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Total Plate Count and Organoleptic Tests of Soft Cheese Made from Goat Milk with the Addition of Lemon Juice (*Citrus limon*)

B. Viaretika*[1], E. Sulistyowati[2], M. Ali[1], M. Dohi[1], Haryanto[1], E. Soetrisno[2], Hidayat[2], and T. Akbarillah[2]

[1]Department of Animal Husbandry, Faculty of Animal Husbandry, Universitas Mataram
[2]Department of Animal Husbandry, Faculty of Agriculture, Universitas Bengkulu
*Corresponding author's email: bqviaretika@gmail.com
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ABSTRACT

This study evaluates the effect of adding local lemon juice (*Citrus limon*) on Total Plate Count (TPC) and organoleptic in soft cheese, including color, texture, taste and preference for color, aroma/smell, texture and flavour. The experimental design used was a Completely Randomized Design (CRD) using four treatments and 4 replications. Treatments differed by lemon juice concentration: T1 (0%), T2 (2%), T3 (4%), T4 (6%). The observation variables are TPC and organoleptic. The research results show that adding local lemon juice significantly effects (P<0.01) on the TPC and Organoleptics of color, texture, taste, and preferences for color, aroma/aroma, texture and flavour. The highest mean TPC was obtained at T1 (0%) with a value of 4.08 x 10^8 cfu/g, and the lowest was at T4 (6%) with a value of 2.25 x 10^8 cfu/g.

Keywords: Goat milk, soft cheese, lemon juice, TPC, and organoleptic

INTRODUCTION

Goat milk can quickly spoil if not handled optimally, shortening its shelf life. Goat milk represents extraordinary potential for development in various forms of dairy processing, strengthened by excellent nutritional content for health. Sulistyowati et al. (2021) reported that goat milk contains protein of 3.82% anf fat of 6.59%. Goat milk can be obtained more quickly. According to Nasution (2020) goats can produce at the age of 1.5 years, unlike cows which can produce at 3 - 4 years, depending on the breed. Generally, goat milk has a higher somatic cell count (SCC) than cow and sheep's milk. High SCC in milk can prolong coagulation and produce a softer coagulum during cheese-making. It ultimately leads to an increase in water content in the cheese and a decrease in overall cheese yield (Chen et al., 2010).

Goat milk has different levels of fat and protein in each lactation phase. The fat content of Etawa crossbreed goat milk in the final lactation phase is higher than in the previous lactation phase. According to Zaidemarno et al. (2016) milk fat content in the first lactation phase is around 5.62%, second lactation around 3.71%, third lactation around 4.35% and fourth lactation around 6.20%. According to Yahya (2001) the average protein content of Etawa crossbreed goats in the first lactation phase is 3.336% and in the fourth lactation phase is 3.354%. Fat is essential in making cheese, the higher the milk fat content, the softer, more aromatic and more attractive the cheese is. The protein found in milk is casein, a component that forms lumps in cheese (Syamsu and Kartika, 2018).

Cheese is a fermented milk product that has long been a favorite culinary dish with its distinctive salty taste. Cheese produced from goat milk carries distinctive taste nuances, providing a new dimension to the experience of consuming cheese. Cheese is generally known for its original taste. However, some people still who do not fully appreciate the diversity of cheese tastes that can be produced in various variants. Even so, cheese has the potential to be processed with a variety of exciting tastes. For example, citrus fruit is one of the ingredients that can be used as a taste enhancer in the cheese-making process, providing a unique and innovative taste dimension.

Lemon fruit is a natural product that has the potential to be antibacterial. Lemon fruit contains many bioactive compounds such as citric acid, flavonoids, saponins, limonoids, tannins, and terpenoids (Dewi et al., 2020). Not only that, lemon juice also contains volatile essential oil components, one of which is limonoid compounds. Lemon juice has a distinctive aroma, which can reduce the fishy aroma (Sulistiyati and Aryani., 2022). It was continued that odor/aroma influences the quality of a product, and the panellists' sense of smell is used to assess the product.

Adding ingredients chilli paste can affect soft cheese's nutritional content and TPC (Khotimah et al., 2019). The research results of Rati et al. (2017), the addition of strawberry paste significantly affected the color, aroma/aroma, and taste. Still, there is no significant effect on the texture and preference for soft cheese, while the highest TPC was found in cheese without adding strawberries.

