The Effect of Coriander Oil Addition to Goat Feed on the Technological Properties of the Resultant Milk; Rayeb as a Product Model

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Article

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Abstract

Goat milk is an essential alternative milk resource for those suffering from cow and buffalo milk allergies and is considered a nutrient protein source for children and neonates. This paper aims to answer the question: Does adding crude coriander oil to goats’ food affect the quality of their milk and the properties of their products? Study the chemical, rheological, and microbiological properties and the acceptability of probiotic goat’s rayeb milk. Two coriander oil concentrations were used in the study; a low level of 0.95% (T1) and a high level of 1.9% (T2). The results declared that coriander oil did not affect the coagulation time, which was almost six hours for all batches. At the same time, the apparent viscosity decreased significantly \((p \leq 0.05)\) in T2 with the high oil level. Moreover, treatments showed a significant \((p \leq 0.05)\) increase in the content of monounsaturated fatty acids and a decrease in polyunsaturated fatty acids. Low-level oil supplementation showed the best rayeb properties, surpassing the control treatment in most properties and higher sensory scores.

Introduction

The share of total non-cattle milk production in world milk output has climbed from 9% in 1961 to 19% in 2018. For instance, goat, sheep, camel, horse, and donkey milk are more easily digestible, less allergic, and more akin to human milk than cattle milk \([1, 2, 3]\). In 2020, goat, sheep, and camel milk accounted for 2.3%, 1.2%, and 0.4% of global production, respectively (https://www.fao.org/faostat/en/#search/milk, accessed 25 June 2022). These species accounted for less than 5% of global milk production. Still, they played a crucial role in the rural economies of several Mediterranean and Southeast Asian regions, where they are primarily used in processed dairy products \([4]\). Non-bovine milk has recently been the subject of extensive research due to its potential health benefits, as summarised in recent reviews \([5, 6]\), and interest in incorporating these types of milk in infant formula \([7, 8]\) due to their low allergenicity compared to cow milk. The use of milk for human consumption takes into account the milk's physicochemical properties, which determine its functional properties and several subsequent technological (utility, yield, structure, and stability) and sensory properties, as well as the milk's and its products' value. Non-bovine milk from animal sources contains several nutrients with nutritional and health benefits, including oligosaccharides, lipids, bioactive peptides, high-quality protein, minerals, and vitamins \([9]\). Egypt breeds approximately 4.4 million goats \([10]\), according to the most recent estimates from the Food and Agriculture Organization (FAO). Goat milk accounts for about 2.3 percent of all milk produced worldwide \([11]\). Compared to 2007, goat milk production in Egypt increased by 13.8 percent in 2017\([11]\).

Goat milk has unique nutritional and medicinal characteristics, making it more appealing to consumers than milk from other species \([12]\). Zarrabi goats (Egyptian Nubian) are the most promising dairy goat among the local Egyptian breeds, with high genetic potential for milk production \([13]\). It is highly digestible, absorbable, and tolerated by people with allergies to cattle milk \([14]\). In general, milk has higher quantities of \(\beta\)-casein, low amounts of \(\alpha_s\) casein, and nearly identical quantities of \(\kappa\)-caseins. In contrast to bovine milk, \(\beta\)-casein is the chief protein in goat milk \([14, 15]\). Goat milk presents a slightly lower casein
concentration level than bovine milk, with very little to no αs1 casein \cite{16}. Since the level of αs1 casein impacts the coagulation ability of milk, this deficiency is one of the features contributing to the poor coagulating properties of goat milk, compromised cheese production, and weak yogurt structure \cite{16}. In the satiating time, it offers a perfect opportunity for neonates as a source of feeding free from allergens like αs1 casein. Much undeniable previous research hypothesized that essential oils' active components would alter fermentation in the rumen and affect nutrient digestion, resulting in enhanced milk production and composition in goats. Coriander oil is one of the most valuable essential oils that have positively impacted goat milk production in quantity and quality \cite{17}. However, there is a noticeable absence of research examining the effect of this fortification on the resulting milk when added to dairy products. Studies have demonstrated the potential of coriander's oil as antimicrobial \cite{18}, antibacterial \cite{19}, and cytotoxic \cite{20} agents, among others. One of the most significant functional fermented milk products is stirred yogurt made with yogurt starters, often known as Rayeb milk in the Middle East \cite{21}. In rural locations, a traditional Rayeb milk production process relies on the natural fermentation of raw milk by microbes and their enzymes). Rayeb, "semi-liquid fermented milk," is the most acceptable form as a fermented product in case of the weakness of milk curd, so in the case of goat milk which performs weak curd, Rayeb is the most appropriate product to use in that case. Given the preceding, this study evaluated the impact of using different concentrations of coriander oil as a feeding supplement in lactating goats on the properties of the resultant milk and rayeb as a model product, physiochemical properties, sensorial acceptance, and especially fatty acid composition.

