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Chemical and Organoleptic Properties of Palopo (Local Soft Cheese) Produced Using Natural Additive as Milk Coagulant

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A B S T R A C T

Palopo is a traditional food that originated in Taliwang, West Sumbawa. This traditional processed product is made of buffalo milk mixed with palm sugar and a natural coagulant of wild eggplant (*Solanum carolinense*). The purpose of this study was to determine the use of four natural coagulants such as *Solanum carolinense*; *Caloutropis gigantea*; *Wrigthia javanica*; and *Averrhoa bilimbi* L. as milk coagulant on the quality of soft cheese (palopo). The study used a Completely Randomized Design (CRD), consisting of 4 treatments, Juice of four natural coagulants in 2.5 %, and repeated 5 times. The data obtained were analyzed using ANOVA (Analysis of Variance) at a 5 % level using Statistical Analysis System (SAS) Software and continued tested using Least Significant Difference (LSD). The results showed that the addition of the treatments gave a significant effect on chemical and organoleptic quality. It was concluded that the treatment of CG (*Caloutropis gigantea*) was the best in terms of the chemical content and organoleptic value. The overall panelists' acceptability of the palopo were the CG (*Caloutropis gigantea*) treatment, Moreover, the most preferred palopo' taste ranged from CG, SI, and WJ respectively, with the brownish-yellow color, slightly milky aroma, slightly chewy texture, sweet taste so that the panelists liked it.

1. INTRODUCTION

1.1. Research Background

Milk is a secretion from the mammary glands of mammals, composed in different from the blood composition which is the origin of milk [1]. Milk is called a rich nutrients food that has a complete nutritional value needed by the human body as nutritional intake, including water, fat, lactose, pectin, vitamins, and minerals [2]. The content of protein, glucose, lipids, mineral salts, and vitamins with a pH of around 6.80 causes microorganisms to easily grow in milk. Some bacteria such as *Salmonella sp, Campylobacter jejuni, E. coli, and Listeria monocytogenes* were reported to contaminate milk with a small prevalence [3]. The perishable nature of milk is what drives the public and industry players to process milk into various products. Diversification of various dairy products is important, this can improve people's nutrition, especially for people who do not like to consume fresh milk. Milk processing that is carried out with simple technology and can produce products that consumers like needs to be sought and developed [4]. One of the techniques or ways to develop milk processing is soft-cheese (palopo). Palopo is one of the traditional food products typical of West Sumbawa District, West Nusa Tenggara Province which is made of pure buffalo milk with a characteristic soft texture.

Palopo is made of pure buffalo milk, which is added with a solution of brown palm sugar, and wild eggplant (Solanum carolinense) as milk coagulant. The use of wild eggplant (*Solanum carolinense*) as a milk coagulant in the manufacture of palopo is an important factor for the quality of palopo [5]. The producers of palopo are used to apply wild eggplant as a natural milk coagulant. However, along with the times, wild eggplant is increasingly difficult to find. Consequently, it can hinder the process of palopo making, so it can be detrimental to palopo producers. Therefore, it is necessary to have another alternative of natural milk coagulants to be used as a milk clotting in processing palopo. To solve the problem, a study using several natural milk coagulants needs to be performed

1.2. Literature Review

Milk is considered a nutrient fluid, which is acts as the basic source of nutrients for the young until they are capable to digest various food. It is also used as raw material for various milk products such as cheese, cream, dried milk powder, frozen yogurt, margarine, and so forth [6]. Milk can be coagulated by the rennet enzyme or the help of acid to become cheese [7]. Other compounds that are commonly used as milk coagulants are

