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Storage stability of sweet cream butter prepared from goat milk

Abstract

This research assessed the storage stability of sweet cream butter from goat milk. Both salted (1.24% NaCl) and unsalted sweet cream butters prepared from goat milk were stored in closed plastic containers at refrigeration temperature (4°C) for 21days. Lightness of the cream butter decreased with storage time. Hardness of the butter significantly decreased, but stickiness values increased over the time. Acid degree values (ADV) of the butter increased as storage time progressed. Eleven free fatty acids (FFA) were isolated from the butter, and the concentrations of butyric (C4:0), capric (C10:0), lauric (C12:0), myristic (C14:0), palmitic (C16:0), and oleic (C18:1n9) acids increased over the 21d of storage. However, inclusion of 1.24% NaCl in the goat cream butter did not improve the storage stability of goat cream butter. The results indicated that autoxidation and/or hydrolytic rancidity might occur in the goat cream butter stored at refrigeration temperature for 21d.

Keywords: salted and unsalted sweet cream butter, goat milk, storage stability, free fatty acid

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Introduction

Like other dairy products, goat milk and its products are important sources of nutrients to humans. Dairy products from goats have received limited attention as a source of the dairy product in the United States compared to those from cows; however, demanding of goat milk has been steadily increasing in recentyears because of a growing interest in gourmet and functional foods.[1,2] About 18% of all the goat milk around world is produced in the Mediterranean region that plays a prominent role in the national economy because of traditional and successful commercialization into dairy products.[1] Goat milk has been considered as a functional food because of its nutritional values and health maintenance properties. Goat milk is recommended for children and elderly people with an intolerance to cow milk because it has a lower concentration of casein αs1, a higher short-chain fatty acid content (10 to 15 *Vs.* 5 to 9%) and a smaller fat droplet size (1.99 *Vs.* 3.52µm) than cow milk. Furthermore, goat milk also has higher digestibility and buffering capacity, distinct alkalinity, and therapeutic values in medicine and human nutrition compared with cow milk.[3] However, there is a general conception that goat milk is inferior to cow milk in palatability. Although goat milk has widely used for a variety of cheeses and yogurts, a relatively small amount of the milk is used for other dairy products such as butter, milk powder, and frozen desserts.[1,3]

Traditionally, butter is produced by churning either fresh or fermented cream/milk from dairy cow. Butter is a plastic emulsion of the water-in-oil type which contains a minimum of 80% fat and a maximum of 16% moisture.[4] Flavor or taste quality attributes are the key factors to determine the price of butter. Flavor and texture properties of butter are influenced by milk from the different dairy animals, diets, stages of lactation, and seasons of the year.[5,6] Furthermore, processing and storage conditions also contribute to the diverse flavor characteristics of butter. Commercial butter in the U.S. is mostly made by continuous churn. Sweet cream butter is commonly known to Americans which is produced with or without the addition of salt in the pasteurized, churned cream.[7] Compared to cream from cow milk, cream from goat milk has a lower melting point due to higher proportions of short- and medium-chain fatty acids such as caproic (C6:0), carprylic (C8:0) and capric (C10:0) acids.[1,2] This factor also imparts a distinctive flavor and texture characteristic to the butter from goat milk. Furthermore, goat cream is white compared to cow cream because of the absence of carotenoids. In general, sweet cream butter has a shorter shelf-life because of its higher pH range compared to other types of butter.[8] Salt has been added to improve the flavor and shelf-life of butter, as well as its consistency in the dairy industry.[4] Yet it is not determined whether the addition of salt improves the flavor and stability of goat sweet cream butter, as well as its consistency. Creating new applications for goat milk, such as sweet cream butter could be beneficial for consumers because of the potential benefit of people with cow milk allergies and other gastrointestinal ailments. To our knowledge, recent studies have not addressed the storage stability of sweet cream butter made from goat milk. The purpose of this study was to evaluate the quality of fresh and refrigerated goat sweet cream butter prepared either with or without inclusion of salt.