**Methods**

Milk was obtained at the end of the study by \cite{22}, where the experiment was conducted at the experimental farm, Faculty of Agriculture, Alexandria University, Egypt, using farm-owned animals. This mentioned study contained three groups of goats who were served the basal diet without a supplement (control treatment, C) or with the crude coriander oil supplement (per kg DM feed daily) at 0.95 g (Low coriander treatment, T1) or 1.9 g (High coriander treatment, T2). Diets were offered twice a day at 08:00 and 16:00 h. to ensure consumption of total doses of crude coriander oil supplement, the oil was delivered in 100 g total diet DM to individual goats before the morning feeding.

**Rayeb Preparation**

After receiving the milk (C, Control, T1, Milk of low coriander oil treatment 0.95% and T2, Milk of high coriander oil treatment 1.90 %). Rayeb milk was made following the method described by \cite{23}. Standardized milk (3% fat) was heat treated at 90 °C for five min., cooled to 41 °C, and then inoculated with 3% of the ABT culture (ABT- 5) mixed strains of *Lactobacillus delbrueckii* sub sp. *bulgaricus* (Chr. Hansen's Lab A/S Copenhagen, Denmark) were used, and incubated at 42°C for complete coagulation, then blended for 5 minutes, and stored refrigerated at 4°C. Rayeb milk samples were analyzed on day one and after 7, 14, and 21 days of refrigerated storage.

**Chemical analysis**
The titratable acidity content of samples was determined according to the Association of Official Analytical Chemists [24]. The pH value was measured electrometrically in all samples using a glass electrode type digital (Model, Crison -Basic 20-EU) pH meter according to the method [25]. The conventional Gerber's Method determined the fat content as described by [26]. The total protein content of rayeb was determined by the semi-micro Kjeldahl as described by [26]. Complete protein was calculated by the total nitrogen x Factor (6.38) percentage of all samples.

Fatty acid composition

Fat extraction and derivatization, Fat was extracted from milk and fermented milk using a modified Bligh and Dyer chloroform-methanol extraction method [27]. Fatty acid methyl esters (FAME) were prepared as follows, 250 µL of methanol and 50 µL of H2SO4 were added to the dry sample and then heated at 60°C for one hour. After the reaction, the samples were cooled and mixed with 1 mL of chloroform and salt solution, then shaken and taken from the lower part to inject into GC-MS.

GC-MS

Gas chromatography-mass spectrometry (GC-MS) analysis was performed with a TRACE GC Ultra Gas Chromatograph (THERMO Scientific Corp., USA) coupled to a Thermo mass spectrometer detector (ISQ Single Quadrupole Mass Spectrometer). The GC-MS system utilized a TR-5 MS column with a 30 m 0.32 mm inner diameter and 0.25 m film thickness. Using the following temperature program, analyses were conducted with helium as the carrier gas at a flow rate of 1.0 mL/min and a split ratio of 1:10. 60°C for 1 minute, 240°C at a rate of four °C/minute, 1 minute at 240°C. Both the injector and the detector were maintained at 210°C. Continuous injections of 1L diluted samples (1:10 hexane, v/v) of the mixtures were performed. Electron ionization (EI) at 70 eV was used to obtain mass spectra with a spectral range of m/z 40-450. The chemical constituents of the essential oil were identified by their retention indices (relative to n-alkanes C8-C22), mass spectrum matching to authentic standards (when available), the Wiley spectral library collection, and the NSIT library database. The percentage of individual fatty acids was calculated from their peak area to the total peak area of identified acids*100.