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vinegar, lactic acid, acetic acid, hydrochloric acid, and citric acid. Coagulation using natural acids from fruit juices has been carried out by Ref. [8] who applied the direct acidification technique using juices of lime, sour star-fruit, and pineapple in the manufacture of soft cheese. The use of this coagulant is very feasible to be used in the manufacture of soft cheese because it is faster, practical, and inexpensive. Sour Star-fruit (*Averrhoa bilimbi L.*) Juice used in the manufacture of soft cheese can produce high protein content and yield. It is because Sour Star-fruit has a sour taste. The natural acidic of sour Star-fruit can be used as a protein coagulant. According to Ref. [9], sour star-fruit juice with a concentration of 8-12% can be used in cheese making. The addition of Sour Star-fruit Juice with a concentration of 7% can produce cheese with the best physicochemical characteristics [10]. In addition, according to Ref. [11], sour star-fruit contains flavonoids, tannin, and saponin compounds that can be used other than as a clotting agent, Sour Star-fruit can also be used as a natural food preservative. Moreover, the addition of citric acid or the usual is called direct acidification can save time manufacture, due to the high acidity desired to be achieved immediately after citric acid is added without having to wait for bacterial culture to work from lactic acid [12].

One of the determining factors for the success of making *palopo* is the use of a milk protein coagulating agent. Sumbawa people generally use plant-based coagulants to make *palopo*. The vegetable coagulants include wild eggplant (*Solanum indicum*), *Biduri* (*Caloutropis gigantea*), and *Jeliti* (*Wrigthia javanica*). The use of excessive concentrations of vegetable coagulant will cause a bitter taste in the *palopo* [13].

Cheese is a milk protein that is precipitated or coagulated using acids, enzymes, or lactic acid bacterial fermentation resulting in curd and serum separation milk. Cheese as a product with milk-based ingredients is a viable alternative used to meet the need for animal protein. Almost all cheese marketed in Indonesia is hard cheese type, namely cheese that requires stages longer maturation so that production costs are high. However, manufacturing soft cheese as a traditional milk product needs to be improved in terms of its qualities. The USDA issued the standard quality of soft cheese that is commonly used as a standard composition and characteristics of cottage cheese similar to the *palopo* and Dry Curd Cottage Cheese. The suggested parameters and limits can be seen in Table 1.

Table 1. Specifications of Cottage Cheese According to USDA [14]

Composition and quality	Standards
Moisture content	≤ 80 %
Fat content	≤ 0.5 %
pH	5.5
Taste	Salty or slightly salty
Texture	Smooth, not like flour, not sticky, and not runny
Color	Cream white
Coliform and Fungi	≤ 10 per g

1.3. Research Objective

The purpose of this study was to determine the quality of soft cheese (palopo) and the best natural coagulant in terms of the chemical content such as protein, fat, and ash of the cheese and sensory acceptability of four natural coagulants such as *Solanum carolinense; Caloutropis gigantea; Wrigthia javanica;* and *Averrhoa bilimbi* L.

2. MATERIALS AND METHODS

2.1. Material and Equipment

This research was carried out at the Laboratory of Animal Products Processing Technology, and Laboratory of Feed and Animal Nutrition, Faculty of Animal Husbandry, the University of Mataram from September to November 2020. The materials used in this study were pure buffalo milk, brown sugar, *Solanum carolinense; Caloutropis gigantea; Wrigthia javanica; and Averrhoa bilimbi L.* as milk coagulant. Aqua brand water, white sugar, aqua dest, concentrated H_2SO4, K_2SO_4, $CuSO_4$, NaOH 40%, H_2SO_4 0.1 N, Bromine Cresol Green (BCG), and Methyl Red (MR) indicators. The tools used in this study were New Gea Freeze Brand Freeze Fast down to -26 ^{0}C Denmark, plastic cool box, texture analyzer, Miyako JE-507 brand juicer, pH meter, pipette volume, KERN brand analytical balance EW 600-2m Max 600 g, e= 0.19, Min 0.5 g, d = 0.019 Baligon Germani, Kjedhal flask, distillation device, destruction stove.

