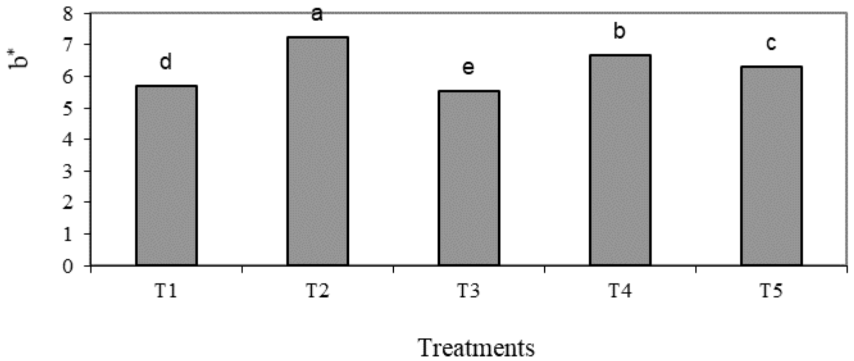

Figure 6. Changes in yellow-blue color index (b*) of cream** with fat percentages and different homogenization pressures
** Treatments prepared as follows: T_1: 25% of fat and homogenization pressure was 100 bar, T_2: 30% of fat and homogenization pressure was 100 bar, T_3: 25% of fat and homogenization pressure was 200 bar, T_4: 30% of fat and homogenization pressure was 200 bar and T_5 as a control sample: 25% of fat and homogenization pressure was 150 bar. Different letters on the histograms indicate significant differences at the p<0.05 level.

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3-10-3. Red-green color index (a*)

Treatments T1, T3 and T5 (as a control treatment) have a negative a∗ factor (-0.08, -0.06 and -0.04), respectively, and treatments T2 and T4 have a positive a∗ factor (0.13). + and 0.07). As the percentage of fat increases, factor a∗ increases and the highest amount of factor a∗ is related to T2 treatment and the closest treatment to the control treatment is T3 treatment containing 25% fat and 200 bar homogenization pressure. (Figure 7). This parameter is the red-green index. The higher the fat percentage of the samples, the higher the red-green index. The treatment containing 30% fat and 200 times homogenization pressure had the highest red-green index. The results of this research were consistent with the results of other researchers (Ghoreishi Rad *et al*., 2011).

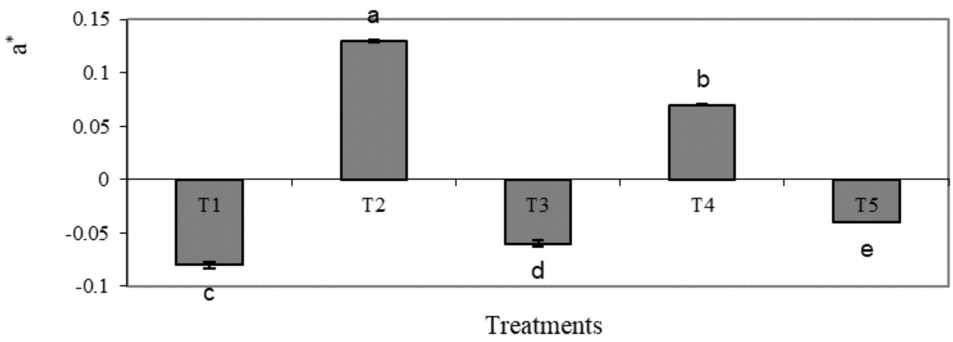

Figure 7. Changes in red-green color index (a*) of cream** with fat percentages and different homogenization pressures

** Treatments prepared as follows: T_1: 25% of fat and homogenization pressure was 100 bar, T_2: 30% of fat and homogenization pressure was 100 bar, T_3: 25% of fat and homogenization pressure was 200 bar, T_4: 30% of fat and homogenization pressure was 200 bar and T_5 as a control sample: 25% of fat and homogenization pressure was 150 bar. Different letters on the histograms indicate significant differences at the p<0.05 level.

3-11. Changes in color sensory score

The highest amount of sensory color score related to treatments T4 and T5 contain 30 and 25% of fat and homogenization pressure of 200 and 150 bar respectively, and the lowest amount of sensory color score related to treatments T1, T2 and T3 contain 25, 30 and 25% of fat and homogenization pressure of 100. 100 and 200 times, and the closest treatment in terms of color sensory score to the control treatment is T4 treatment containing 30% fat and homogenization pressure of 200 times (Table 2). In terms of color sensory score, no significant difference was observed between the samples because p<0.05 Very minor changes in color made it impossible to be recognized by the group of sensory evaluators, and the increase of fat in the treatments up to 5% level did not cause a significant difference in the color of the produced samples, but the group of sensory evaluators of the samples that had a more noticeable whiteness and of course were under higher homogenization pressure This research was in line with the results obtained by Katouzian et al. (2016).