Phenolic, Flavonoid Content, and antioxidant Potentials

Preparing yogurt supernatant to determine radical scavenging activity and total phenolic content, 10 g of yogurt Samples were centrifuged at 4330×g for 5 min at four °C. Then, the supernatants were re-centrifuged under the same conditions and stored at -80 °C until use. The total phenolic content (TPC) expressed as a gallic acid equivalent in the µg/g sample was determined by the Folin–Ciocalteu method. Total flavonoid content (TPC) was assessed via the colorimetric method described by [28]. The results were expressed as µg of catechol equivalent per g of sample. The 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay was performed as described by [29]. Antioxidant activity was expressed as IC50 (mgmL-1), where the inhibition percent of the DPPH radical was 50%.

Microbiological analysis of Rayeb
Appropriate serial dilutions of Rayeb samples were prepared for microbial enumeration by using 2% sodium citrate. For the enumeration of S. thermphilus, counts were performed on M17 agar (Biolife, Italy) and incubated at 37 C for 48 h under aerobe conditions. The L. bulgaricus was enumeration on MRS agar (Biolife, Italy) and incubated aerobically at 37°C for 72 h (35). The enumeration of yeasts and molds was performed as recommended by [30] using potato dextrose agar (Difico, Italy) acidified with 10% tartaric acid and incubated at 25°C for five days. Violet red bile lactose agar (Oxide, UK) was used for the coliform count according to [31]. The plates were incubated at 37°C for 24 h. The colony-forming units were measured as Log10 CFUg-1.

**Sensory properties**

Ten expert staff members of the Food Technology Department, Arid Lands Cultivation and Research Institute, SRTA-City, Egypt University, organoleptically evaluated samples using the score card of fermented milk suggested by [32] as follows: Flavour 5 Points, Body/ Texture 4 Points and Colour/ Appearance 1 Point.

**Dodecyl Sulphate Polyacrylamide Gel Electrophoresis (SDS-PAGE)**

SDS-PAGE, 12.5% T, was conducted under reducing conditions using the discontinuous buffer system described by [33]. SDS-PAGE was performed on cheese samples using a Mini-PROTEAN electrophoresis cell (Bio-Rad Laboratories, Hercules, CA, USA). One ml of each rayeb sample was stirred with 1 mL of sample buffer for 10 min. Samples were denatured by boiling for 5 min, and then 7 µL of each sample was injected.

**Statistical analyses**

All samples were withdrawn twice with triplicate analysis. Results were analyzed by analysis of variance (ANOVA) and Duncan's multiple mean comparisons [34]. The level of significance was (P ≤ 0.05), and all statistical analyses were performed using SPSS statistical software (version 16.0, SPSS Inc., Chicago, IL, USA).

**Results And Discussion**

**Chemical Composition of goat rayeb**

Data in Table 1 showed the supplementation of crude coriander oil with the two levels (0.95 and 1.9 gm %) in goats feeding on the Fat, total protein, lactose, total solids, and ash content of goat rayeb. The chemical composition of goat’s milk ranged within the normal range, and all values of the mentioned properties corresponded to the results recorded by other researchers [35, 36].