Materials and methods

Sweet cream butter production and storage

Raw milk from the herd of dairy goats (Saanen, Nubian, and Alpine) was obtained from the university milking parlor at Fort Valley State University (Fort Valley, GA, USA). It was collected for 3 consecutive days of milking and stored in a bulk tank (Mueller Milk Cooler, Paul Mueller Co., Springfield, MO, USA) at 4°C. The raw milk was pasteurized at 63°C for 30min with agitation in a vat pasteurizer (Nord Gear Corp., Waunakee, WI, USA). Pasteurized milk was separated into cream (28~30% fat) and skin milk by a FJ 125 cream separator (Clair Milky, Franz Janschitz GmbH Co., Althofen, Austria). The separated cream was stored overnight at 4°C. The following day, the cream temperature was raised to 10°C in a water batch, and the cream was churned in a 9.5L electric butter churn (Berry Hill Limited Co., Ontario, Canada) until the butter kernels developed at ambient temperature. The buttermilk was separated from the butter kernels by draining through cheesecloth. Butter was pressed, washed with cold water and worked with a spatula to remove excess buttermilk

in a stainless steel container. Only half of the prepared butter was salted uniformly with 1.24% (w/w) NaCl in the container. Three batches of salted or unsalted sweet cream butter (batch/week) were produced within 3 consecutive weeks by using the same procedures described previously. Each batch of salted or unsalted butter was divided into four equal portions and each portion was subdivided into four samples. Individual samples of the salted or unsalted butter were placed in 250mL high density polyethylene (HDPE) wide mouth jars (200g butter/jar; Fisher Scientific Co., Pittsburg, PA, USA), sealed, and stored at refrigeration temperature(4°C) for 1, 7, 14 or 21d. All samples taken at each storage time (n=24; 12 jar/butter/d) were subject to physical and chemical analysis.

Physical and chemical analysis

Color: At the end of each storage time, the color of butter was measured directly from the surface of butter, which was prepared by spreading the sample in the 6-well Multi well tissue culture plate (Becton Dickinson Labware Co., Lincoln Park, NJ, USA) to a volume of approximately 15.5cm^3 in each well. A Mini Scan XE Plus colorimeter (Hunter Associate Laboratory, Reston, VA, USA) with illuminant D65 as a light source was used to determine the CIE L*a*b* color coordinate values of butter. Total of six measurements were taken from each butter sample prepared on the plate according to Gonzalez et al.,[9] and the average of six measurements was recorded as a color coordinate value of the each butter sample.

Texture: Hardness and stickiness of the butter samples were determined over the 21d of refrigerated storage using a TA.XT2i texture analyzer (Stable Micro Systems Ltd., Godalming, UK) equipped with a 40° conical probe. The probe was travelled at 1.0mm/s to a depth of 2 mm from the surface of butter sample in the 250mL HDPE wide mouth jar (200g butter) and then was withdrawn at the same speed. Data acquisition began at 5g force detected on the surface of the butter sample and analyzed by Macro software (Stable Micro Systems Ltd., Godalming, UK). The penetration force of the probe and its resistance force to withdrawal were reported as hardness and stickiness of butter, respectively. The measurements were replicated three times for individual butter samples as described by Bobe et al.,[5] and the average values were used for statistical analyses.

Proximate composition: Only fresh butter (d1) was sampled for the determination of proximate composition and analyzed in triplicate for fat, protein, moisture, and ash contents. Total lipid in butter sample was extracted by the chloroform/methanol (2:1, v/v) method Lee et al.,[10] estimated gravimetrically.[10] Protein content was determined by a carbon/nitrogen analyzer (model Vario Max CN, Elementar Americas Inc., Mt. Laurel, NJ, USA). Moisture and ash contents were determined by the oven drying and furnace methods AOAC,[11] respectively.