3-12. Sensory of aroma and smell scores

The highest aroma and smell sensory score related to T4 treatment contains 30% fat and homogenization pressure 200 bar, and the lowest aroma and odor sensory score related to T1 treatment contains 25% fat and 100 bar homogenization. And the closest treatment in terms of aroma and smell sensory score to control treatment is T4 treatment. It contains 30% fat and homogenization pressure of 200 bar (Table 2). In general, the higher the percentage of fat in the samples and the higher

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the homogenization pressure, the more the sensory evaluators accepted the sample, because the greater dispersion of the smaller size fat in the fat bed led to a favorable aroma and flavor in the samples, therefore, the samples with higher homogenization pressure and higher fat had a higher sensory score. This research was in line with the results obtained by Katouzian *et al*. (2016).

3-13. Texture sensory score

The highest tissue sensory score related to T4 treatment contains 30% fat and homogenization pressure 200 bar, and the lowest tissue sensory score related to T1 treatment contains 25% fat and 100 bar homogenization. And the closest treatment in terms of tissue sensory score to the control treatment is T4 treatment containing 30% fat and The homogenization pressure is 200 bar (Table 2). As expected, reducing the amount of fat significantly affected the taste, texture, color and final desirability, and the low-fat cream got the lowest points in terms of all attributes. Sample with higher fat presented a firmer texture and a more favorable mouthfeel, and this factor caused these samples to have a higher sensory score. The results of this research were consistent with the results obtained by Orouji *et al*. (Orouji *et al*., 2017).

3-14. Sensory score of flavor

The highest flavor sensory score is related to the T4 treatment containing 30% fat and 200 bar homogenization pressure, and the lowest flavor sensory score is related to the T4 treatment containing 30% fat and 200 bar homogenization. And the closest treatment in terms of flavor sensory score to the control treatment is the T4 treatment. It contains 30% fat and homogenization pressure of 200 bar (Table 2). As the percentage of cream fat and homogenization pressure increased, the produced samples were more acceptable in terms of taste and taste by sensory evaluators, and samples with higher fat and uniform distribution along with smaller sizes of fat globules in the fat bed caused flavor and the flavor was better and the mouthfeel was more favorable. The results of this research were consistent with the results obtained by Orouji et al. (Orouji et al., 2017).

3-15. Acceptability sensory score

The highest acceptability sensory score is related to T4 treatment containing 30% fat and 200 bar homogenization pressure, and the lowest acceptability sensory score is related to T1 treatment containing 25% fat and 100 bar homogenization. And the closest treatment in terms of acceptability sensory score to the control treatment is T4 treatment. It contains 30% fat and homogenization pressure of 200 bar (Table 2). In general, the samples were evaluated in terms of sensory indicators such as color, smell, texture and taste, and the samples with the highest sensory score in terms of the above indicators They are introduced as the superior treatment. In this regard, the T4 treatment containing 30% fat and homogenization pressure of 200 bar got the highest sensory scores and in terms of acceptability, the results of this research were consistent with the results obtained by Oroji *et al*. (Orouji *et al*., 2017).

Table 2. Changes in sensory characteristics of cream** with different fat percentages and homogenization pressure

Sensory properties					Treatments
Acceptability	Flavor	Texture	Aroma	Color	
5.14^{c}	6.30^{c}	5.30^{c}	6.71^{ab}	7.86^{a}	T1
6.86^{b}	7.00^{ab}	6.86^{b}	7.14^{ab}	7.86^{a}	T2
5.57^{c}	5.86^{c}	5.43^{c}	6.71^{ab}	7.86^{a}	T3
8.00^{a}	8.00^{a}	8.00^{a}	7.86^{a}	8.00^{a}	T4
7.14^{b}	7.43^{ab}	7.30^{b}	7.43^{ab}	8.00^{a}	T5(Control)

