Using sesame oil as fat substitute in yogurt

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Abstract: Yogurt is one of the most important and common dairy products that is more acceptable due to its sensory properties and health-related values. Now most of the yogurt in Iran is high-fat yogurt and due to the saturated fat and cholesterol and the relation of this kind of fat with some diseases, the consumption of yogurt got problematic. Substitution of the fat of milk with healthy vegetable oil is one of the strategies of producing high fat yogurt by keeping the sensory, tissue properties and improving nutritional properties. In the current study, the effect of substitution of milk fat with refined sesame oil on sensory, physicochemical and rheological properties of high-fat yogurt is studied. After the thickening of the initial milk by adding 2% non-fat dry milk, the milk fat content was adjusted by mixing the cream and sesame oil. The results of the study showed that acidity changes and PH didn’t have correlation with sesame oil ratio in each sample but the samples with more sesame oil had high PH. The fat percent of the samples at the end of the storage period was partially more than the beginning of the period. Thus, this study showed that in case of formulation modification, we can use sesame oil in production of high-fat yogurt as the substitute of a part of milk fat.

Keywords: Yogurt; sesame oil; Fat substitute; Vegetable oil

Introduction

Milk due to having unique ingredients is the only recognized matter in the nature can provide all the body needs including energy, building and repair of the tissues. The major characteristic of milk is the protein composition and the vitamins and special minerals as Vitamin B, Vitamin A, Calcium and its phosphor. But milk products have considerable amount of saturated fat and cholesterol. For example, each 100 mL milk is including 3.5-4 g fat and the range 2.5-2.2 g is saturated and it has about 33-34 mg cholesterol. The fat content of different kinds of yogurts is ranging 1-7% and its cholesterol is varied depending upon the yogurt fat (1). Yogurt is one of the famous dairy products. Its consumption in the locations with more available dairy products is more than other products. Although, the principles of production of this product is similar in all over the world, but sensory properties, smell, taste, tissue, etc are different and it is used in different types. The ancient person of Middle East, used yogurt to cure
gastric and liver dysfunction and it was a kind of appetizer (2). Yogurt by reinforcing the useful bacteria of the intestine increases the health of gastric system (3). Normally, triglycerides dedicated the 95% of yogurt fat, of which 74% are dedicated to saturated fatty acid (SFA), 23% to Mono-unsaturated fatty acid (MUFA), 3% to Poly-unsaturated fatty acid or some (PUFA). According to the researchers of nutrition, the ideal fat of milk and milk products in diet should be including 10% PUFA, 8% SFA, at least 82% MUFA (4). The saturated fatty acid increases the cholesterol level (LDL) and MUFA, PUFA reduce it and the Coronary Heart Disease (CHD) will be decreased. Thus, using vegetable oil and replacing them by milk fat in dairy products namely yogurt is considered for reduction of yogurt cholesterol and the improvement of the variety of its fatty acid (5). Vegetable oil have high saturation property compared to milk fat and they are without cholesterol and are cheaper and are less affected by seasonal changes and fatty acid changes than milk fat (6). Sesame oil is recognized for its resistance to oxidation. One of the reasons of high resistance is due to tocopherol in this oil and it is 1200 mg/kg in sesame oil. Gamma tocopherol is consisting of the major part of sesame oil, then delta and alpha include about 5% of tocopherol of oil. Among different isomers of tocopherol, gamma tocopherol is the dominant antioxidant in the oil (7). Sesame oil is without any LDL and prevents the synthesis of LDL in the body to 50% and this oil can affect the metabolism of HDL in the body to 85% preventing the blockage of veins and arteries of heart. Sesame oil is recommended highly for the patients suffering from high pressure. The high antioxidant property of sesame oil is due to two chemical materials as sesamin and sesamol, and they fight with the free radicals damaging the body cells and facilitate early aging (8).

Materials and methods

• The milk including 3% fat content and skimmed milk and non-fat dry milk were provided from Pegah Company in Tehran.

• High-quality sesame oil

• Yogurt starter was purchased from Christian Hansen Company of Denmark.

For preparing the samples, after mixing the milk and dry milk and various percents of sesame oil (in accordance with the formula of each sample), the samples were transferred to homogenization device and is homogenized at pressure 200 bar and then is heated at 85°C for 20 min to be pasteurized and then was cooled to 45°C. To prepare the starter, the freeze-dried starter consisting of the mixture of lactobacillus bulgaricus streptococcus thermophilus bacteria was added to 500mL milk after sterile skim and to prepare yogurt, for each 1000 mL milk, 2 mL of this mixture was ready for inoculation. The inoculated milk after being filled in the dishes was heated at 44-45°C to reach the required pH for 3-4 hours. After reaching the required PH, the yogurt was cooled at 6°C and was kept at the same temperature to pass the secondary period of acidity and production of aromatic ingredients. The required tests were carried out on the samples one day after the production and the time interval of yogurt storage (7th, 14th, 21th)
Table 1- Animal or vegetable fat percent in the provided yogurt samples

<table>
<thead>
<tr>
<th>Sample</th>
<th>Fat percent of milk (animal fat)</th>
<th>Fat percent or sesame oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>A control sample</td>
<td>3%</td>
<td>-</td>
</tr>
<tr>
<td>A_B_1</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>A_B_2</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>B</td>
<td>-</td>
<td>3%</td>
</tr>
</tbody>
</table>

**Abbreviations**

- A: The control sample milk including 3% full fat
- A\_B\_1: Including 2% milk fat and 1% sesame oil
- A\_B\_2: Including 1% milk fat and 2% sesame oil and B including 3% replaced sesame oil.

