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Scientific Research

Production of Fat-Free Strained Yoghurt Based on Buttermilk; Investigation on Physical, Chemical and Sensory Analysis During Shelf Life

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ABSTRACT

Buttermilk has many functional and nutritional impacts due to the presence of phospholipids and proteins in the membrane of fat cells. Based on this, the present study was designed to investigate the use of sweet buttermilk in free-fat strained yogurt (FFSY). For this purpose, ratios of 5, 10, and 15% (w/w) sweet buttermilk were used in the preparation of the yogurt base. This research was conducted in the form of a completely random design. On days 0, 5, 10, 15, and 20, the pH, dry matter (%), and protein (%) of the FFSY were evaluated. In addition, the viscosity (mPa.s) and the sensory analysis of the FFSY, including appearance, odor, taste & flavor, mouthfeel and, and general acceptance, were examined during the first and 20th days. The results showed that the pH of the samples containing buttermilk decreased more during shelf life ($P > 0.05$). Dry matter (%) decreased with increasing the buttermilk (%), although no significant change in dry matter was observed during the shelf life ($P > 0.05$). With increasing buttermilk (%), the protein (%) decreased and it did not change over the shelf life ($P > 0.05$). By reducing the buttermilk (%), the viscosity (mPa.s) also decreased ($P > 0.05$). The sensory evaluation test showed the FFSY containing 10% (w/w) buttermilk possessed the highest score for taste & flavor, mouthfeel, and general acceptance. Therefore, this treatment was selected as the best sample. In general, the present study showed that the use of buttermilk in the production of FFSY is functionally and practically useful.

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1- Introduction

Buttermilk is a byproduct of the butter-churning process, renowned for its industrial and nutritional significance. This dairy derivative comprises primary milk constituents, including caseins, whey proteins, lactose, along with substantial quantities of phospholipids and milk fat globule membrane proteins (PMFGM) [1]. The inclusion of these compounds in buttermilk stems from the degradation of milk fat globule membranes during the butter-churning process, thereby enhancing its nutritional profile. Furthermore, the serum phase composition of buttermilk closely resembles that of cheese whey. Notably, buttermilk is rich in calcium, thereby enhancing its health-promoting attributes [2].

Yogurt, due to its high digestibility, nutritional value, and health benefits, is one of the most consumed fermented dairy products [3]. With the increasing risks of obesity, cardiovascular diseases, and hypertension in developed societies, low-fat or fat-free dairy products (containing less than 0.5% fat) have gained attention from a wide spectrum of consumers [4]. In recent years, fat-free yogurt, marketed under various brand names, has been introduced to the Iranian market. This type of yogurt falls into the flavored yogurt category according to the Iranian National Standard number 4046 [5].

Due to their high protein content and low fat, these yogurts are a very suitable option for athletes' nutrition. However, reducing the fat content in dairy products, especially yogurt, can have undesirable effects on its properties, including texture, viscosity, and taste, especially during storage. This can lead to an unpleasant mouthfeel and, consequently, consumer rejection [6].

Therefore, various methods have been investigated to improve the quality characteristics of low-fat or fat-free yogurt, such as adding milk derivatives, thickeners, stabilizers, and enzymes (e.g., transglutaminase enzyme) [7-9].

Another solution involves using starter cultures that produce exopolysaccharides (EPS) to enhance firmness and viscosity. These cultures can interact with the casein network and improve its structure [10].

Generally, the methods mentioned have focused less on improving the nutritional properties of yogurt. In some studies, the impact of buttermilk (in powder or liquid form) on the quality attributes of fat-free yogurt has been investigated, but the outcomes of these studies have been inconsistent.

Zhao et al. [11] reported that the addition of buttermilk enhances compounds that influence the aroma and taste of low-fat yogurt, thereby improving its flavor profile. In another investigation, Zhao and colleagues used up to 4% (w/w) buttermilk powder in the production of low-fat yogurt. Their findings revealed that incorporating buttermilk led to a reduction in pH during coagulation, shortened gel network formation duration, mitigated syneresis, and amplified viscosity and firmness of low-fat yogurt throughout storage [12]. Nevertheless, Lee et al. [13] contended that the inclusion of buttermilk exerted no discernible influence on the texture of fat-free yogurt, whereas Romeih et al. [14] observed that fat-free yogurt formulated with buffalo milk containing buttermilk exhibited a denser and more compact gel network. Hence, further investigation is warranted to ascertain whether buttermilk can effectively enhance the texture of fat-free yogurt. Limited data are available regarding the impact of adding buttermilk on the physicochemical and sensory attributes of yogurt during storage. Given that fat-free condensed yogurts have high protein content, they may cause a gritty sensation in the mouth, which consumers may find undesirable. Given the pivotal role of fat in improving mouthfeel and the minimal fat content of condensed yogurt, this study utilized buttermilk in the production of base yogurt for fat-free condensed yogurt. In summary, the primary objective of this research is to investigate the impact of sweet buttermilk on the physical, chemical, rheological, and sensory properties of fat-free condensed yogurt during storage. This represents a unique and unexplored area of study in this field.

