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Utilization of Fruit Extract as Acidulant on Physicochemical and Organoleptic Properties of Cottage Cheese with Addition Calcium Chloride

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A B S T R A C T

The aimed of this research to determine the effect of the type of fruit extract as an acidulant and calcium chloride concentration on the physicochemical and organoleptic properties of cottage cheese. The research used a completely randomized design (CRD) with two factors and three repetitions to produce 27 treatments. Data analysis using ANOVA was the continued with duncan's new multiple range test (DNMRT) at a significance level of 5%. The first factor was the type of fruit extract as a acidulant (A) which consists of three levels. that was wuluh stratfruit 30% (A1). lime 7.5% (A2). lemon 7.5% (A3) and concetration of calcium chloride (B) which consists of three levels (0.01% (B1). 0.02% (B2). and 0.03% (B3)). Parameters observed included pH. tittratable acidity. water content. yield. calcium. fat content. protein content. ash. hardness and organoleptic analysis including taste. aroma. color. and hardness. The results of the treatment fruit extract as acidulant and calcium chloride concentration significantly affected the pH value. titratable acidity. yield. water content. hardness. yield. calcium. fat content. protein content. ash. and organoleptic tests. Cottage cheese treated with 7.5% lemon acidulant and 0.02% calcium chloride was the best treatment with pH 5.14. titratable acidity 2.99%. water content 62.04%. yield 24.98%. calcium 1.152 mg/100 g. 0.074% fat. 17.89% protein. 12.45 gf hardness. and taste not sour. not fruity. moderate yellowish white color. and not hard.

1. INTRODUCTION

1.1. Research Background

Cheese as a milk derivative product is formed from the process of clumping due to the presence of rennin or protease enzymes. Hence. two main components will be formed. The clumping component is called as curd while the other component in liquid phse is known as whey [1]. The cheese making process includes five main stages such as acidification. protein coagulation. dehydration. cutting. and salting. Generally. the process of acidification of milk can be achieved by the addition of lactic acid bacteria as an acidifier. Therefore. the desired acidic conditions are achieved. However. the use of lactic acid bacterial cultures requires a relatively longer time to be able to create acidic conditions [2]. Another problem that arises due to the use of lactic acid bacteria. especially in the cottage cheese industry. can produce diacetyl. acetate and CO2 **compounds** that form defects in the curd known as "floating curd" thus produce curd with a brittle texture and can reduce the value of the cheese yield [3].

The direct acidification process can be applied as an effort to overcome some of the existing problems. Direct acidification is a traditional unrippened cheese processing method carried out with the aim of accelerating the creation of acidic conditions in milk. Acidic food grade ingredients. fruit. flowers or other acidic plant parts can be added in this method. In addition to accelerating the formation of acidic conditions. The use of these materials can control the acid conditions formed at a relatively cheaper price and with easier preparation [4].

As a tropical country. Indonesia produces various fruits with a sour taste that can be used as an acidifying agent. including starfruit (*Averrhoa bilimbi*). lemon (*Citrus limon*). and lime (*Citrus aurantiifolia*). These fruits can be used as an acid because they have a sour taste [5]. During the acidification process. the decrease of milk pH simultaneously causes the dissolution of

several minerals due to the demineralization process. One mineral component is calcium, which occurs due to protein dissociation, which causes Colloidal Calcium Phosphate (CCP) to dissociate from casein micelles and dissolve with whey. A decrease in free calcium or CCP causes the coagulation process to be disrupted. In the coagulation process. especially the aggregation stage. calcium is able to neutralize the negative charge of casein micelles in the form of CCP. Hence. the coagulation process will run faster. forming a firm curd texture thus not a lot of protein and fat will be dissolved with the whey and an increase in cheese yield. However. the addition of excess calcium is able to produce a cheese texture with a harder texture [6]. Based on this conditions. this research is needed to determine the type of fruit extract as an acidifier and the concentration of calcium chloride on the physicochemical and organoleptic characteristics of cottage cheese.