**Physiochemical analysis**
The addition of coriander oil had no discernible effect on the coagulation time of rayeb up to pH 4.6, as all batches reached pH 4.6 ± 0.1 after six hours. This observation is consistent with findings previously reported [37]. Figure 3 depicts the changes in pH and titratable acidity values of rayeb treatments during 21 days of cold storage. The results declare that there were no significant differences between the treatments at the day one product stage as it was around (4.0). The pH values were significantly decreased (p ≤ 0.05) at 21 days of storage in all treatments, and values ranged from 4.0 to 3.87. The lowest pH value was recorded in treatment T2 (3.87), fortified with 1.9% coriander oil at the storage end. The results are comparable to [38]. The opposite trend was observed in the titratable acidity of all treatments that increased gradually during the storage period up to the end of storage. The Titratable acidity was significantly higher at the end of storage in treatment T2 (1.58) than in the rest of the treatments.

**Apparent viscosity of goat rayeb**

Apparent viscosity of rayeb at day one, 7, 14, and 21 days of storage are illustrated in Table 2, Rayeb exhibits a complex, shear-thickening, time-dependent flow behavior, and rayeb viscosity is therefore essential for processing, handling, process design, product development, and quality control aspects [39, 40]. The up-mode shear rates showed the rayeb shear-thickening as the apparent viscosity of all samples was significantly increased along with decreasing the shear rate. The addition of different levels of Coriander oil decreased the apparent viscosity of Rayeb milk significantly (p ≤ 0.05) as compared with that made without additives (control) Table 2. Furthermore, the apparent viscosity of Rayeb milk samples increased during the cold storage period, and this may be attributed to the coagulated particles of the gel that became stronger or greater in numbers particles became more hydrated [41].

**Microbiological analysis of rayeb**

The changes in the viable counts of starter *S. thermophilus, L. bulgaricus*

for the different rayeb treatments shown in Figures 1 and 2, fresh treatments, the *S. thermophilus*, and *L. bulgaricus* count for treatments were comparable to the control. These outcomes were consistent with what was reported by Crowley et al., 2017 [42]. The *L. bulgaricus* count in treatments (T1 and T2) was higher than the control due to coriander oil that activated microbial growth, the same findings were found by [43]. The TA reflected these results, which showed higher values in T1 and T2 (Table 2), confirming the microbiological analysis results. The *S. thermophilus* and *L. bulgaricus* counts showed insignificant decreases during storage. Yeast, molds, and coliforms were absent, this may be due to the good hygienic conditions during manufacturing.

**Sensory evaluation of rayeb**

Sensory properties of rayeb treatments compared to control when at day one and after 21 days of refrigerated storage are illustrated in Figure 4 (a, b). overall, the panelists preferred treatment T1 more than the control, while T2 showed the lowest acceptability records, especially concerning body and
texture. After 21 days of cold storage, no changes in sensory parameters or acceptance were observed. These results indicate that using (0.95%) coriander oil within goat feeding is the most appropriate percentage to obtain acceptable sensory properties in terms of color, odor, taste, and goaty flavor in the final product. These findings reflect the positive impact of some coriander oil fatty acids on rayeb, such as Linalool fatty acid, which is identified as the principal constituent of the oil of seeds of Coriandrum sativum 64.4% [44], and have a pleasant floral flavor that alters the goaty flavor. Similar findings were noted by [45], who found that Doogh containing 0.05% coriander leaf extract was preferred by panelists and had the highest scores.

**Fatty acid Profile**

The overall means of milk fatty acids show that the 22 fatty acids were identified in the studied raw goat milk and rayeb after 14 days of storage, 14 saturated short, medium, and long chains (C4 to C18), 2 monounsaturated medium and long chains (C16 & C18), and six polyunsaturated long-chains (C18: C22), as shown in Table 4.