Acid degree values (ADV): The ADV of butter samples were determined by the method of Case et al.,[12] with each sample determined in triplicate. Butterfat was extracted from 5.0g of butter sample in a Babcock bottle. One gram of the extracted butterfat was titrated with a standard alcoholic 0.02 N KOH solution (1.12g of KOH in 1000 mL of aldehyde free alcohol solution) using a micro burette with 1% phenolphthalein as an indicator and then the ADV of the sample was estimated using the formula given by Case et al.[12]

Free fatty acids (FFA): Extraction of FFA in the butter sample was conducted according to procedures adopted from that of Deeth et al.,[13] with each butter sample extracted in triplicate. Cream butter (1.0g) was delivered into a 25mL screw-cap test tube. Five milliliters of an internal standard solution consisted of heptanoic (C7:0) and heptadecanoic (C17:0) acids in diethyl ether (0.25µg/mL), 0.3mL of 4 N H2SO4 and 2.5g of Na2SO4 were placed in a test tube. The test tube was vigorously mixed for 2min using a vortex (Fisher Scientific, Pittsburgh, PA, USA) and then placed in an ice bath, and followed by 5mL of hexane in the tube. The tube was vigorously vortexted for 2min and then centrifuged for 15min at 3000g at 0°C (model TJ-6 centrifuge, Beckman Instruments Inc., Palo Alto, CA, USA). The content was allowed to stand for 2h in an ice bath and then passed through a prepared and conditioned polypropylene column (2mL bed vol. (0.8 x 4cm), Bio-Rad Laboratories, Hercules, CA, USA) with 1.0g of aluminum oxide and 5mL of hexane: dietyl ether (1:1, v/v). In the loaded column, triacylglycerols were washed out with 10mL of hexane: dietyl ether solution under a vacuum of 5mm Hg. The FFA were then eluted from the column with 2mL of di isopropyl ether containing 6% (v/v) formic acid (Fisher Scientific, Pittsburgh, PA, USA) and the eluent was centrifuged for 15min at 2000g at 0°C. An aliquot from the upper phase was collected. Two microliter of the collected content was injected using a split less mode to a Thermo Electronic (Austin, TX, USA) gas chromatography (model TRACE GA Ultra) by an automatic injection system (model AS-3000, Thermo Electronic Co. Austin, TX, USA), separated with a 0.25mm i.d. (0.25µm film thickness) x 30m long fuse silica DB-FFAP capillary column (Agilent Technologies, Wilmington, DE, USA), and detected by a flame ionization detector (FID; Thermo Electronic Co., Austin, TX, USA). The injection and detector temperature were 250 and 280°C, respectively. The column temperature was programmed from 50°C (5min) to 250°C (20min) at 5°C/min. Helium was the carrier gas with a flow rate of 1.5mL/min. Chrom Quest 5.0 version 3.2.1 software (Thermo Fisher Scientific Inc., Pittsburgh, PA, USA) was used for data analysis. Identification was achieved by comparing the retention time of unknown FFA with those of known FAA standard mixture (All tech Associates, Inc., Deerfield, IL, USA; Sigma-Aldrich Corp., Bellefonte, PA, USA). Quantitative analysis of FAA was based on C7:0 and C17:0 as internal standards on relative peak areas of the FFA.

Statistical analysis

All data were analyzed as a randomized block design (RBD), block on batch, with factorial treatment arrangement using the MIXED procedure of SAS (SAS Institute Inc., Cary, NC, USA), with individual containers containing butter as an experimental unit. The effects of inclusion of salt (with or without NaCl) and storage times (1, 7, 14, or 21 d) as well as their two-way interaction was considered to be fixed. Significant differences among means were determined by the Least-Squares Means generated and separated using the PDIFF (*P*-values for difference) option of SAS for main or interaction effects. Significance was determined at $P< 0.05$, but differences of $0.05\leq P< 0.1$ were considered as trends.