1.2. Literature Review

1.2.1. Cottage Cheese

Cottage cheese is one type of fresh cheese. has a soft texture with a water content of 53-80% which has relative short ripening time due to the absence of ripening process during processing and has a fat content less than 4% which is often consumed as an alternative low-fat diet menus [7]. This cheese usually used by the community as a mixture in making cakes and bread side dish. The basic principle of cheese processing is casein coagulation by adding a proteolytic enzyme that will work specifically to cut off 105-phenylalan and 106-methionine which are located on kappa-casein thus the stability of casein micelles will be disturbed [8].

The aimed of accidulant addition was to create optimal conditions for enzymes by lowering the pH of milk from 6.7 to 5.4. The type of acid used is one of the factors that can affect the curd. the lowest pH when adding acid can increase proteolysis. Because of that. lots of protein will dissolve together with the whey. Therefor. it will reduce the yield produced [9]. According to [10] when the coagulation process runs at optimal acid conditions. the curd produced will be compact and sturdy. Therefore. when the curd is cut. few of casein will dissolve with the whey and will be retained in the curd thus the resulting cheese yield will increase. The pH of milk is one of the important factors in the coagulation phase during cheese processing because pH will affect enzyme activity by lowering the pH of milk. and reducing the colloid stability of milk.

1.2.2. Direct Acidification

The direct acidification process is a traditional method of making unrippened cheese, which is carried out to shorten the time to create an acidic atmosphere in milk. This method will lower the pH of milk more quickly because hydrogen ions will neutralize the charge of milk protein [11]. The pH of milk can immediately decrease from 6.7 to 5.4. Direct acidification will be faster in lowering the pH of milk when compared to the use of lactic acid bacteria. Hence. The texture of the resulting cheese becomes softer with a high water content [12].

Belimbing wuluh has a sour taste with citric acid content reach 92-133 mEq of acid/100 g of total solids [13]. Citrus families such as limes and lemons have a sour taste due to their high content of organic acids. especially citric acid. Lime contains 62.422 g/L citric acid [14] and 51.46 g/L citric acid in lemons [9]. Each type of fruit has varying levels of acidity depending on the components of the organic acids that make up the fruit. Therefore. the selection of the appropriate type of fruit is needed to optimize the coagulation process of milk. When the pH is over high. it will produce a cheese with a texture like a pudding and hollow due to syneresis. while adding an acidifier with over low pH causes the solubility of casein into whey to increase. thereby reducing the protein content of cheese [15].

During the acidification process. some minerals bound to protein as Colloidal Calcium Phosphate (CCP) are demineralized into the whey phase. Generally. a certain degree of demineralization is required to prevent the formation of a hard cheese texture [16]. However. the decrease in Colloidal Calcium Phosphate (CCP) was able to inhibit the coagulation process. especially during the aggregation stage [8]. Calcium is worked by neutralizing the negative charge of casein micelles as Colloidal Calcium Phosphate (CCP) and being a bridge between the negatively charged phosphate groups. Calcium chloride also able to restore the fat content and water content lost during the processing by accelerating the time of curd formation and increasing the strength of the curd during the early stages of syneresis which results in limited ability of the matrix to form whey increasing cheese yield [17]. Therefore. Acidification conditions and optimal calcium chloride concentration are required in processing

1.3. Research Objective

The aimed of this study to determine the type of fruit extract as an acidulant and the concentration of calcium chloride on the physicochemical and organoleptic characteristics of cottage cheese.

2. MATERIALS AND METHODS

2.1. Material and Tools

The main raw materials used are wuluh starfruit. skim milk. lime and lemon. rennet enzyme. calcium chloride and salt. The materials used for chemical analysis are H2SO4. NaOH. HCl. petroleum ether. Kjeldahl tablets. Bromine Cresol Green-Methyl Red indicator. saturated Ammonium oxlate. 0.1N NaOH and Aqua

The tools used include pH meter. soxhlet. kjeldahl flask. burette. furnace. oven. stative and clamps. analytical balance. texture analyzer. pH meter. thermometer. juice extractor. hot plate analytical balance. erlenmayer. beaker glass. watch glass . And stirrer.