Based on the explanation above, this research was carried out by adding lemon juice to soft cheese to evaluate the effects of local lemon juice on TPC and organoleptics, including color, texture taste and preference for color, aroma/smell, texture and flavour.

MATERIALS AND METHODS

The research was carried out in March-June 2024 at the Animal Husbandry Laboratory, Department of Animal Husbandry, Faculty of Agriculture, Universitas Bengkulu.

Materials and Equipment

The main ingredient used in this research was Anglo-Nubian goat milk obtained from the Commercial Zone Animal Laboratory (CZAL), Department of Animal Husbandry, Faculty of Agriculture, Universitas Bengkulu. The bacterial starter used is *Lactobacillus bulgaricus* brand "Bio Kull", salt brand "miwon", salad dressing brand "Maestro", lemon juice and rennet made from vegetable ingredients. Some materials for microbiological analysis were cheese samples of 10 grams each for 16 samples, NaCl and PCA.

The tools used include pans, thermometers, analytical scales of the "KRIS" brand, knives, gas stoves of the "Rinnai" brand, napkins, measuring cups, scissors, tissue, plates, spoons, plastic boxes, masks, test tubes, measuring cups, camera, colony counter brand "Stuart", petri dishes, laminar air flow, bunsen, desiccator, autoclave, water bath, stomacher, spatula and stove.

Lemon Juice Preparation

Local lemons were obtained from the Nayla fruit shop near the UNIB campus, Bengkulu. The equipment is a container, knife, analytical scale, orange squeezer, spoon and filter. The way to make lemon juice is to wash the lemons clean, weigh 1000 grams of them, cut them into two parts and then squeeze them using a citrus squeezer. It was out of 1000 grams of lemons and 355 ml of lemon juice, yielding 35.57%.

Making Soft Cheese

About 1 litre of goat milk is pasteurized using Low-Temperature Long Time (LTLT) for 30 minutes at 62°C while stirring. After that, the milk was cooled at room temperature until the temperature reached 45°C. The starter, namely *Lactobacillus bulgaricus bacteria,* was added to the pasteurized milk by as much as 15% of the weight and stirred until evenly distributed. Then add ¼ tablet of rennet, mix thoroughly and let sit for approximately 5 minutes until casein coagulates (curding). After clumping occurs, the Curd and Whey were then filtered using a filter cloth (Rahmawati et al., 2012). The whey obtained was weighed then discarded, the curd was weighed, and then lemon juice is added T1 (0%), T2 (2%), T3 (4%), and T4 (6%) of the weight of the curd produced. Add 3% mayonnaise and 4% salt from the weight of the curd produced to all treatments, then mix homogeneously. Then put it in a storage medium, a plastic box labelled according to the treatment and closed tightly, stored in the show case for 4 to 6 days. Afterwards, the organoleptic and TPC tests were carried out according to Khotimah et al. (2019).

Curd and Whey Ratio

According to (Nasution, 2020), curd is the coagulation of milk by enzymes, curd is a lump that forms during milk processing into cheese, while whey is the liquid produced from separating curd. Based on research by Budiman et al. (2017), total curd is a critical parameter for assessing the amount of curd formed after the milk casein coagulation process and separation from whey. Likewise, total whey is a relevant indicator in determining the amount of whey produced. The high value of total curd and low total whey indicates a significant amount of curd is formed in the process. The ratio between curd and whey is calculated by detailing the amount of curd and whey produced then calculating the ratio. Thus, calculating this ratio provides important information regarding the proportion between curd and whey, which is a benchmark for evaluating the efficiency of the coagulation and separation process in making dairy products. The curd and whey ratio is calculated based on the curd and whey produced, each being weighed and then calculated.

Formula :

[Curd (g)/milk weight (g)] x 100%

[Whey (g)/milk weight (g)] x 100%

Experimental Design

This research used a Completely Randomized Design (CRD) with 4 treatments and 4 replications. The treatments given were T1: (0% lemon juice), T2: (2% lemon juice), T3: (4% lemon juice), T4: (6% lemon juice).