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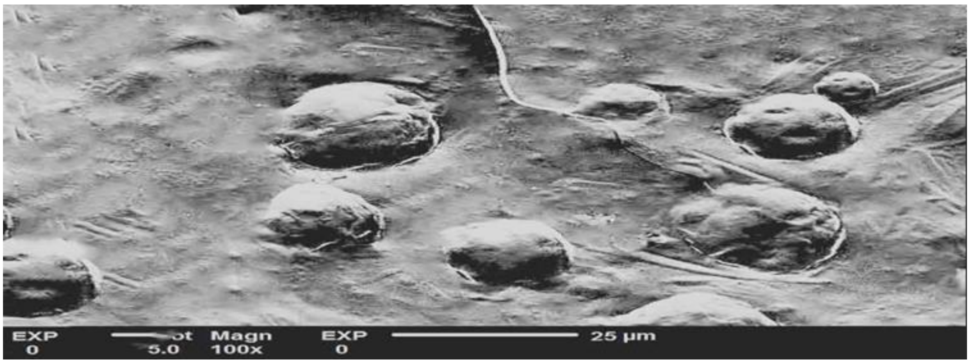
** Treatments prepared as follows: T_1: 25% of fat and homogenization pressure was 100 bar, T_2: 30% of fat and homogenization pressure was 100 bar, T_3: 25% of fat and homogenization pressure was 200 bar, T_4: 30% of fat and homogenization pressure was 200 bar and T_5 as a control sample: 25% of fat and homogenization pressure was 150 bar. Different letters in each column indicate significant differences at $p<0.05$ level.

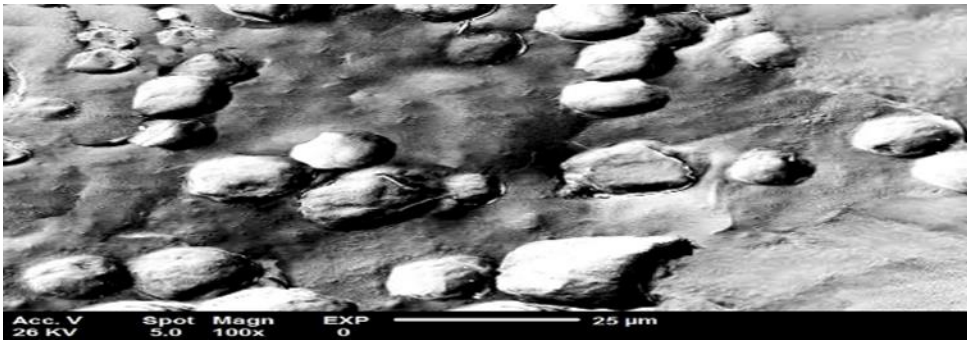
3-16. Evaluation of electron micrograph images

As shown in the electron micrographs (Figure 8), the more the homogenization pressure increases, the smaller the size of the fat cells and the distribution of their distribution in the fat bed is more uniform, and vice versa, at low homogenization pressures, the size of the cells is larger and the distribution is more uniform. The distribution of fat cells in the fat bed is more uneven.

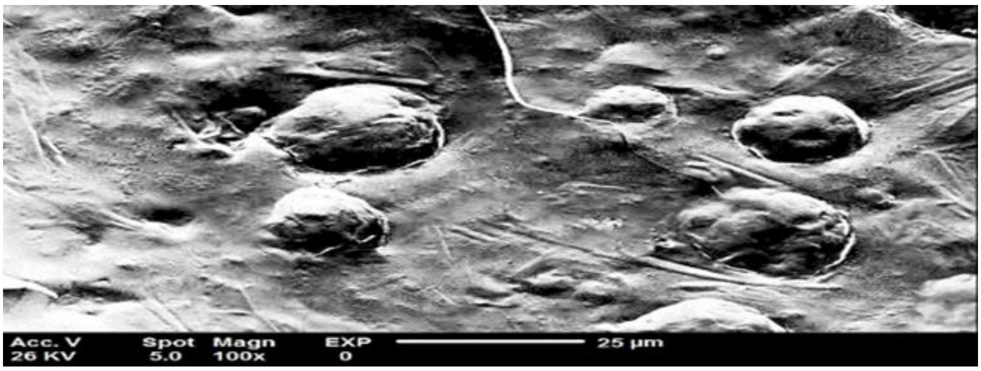


T1

T2



T3



T4

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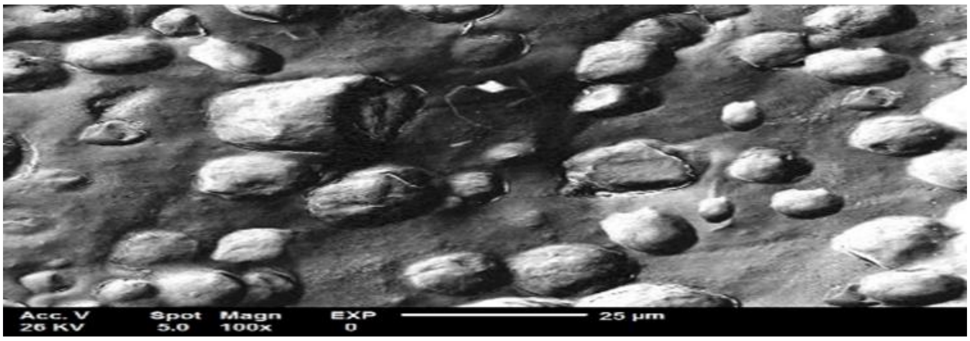

T5

Figure 8. Changes in fat globules of cream ** **with fat percentages and different homogenization pressures**

** Treatments prepared as follows: T_1: 25% of fat and homogenization pressure was 100 bar, T_2: 30% of fat and homogenization pressure was 100 bar, T_3: 25% of fat and homogenization pressure was 200 bar, T_4: 30% of fat and homogenization pressure was 200 bar and T_5 as a control sample: 25% of fat and homogenization pressure was 150 bar.