2.2. Design Experiment and Analysis

The research design used in this study was a completely randomized design (CRD) with 2 treatments and 3 replications. The treatment used is type of fruit extract as an acidulant (30% starfruit extract. 7.5% lime extract. 7.5% lemon extract) and calcium chloride concentration (0.01%. 0.02%. 0.03%). Chemical observation variable data is statistically tested using variance analysis at $\alpha = 5\%$, using DNMRT advanced test.

Table 1. Formulation of cottage cheese

Fruit extract	Calcium chloride concentration (%)

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	0.01% (B1)	0.02% (B2)	0.03% (B3)
Wuluh Starfruit extract (A1)	A1B1	A1B2	A1B3
Lime extract (A2)	A2B1	A2B2	A2B3
lemon extract (A3)	A3B1	A3B2	A3B3

2.3. Implementation of Research

2.3.1. Wuluh starfruit extract processing

1 kg of ripe wuluh starfruit is washed thoroughly. then cut into two parts. After that crushed using a juice extractor. Then the wuluh starfruit extract is separated with the dregs.

2.3.2. lime extract processing

1.5 kg of lime is washed until clean. then cut into half. After that. squeeze the lime juice using an orange squeezer. Then the lime extract was separated from the seeds.

2.3.3. lemon extract processing

1 kg of lemon is washed thoroughly and cut into half. After that. squeezed the lemon juice using an orange squeezer. Then the lemon extract was separated from the seeds.

2.3.4. Cottage cheese processing

60 g of skim milk was weighed and dissolved into 300 ml of distilled water. Then pasteurized at a temperature of 63˚C for 30 minutes. then the temperature was lowered until it reached a temperature of 37˚C. After the temperature was reached. the extract of wuluh starfruit was added 30% (v/v). lime extract 7.5% (v/v). and lemon extract 7.5% (v/v) then allowed to stand for 5 minutes to reduce the temperature of milk. After 5 minutes. 50 ml of 0.05% rennet enzyme was added. After that. calcium chloride 0.01%. 0.02%. 0.03% were added. then allowed to stand for 120 minutes to form a curd and occasionally cut to remove whey. The curd formed is filtered and whey is removed. Then add salt as much as 2% of the weight of the curd (w/v).

2.4. Observation

2.4.1. Physicochemical Analysis

The parameter analysis includes an analysis of yield (%). moisture content (%). pH. titratable acidity (%). protein content (%) fat content (%). ash content (%). calcium content (mg/100 g). hardness (gf) in cottage cheese and analysis of pH. titratable acidity (%) in fruit axtract.

2.4.2. Sensory Analysis

Organoleptic testing was performed on samples of cottage cheese. In this organoleptic test. 25 panelists provided an assessment of the colour. taste. aroma and hardness of cottage cheese. The analysis was continued with the effectiveness index test to determine the best treatment for physicochemical and organoleptic properties. Then. the best treatment was analyzed by coliform bacteria and yeast numbers.

3. RESULT AND DISCUSSION

3.1. Physicochemical Analysis

3.1.1. Raw material analysis

Preliminary analysis of acidulant from extracts of wuluh starfruit. lime. and lemon includes measuring the pH value and titratable acidity which can be seen in table 1 below.

Table 2. pH value and titratable acidty of fruit extract

Fruit extract	Parameter	
	pH value	Titratable acidity (%)
Wuluh starfruit extract	1.90 ± 0.03	1.53 ± 0.06
Lime extract	2.54 ± 0.02	11.85 ± 0.55
Lemon extract	2.73 ± 0.02	6.53 ± 0.33

Based on the data in Table 2. it shows that there are differences in the pH values of the three types of fruit extracts. where the pH of lemon extract (2.73) is higher than lime extract (2.54) and the starfruit extract (1.90). This is due to the difference in the concentration of the acid constituents of the fruit extract used. Based on the analysis of the total titrated acid which is calculated as citric acid as the main component of star fruit. lime and lemon. it shows that starfruit extract contains a total percentage of titrated acid of 1.53%. lower than that of lemon 6.53% and lime 11.58%. Thus. the higher concentration of citric acid contained in the material will lower the pH of the fruit extract. This statement is in accordance with [18] that the higher concentration of citric acid will lower the pH value due to the presence of H^+ ions or hydrogenium H_3O^+ ions.