Palmitic oil (C16:0) is the most prevalent fatty acid in goat milk [46]. In all treatments, the control raw goat milk, has the highest percentage of (C16:0), (32.1), while the rate decreased in rayeb treatments, T2 has the lowest value (24.73), on the other hand, monounsaturated fatty acids such as Palmetiolic acid (C16:1 n-7) content increased in rayeb treatments compared to raw milk in the same treatment. Whereas in raw milk C, T1 and T2 were (0.89, 1.24, and 0.48) and in rayeb samples C, T1 and T2 increased to (1.22, 1.99, and 1.93), this may be due to lactic acid bacteria fermentation and using saturated fatty acid in its metabolism and converting to unsaturated fatty acids, according to a study by [47]. Oleic acid (C18:1 n-9) followed the same pattern in which its content was higher in rayeb treatments than raw milk, and the T2 rayeb sample recorded the highest value (26.26). Furthermore, polyunsaturated fatty acid conjugated linoleic acid (C18:2 n-6) content also increased in rayeb samples (3.21, 3.17, and 3.94) respectively for C, T1, and T2 compared with (1.27, 2.88 and 2.9) for raw milk C, T1, and T2. Conjugated linoleic acid (CLA) is known as essential for human health. It is considered a precursor that reduces or eliminates cancer, prevents heart disease, enhances immune function, and plays an essential role in treating obesity or building lean body mass [48].

According to [49], The proportion of acetate and -hydroxybutyrate, essential precursors to the synthesis de novo of short- and medium-chain fatty acids (SMCFA) in the mammary gland, increases when cows consume more forage. Using 1.9% coriander oil in the goat feeding resulted in a higher content of saturated fatty acids in T2 raw milk treatment (C6 and C14), while in T1 raw milk treatment (C10, C14, C15, C17, and C18) increased compared with control raw milk, along with no significant changes were observed in the content of MUFAs and PUFAs. Alternatively, rayeb treatments showed substantial differences in the range of USFA's and MUFAs, especially in T1, where their values were 28.28 and 52.25, respectively, compared to control and T2 treatments after 14- days of storage. Also, the UFAs: SFAs ratio is high in T2 (61.70%) compared with all medicines, and USFs showed the highest values in control rayeb
treatment and T2 compared with the rest of the treatments. Coriander oil supplementation in goats feeding has a positive impact on increasing the proportion of conjugated linoleic acid (CLA) and unsaturated fatty acids in rayeb treatments having the highest value compared with its raw milk, which is a good indicator of a healthy product for consumers. It is preferred to consume goat’s milk in rayeb form due to the good features of the lactic acid bacteria fermentation process and its products.

The fatty acid profiles of fresh goat milk changed during the processing of yogurt and concentrated yogurt. Saturated fatty acids make up a higher percentage of all products than unsaturated fatty acids. The predominant fatty acids were stearic and palmitic, oleic acid was the most prevalent unsaturated fatty acid, linoleic acid was the most pervasive polyunsaturated fatty acid, and capric acid was the most pervasive medium-chain triglyceride.

**Electrophoresis of the rayeb**

Observing the electrophoretogram of day one and after 21 days of cold storage goat rayeb (Fig 5), we noted distinctively clear bands of αs2-Casein and negligible amounts or absence of αs1- Casein, and T2 treatment showed a higher degree of proteolysis compared with control and T1. This result was expected because goat milk reportedly contains less αs1- Casein than αs2- Casein compared to cow milk [50].

**Phenolic, Flavonoid Content, and antioxidant Potentials**

The antioxidant activity was quantified in fresh Rayeb milk made from goat’s milk or treated goat’s milk. Data obtained are presented in Table 3. Rayeb milk with high coriander oil concentration (T2, 287.28 ± 0.49) was richer in the ratio of DPPH inhibition than (control Rayeb, 134.23 ± 0.92, and (T1, 224.91 ± 1.65). Of course, this was due to the effect of coriander oil feed supplementation of coriander oil, and these results were the consistency of findings by [51], who cleared that replacing cereal with dry orange paper in the diet of goats during the early lactation phase, a diet had no significant effect on FA content. However, the resultant milk’s α-tocopherol, total phenolic compound (TPC), and total antioxidant capacity (TAC) increased.