The mathematical model of this design, according to Letner and Bhishop (1986), was:

$Yij = \mu + \beta i + \varepsilon ij$

Information:

Yij = Observed value in the i-th and j-th treatment
μ = General average value of the treatment
βi = Effect of treatment i-th
εij = Error in the i-th treatment and j-th replication
i = Treatment
j = Replication

Variables Observed

The variables observed in this research were TPC and organoleptics of soft cheese.

Total Plate Count (TPC)

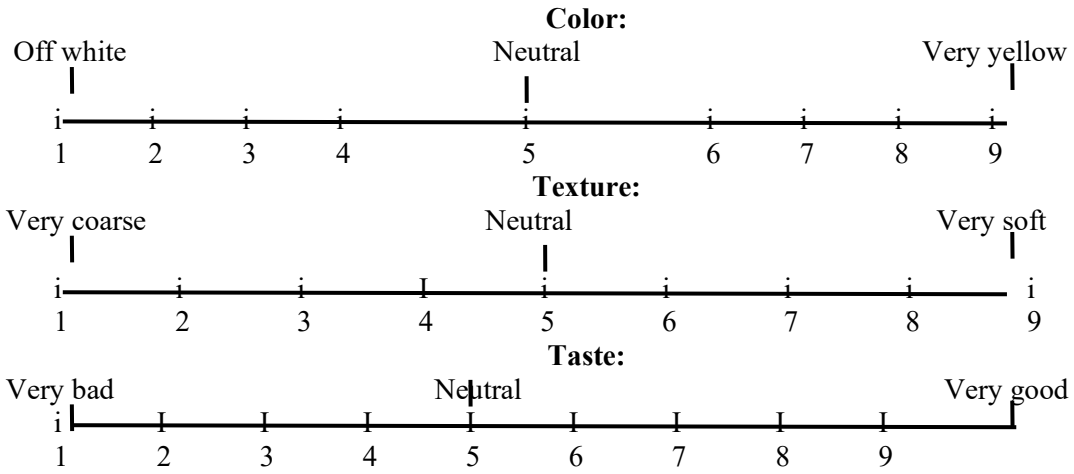
The TPC is determined as follows, a sample with a dilution of 10^{-1} is carried out by adding 5 grams of sample and placing it in 45 ml of NaCl solution, then homogenizing using Stomacher for 2 minutes. The subsequen dilution, namely $10^{-2,}$ was carried out by taking a sample of 1 ml and placing it in 9 ml of NaCl solution, then homogenizing using a stomacher for 2 minutes. Likewise with the dilutions 10^{-3}, 10^{-4}, 10^{-5} and 10^{-6}, then put them in a petri dish. Add 12 - 15 ml of PCA which has been cooled in a water bath until it reaches a temperature of 45°C into each cup containing the solution/sample. After the agar solidified, the plates were incubated for 48 hours at 35°C. The number of bacteria was counted using a Colony Counter (Khotimah et al., 2019).

Organoleptic

Organoleptic test parameters for soft cheese made from goat milk with the addition of lemon juice.

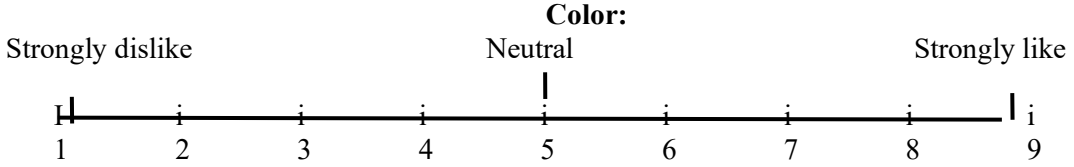
a. Hedonic quality: color, texture and taste created using the following line scale:

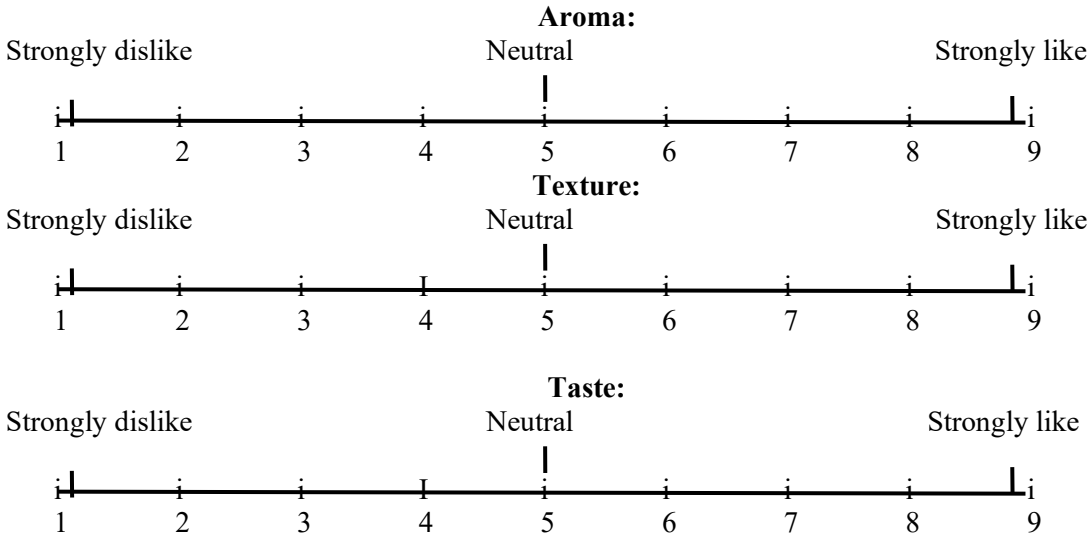
Hedonic qualities of soft cheese



b. Hedonic: the level of preference starting from color, aroma, texture, taste and acceptability, which is made using the following line scale:

Hedonic soft cheese





Data analysis

The data obtained in this study was tabulated and then analysed using Analysis of Variance (ANOVA). If the results of the analysis have a significant effect ($P<0.05$), then continue with the Duncan's Multiple Range Test (DMRT) according to Letner and Bhishop (1986).

RESULTS AND DISCUSSION

Milk Production

The milk used to make soft cheese in this research was obtained from the milk production of goats kept by the Commercial Zone Animal Laboratory (CZAL), Department of Animal Husbandry, Faculty of Agriculture, Universitas Bengkulu.

Table 1. Anglo-Nubian goat milk production at CZAL

Goat	Timing	Milking days (ml/d)				Total	Average
		1	2	3	4		
A	Morning	1400	1450	1500	1500	5850	1462.5±41.46
	Afternoon	1200	1190	1080	980	4450	1112.5±89.83
B	Morning	1100	1160	1180	1000	4440	1110±70.00
	Afternoon	650	600	650	590	2490	622.5±27.73

Notes: Goat milk production in the Commercial Zone Animal Laboratory (CZAL), Department of Animal Husbandry, Faculty of Agriculture, Universitas Bengkulu

Based on Table 1, goat A's average daily milk production is around 2575 ± 58.95 ml/day, while the average production of goat B is around 1732.5 ± 87.86 ml/day. The goats were Anglo-Nubian in the third lactation phase and have entered the final lactation phase. According to Suryandari et al. (2023), the average milk production of Anglo-Nubian goats is 784.62 ml/day. Meanwhile, according to Rusdiana et al. (2015), the average production of Anglo-Nubian goats was 1,190 ml/day. Brown et al. (1988) reported that Anglo-Nubian goat milk production at 27°C and 34°C was 3.32 and 3.28 kg/day, respectively. Several factors, including genetic factors, the environment, and differences in rearing management on each farm, cause differences in average milk production.

Curd and Whey Ratio

Curd is a lump that forms during milk processing into cheese, while whey is the liquid produced from separating curd, as presented in Table 2.

Table 2. Average weight and ratio of curd and whey cheese with the addition of lemon juice

Variable	Treatment				Average
	T1	T2	T3	T4	
Curd (g)	128.50	134.98	131.80	130.13	131.35
Curds (%)	12.87	13.82	13.90	13.21	13.45
Whey (g)	679.13	719.55	655.93	648.50	675.78
Whey (%)	68.01	73.70	68.47	65.89	69.02

Description: Average weight and ratio of Curd and Whey. T1: (0% lemon juice), T2: (2% lemon juice), T3: (4% lemon juice), T4: (6% lemon juice).