4. Conclusion

In terms of physicochemical characteristics, pH value decreased and acidity increased in treatments containing higher fat, and treatments with low fat and low homogenization pressure showed a higher percentage of dry matter hardness due to increased viscosity and stability, and treatments with higher homogenization pressure due to tissue stability. Weaker showed a higher water flow and as the percentage of fat increases and the homogenization pressure decreases, the rheological indices G′ and G″ increase, and the intensity of the increase in G′ is greater than G″, and the viscosity increases, and the drop tangent decreases, and in terms of color indicators, the samples with higher percentage of fat had a yellower color. Sensory evaluation studies showed that the samples with higher fat and higher homogenization pressure also have a higher degree of acceptance, however, according to the physicochemical, rheological characteristics and sensory and color indices as well as evaluation of cream microstructure, T4 treatment with 30% fat and 200 times homogenization pressure was more similar to the control treatment and was recognized as the superior treatment.

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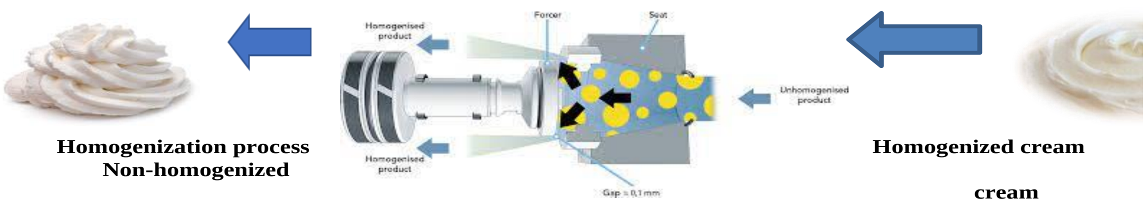

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تاثیر درصد چربی و فشار هموژنیزاسیون بر ویژگی های فیزیکوشیمیایی، رئولوژیکی و حسی خامه صبحانه

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چکیده

در این تحقیق یک نوع خامه مطابق با روش استاندارد با درصدهای متفاوت چربی و فشارهای متفاوت هموژنیزاسیون تولید شد تیمارها شامل، T_1 : حاوی ۲۵٪ چربی و فشار هموژنیزاسیون معادل ۱۰۰ بار ، T_2: حاوی ۳۰٪ چربی و فشار هموژنیزاسیون معادل ۱۰۰ بار، T_3: حاوی ۲۵٪ چربی و فشار هموژنیزاسیون معادل ۲۰۰ بار، T_4: حاوی ۳۰٪ چربی و فشار هموژنیزاسیون معادل ۲۰۰ بار و T_5 به عنوان تیمار شاهد: حاوی ۲۵٪ چربی و فشار هموژنیزاسیون معادل ۱۵۰ بار. آزمایش به صورت فاکتوریل در قالب طرح کاملا تصادفی و در سه تکرار انجام شد. نتایج نشان داد تیمارهای با درصد چربی بالاتر دارای اسیدیته(دورنیک) بیشتر و pH پایین تر و تیمارهای با چربی کمتر و فشار هموژنیزاسیون کمتر دارای ماده خشک بیشتر و تیمارهای با فشار هموژنیزاسیون بالاتر آب اندازی بیشتری نشان داد. نتایج حاصل از ویژگیهای رئولوژیکی نشان داد که با افزایش درصد چربی و کاهش فشار هموژنیزاسیون شاخص های رئولوژیک نظیر G' و G'' افزایش و همزمان با افزایش G' ویسکوزیته نیز افزایش یافت همچنین تانژانت افت در زمانی که G' افزایش پیدا کرد کاهش یافت.رنگ سنجی نشان داد که نمونه های با چربی بیشتر دارای زردی بیشتر نسبت به سایر تیمارها می باشد.ارزیابی حسی نشان داد که نمونه های با چربی بالاتر و فشار هموژنیزاسیون بالاتر بیشتر مورد پذیرش ارزیابان حسی واقع شدند.بر مبنای نتایج ذکر شده فوق تیمار T_4 با ۳۰درصد چربی و فشار هموژنیزاسیون ۲۰۰ بار به عنوان بهترین تیمار از میان سایر تیمارها انتخاب شد.