**Conclusion**

This study demonstrated that using coriander crude oil with a percentage (0.95%) in goat feeding positively affects the technological and sensorial aspects of rayeb as a product model, reflecting better texture properties and elevating acceptance of the taste and flavor of rayeb compared to the control. It also increased the percentage of polyunsaturated fatty acids, which had immense health benefits, and did not affect the coagulation time.

**Declarations**

**Conflict of interest**
The authors have declared no conflicts of interest for this article.

**Data availability**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Acknowledgment**

**Competing interests**

The authors declare no competing interests.

**References**


**Tables**

**Table (1) Chemical Composition of goat rayeb**
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Day One</th>
<th>21 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>T1</td>
</tr>
<tr>
<td>Fat</td>
<td>3.50 ± 0.1</td>
<td>3.20 ± 0.2</td>
</tr>
<tr>
<td>Protein</td>
<td>3.34 ± 0.1</td>
<td>3.94 ± 0.1</td>
</tr>
<tr>
<td>Lactose</td>
<td>3.13 ± 0.2</td>
<td>4.12 ± 0.2</td>
</tr>
<tr>
<td>TS</td>
<td>10.58 ± 0.4</td>
<td>11.88 ± 0.5</td>
</tr>
<tr>
<td>Ash</td>
<td>0.61 ± 0.03</td>
<td>0.62 ± 0.03</td>
</tr>
</tbody>
</table>

Each reported value is the mean ± SD of three replicates. Means in the same row followed by different letters are significantly different (p<0.05)

**Table (2): Apparent viscosity of goat rayeb**

<table>
<thead>
<tr>
<th>Viscosity (cP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>T1</td>
</tr>
<tr>
<td>T2</td>
</tr>
</tbody>
</table>

Each reported value is the mean ± SD of three replicates. Means in the same row followed by different letters are significantly different (p<0.05)

**Table (3): Antioxidant activity (DPPH, and ABTS radical scavenging assay) of goat rayeb**
<table>
<thead>
<tr>
<th>Time</th>
<th>Treatment</th>
<th>(DPPH) IC50 (µl/ml)</th>
<th>(ABTS) IC50 (µg/ml)</th>
<th>Total phenolic content (µg GAE/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ascorbic acid</td>
<td>11.16±0.43</td>
<td>11.60 ± 1.49</td>
<td>---</td>
</tr>
<tr>
<td>Day One</td>
<td>C</td>
<td>134.23 ± 0.92  d</td>
<td>146.60 ± 0.85  b</td>
<td>204.02 ± 5.16  a</td>
</tr>
<tr>
<td></td>
<td>T1</td>
<td>224.91 ± 1.65  b</td>
<td>100.69 ± 1.13  f</td>
<td>146.87 ± 4.42  d</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>287.28 ± 0.49  a</td>
<td>160.53 ± 0.50  a</td>
<td>150.17 ± 6.37  d</td>
</tr>
<tr>
<td>21 Days</td>
<td>C</td>
<td>131.33 ± 1.15  e</td>
<td>143.33 ± 0.57  c</td>
<td>194.82 ± 0.78  b</td>
</tr>
<tr>
<td></td>
<td>T1</td>
<td>130.95 ± 0.93  e</td>
<td>116.28 ± 1.45  d</td>
<td>165.34 ± 9.98  c</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>182.57 ± 0.51  c</td>
<td>113.85 ± 0.79  e</td>
<td>173.54 ± 5.98  c</td>
</tr>
</tbody>
</table>

IC50: Effective concentration which achieves 50% DPPH radical scavenging activity. ABTS•+ radical assay expressed as percentage activity as a function of the concentration of extracts. Each reported value is the mean ± SE of three replicates. Means in the same column followed by different letters are significantly different (p<0.05).