3.1.2. Cottage cheese analysis

Physicochemical analysis consist of yield. moisture content. pH. titratable acidity. protein content. fat content. ash content. calcium content. and hardness can be seen in Table 3.

The result of the pH value of cottage cheese are between 4.86-5.39. The acidity level of cottage cheese is influenced by the difference in the acidity level of the fruit extract used. based on Table 3 it is known that the lime extract has titratable acidity of 11.85%. compared to the lemon extract 6.53% and the wuluh starfruit extract 1.53% where the more acidity of the fruit extract used will increase the acidity of the cottage cheese. The addition of calcium chloride also plays a role in increasing the acidity of cottage cheese. the higher concentration of calcium chloride will decrease the pH of cottage cheese. Further. this is related to the reaction that occurs between gram phosphate and Ca^{2+} ions in milk. The formation of calcium phosphate due to the binding of Ca^{2+} ions to casein micelles after the addition of $CaCl_2$ at the same time will release protons (H^+) resulting in a decrease in pH [19]. Based on the [20] standard. the maximum pH of cottage cheese is 5.2. Therefore. the A1B1. A1B2. A1B3. and A3B1 treatments did not meet the existing standards. The total titrated acid in cottage cheese is considered as citric acid which is the main component of the fruit extract. The higher concentration of citric acid will lower the pH value of the cheese. thus the percentage of total acid will increase. The total acid value is closely related to the pH value. where the lower of pH. the total titrated acid will increase. and vice versa [21].

From table 3 it is known that the yield content of cottage cheese between 17.98% - 24.98%. The addition of calcium chloride can increase the concentration of Ca2+ ions in the form of Colloidal Calcium Phosphate (CCP) which will neutralize the negative charge of casein micelles during the aggregation stage. Therefore. the texture of the curd formed becomes more compact. When the coagulation process runs faster and the resulting curd is more compact. the fat and water content lost during the processing can be minimized due to the limited ability of the protein matrix to form whey. the result was increasing in cheese yield [17]. The use of fruit extracts with different acidity levels causes the ability of the rennet enzyme to coagulate casein differently. The lower pH in milk after acidification. the more optimal the ability of rennet to coagulate casein. According to [15]. cheese with high pH value will be more difficult to separate the whey. Hence. many components of the curd will dissolve easily with the whey.