2.2. Design Experiment

The research design used in this study was a completely randomized design (CRD) with 5 treatments and 3 replications. a)*Treatment A*: Without adding durian to 1000 g of coffee cherries. b) *Treatment B:* Addition of 25 g of durian flesh into 1000 g of coffee cherries; c) *Treatment C*: The addition of 50 grams of durian flesh into 1000 g of coffee cherries, d) *Treatment D*: Addition of 75 g of durian flesh into 1000 g of coffee cherries; e) *Treatment E*: Addition of 100 g of durian flesh to 1000 g of coffee cherries. The results of the observations of each parameter were statistically analyzed with the F test and continued with the Duncan's New Multiple Range Test (DNMRT) test at a 5% significance level.

2.3. Research Stages.

This research was carried out in three stages of work, namely the stages of making (*Solanum carolinense*; *Caloutropis gigantea*; *Wrigthia javanica*; and *Averrhoa bilimbi* L.) Juice, and manufacturing *palopo*.

2.3.1. Wild eggplant (Solanum indicum) extract.

The steps in the extraction of this wild eggplant enzyme are:
Cleaning and washing wild eggplant (*Solanum indicum*) Extract wild eggplant (*Solanum indicum*) with a juicer, then the seeds are filtered with a clean cloth to obtain a coarse extract of wild eggplant. Storing wild eggplant (*Solanum indicum)* extract in the refrigerator to prevent protein breakdown.

2.3.2. Extract of Biduri (Caloutropis gigantea).

The *Caloutropis gigantea* extract was done by cutting the tip of the stem or twig of the *biduri* tree, then it was stored in a clean container. To prevent protein damage, it was stored in the refrigerator.

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2.3.3. Extract of Jeliti (Wrightia javanica)

The *jeliti* tree (*Wrightia javanica*) used to make *palopo* was the part of the bark that was neither too old nor too young. The process of extracting substances contained in the *jeliti* tree bark is as follows: Clean the outer (epidermis) bark of *jeliti* tree (*Wrightia javanica*) with a knife. Weigh and pound the *jeliti* tree bark, for 100 grams of *jeliti* tree bark soaked with water as much as 10 ml. Squeeze carefully so that the enzymes that are still present in the tree bark fibers can come out perfectly. Filter the solution from the immersion, to obtain a solution of the enzyme that will be used in the manufacture of palopo. Store *jeliti* extract in the refrigerator to prevent protein damage.

2.3.4. Preparing Sour Star-fruit (Averrhoa bilimbi L.) Juice.

The sour star-fruit used was selected or sorted, weighed 1 kg, washed, separated between the pulp and the filtrate using a juicer, and 300 mL of filtrate was collected.

2.3.5. Manufacturing Palopo.

Prepared pure buffalo milk, each treatment 200 mL, mixed with auxiliary materials such as 50 mL sugar solution consisting of 80 % brown sugar and 20 % white sugar and 2.5 % of (*Solanum carolinense*; *Caloutropis gigantea*; *Wrigthia javanica*; and *Averrhoa bilimbi L.*) extract according to the treatments. Then stirred until homogeneous, and analyzed the level of acidity (pH). The next process was filling into a plastic cup as much as 50 mL, then steamed at a temperature of ± 100˚C for ± 10 minutes.

2.4. Research Parameters

Parameters observed in this study include physical, chemical, and organoleptic properties. Physical properties include density, chemical properties include acidity (pH), moisture content, protein, content, fat content, and ash content using the method of proximate analysis [15]. Meanwhile, organoleptic parameters including color, aroma, texture, taste, and acceptable were carried out using hedonic and scoring tests [16].

2.5. Experiment Design and Data Analysis

The research was conducted in an experimental laboratory method according to a completely randomized design. The design method consisted of 4 factors, namely four natural coagulants such as *Solanum carolinense*; *Caloutropis gigantea*; *Wrigthia javanica*; and *Averrhoa bilimbi L.* Each treatment was repeated 5 times so that 20 samples were obtained. A total of 25 trained panelists were involved in conducting the sensory test. The final results of *palopo* were tested for color, flavor, texture, taste, and total acceptance; using a nine-level Hedonic scale, from one for strongly dislike and nine for strongly like. Before being tested, *palopo* was given a three-digit code at random. The data displayed is the average result of the four treatments given to *palopo*. All data were obtained from a questionnaire given to the panelists which was designed to determine the level of preference of the panelists, which consisted of nine levels, on the *palopo* sample from each treatment [17].