**Tests**

- Measuring pH in accordance with Iran national standard NO. 2852 and by pH meter Metrohm, model 691, made in Swiss.
- The acidity of the samples was measured in accordance with Iran national standard NO. 2852.
- Yogurt fat percent was measured after being diluted by Gerber (Butyrometer. Gerber) and in accordance with Iran national standard No. 366.
- Viscosity of the produced samples was measured by Brookfield viscometer (RV-DVII).
- For sensory analysis of the yogurt samples, 10-point Hedonic test was used. The samples were evaluated in terms of organoleptic properties such as taste, tissue, color and final desirability.
- To measure the syneresis of yogurt, 25 g of the sample was weighted on Whatman filter papers No. 41 and were placed on funnel. The amount of the water exiting the funnel after 120 min at 4°C was defined as syneresis.
Results and discussion

Chemical properties

The measured chemical properties (pH, acidity and fat percent) of the samples were shown at the beginning of the production and during 21 days storage in charts 1,2,3. During 21 days storage of the samples in refrigerator, pH was reduced and acidity was increased. The storage had significant effect on acidity and ph of the samples. The reduction of ph and the increase of acidity are due to the activity of useful or harmful microorganisms that by taking sugar and production of organic acids can lead into the reduction of pH.

Acidity changes during storage

The results showed that the acidity in the samples is less than the acidity of the control group by the increase of the replacement with vegetable oil. A2B1 sample didn’t follow this trend (Chart 1). The low acidity in the replaced samples is due to the vegetable fat in them. Bonczar et al., (2002) showed that the milk fat is effective on the properties of normal and probiotic yogurt such as pH, acidity and free fatty acid. Also, it showed that the samples with high fat percent had high pH compared to the samples with low fat percent (9). Shaker et al., (2000) studied the rheological properties of yogurt with four fat levels during fermentation process and concluded that the increase of the milk fat increased the viscosity and decreased the production of acid by starter bacteria (10).

Chart 1- Acidity changes during storage time
The fat percent changes of the samples didn’t change considerably during the storage.

The pH changes of the samples are reduced by the increase of replacement with vegetable oil. The changes of pH in the samples with high amount of sesame oil was less than the pH change of the control sample as the higher the amount of sesame oil, the less the changes of pH during the storage compared to control sample and A₂B₁ sample. The pH change in A₂B₁ had the highest reduction and fluctuation during storage.
the storage time compared to other samples. The lowest reduction of fluctuation of pH during the storage time was dedicated to B sample with the lowest pH reduction and the lowest fluctuation of pH.

![Chart 4- Syneresis changes during storage]

**Syneresis changes during storage**

One of the major drawbacks of yogurt is syneresis and it is the appearance of serum or whey on the surface of yogurt. Yogurt syneresis is occurred due to the shrinkage of 3-D structure of protein matrix and it leads into the weak bond of protein of when and the removal of water from yogurt (11).

The study of the syneresis changes of the samples during the storage showed that the highest amount of syneresis was occurred in the first week (chart 4) and it is due to the increase of acidity and contraction of gel network due to cooling and it leads into the increase of syneresis in the first week. As is shown, increasing sesame oil in yogurt samples increased the syneresis of the samples and by reduction of sesame oil decreased the syneresis of the samples that is due to the creation of compressed gel network compared to the samples with high sesame oil. In control sample, during the storage, syneresis is decreased and it is due to the reduction of acidity during the storage (12). Storage time had considerable effect on syneresis as syneresis value was reduced significantly on day 14 of storage period compared to the first day.
Viscosity changes during storage

Viscosity of a matter is the fluid resistance against deformation and in fermentation dairy products is called cohesion (13). As yogurt is a non-Newton fluid, measuring its viscosity is hard (14). Viscosity of the produced samples was measured by Brookfield viscometer (RV-DVII) and the results of the measurements are shown in chart (1-5). During the storage period, the viscosity of the samples was increased significantly as the highest viscosity was dedicated to the samples on 14 day of storage period and the increase of viscosity during the time can be due to the changes of protein-protein bonds in 3-D protein network of yogurt samples (15). The viscosity difference of the samples can be due to various factors as non-fat dry matter of milk, fat percent, the type of fermentation starter, the type of thermal treatment and fermentation temperature.

The replaced sesame oil in the samples can create some changes in macrostructure of yogurt gel as the matrix is more open and by reducing the interfacial tension reduces viscosity (16). The viscosity of the samples showed significant difference as the difference of viscosity of the samples can be due to various factors as non-fat dry matter of milk and the type of vegetable oil in the samples.
The results of sensory analysis of the produced samples during the storage are shown in Table 2. According to the sensory analysis scores, it was defined that A₁B₂ sample and control sample had the highest score compared to other samples during the storage period and sample B was in the next order after two other samples and the lowest score was dedicated to A₂B₁.

Conclusion

The results of this study showed that the acidity changes and pH didn’t have correlation with sesame oil ratio in each sample but the samples with high sesame oil had high pH. The fat content of the sample at the end of storage period was partially more than the beginning of the period. The increase of syneresis and the decrease of viscosity of the samples with the increase of sesame oil in yogurt during the storage period were the results of the current study. The results of the sensory analysis showed that control sample (3% milk fat) was the most desirable sample and the sample with 2% sesame oil and 1% milk fat, the sample with 3% sesame oil and the sample with 2% milk fat and 1% sesame oil were in the next ranks, respectively. The current study showed that in case of the modification of the formulation, sesame oil can be applied in production of high-fat yogurt as the substitute of a part of milk fat.

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