1. Materials

Fat-free milk (skimmed), sourced from Mihan Dairy Factory (Islamshahr, Tehran, Iran), exhibited the following chemical properties: pH: 7.6, Total solids: 7.8%, Fat content: 0.2%, Protein content: 3%. Sweet buttermilk, a byproduct of the butter-making process, was also obtained from the same factory, with the following chemical characteristics: pH: 7.6, Total solids: 3.8%, Fat content: 5.0%, Protein content: 2.2%, Lactose content: 2.3%. Lyophilized starter cultures containing Lactobacillus delbrueckii subsp. Bulgaricus and Streptococcus Thermophilus bacteria, sourced from Christian Hansen Company (Denmark), were used for fermentation. All chemicals used in this study were of food-grade quality and obtained from Merck Company (Darmstadt, Germany).

2- Methods

2.1. Production of Fat-Free Condensed Yogurt

To produce fat-free condensed yogurt, sweet buttermilk was blended with skimmed milk at ratios of 5%, 10%, and 15% (w/w), guided by preliminary treatments and prior research. The blend underwent preheating to 55°C using an OMVE plate pasteurizer (Netherlands). Following two-stage homogenization at 200 bars (160:40) using a GEA NS2002H homogenizer (Germany), pasteurization occurred at 90°C for 5 minutes using a plate pasteurizer. Subsequently, cooling brought the milk temperature was lowered to 45°C through cooling. After inoculating starter cultures at 0.1% (w/w) into the milk, the mixture was incubated in a hot air incubator at 45°C until it reached a pH of 4.4. Separation into fat-free yogurt and condensed yogurt was achieved using a GEA nozzle separator (Germany) at 65°C. Finally, the fat-free condensed yogurt was uniformly homogenized with a mixer, followed by cooling to 20°C.

2.2. Viscosity Measurement

The apparent viscosity of the treatments was assessed using a digital rotational viscometer, the Atago Pro Series L model (Tokyo, Japan), equipped with spindle number 4 rotating at 50 revolutions per minute at a temperature of 7°C following shear processing for 50 seconds. Viscosity measurements were reported in mPa.S [11].

2.3. Fat Analysis

In compliance with Iranian National Standard No. 695, the fat content of fat-free condensed yogurt and sweet buttermilk samples was determined [15].2.4. Protein Determination TestAccording to Iranian National Standard No. 1811, the protein content of the samples was measured on days 0, 5, 10, 15, and 20 [16].2.5. Total Solids Percentage AssessmentThe percentage of total solids in the treatments was evaluated on days 0, 5, 10, 15, and 20 according to Iranian National Standard No. 1753 [17].2.6. pH MeasurementThe pH of the samples was monitored on days 0, 5, 10, 15, and 20 following Iranian National Standard No. 2852 [18].2.7. Sensory EvaluationSensory evaluation of the fat-free condensed yogurt samples involved consumer-oriented tests. A 5-point hedonic test (ranging from very poor (1) to excellent (5)) was conducted. A total of 60 personnel from various departments, such as research and development, production, quality control, laboratory, quality assurance, technical, and security, were involved at Mihan Dairy Factory. Sensory attributes evaluated included color and appearance, aroma, taste, mouthfeel, and overall acceptability. For this purpose, yogurt samples were stored in a refrigerator, and sensory evaluation was performed on days 1 and 20 after production.2.8. Statistical AnalysisFor comparing the means of treatments, a factorial design analysis was conducted using SPSS version 16 software (SPSS Inc., Chicago, IL, USA). To assess significance at a 95% confidence level, Duncan's post hoc test was employed. All data were reported as the mean ± standard deviation of three replicates. Tables and graphs were generated using Microsoft Office 2016 software (Microsoft Corporation, Redmond, WA, USA).3.

3- Results and Discussion

3.1. pH

The pH of the various treatments during the storage period are outlined in Table 1. Statistical analysis indicated no significant differences in pH values among the treatments on different days ($P > 0.05$). Nevertheless, a significant decrease in pH was observed over time and storage duration ($P < 0.05$). Interestingly, samples YF10 and YF15 exhibited a slightly more pronounced decline in pH compared to the control group. This phenomenon could be attributed to the fermentation of lactose present in the yogurt, resulting in the production of lactic acid [19]. These findings are consistent with those reported by Romeih et al. [14], who observed a slightly accelerated pH reduction in fat-free yogurt containing powdered buttermilk. Moreover, the faster pH decline observed in treatments YF10 and YF15 is consistent with the findings of Fernandez Garcia et al. [20], who attributed this trend to the presence of organic acids. This led to a more significant pH reduction in samples containing buttermilk powder during refrigerated storage.