Table 3. Physicochemical analysis result of cottage cheese

Physicochemical analysist	Treatment								
	A1B1	**A1B2**	**A1B3**	**A2B1**	**A2B2**	**A2B3**	**A3B1**	**A3B2**	**A3B3**
pH Value	5.39± 0.064^{f}	5.32± 0.047^{e}	5.28± 0.049^{e}	5.18± 0.062^{c}	5.09± 0.012^{b}	4.86± 0.040^{a}	5.25± 0.025^{d}	5.14± 0.036^{b}	5.05± 0.040^{b}
Titratable acidity (%)	2.14± 0.110^{g}	2.35± 0.113^{f}	2.54± 0.122^{d}	2.74± 0.107^{c}	3.04± 0.006^{b}	3.56± 0.107^{a}	2.61± 0.118^{e}	2.99± 0.113^{e}	3.25± 0.010^{c}
Yield (%)	17.98± 0.200^{a}	19.02± 0.021^{b}	18.53± 0.064^{b}	19.72± 0.731^{c}	23.87± 0.145^{f}	21.37± 0.160^{d}	19.88± 0.229^{c}	24.98± 0.227^{g}	22.05± 0.125^{e}
Moisture (%)	60.22± 0.249^{b}	59.83± 0.107^{b}	57.98± 0.300^{a}	62.01± 0.0364^{c}	60.43± 0.842^{b}	59.93± 0.280^{b}	62.25± 0.502^{c}	62.04± 0.061^{c}	60.80± 0.474^{d}
Protein (%)	15.36± 0.193^{g}	15.82± 0.026^{i}	16.44± 0.040^{h}	17.56± 0.040^{b}	18.21± 0.025^{c}	19.57± 0.015^{a}	16.73± 0.025^{e}	17.89± 0.015^{f}	18.87± 0.025^{d}
Fat (%)	0.035± 0.005^{a}	0.041± 0.003^{a}	0.048± 0.003^{b}	0.064± 0.004^{d}	0.081± 0.003^{e}	0.1± 0.034^{g}	0.051± 0.002^{c}	0.074± 0.004^{e}	0.090± 0.003^{f}
Ash (%)	2.27± 0.051^{g}	2.33± 0.030^{g}	2.49± 0.015^{i}	1.54± 0.012^{a}	1.76± 0.038^{c}	1.94± 0.031^{d}	1.65± 0.075^{b}	2.04± 0.015^{e}	2.13± 0.050^{f}
calcium (mg/100 g)	1.25± 0.005^{e}	1.25± 0.004^{f}	1.26± 0.006^{g}	1.02± 0.002^{a}	1.02± 0.002^{a}	1.04± 0.002^{b}	1.12± 0.001^{c}	1.15± 0.004^{d}	1.16± 0.002^{d}
Hardness (gf)	12.79± 0.096^{g}	16.41± 0.110^{h}	23.58± 0.030^{i}	7.36± 0.042^{a}	8.31± 0.123^{c}	10.65± 0.065^{d}	10.25± 0.030^{b}	12.45± 0.045^{e}	14.87± 0.049^{f}

The numbers on the same coloumn and followed by different lowercase letters differ markedly by 5% according to *Duncan's Multiple Range Test* (DMRT)

From Table 3 it is known that the moisture content of cottage cheese between 57.98% - 62.25%. The use of star fruit extract resulted in lower average water content than the other two fruit extracts. This is because the addition of calcium chloride can increase the interaction between proteins thus the hydration ability of the protein decreases which causes the moisture content of cottage cheese using starfruit extract to have the lowest value. This is in accordance with the opinion of [22] Cheese with lower calcium content has a higher water content than cheese with high calcium content. In the use of lime extract. the high content of citric acid causes the acidification process of milk to optimize the work of rennet enzyme in destroying k-casein. Hence. some of the hydrophobic side of the protein will be exposed to the outside and the attraction between protein molecules increases and decreases the moisture content of the cheese. According to Ref. [23] the lower pH of acidification. the attraction between proteins will increase. thus the water initially trapped in the gel will shrink. The high water content of cottage cheese using lemon extract was caused by less than optimal coagulation conditions. Therefore. a lot of water was retained in the curd. According to Ref. [15] cheese with high pH value will have a higher water holding capacity than cheese with a low pH value.

The higher concentration of calcium chloride will lower the moisture content of cottage cheese. according to [24] after the addition of calcium. the cheese will be more prone to syneresis due to increased interactions between proteins and decreased hydration of casein. because of that. the ability of cheese to retain water is limited. Based on [20] the maximum moisture content of cottage cheese is 80%. while according to [25] cheese is considered soft if it has an average moisture content of 55 – 80%.

The result of protein content of cottage cheese are between 15.36% – 19.57%. The protein content of cheese is closely related to the process of protein denaturation due to acid. the higher concentration of H+ will lower the pH and the resulting protein will increase. According [26] the protein clumping process begins with a denaturation process which causes protein molecules to interact with each other with the same and adjacent reactive groups. The addition of calcium chloride has a positive impact during the aggregation stage by bridging the degraded casein micelles. Therefore. the coagulation process will run faster and more protein can be retained in the curd. According to [27] when calcium is added. the interactions between casein micelles will be strengthened. thereby reducing the protein's ability to hydrate. when protein hydration is low. the protein solubility will decrease thus form a compact cheese structure.