Results and discussion

The proximate composition of fresh (d 1) salted or unsalted sweet cream butter from goat milk is presented in Table 1. No significant differences ($P>0.05$) were found in the amounts of fat and protein between salted and unsalted experimental butters. The ash content of the salted goat cream butter expected to be higher ($P<0.05$) than

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that of the unsalted butter because of the addition of NaCl in the preparation of salted butter. However, the salted butter contained less amounts of moisture (P<0.05) than the unsalted butter. Both moisture and fat contents are important quality factors of butter because they are the principal ingredients of developing a plastic emulsion (water-in-oil) in butter. Butter is a viscoelastic solid, which is legally required to contain a minimum of 80% fat by weight and a maximum of 16% moisture.[4] Moisture and fat contents of fresh butters in the present study were in the acceptable ranges.

Table 1 Proximate composition of salted or unsalted sweet cream butter prepared from goat milk. Within a raw, least squares means that do not have a common letters different (P<0.05)

Component	Salted butter	Unsalted butter	SE
Fat	81.2	81.4	0.89
Protein	0.95	0.97	0.05
Moisture	14.7b	15.9a	0.31
Ash	1.55a	0.45b	0.14

No differences (P>0.05) were observed in color between the fresh (d1) salted and unsalted goat sweet cream butters. Compared to sweet cream butter from cow milk,[8] the experimental goat cream butters were much less yellow (CIE b*; 20.96 *vs.* 4.89) because of the absence of carotene in goat milk. The color variation of goat cream butters was observed during the 21-d of refrigerated storage. Color measurements (CIE L*a*b*) of salted or unsalted goat cream butter stored at 4°C for 1, 7, 14, or 21 d are showed in Figure 1. No differences (P>0.05) in the CIE L* (lightness; 94.97 *vs.* 95.57±0.983), a* (greenness; -1.38 *vs.* -1.28±0.216), and b* (yellowness; 4.90 *vs.* 4.88±0.145) values were observed between the salted and unsalted goat cream butters regardless of the refrigerated storage time. The CIE a* (-1.41 to -1.29±0.219) and b* (4.73 to 5.04±0.172) values of the butters were not significantly changed during the 21 d of refrigeration without considering types of butters (with or without adding NaCl). However, the CIE L* (lightness) value of the butters was decreased (P<0.05) after the 14 d of refrigeration storage, and there was no further changes in the CIE L* value of the butter stored at 4°C. Kristensen et al.,[14] also reported that the color of salted cow sweet cream butter stored under refrigerated conditions darkened (decreased CIE L* values) over storage time. The interaction of inclusion of salt (with or without NaCl) and refrigerated storage time influenced (P< 0.05) the CIE L* and a* values of the two different experimental butters (Figure 1). There were significantly differences in the CIE L* values between the d 7 salted butter and the d-14 or 21either salted or unsalted butter. The CIE L* values of the unsalted butter increased (P<0.05) at the d 7, then decreased at the d-14or 21; however, the values were not changed (P>0.05) in salted butter during the 21-d of refrigerated storage. The CIE a* values were different (P<0.05) between the d 14 unsalted butter and the fresh (d 1) or d 7 salted butter. Moreover, the salted butter from d-1 or 7was more greenish (lower CIE a* values) than the d-14 unsalted butter. As the storage time progressed, the color of butter generally changed from yellow to light yellow because of the oxidation of organic pigments such as carotenoids in cow milk butter.[15] However, this trend was not observed in the goat cream butters due to the lack of carotenoids in its milk.