3.2. Total Solids Percentage

The percentage of total solids in the different treatments from day zero to day twenty is shown in Table 2. Statistical analysis indicated a significant difference in the percentage of total solids among the treatments ($P < 0.05$). During the storage period, there were no significant changes in the percentage of total solids in the treatments ($P > 0.05$). Overall, incorporating buttermilk into yogurt production resulted in a slight decrease in total solids and, consequently, a slight increase in sample moisture content. For instance, the total solids percentage decreased from 15% in sample YF0 to 14% in sample YF15. This could be attributed to the lower total solids percentage in sweet buttermilk (7.8% for skim milk and 2.8% for buttermilk). In this regard, Kasinos et al. [21] reported that the presence of lipoprotein compounds, especially phospholipids and polar milk fat globule membrane (PMFGM) components, in samples containing buttermilk led to a decrease in the percentage of total solids. These compounds have the ability to retain water, leading to an increase in product moisture and as a decrease in the percentage of total solids. Additionally, Deshwal et al. [22] suggested that the decrease in total solids percentage could be attributed to the consumption of carbohydrates by starter cultures. However, some findings have indicated that the percentage of total solids increases over the storage period, which could be attributed to surface evaporation of moisture from the product. In this regard, it has been reported that as pH decreases over storage time, water activity increases, resulting in a decrease in product moisture percentage. On the other hand, other studies have shown that the increase in the percentage of total solids over 14 days is not significant and is related to surface moisture evaporation from the product.

3.3. Protein Percentage

The percentage of protein in the samples is presented in Table 3. Although the control treatment (YF0) had a higher protein percentage compared to the samples containing buttermilk, this difference was not significant (P > 0.05). Additionally, there were no significant changes in the protein content of the treatments over the storage period (P > 0.05). The findings of Bahrami et al. [24] demonstrated that the protein content of samples decreases with increasing buttermilk content. Moreover, other studies have shown that the protein percentage decreases as storage time increases. In this regard, Salwa et al. [25] reported that this phenomenon could be attributed to the breakdown of amino acids by starter cultures. As a result of casein proteolysis and the formation of water-soluble peptides, the soluble nitrogen content increases, which leads to a decrease in the total protein percentage. This finding contradicts that of Ahmed et al. [26], who stated that during the fermentation process, the population of Lactobacillus bulgaricus and Streptococcus thermophilus bacteria increases, leading to elevated microbial protein levels and, consequently, an increase in the overall protein content in yogurt.

3.4. Viscosity

As illustrated in Figure 1, incorporating buttermilk in the base yogurt production process to create fat-free yogurt resulted in a slight increase in sample viscosity on the initial day, which was not statistically significant ($P > 0.05$). Consequently, with increasing levels of buttermilk in the product, the viscosity of the samples increased to some extent. This could be attributed to the presence of specific compounds in buttermilk, such as proteins and phospholipids, which possess emulsifying properties. In this regard, PMFGMs form disulfide or non-covalent bonds with caseins and whey proteins [27]. Such a phenomenon enhances the interaction between milk proteins, leading to improved texture and increased viscosity of the product. Moreover, due to their hydrophilic and hydrophobic properties, phospholipids have a high water-holding capacity [14]. In this regard, phospholipids form electrostatic and hydrophobic bonds with cheese whey proteins and beta-casein [31-30]. Additionally, some studies have suggested that buttermilk may be a suitable food source for Streptococcus thermophilus bacteria, as these

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bacteria can secrete EPS, thereby improving product texture properties [32]. However, the findings of Le et al. [13] contradict the results of the present study. They reported that low-fat yogurts containing buttermilk had weaker texture properties compared to the control sample. This could be attributed to the higher phospholipid content in their used buttermilk (3.3%). It is worth noting that phospholipids have less hydration capacity than proteins, which may reduce the water-holding capacity in the gel network of yogurt [33]. Furthermore, the utilization of elevated levels of phospholipids may occupy more space, precipitate more soluble calcium, and ultimately disrupt the gel network formation process [34-35]. The results at the end of the twentieth day of storage also indicate a somewhat insignificant change in sample viscosity (P > 0.05). This could be attributed to the negligible amounts of free water and the high protein content in fat-free yogurt samples.

3.5. Sensory Evaluation

3.5.1. Color and Appearance

In Figure 2-A, the sensory evaluation results of different treatments on the first day of storage are presented. Based on this, no significant difference was observed in the color and appearance features of the samples ($P > 0.05$). The control sample and YF10 sample had the highest scores. However, as shown in Figure 2-B, a significant difference in the scores of color and appearance between treatments was observed with increasing storage time until the twentieth day ($P < 0.05$). Accordingly, the control sample had the highest score, while the YF15 sample had the lowest score in terms of color and appearance. These findings are consistent with the results of Vargas and colleagues [36], who reported changes in color over time, attributing them to the compactness of the structure and increased moisture content of the product. Additionally, Hutchings suggested that changes in the color coordinates of the product could be related to different levels of buttermilk opacity [37].

3.5.2. Odor and Smell

The results of odor and smell of different treatments on the first day of storage are shown in Figure 2-A. Based on this, no significant difference was observed in the odor and smell characteristics of the treatments ($P > 0.05$). In this regard, the control sample had the highest score. However, as indicated in Figure 2-B, a statistically significant difference was observed in the odor and smell results of the samples on the twentieth day of storage ($P < 0.05$). Accordingly, YF10 had the highest scores, while YF15 had the lowest scores in terms of odor and smell. The decrease in odor and smell scores of treatments aligns with the findings of Ekinci and colleagues [38], who reported a decrease in carbonyl compounds over time at refrigeration temperature, possibly linked to metabolic activity during storage.