Based on Table 2, the average weight of curd from making this soft cheese was around 131.35 g, while the average weight of whey produced was around 675.78 g. The average curd ratio produced from making this soft cheese was around 13.45%, while the average ratio of whey produced was around 69.02%. The temperature and length of the pasteurization process in this study set a temperature of about 62°C for 30 minutes (Rahmawati *et al*., 2012).

Total Plate Count Test

The TPC test counts the number of bacteria in a sample. This method is significant because it helps ensure the product is free from bacterial contamination that could harm consumers. The average TPC test results for soft cheese with the addition of lemon juice after 6 days of storage are presented in Table 3.

Table 3. Total plate count of cheese with the addition of lemon juice

Treatment	Test				Average
	1	2	3	4	
	…… Cfu/g ……..				
T1	4.8×10^8	4.8×10^8	3.5×10^8	3.2×10^8	4.08 ± 0.85^a
T2	4.6×10^8	3.7×10^8	3.2×10^8	3.9×10^8	3.85 ± 0.58^a
T3	4.1×10^8	2.7×10^8	4.7×10^8	2.2×10^8	3.43 ± 1.17^a
T4	3.4×10^8	1.3×10^8	2.6×10^8	1.7×10^8	2.25 ± 0.94^b

Note: Different superscripts in the same column show a very significant (P<0.01), T1: (0% lemon juice), T2: (2% lemon juice), T3: (4% lemon juice), T4: (6% lemon juice).

The results showed that the treatment had a significant effect (P<0.01) on microbial growth in soft cheese. However, there were no significant differences in T1 (0%), T2 (2%) and T3 (4%). These results showed that adding a concentration of lemon juice could suppress bacterial growth in soft cheese. It is thought to be due to the active compounds in lemon juice, which are believed to inhibit bacterial growth, one of which is citric acid. It is in connection with the opinion of Dewi *et al.* (2020) who stated that lemon juice is acidic because it contains citric acid, which can reduce the internal pH of bacterial cells. It can disrupt bacterial cell activity and inhibit bacterial growth.

Organoleptic Test

Organoleptic quality testing is significant for manufacturers because it provides insight into consumer preferences. By understanding what consumers like and don't like, manufacturers can improve their products to make them more satisfying. The average results of the organoleptic quality test involving color, texture and taste of soft cheese with the addition of lemon juice after 4 days of storage are presented in Table 4.

Table 4. Means of organoleptic tests on color, texture and taste

Parameter	T1	T2	T3	T4
Color	3.48 ± 0.68^b	3.70 ± 0.59^b	4.05 ± 0.54^{bc}	4.75 ± 0.16^a
Texture	4.50 ± 0.55^c	4.68 ± 0.59^{bc}	6.74 ± 1.01^a	4.58 ± 0.58^c
Taste	5.65 ± 0.41^c	5.73 ± 0.19^{bc}	5.84 ± 0.09^a	6.13 ± 0.13^a

Note: Different superscripts in the same column show a very significant effect (P<0.01). T1: (0% lemon juice), T2: (2% lemon juice), T3: (4% lemon juice), T4: (6% lemon juice).

The hedonic quality test results showed that adding lemon juice significantly affected colour, texture and taste (P<0.01) on color, texture and taste. The highest scores in T4 (6% lemon juice) were found in the color and taste categories. Increasing the concentration of lemon juice significantly increased the score on the color of soft cheese. The higher the lemon juice concentration added, the more significant the colour change. It is thought to be because lemon juice contains yellow to orange carotene (Sulistiyati and Aryani, 2022). According to Wang et al. (2022), this color change is strongly influenced by pigments in polysaccharides, such as carotenoids. This pigment becomes colored when a stable complex is formed between the polysaccharides and the cheese matrix, influencing goat milk cheese's appearance cheese.

The higher the addition of lemon juice, the more significant the resulting change in texture. The highest mean was obtained at T3 with a value of 6.74 ±1.01, indicating that the cheese's textur of the cheese is slightly smoother. It is thought to be due to the content in lemon juice, such as citric acid, which can give lemons sour properties. In connection with the research results of Wardhani et al. (2018), the texture of curd produced with acid coagulant tends to be soft easily broken, while orange extract coagulant produces soft, clayey curd. According to another opinion, Sulistiyati and Aryani, (2022) the resulting texture is formed due to the combination of several physical elements, one of which is the elements comprising the material that the sense of taste can feel. Meanwhile, according to Wang et al. (2022) stated that cheese processed using goat milk has lower textural integrity.