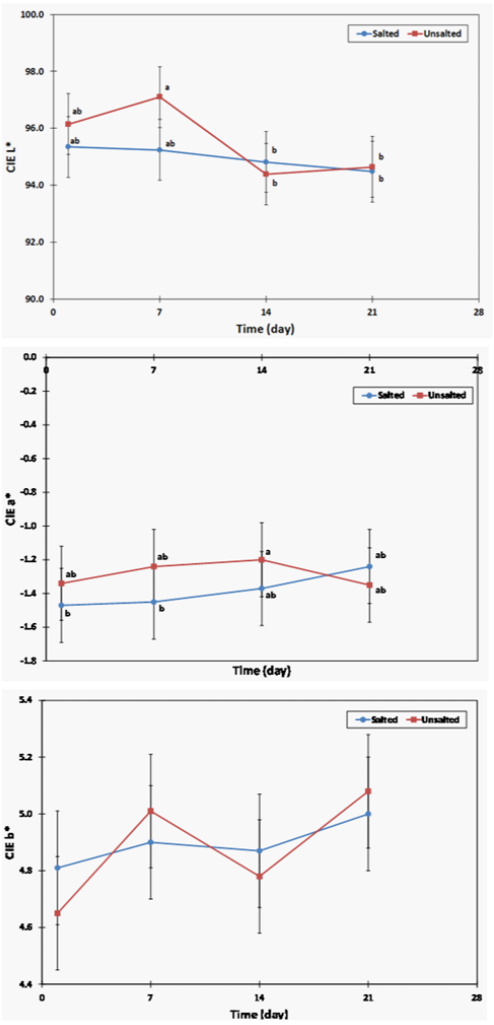

Figure 1 Changes of cie l* a* b* values (n=12) in goat sweet cream butters prepared with or without adding salt and stored under refrigerated temperatures for 21d; points with no common letters are different (p<0.05).

Hardness and stickiness of salted or unsalted goat sweet cream butter stored at refrigeration temperature (4°C) for 1, 7, 14, or 21d are showed in Figure 2. No significant differences were found in the hardness (217 and 214±36.8 g) or stickiness (71.9 and 76.6±6.04 g) of the salted and unsalted butters regardless of the refrigerated storage time. However, the storage time significantly affected both hardness and stickiness of butters without considering the inclusion of salt (with or without NaCl). Compared to fresh butters (d 1), the hardness of butters was decreased (P<0.05) from 229 to 164±37.5g, and the stickiness of butters was increased from 67.4 to 82.2±6.44g. Furthermore, the interaction of inclusion of salt (with or without NaCl) and refrigerated storage time significantly influenced the hardness and stickiness of experimental butters. The first 14d of refrigerated storage, the hardness of both salted and unsalted butters was decreased (P<0.05) from 266 to 168 and from 260 to 160±38.6g with some deviation, while there was no further changes (P>0.05) in the hardness values of the butters. The stickiness of both salted and

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unsalted butters was increased (P<0.05) from 69.99 to 86.6 and 64.7 to 79.4±6.96g, respectively, with some deflection during the 21-d of refrigerated storage. Compared with fresh (d 1) salted or unsalted goat cream butters, refrigerated salted or unsalted goat butters were 36.8 or 38.5% softer and 23.7 or 22.7% less sticky, respectively. This present study showed that goat cream butter might have a tendency to decrease hardness and to increase stickiness as the refrigerated storage time progressed. Over the several decades, dairy industries have focused their research on milk fat modification using biological, (dietary modification and genetic manipulation), physical (fractionation), chemical (hydrogenation and interesterification) processes to increase unsaturated fat amounts in dairy products. Accordingly, the texture properties of cow cream butter prepared with modified milk fat were evaluated. The modified milk fat containing lower saturated and higher unsaturated fats might lower the melting point and produce a softer and less adhesive butter at refrigeration temperature.[5,9,16] However, hardness and stickiness data on goat cream butters have not been reported previously.