3.5.3. Taste

According to Figure 2-A, the statistical results comparing the mean taste of the product indicated that on the first day, the YF10 sample had the highest score, while the control sample (without buttermilk) had the lowest taste score ($P < 0.05$). With time, on the twentieth day of storage, different results were observed compared to the first day (see Figure 2-B). In this regard, a notable difference in the taste scores of the samples was observed on the twentieth day of storage ($P < 0.05$), with YF10 receiving the highest score and YF15 receiving the lowest score. This finding suggests that the taste of the sample containing 15% buttermilk (YF15) decreases more compared to other samples with increased storage time. On the other hand, Zhao and colleagues reported that adding buttermilk increased the frequency of compounds affecting odor and taste, thus significantly enhancing the taste of low-fat yogurt [12]. The results obtained in this study are consistent with the findings of Radi and colleagues [39], who reported that over time, acetaldehid (the principal compound responsible for the yoghurt flavor) is metabolized by the alcohol dehydrogenase enzyme secreted by Streptococcus thermophilus and converted to ethanol. In this context, Oberman [40] reported that the enzyme diacetyl reductase is primarily accountable for reducing the yoghurt flavor and taste of yogurt after extended storage.

3.5.4. Mouthfeel

As shown in Figure 2-A, the mouthfeel score of the YF15 sample is higher than that of the other samples. In this regard, although no significant difference was observed between the YF15 and

YF10 samples statistically (P > 0.05), they were significantly different from the control sample and the YF5 sample (P < 0.05). According to Figure 2-B, on the twentieth day of storage, the YF10 and YF15 samples still had the highest scores in terms of mouthfeel, and they were statistically different from the other samples (P < 0.05). Accordingly, the control sample had the lowest score, and the YF10 sample had the highest score. These results align with those of Becker and Puhan [41], who reported that samples with higher protein content are firmer and, therefore, create a thicker consistency. In this regard, Romeih and colleagues reported that incorporating buttermilk powder (at levels of 4% to 5%) in yogurt production results in a desirable mouthfeel [14].

3.5.5. Overall Acceptance

According to Figure 2-A, the YF10 sample had the highest overall acceptance scores, while the control sample had the lowest scores (P < 0.05). Based on Figure 2-B, on the twentieth day of storage at refrigeration temperature, the YF10 sample still had the highest overall acceptance score (P < 0.05). However, the lowest overall acceptance score was related to the YF15 sample, whereas on the first day of storage, the control sample had the lowest score. This indicates that using more than 10% (w/w) buttermilk in the long term could reduce product quality in terms of odor and taste. Zhao and colleagues stated that low-fat yogurt containing 1% (w/w) buttermilk powder had similar sensory scores to full-fat yogurt. Based on the sensory evaluation results, the YF10 sample has been chosen as the top sample.

4- Conclusion

Since fat-free yogurts are characterized by high protein content and lack suitable mouthfeel, adding buttermilk can enhance their mouthfeel while maintaining the yogurt's fat content. The findings of this study showed that over time, the pH of butter-containing samples decreases more. The total solids content of the product increased with a rise in buttermilk content, although no significant change in this indicator was observed over time. The increase in buttermilk content resulted in a slight decrease in the protein content of the samples. In this regard, the increase in time had no significant effect on the protein percentage of the samples. Sensory evaluation results indicated that samples containing buttermilk received the highest scores for taste, mouthfeel, and overall acceptance. In this regard, the YF10 sample (containing 10% buttermilk) received the highest overall acceptance score. Based on the findings of this study, it is recommended to use butter milk in other dairy products. In this regard, while enhancing the nutritional and sensory properties of the product, one of the by-products of butter production is utilized, which will also have positive environmental implications.

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[1] Roesch, R.R., Rincon, A. and Corredig, M. (2004). Emulsifying properties of fractions prepared from commercial buttermilk by microfiltration. *Journal of dairy science*, *87*(12), 4080-4087.

[2] Sodini I, Morin P, Olabi A, Jiménez-Flores R. (2006). Compositional and functional properties of buttermilk: A comparison between sweet, sour, and whey buttermilk. Journal of Dairy Science; 89(2), 525-36.

[3] Shah NP. Health benefits of yogurt and fermented milks. (2006) Manufacturing yogurt and fermented milks. 26, 327.

[4] Persoons P, Vermeire S, Demyttenaere K, Fischler B, Vandenberghe J, Van Oudenhove L, Pierik M, Hlavaty T, Van Assche G, Noman M, Rutgeerts P. (2005). The impact of major depressive disorder on the short-and long-term outcome of Crohn's disease treatment with infliximab. Alimentary pharmacology & therapeutics, 22(2), 101-110.

[5] INSO (2017). Milk and milk products-Flavored yoghurt Specifications and test methods, Standard No. 4046. Tehran, Iran: Iranian National Standards Organization

[6] Lee WJ, Lucey JA. Formation and physical properties of yogurt. (2010). Asian-Australasian Journal of Animal Sciences. 23(9), 112711-36.