2.6. Data analysis

Variables observed were the chemical composition of *palopo* such as moisture content, protein content, fat content, and ash content. While data on organoleptic properties were color, flavor, texture, taste, and total acceptance. Data on chemical and organoleptic value were statistically analyzed using analysis of variance (ANOVA) in a completely randomized design the general linear model (GLM) procedure of the SAS software was used in the subsamples. The Least Significant Difference (LSD) was used in the comparison of treatment sources of natural milk coagulant means [18] [15].

3. RESULT AND DISCUSSION

3.1. Chemical Composition of Palopo

Results of the observations on the chemical composition of the cheese (*palopo*) were presented in Table 1, while the organoleptic value of *palopo* was presented in Table 2. The cheese was a soft type cheese in which the manufacturing process no needs to be ripped. The chemical content of the cheese was significantly ($P \leq 0.05$) affected by all treatments.

Tabel 2. Chemical Composition of Indigenous Soft Cheese (*Palopo*)

Treatments	Chemical Contents (%)			
	Moisture	Protien	Fat	Ash
(SI)	(66.558 ± 0.357) [b]	(6.182 ± 0.114) [b]	(7.940 ± 0.165) [b]	(0.770 ± 0.117) [b]
(CG)	(61.998 ± 0.143) [d]	(6.748 ± 0.312) [a]	(9.134 ± 0.118) [a]	(1.046 ± 0.057) [a]
(WJ)	(65.662 ± 0.491) [c]	(5.996 ± 0.157) [b]	(7.108 ± 0.538) [c]	(1.026 ± 0.053) [a]
(SSt)	(69.712 ± 0.760) [a]	(4.196 ± 0.257) [c]	(7.058 ± 0.274) [c]	(0.872 ± 0.137) [b]
LSD:	0.66	0.30	0.43	0.13

Note: SI = Terung liar (*Solanum indicum*)
CG = Biduri (*Caloutropis gigantea*)
WJ = Jeliti (*Wrigthia javanica*)
SSt = Blimbing Wuluh (*Averrhoa bilimbi*, L.)
LSD = Least Significant Difference at 5 % level.

Table 2 shows that the use of *Caloutropis gigantea* extract as milk coagulant gave the highest content of protein, fat, and ash of the cheese. On the other hand, the moisture content was the lowest. The treatment of Sour Star-fruit juice at the same concentration (2.5%) as a milk coagulant resulted in the highest moisture content, but it was the lowest in protein, fat, and ash content. While the *Solanum indicum* and *Wrigthia javanica* were in between of the others. This was due to the addition of Sour Star-fruit juice with the same concentration as the other treatments did not completely coagulate milk protein to become *palopo*. According to Ref. [19], the less acid content contained, the longer the coagulation process occurs, in this study, the coagulation time was uniform to 10 minutes in all treatments. The use of acid will also be more if the coagulation temperature is lower and vice versa if the coagulation temperature is higher, the need for acid is relatively less. The higher the concentration of Sour Star-fruit juice, the higher the density of *palopo*. It is because the higher the Sour Star-fruit Juice, the higher the acid content that can coagulate the protein in milk so that the density of *palopo* increases [8]. When the acid is added, the positively charged hydrogen ions are carried by the acid into the milk, which in turn the positive charge combines with the negative charge in the casein micelles, resulting in a charge neutralization. No electrical charge remains to stabilize the casein in suspension, causing the casein to precipitate or agglomerate to form a curd. According to Ref. [20], that fruit Juice can lower the pH of milk which causes an imbalance of casein so that clumping occurs. Judging from the results of the correlation analysis, the coefficient of r between density and acidity (pH) is -0.647. This means that there is a negative correlation between density and the level of acidity (pH), the lower the pH value of the *palopo*, the higher the density. Moreover, the use of various types of thickening agents in the same concentrations greatly affected the *palopo* moisture content. The average moisture content of *palopo* with the treatment observed from the highs to the lowest was SSt, SI, WJ, and CG. The high levels of *palopo* crude protein at the concentrations treatment of wild eggplant, following the results of research by Ref. [21], that using a lower concentration of wild eggplant (Solanum indicum) extract resulted in higher *palopo* protein levels. In the use of low concentrations of wild eggplant and *biduri*, the enzyme works more optimally. While in observance the use of high concentrations of coagulating agents in the treatment achieves maximum work.