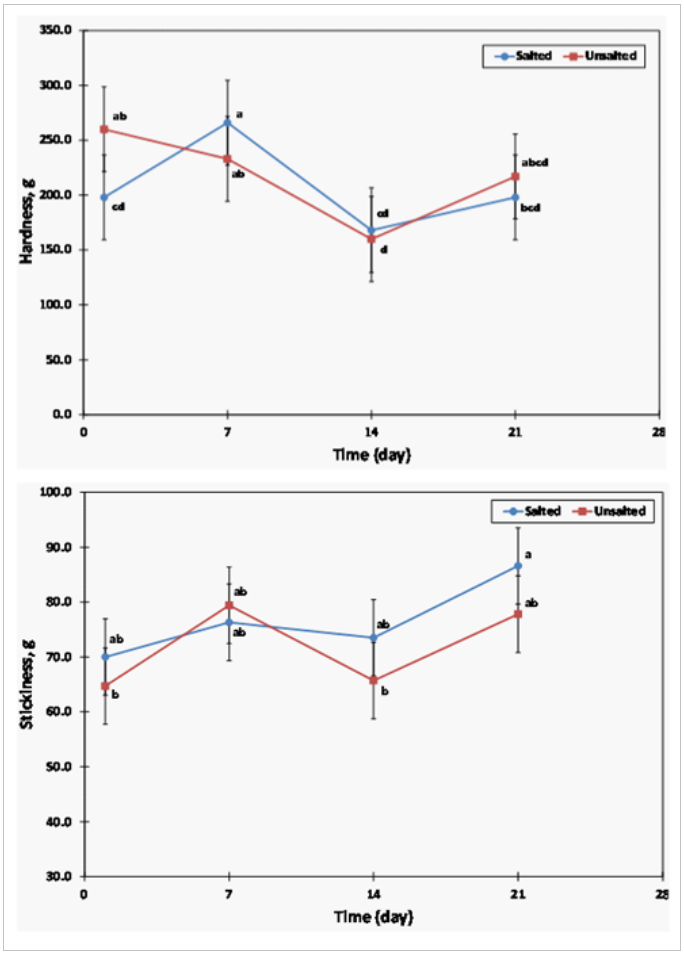

Figure 2 Hardness (g) and stickiness (g) values (n=12) of salted or unsalted goat sweet cream butter stored for 21d at refrigeration temperature; points with no common letters are different (p<0.05).

The inclusion of salt (with or without NaCl) did not affect (P>0.05) the ADV (1.44 and 1.56±0.339meq FFA/100g fat) of the goat cream butter; however, the ADV of the butter regardless of two different butter types (salted or unsalted) were significantly influenced by the refrigerated storage time. Compared to fresh (d 1) butter samples, the ADV of butter samples were sharply increased (P<0.05) from 1.21 to 2.02±0.347meq FFA/100g fat after the 21d of refrigerated storage. The interaction of inclusion of salt (with or without NaCl) and refrigerated storage time also significantly affected the ADV of fats extracted from the butter samples (Figure 3). After the 21d of refrigerated storage, the ADV of salted and unsalted butters were increased (P<0.05) from 1.17 to 1.90 and from 1.25 to 2.15±0.347 meq FFA/100g fat, respectively. This indicated that autoxidation reaction or hydrolytic rancidity occurred in the experimental butters stored at 4°C for 21d. However, according to Stegeman et al.,[17] & Ramaswamy et al.,[18] no significant increments of the peroxide and acid degree values were found in cow cream butters stored for 3months at refrigeration temperature.

Eleven free fatty acids (FFA) were extracted and identified from the sweet cream butters from goat milk, and the most predominant FFA were palmitic (C16:0), stearic (C18:0) and oleic (C18:1n9) acids (Table 2). The identified FFA from goat cream butters were divided into 3 major groups according to their carbon chain length: short-(C4:0 to C8:0), medium-(C10:0 to C14:0), and long-chain (C16:0 to C18:3) FFA. The FFA profile of goat cream butters in the present study was not different from that of sweet cream butters prepared with dairy cow milk.[19,20] However, the individual concentrations of FFA were significantly different between the butters prepared dairy cow and goat milk, especially in short-chain FFA. In general, volatile compounds such as FFA are contributed to the flavor of sweet cream butter, whereas excessive amounts of FFA (C4 to C18) from butterfat induced by lipase are known as the hydrolytic rancidity flavor in the sweet cream butter. A higher amount of shorter chain FFA (C4 to C12) is responsible for rancid flavor; however, longer chain FFA (C14 to C18) is not important in terms of rancidity.[21] According to the sensory perception of FFA in the sweet cream butter from cow milk,[19,22] butyric (C4:0) and caproic (C6:0) acids are primarily responsible for hydrolytic rancidity off-flavor such as butyric acid and goat-like flavors, respectively. Caprylic acid (C8:0) also contributes goat-like flavors in the butter. The soapy and bitter flavors are elicited predominately by capric (C10:0) and lauric (C12:0) acids, whereas the FFA with C14 to C18 carbons are of little importance in terms of lipase flavor, and give slightly soapy tastes.