[7] Andiç S, Boran G, Tunçtürk Y. (2013). Effects of Carboxyl Methyl Cellulose and Edible Cow Gelatin on Physico-chemical, Textural and Sensory Properties of Yoghurt. International Journal of Agriculture & Biology. 15(2).

[8] Peng Y, Horne DS, Lucey JA. (2009). Impact of preacidification of milk and fermentation time on the properties of yogurt. Journal of dairy science. 92(7), 2977-90.

[9] Sodini I, Remeuf F, Haddad S, Corrieu G. (2004). The relative effect of milk base, starter, and process on yogurt texture: a review. Critical reviews in food science and nutrition. 44(2),113-37.

[10] Tiwari S, Kavitake D, Devi PB, Shetty PH. (2021). Bacterial exopolysaccharides for improvement of technological, functional and rheological properties of yoghurt. International Journal of Biological Macromolecules. 183,1585-95.

[11] Zhao L, Feng R, Mao X. (2020). Addition of buttermilk powder improved the rheological and storage properties of low-fat yogurt. Food Science & Nutrition. 8(7), 3061-3069.

[12] Zhao L, Feng R, Ren F, Mao X. (2018) Addition of buttermilk improves the flavor and volatile compound profiles of low-fat yogurt. Lwt; 98:9-17.

[13] Le TT, Van Camp J, Pascual PA, Meesen G, Thienpont N, Messens K, Dewettinck K. (2011) Physical properties and microstructure of yoghurt enriched with milk fat globule membrane material. International Dairy Journal, 21(10), 798-805.

[14] Romeih EA, Abdel-Hamid M, Awad AA. (2014). The addition of buttermilk powder and transglutaminase improves textural and organoleptic properties of fat-free buffalo yogurt. Dairy Science & Technology, 94, 297-309.

[15] INSO (2019). Yoghurt-Specifications and test methods, Standard No. 695. Tehran, Iran: Iranian National Standards Organization.

[16] INSO (2015). Milk and milk products — Determination of nitrogen content, Standard No. 1811. Tehran, Iran: Iranian National Standards Organization.

[17] INSO (2002). Cheese and processed cheeses - determination of total dry matter, Standard No. 1753. Tehran, Iran: Iranian National Standards Organization.

[18] INSO (2022). Milk and milk products Determination of titrable acidity and pH Test method, Standard No. 2852. Tehran, Iran: Iranian National Standards Organization.

[19] Szudera-Kończal K, Myszka K, Kubiak P, Majcher MA. (2021). Analysis of the Ability to Produce Pleasant Aromas on Sour Whey and Buttermilk By-Products by Mold Galactomyces geotrichum: Identification of Key Odorants. Molecules. 26(20), 6239-6247.

[20] Fernandez Garcia E. (1994). Determination of organic acids during the fermentation and cold storage of yogurt. Journal of Dairy Science. 77(10), 2934-2939

[21] Kasinos MP, Sabatino P, Vanloo B, Gevaert K, Martins JC, Van der Meeren P. (2013). Effect of phospholipid molecular structure on its interaction with whey proteins in aqueous solution. Food Hydrocolloids, 32(2), 312-321.

[22] Deshwal GK, Tiwari S, Kumar A, Raman RK, Kadyan S. (2021). Review on factors affecting and control of post-acidification in yoghurt and related products. Trends in Food Science & Technology,109, 499-512.

[23] Kavas G, Uysal H, Kihc S, Akbulut N, Kesenkas H. (2003). Some properties of yoghurts produced from goat milk and cow-goat milk mixtures by different fortification methods. Pakistan Journal of Biological Sciences, 23(6), 1936-1939.

[24] Bahrami M, Ahmadi D, Beigmohammadi F, Hosseini F. (2015). Mixing sweet cream buttermilk with whole milk to produce cream cheese. Irish Journal of Agricultural and Food Research, 54(2), 73-78.

[25] Salwa AA, Galal EA, Neimat AE. (2004). Carrot yoghurt: Sensory, chemical, microbiological properties and consumer acceptance. Pakistan Journal of Nutrition, 3(6), 322-330.

[26] Ahmed J, Razig K. (2017). Effect of levels of buttermilk on quality of set yoghurt. Journal of Nutrition & Food Sciences, 7(2), 634-639.

[DOI: 10.22034/FSCT.21.152.17]

[27] Romeih EA, Moe KM, Skeie S. (2012). The influence of fat globule membrane material on the microstructure of low-fat Cheddar cheese. International Dairy Journal, 26(1), 66-72.

[28] Lopez C, Camier B, Gassi JY. (2007). Development of the milk fat microstructure during the manufacture and ripening of Emmental cheese observed by confocal laser scanning microscopy. International Dairy Journal, 17(3), 235-247.

[29] Elias-Argote X, Jimenez-Flores R. (2010). Effect of processing on the milk fat globule membrane constituents. Journal of dairy science, 93, 606-618.