3.2. Sensory properties of palopo

Sensory testing is a testing process using panelists and producing organoleptic values. The panelists' acceptance of the *palopo* was based on the panelists' organoleptic assessment which included color, aroma, texture, taste, and acceptance (Table 3).

Tabel 3. Organoleptic Value of Indigenous Soft Cheese (*Palopo*)

Treatments	Organoleptic Properties				
	Color	Aroma	Texture	Taste	Acceptability
(SI)	8.378 $\pm$ 0.424 ^{a}	7.478 $\pm$ 0.117 ^{b}	6.998 $\pm$ 0.160 ^{b}	8.156 $\pm$ 0.197 ^{a}	7.928 $\pm$ 0.149 ^{a}
(CG)	8.336 $\pm$ 0.383 ^{a}	7.320 $\pm$ 0.399 ^{b}	8.308 $\pm$ 0.112 ^{a}	8.208 $\pm$ 0.168 ^{a}	7.412 $\pm$ 0.248 ^{b}
(WJ)	8.418 $\pm$ 0.163 ^{a}	7.350 $\pm$ 0.152 ^{b}	6.788 $\pm$ 0.169 ^{c}	8.128 $\pm$ 0.240 ^{a}	7.162 $\pm$ 0.321 ^{b}
(SSt)	7.708 $\pm$ 0.218 ^{b}	7.854 $\pm$ 0.086 ^{a}	6.122 $\pm$ 0.078 ^{d}	6.602 $\pm$ 0.192 ^{b}	6.490 $\pm$ 0.117 ^{c}
LSD:	0.42	0.30	0.18	0.27	0.30

Note: SI = Terung liar (*Solanum indicum*)
CG = Biduri (*Caloutropis gigantea*)
WJ = Jeliti (*Wrigthia javanica*)
SSt = Blimbing Wuluh (*Averrhoa bilimbi, L.)*
LSD = Least Significant Difference at 5 % level.

It can be seen in Table 2, that the panelists' responses to the *palopo* colors' were dominant in SI, CG, and WJ treatments, while the highs score of aroma was the SSt. On the other hand, texture and taste were dominated by CG treatments. Meanwhile, in CG, SI, and *WJ*, the concentration treatment did not affect the *palopo'* color difference, but it was still acceptable to the panelists because all scores were >8. This indicates that the color of the *palopo'* made was almost following the color standard expected by the panelists, which is light brown (highest score of 9). The *palopo'* color that was most favored by the panelists from all treatment combinations was the *palopo'* color at the treatment of WJ (*Wrigthia javanica*) with an average rating of 8.418 $\pm$ 0.163 (light brown). On the other hand, the SSt treatment has a pale color (light brownish yellow) of the *palopo*, the color was affected by the color of sour star-fruit juice (SSt). Meanwhile, the panelists' acceptance rate, the higher the concentration of star fruit juice, the more yellow the color of the *palopo*. This is following the results of research conducted by Ref. [22] that the addition of Sour Star-fruit juice gives the color of *cowpea* tofu and *munggur* tofu a slightly white color, due to the yellow color of Sour Star-fruit, which affects the color quality of the tofu.