There was no effect (P>0.05) of adding NaCl on concentrations of each FFA in the goat cream butters regardless of the refrigerated storage time. However, the refrigerated storage time (1, 7, 14, or 21d) and the interaction of types of butter (salted and unsalted) and storage time were significantly influenced on the levels of individual FFA in the goat butters. Without consideration of types of butter, the concentrations of C4:0, C10:0, C12:0, myristic (C14:0), C16:0, and C18:1n9were increased (P<0.05) from 71.11 to 89.95±7.641, 182 to 282±36.9, 46.9 to 66.5±7.67, 55.1 to 72.2±7.57, 479.23 to 564.27±54.976, and 269.23 to 309.84± 25.69mg/kg fat, respectively, with some deviation during the 21-d of refrigerated storage. In short-chain FFA (C4:0 to C8:0), significant differences were found in the amounts of C4:0 and C8:0 in the salted or unsalted butters stored at refrigeration temperature for 21d. The concentration of C4:0 in the salted butter was not changed (P>0.05) until the first 14d of storage, but increased (P<0.05) after the 21d of storage, whereas it was not significantly changed with the storage time in the unsalted butter. The level of C4:0 in unsalted butter stored for 21-d was significantly higher than that in fresh (1d) salted butter. Meanwhile, the amount of C8:0 increased (P<0.05) in the unsalted butter with the storage time, whereas it was not changed (P>0.05) in the salted butter with the storage time. The concentration of C8:0 in the unsalted butter was not changed (P>0.05) until the first 14-d of storage, but increased

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(P<0.05) after the 21d of storage. Furthermore, the level of C8:0 in salted or unsalted butter was significantly higher at the 21d of storage than that in fresh (1-d) unsalted butter. In medium-chain FFA (C10:0 to C14:0), significant differences were found in the amounts of C12:0 and C14:0 in the butters prepared with or without addition of NaCl, and stored at refrigeration temperature for 21-d. The concentration of C12:0 in the unsalted butter increased (P<0.05) with the storage time, whereas it was not changed with the storage time in the salted butter. The concentration of C12:0 in the unsalted butter was not significantly increased until the first 14d of storage, but increased after the 21d of storage. The level of C12:0 in unsalted butter stored for 21d was significantly higher than that in fresh (1d) salted or unsalted butters. The concentration of C14:0 progressively increased (P<0.05) in the unsalted butter with the storage time. The differences (P<0.05) in C14:0 concentrations were also found in the 14 and 21d stored salted butter samples. The concentration of C14:0 in the unsalted butter was not changed (P>0.05) until the first 14d of storage, but increased (P<0.05) after the 21d of storage. The level of C14:0 in unsalted butters stored for 21d was significantly higher than that in fresh (1d) unsalted butter. In long-chain FFA (C16:0 to C18:3n^3), significant differences were found in the amounts of oleic (C18:1n9) and linoleic (C18:2n6) acids in the goat cream butters prepared with or without addition of NaCl, and stored at refrigeration temperature for 21d. The amount of C18:1n9 increased (P<0.05) in the salted butter after the 7d of storage, but there was no further increase (P>0.05) of C18:1n9 content in the salted butter until d 21. However, the level of C18:1n9 was not changed (P>0.05) in the unsalted butter with storage time. The concentration of C18:2n6 in the unsalted butter significantly increased at d 21, whereas it was not changed (P>0.05) with the storage time in the salted butter. In the current study, statistical differences were present in the individual FFA contents in the fresh (d 1) and d 21 refrigerated samples. Similar results were reported by Okturk et al.,[23] who reported that total FFA contents of cow cream butters increased (P<0.05) within 90d of refrigerated storage. Conversely, Krause et al.[7] found that the FFA amounts were consistent until 6m of storage at 5°C.