[30] Gallier S, Gragson D, Jiménez-Flores R, Everett DW. (2012). β-Casein–phospholipid monolayers as model systems to understand lipid–protein interactions in the milk fat globule membrane. International Dairy Journal, 22(1), 58-65.

[31] Kasinos MP, Sabatino P, Vanloo B, Gevaert K, Martins JC, Van der Meeren P. (2013). Effect of phospholipid molecular structure on its interaction with whey proteins in aqueous solution. Food Hydrocolloids, 32(2), 312-321.

[32] Mende S, Peter M, Bartels K, Rohm H, Jaros D. (2013). Addition of purified exopolysaccharide isolates from S. thermophilus to milk and their impact on the rheology of acid gels. Food Hydrocolloids, 32(1), 178-185.

[33] Dickinson E, Chen J. (1999) Heat-set whey protein emulsion gels: Role of active and inactive filler particles. Journal of dispersion science and technology, 20(1-2), 197-213.

[34] O'Connell JE, Fox PF. (2000). The two-stage coagulation of milk proteins in the minimum of the heat coagulation time-pH profile of milk: Effect of casein micelle size. Journal of dairy science, 83(3), 378-86.

[35] Saffon M, Britten M, Pouliot Y. (2011). Thermal aggregation of whey proteins in the presence of buttermilk concentrate. Journal of Food Engineering,103(3), 244-250.

[36] Vargas M, Cháfer M, Albors A, Chiralt A, González-Martínez C. (2008). Physicochemical and sensory characteristics of yoghurt produced from mixtures of cows' and goats' milk. International Dairy Journal,18(12), 1146-52.

[37] Hutchings JB (1991). Food colour and appearance. 2nd ed. Inc; Gaithersturg, MD, USA Aspen Publishers,

[38] Ekinci FY, Gurel M. (2008) Effect of using propionic acid bacteria as an adjunct culture in yogurt production. Journal of Dairy Science, 91(3), 892-899.

[39] Radi M, Niakousari M, Amiri S. (2009). Physicochemical, textural and sensory properties of low-fat yogurt produced by using modified wheat starch as a fat replacer. Journal of Applied Science, 9(11), 2194-2197.

[40] Wood BJ. Microbiology of fermented foods. (2012). Springer Science & Business Media; 2012

[41] Becker T, Puhan Z. (1988). Effect of different processes to increase the milk solids non-fat content on the rheological properties of yoghurt. Schweizerische Milchwirtschaftliche Forschung, 44, 626-629

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Tables

Table 1. pH of fat-free strained yogurt samples containing different amounts of sweet buttermilk during shelf life

Treatment	Day 0	5th Day	10th Day	15th Day	20th Day
YF0	4.4±0.04 Aa	4.3±0.04 Aa	4.2±0.04 Aa	4.2±0.05 Aab	4.1±0.05 Ab
YF5	4.4±0.04 Aa	4.3±0.05 Aa	4.2±0.05 Aa	4.2±0.05 Aab	4.1±0.05 Ab
YF10	4.4±0.05 Aa	4.3±0.05 Aa	4.2±0.04 Aab	4.1±0.04 Abc	4.0±0.05 Ac
YF15	4.4±0.04 Aa	4.3±0.05 Aa	4.2±0.04 Aab	4.1±0.04 Ab	4.0±0.05 Ab

Data are shown as mean ± standard deviation. The same letters in each row (lowercase) and column (uppercase), respectively indicate the lack of significance at the $P<0.05$ level. **YF0:** Free-fat strained yoghurt, **YF5:** Free-fat strained yoghurt containing 5% sweet buttermilk, **YF10:** Free-fat strained yoghurt containing 10% sweet buttermilk, **YF15:** Free-fat strained yoghurt containing 15% sweet buttermilk.

Table 2. Total solids (%) of fat-free strained yogurt samples containing different amounts of sweet buttermilk during shelf life

Treatment	Day 0	5th Day	10th Day	15th Day	20th Day
YF0	15±0.1 Aa	15.02±0.1 Aa	15.03±0.1 Aa	15.03±0.1 Aa	15.0±0.1 Aa
YF5	14.6±0.1 Aa	14.6±0.1 Aa	14.7±0.1 Aa	14.8±0.1 Aa	14.8±0.1 Aa
YF10	14.3±0.1 ABa	14.4±0.1 ABa	14.4±0.1 ABa	14.5±0.1 ABa	14.5±0.1 ABa
YF15	13.9±0.1 Ba	13.9±0.1 Ba	14.0±0.1 Ba	14.0±0.1 Ba	14.0±0.1 Ba

Data are shown as mean ± standard deviation. The same letters in each row (lowercase) and column (uppercase), respectively indicate the lack of significance at the $P<0.05$ level. **YF0:** Free-fat strained yoghurt, **YF5:** Free-fat strained yoghurt containing 5% sweet buttermilk, **YF10:** Free-fat strained yoghurt containing 10% sweet buttermilk, **YF15:** Free-fat strained yoghurt containing 15% sweet buttermilk.