Panelists' responses to the aroma of *palopo'* showed that the use of each at different natural coagulants had a significantly different effect (P<0.05) on the resulting *palopo'* aroma. The best *palopo'* aroma from all treatments was SSt (sour star-fruit). It was because the aroma of *palopo* produced was the aroma of buffalo milk which is the basic ingredient for *palopo* making, following what was stated by Ref. [5] that the aroma of *palopo* was an integration between the aroma of buffalo milk and sugar palm. However, the most dominant was the aroma of buffalo milk. The panelists' comment that the acidic aroma of SSt has a pleasant choice. Whereas panelists' responses to the *palopo'* texture in treatment of *biduri* (*Caloutropis gigantea*) produced the best *palopo* texture from all treatments, with an average rating of somewhat compact with a mean rank of 8.308 $\pm$ 0.112. The texture of soft cheese is also affected by Calcium chloride [23]. The *palopo* texture produce in SSt treatment was the softest, because of less acid in the treatment. It was following was stated by Ref. [8] [24] that the higher the acid content that can coagulate the protein in milk so that the density of *palopo* increases. While the use of the different thickening agents had different effects (P<0.05) on the taste of *palopo'*. The most preferred *palopo'* taste was CG, SI, and WJ respectively. Meanwhile, the CG thickening material did not show a correlation between the taste of *palopo*.

The panelists' acceptance rate values for all treatments ranged from the higher was SI, CG, WJ, and SSt respectively. Overall panelists' acceptability of the *palopo* revealed in Figure 1 was the treatment of CG (*Caloutropis gigantea*) (Figure 2)..The highest panelist acceptance rate with an average of (7.928 $\pm$ 0.149) was in the SI (*Solanum indicum*) (Figure 2). While the lowest acceptance rate with an average of (6.490 $\pm$ 0.117) was in the Sour Star-fruit juice treatment (SSt). It is directly proportional to the density of *palopo* which is influenced by milk fat which is also the main ingredient for making *palopo*. According to Ref. [25] that a high proportion of milk fat will result in a soft curd texture. The results of this study produced *palopo* with the higher concentration of star fruit Juice, the chewier the texture of the *palopo*. It is following [9] that the greater the amount of Sour Star-fruit Juice, the higher the level of flexibility which has an impact on the texture of the cheese.

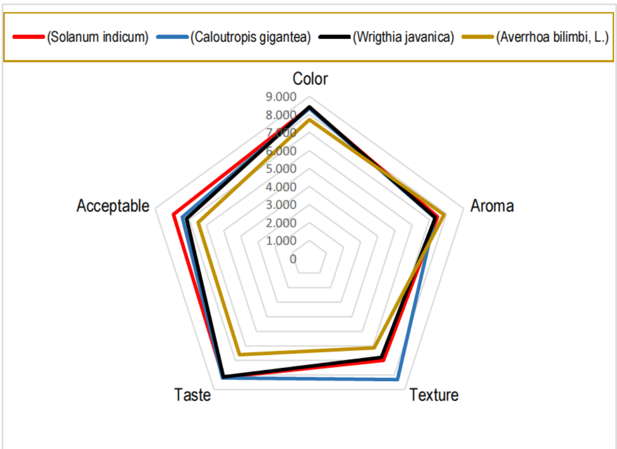

Figure 1. Overall Acceptability of The Cheese

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Figure 2. Palopo product using *Caloutropis gigantea as milk coagulant*

Figure 3. Palopo product using *Solanum indicum as milk coagulant.*

4. CONCLUSION

It was concluded that the treatment of CG (*Caloutropis gigantea*) was the best in terms of the chemical content such as protein, fat, and ash of the cheese. Also, the overall panelists' acceptability of the palopo was the CG (*Caloutropis gigantea*) treatment, even though the panelists comment that the acidic aroma of SSt has a pleasant choice. Moreover, the most preferred palopo' taste ranged from CG, SI, and WJ respectively, with the brownish-yellow color, slightly milky aroma, slightly chewy texture, sweet taste so that the panelists liked it. More studies in combination treatments of other natural milk coagulants need to be continued.

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