The higher the level of lemon juice added, the better the resulting taste. It is due to the content in lemon juice, namely citric acid. According to Dewi et al. (2020), citric acid can give lemons a sour taste. Combining the salty taste of cheese and the sourness of lemon juice adds taste to the cheese. In connection with the opinion of Irawati et al. (2015) mentioned the taste of a food ingredient originates from the nature of the ingredient itself or because other substances are added during the processing and cooking process, causing the original taste to be reduced (unpleasant) or perhaps become more palatable. According to another opinion, Hayaloglu et al. (2013) stated that milk's high fat and protein content can satisfy cheese taste.

Hedonic Test

The hedonic test is a method to determine how much consumers like a product. The average hedonic test results involving color, aroma, texture and taste of soft cheese with the addition of lemon juice after 4 days of storage are presented in Table 5.

Table 5. Means of hedonic tests of color, aroma/smell, texture and taste

Parameter	T1	T2	T3	T4
Color	3.53±0.13^{d}	3.89±0.06^{c}	4.00±0.23^{bc}	4.74±0.28^{a}
Aroma	5.39 ±0.85^{d}	5.16 ±0.28^{b}	6.36 ±1.17^{a}	7.15 ±0.73^{a}
Texture	4.98±0.87^{bc}	4.54 ±0.73^{c}	7.11 ±0.55^{a}	4.83 ±0.41^{c}
Taste	4.53 ±0.23^{c}	4.88 ±0.50^{c}	5.18 ±0.42^{bc}	7.06 ±0.50^{a}

Note: Different superscripts in the same column show a very significant effect (P<0.01). T1: (0% lemon juice), T2: (2% lemon juice), T3: (4% lemon juice), T4: (6% lemon juice).

The hedonic test results showed that adding lemon juice had a significant effect (P<0.01) on the preference for color, aroma/smell, texture and taste of soft cheese. Increasing the concentration of lemon juice significantly increased the color preference score of soft cheese. The higher the concentration of lemon juice added, the more the panellists liked the color of the resulting soft cheese. The highest average rating of the panellists was obtained at T4 with a value of 4.74±0.28, which indicates that the panellists' preference for cheese color is quite favourable. Similar to the research results of Bahri et al. (2019), namely the bright color of jelly candy made with the addition of lemon juice, which the panellists liked. It is thought to be because lemon juice contains carotene, which is yellow to orange (Sulistiyati and Aryani. 2022).

There was no significant difference in the aroma category at T3 and T4. Increasing the concentration of lemon juice significantly increased the preference score for the aroma of soft cheese. The higher the concentration of.

lemon juice added, the more the panelists prefered the resulting aroma of soft cheese. The highest average panellist assessment was obtained at T4 with a value of 7.15±0.73, indicating that the panellists liked the aroma/aroma of cheese more.

Increasing the concentration of lemon juice significantly increased the preference score for the texture of soft cheese. The higher the concentration of lemon juice added, the smoother the texture of the cheese produced, the more the panellists liked. The highest average panellist assessment was obtained at T3 with a value of 7.11, indicating that the panellists preferred cheese texture. Based on the research results of Pardosi (2024), the texture of buffalo milk curd with pineapple fruit coagulant is more preferred with an average preference value of 48.80 than the texture of buffalo milk curd with lemon coagulant with an average preference value of 28.16.

Increasing the concentration of lemon juice significantly increases the preference score for the taste of soft cheese. The higher the concentration of lemon juice added, the more panellists liked the soft cheese taste produced. The highest average panellist assessment of cheese taste preferences was obtained at T4 with a value of 7.06, indicating that the panellists preferred cheese taste. Similar to the research results of Bahri et al. (2019), the panellists preferred the taste of jelly candy made with the addition of lemon juice taste of jelly candy made with the addition of lemon juice. This is due to the content in lemon juice, namely citric acid. According to Dewi et al. (2020), Citric acid can give lemons a sour taste.

CONCLUSION

Based on the research results, it was concluded that adding 6% lemon juice could reduce the total plate count (TPC) and improve organoleptic and preference for color and taste of soft cheese made from dairy goat milk.

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