Table 3. Protein content (%) of fat-free strained yogurt samples containing different amounts of sweet buttermilk during shelf life

Treatment	Day 0	5th Day	10th Day	15th Day	20th Day
YF0	9.0±0.1 Aa	9.0±0.1 Aa	8.9±0.1 Aa	8.9±0.1 Aa	8.8±0.1 Aa
YF5	8.9±0.1 Aa	8.9±0.1 Aa	8.8±0.1 Aa	8.8±0.1 Aa	8.7±0.1 Aa
YF10	8.8±0.1 Aa	8.8±0.1 Aa	8.7±0.1 Aa	8.7±0.1 Aa	8.6±0.1 Aa
YF15	8.7±0.1 Aa	8.7±0.1 Aa	8.6±0.1 Aa	8.6±0.1 Aa	8.6±0.1 Aa

Data are shown as mean ± standard deviation. The same letters in each row (lowercase) and column (uppercase), respectively indicate the lack of significance at the $P<0.05$ level. **YF0:** Free-fat strained yoghurt, **YF5:** Free-fat strained yoghurt containing 5% sweet buttermilk, **YF10:** Free-fat strained yoghurt containing 10% sweet buttermilk, **YF15:** Free-fat strained yoghurt containing 15% sweet buttermilk.

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Figures

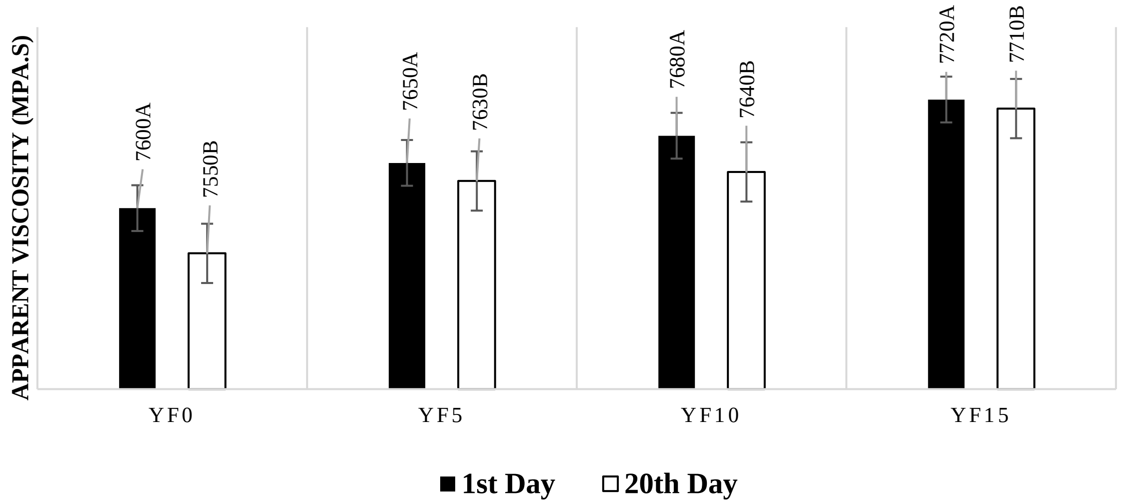
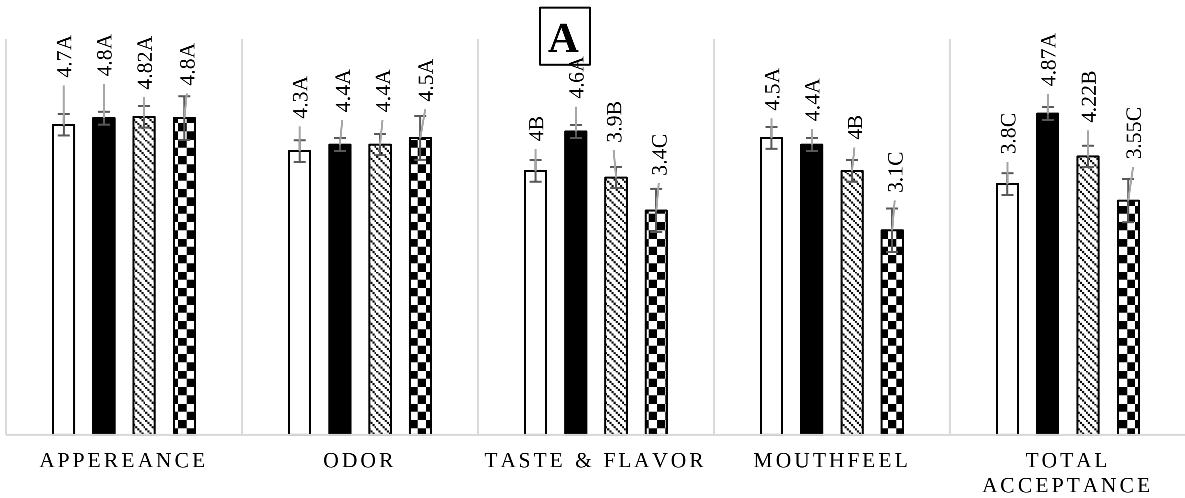


FIG. 1. Apparent viscosity (mPa.s) of fat-free strained yogurt samples containing different amounts of sweet buttermilk for day 1 (A) of day 20 (B). The same letters in each white or black bar charts indicate the lack of significance at the P<0.05 level. **YF0:** Free-fat strained yoghurt, **YF5:** Free-fat strained yoghurt containing 5% sweet buttermilk, **YF10:** Free-fat strained yoghurt containing 10% sweet buttermilk, **YF15:** Free-fat strained yoghurt containing 15% sweet buttermilk.