Table (4): Gas-Liquid Chromatographic analysis of goat rayeb fatty acids content at day one and end of storage
<table>
<thead>
<tr>
<th>Fatty Acids</th>
<th>Symbol</th>
<th>Raw Milk</th>
<th></th>
<th></th>
<th>Rayeb -14 Days</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>T1</td>
<td>T2</td>
<td>C</td>
<td>T1</td>
</tr>
<tr>
<td><strong>SFAs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butyric acid</td>
<td>C4:0</td>
<td>4.99</td>
<td>0.46</td>
<td>0.43</td>
<td>0.23</td>
<td>0.53</td>
</tr>
<tr>
<td>Caproic acid (goaty)</td>
<td>C6:0</td>
<td>2.09</td>
<td>1.02</td>
<td>3.05</td>
<td>0.24</td>
<td>1.06</td>
</tr>
<tr>
<td>Caprylic acid</td>
<td>C8:0</td>
<td>2.14</td>
<td>2.31</td>
<td>2.42</td>
<td>11.25</td>
<td>2.15</td>
</tr>
<tr>
<td>Capric acid</td>
<td>C10:0</td>
<td>3.96</td>
<td>8.18</td>
<td>5.81</td>
<td>28.99</td>
<td>6.74</td>
</tr>
<tr>
<td>Undecanoic acid</td>
<td>C11:1</td>
<td>11.9</td>
<td>2.26</td>
<td>10.59</td>
<td>0.2</td>
<td>0.12</td>
</tr>
<tr>
<td>Lauric acid</td>
<td>C12:0</td>
<td>1.27</td>
<td>3.01</td>
<td>3.16</td>
<td>10.75</td>
<td>2.68</td>
</tr>
<tr>
<td>Tridecanoic acid</td>
<td>C13:0</td>
<td>1.31</td>
<td>0.2</td>
<td>1.84</td>
<td>0.53</td>
<td>0.13</td>
</tr>
<tr>
<td>Myristic acid</td>
<td>C14:0</td>
<td>4.41</td>
<td>9.14</td>
<td>9</td>
<td>3.19</td>
<td>8.76</td>
</tr>
<tr>
<td>Pentadecanoic acid</td>
<td>C15:0</td>
<td>0.56</td>
<td>1.33</td>
<td>0.76</td>
<td>1.69</td>
<td>1.44</td>
</tr>
<tr>
<td>Palmitic acid</td>
<td>C16:0</td>
<td>32.1</td>
<td>27.55</td>
<td>21.48</td>
<td>28.68</td>
<td>24.73</td>
</tr>
<tr>
<td>Heptadecanoic acid</td>
<td>C17:0</td>
<td>0.85</td>
<td>1.07</td>
<td>0.76</td>
<td>1</td>
<td>1.07</td>
</tr>
<tr>
<td>Stearic acid</td>
<td>C18:0</td>
<td>10.5</td>
<td>12.29</td>
<td>9.03</td>
<td>3.09</td>
<td>2.52</td>
</tr>
<tr>
<td>Arachidic acid</td>
<td>C20:0</td>
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<td>0.79</td>
<td>ND</td>
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<td><strong>PUFA`s</strong></td>
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<td>Myristoleic acid</td>
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<td>0.29</td>
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Summary of the essential fatty acid parameters of fat extracted from Treatments
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<td>UFAs: SFAs ratio</td>
<td>20.03</td>
<td>37.13</td>
<td>37.78</td>
<td>36.80</td>
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**Figures**

![Lactic acid bacteria Count of goat rayeb](image)

**Figure 1**

Lactic acid bacteria growth during the storage period
**Figure 2**

*Streptococcus thermophiles* growth during the storage period

**pH and Acidity of goat rayeb**

<table>
<thead>
<tr>
<th>Value</th>
<th>pH</th>
<th>Acidity</th>
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<td>T1</td>
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<tr>
<td></td>
<td>T2</td>
<td></td>
</tr>
</tbody>
</table>

**Treatments**

- C
- T1
- T2

Day one  | 7 days  | 14 days | 21 days
Figure 3

pH and Acidity of goat rayeb

(a) Day one

(b) End of Storage

Figure 4

Sensory evaluation of goat rayeb
Figure 5

Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE, 12.5% T) of goat rayeb at day one and end of storage.