Table 2 Free fatty acid contents (mg/kg) in salted or unsalted sweet goat cream butter stored for 0,7,14, or 21 degree at refrigerator temperature. Within a raw, least squares means that do not have a common letters different (P<0.05)

	Salted				Unsalted				
FAA, mg/kg	1	7	14	21	1	7	14	21	SE
C4:0	69.37b	77.29ab	79.53ab	90.09a	72.84ab	85.75ab	75.44ab	89.80a	9.401
C6:0	44.79	53.13	54.68	60.65	52.49	56.13	56.19	49.78	4.058
C8:0	24.21ab	25.35ab	23.38ab	28.86a	22.33b	24.14ab	26.68ab	32.31a	3.475
C10:0	179	288	209	354	185	185	203	211	60.2
C12:0	47.7bc	55.7abc	49.7abc	61.1ab	46.2bc	53.8abc	60.2abc	71.9a	9.21
C14:0	58.1ab	58.8ab	52.3b	67.9a	52.1b	56.2ab	62.3ab	76.4a	9.10
C16:0	507.13	596.01	393.30	547.64	451.32	431.80	598.43	580.91	77.734
C18:0	217	271	275	322	298	271	283	219	33.0
C18:1n9	241.89b	337.59a	277.00ab	310.87ab	296.58ab	258.64ab	286.96ab	308.82ab	36.31
C18:2n6	20.68ab	24.68ab	20.40ab	28.11ab	18.29b	23.90ab	27.23ab	33.25a	6.050
C18:3n3	15.6	18.5	18.6	22.1	20.4	18.5	20.0	14.3	2.63

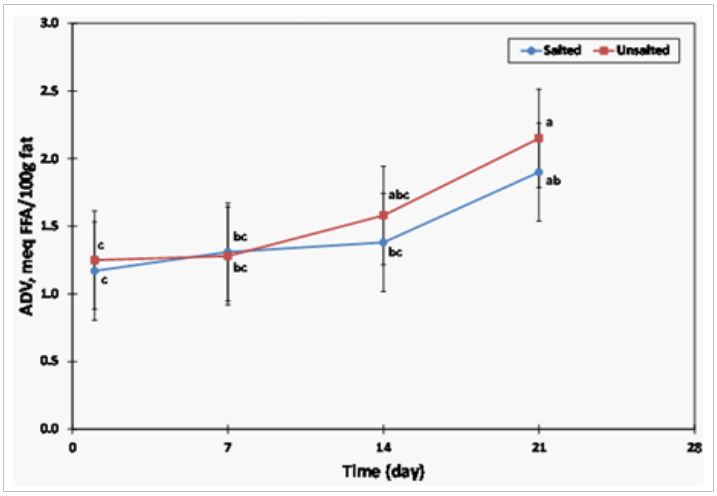

Figure 3 Changes in acid degree values (adv, meq ffa/100g fat) of goat sweet cream butter prepared with or without adding salt during the 21d of refrigerated storage; points with no common letters are different (p<0.05).

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Conclusion

For 21days of refrigerated storage (4°) of both salted (1.24%NaCl) and unsalted goat cream butters induced some changes in the instrumental color values, acid degree values, and individual free fatty acid concentrations. However, the enhancing quality of cream butters due to the inclusion of NaCl was not detected. Ideally, dairy products should maintain optimum quality throughout their shelf-life. Refrigerated goat cream butters showed the decline their quality within 21d because of autoxidation and/or hydrolytic rancidity. Consequently, additional research is needed to develop a reliable packaging and/or storage condition for goat sweet cream butter.

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Conflict of interest

Author declares that there is no conflict of interest.

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