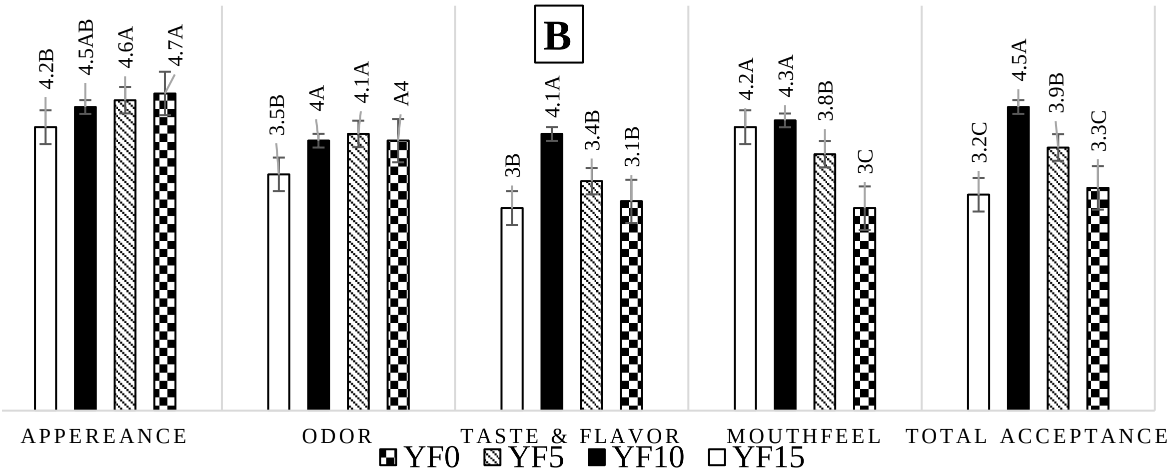


FIG. 2. Sensory analysis of fat-free strained yogurt samples containing different amounts of sweet buttermilk for 1st day 1 (A) of day 20th (B), n=60. The same letters in each bar chart indicate the lack of significance at the P<0.05 level. **YF0:** Free-fat strained yoghurt, **YF5:** Free-fat strained yoghurt containing 5% sweet buttermilk, **YF10:** Free-fat strained yoghurt containing 10% sweet buttermilk, **YF15:** Free-fat strained yoghurt containing 15% sweet buttermilk.

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چکیده

دوغ کره به دلیل دارا بودن فسفولیپیدها و پروتئین‌های غشای گویچه‌های چربی دارای خواص کاربردی و تغذیه‌ای فراوانی است. بر این اساس، پژوهش حاضر با هدف بررسی کاربرد و عملکرد دوغ کره شیرین جهت تولید ماست چکیده بدون چربی طرح‌ریزی شد. برای این منظور، از نسبت‌های ۵، ۱۰ و ۱۵ درصد (وزنی/وزنی) دوغ کره شیرین در تهیه ماست پایه استفاده شد. این بررسی در قالب طرح کاملا تصادفی انجام پذیرفت. pH، درصد ماده خشک کل و درصد پروتئین نمونه‌ها طی روزهای صفر، پنجم، دهم، پانزدهم و بیستم ارزیابی شد. همچنین، ویسکوزیتهٔ نمونه‌ها و ویژگی‌های حسی محصول شامل رنگ و ظاهر، عطر و بو، طعم و مزه، احساس دهانی و پذیرش کلی طی روزهای اول و بیستم بررسی شدند. یافته‌ها مشخص نمود طی زمان ماندگاری pH نمونه‌های حاوی دوغ کره تا حدود بیشتری کاهش می‌یابد ($P>0.05$). درصد ماده خشک کل محصول با افزایش سطح دوغ کره کاهش یافت اگرچه در زمان ماندگاری تغییر معناداری مشاهده نشد ($P>0.05$). با افزایش سطح دوغ کره، پروتئین نمونه‌ها کاهش یافت و در طی ماندگاری درصد پروتئین نمونه‌ها دستخوش تغییر نشد ($P>0.05$). همچنین، با کاهش سطح دوغ کره، ویسکوزیته نمونه‌ها کاهش یافت ($P>0.05$). یافته‌های آزمون ارزیابی حسی نشان داد نمونه حاوی ۱۰ درصد (وزنی/وزنی) دوغ کره دارای بیشترین امتیاز از لحاظ طعم ومزه، احساس دهانی و پذیرش کلی بود و به‌عنوان بهترین نمونه انتخاب شد. به طور کلی، یافته‌های پژوهش حاضر مشخص نمود که استفاده از دوغ کره در تولید ماست‌های چکیده بدون چربی از نظر عملکردی و کاربردی مفید است.