The result of fat content of cottage cheese was between 0.035% - 0.1%. The fat content of cottage cheese will be directly proportional to the increase in the protein content of the cheese. this is because the protein is in the outer layer of the fat globule membrane. Fats are composed of fatty acids and glycerol to form triglycerides wrapped in a protein phospholipid membrane. During the process of acidification or coagulation by enzymes. the protein phospholipid membrane will be damaged thus the fat globules will remain trapped and unite with the curd [28] The more acidic milk when it was acidified will higher the fat content. This statement in accordance with [29] the acidification process

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will cause an increase in fat bound in the curd. the more acidic of pH value when the acidulant is added. the higher fat content produced. Based on the [20] the maximum fat content of cottage cheese is 0.5%. Hence. the cottage cheese produced in all treatments meets the standard.

From table 3 it was known that the ash content of cottage cheese between 2.49% - 1.54%. The use of wuluh starfruit extract resulted in a higher ash content value among other treatments. this was due to the acidity during the processing of cheese that was not optimal for dissolving the mineral components in it. This statement was in accordance with [30] that the higher acidity of milk will greater the possibility of loss of minerals bound to casein micelles. this was because the increase in acidity will gradually dissolve Colloidal Calcium Phosphate and the Mg component contained in casein. The use of lime as an acidifier produces a lower percentage of ash content than the use of other types of fruit. This was due to the demineralization process that occurs due to a direct acidification process which will convert insoluble calcium and phosphate into a soluble form that can be removed together with whey thus the ash content decreases. This statement was in accordance with [31] which stated that increasing in H^+ ions due to initial acidification causes the breakdown of calcium phosphate compounds into calcium ions and mineral salts which will be carried into the serum phase. According to Ref. [32] that during the process of acidification of milk. the mineral content will dissociate into the serum phase. this can happen because minerals are very sensitive to changes in temperature and pH.

The addition of calcium chloride can increase the percentage of cottage cheese ash content. The ash content indicates the mineral content in cottage cheese such as calcium. Calcium in milk can be found as colloidal calcium phosphate (CCP) in casein micelles or bound to phosphoserine as Ca^{2+} ions thus the addition of calcium chloride directly can increase the concentration of Ca^{2+} and CCP ions in cheese processing. This is in accordance with the statement of [33] the addition of calcium chloride has a positive effect. including an increase in the concentration of Ca^{2+} and colloidal calcium phosphate.

The result of calcium content of cottage cheese between 1.02 - 1.25 mg/100g. The acidification process using lime extract produces the smallest average due to the lower acidity of lime compared to other fruit extracts which causes demineralization of calcium. Therefore. the calcium content of cottage cheese decreases. The addition of a weak acid such as citric acid will produce protons that are able to disrupt the balance between casein micelles and free calcium ions by binding to the micellar surface resulting in charge neutralization resulting in dissociation of CCP and other components bound to casein micelles [34]. According to [35] in the pH range of 5.5 – 5.0 most of the CCP will break down and dissolve with whey and will dissolve completely at pH of less than 4.9.

Increasing the concentration of calcium chloride causes an increase in calcium levels in the form of Ca^{2+} ions or CCP in cottage cheese. According to [36] Calcium in chees was present in the colloidal phase as colloidal calcium phosphate (CCP) in casein micelles or bound as phosphoserine residues as Ca^{2+} ions of about 20 mmol and as much as 10 mmol is present as calcium citrate. calcium phosphate. and calcium phosphate ions.

From table 3 it was known that the hardness of cottage cheese between 8.31 – 23.58 gf. Hardness in cheese was generally influenced by the level of acidity during the process of acidification of milk. where the more acidic fruit extract used. the ability of the curd to excrete whey will increase thus texture of the curd will be denser and compact [37]. However. the texture of cheese is closely related to the calcium content in it. where the lower pH value during acidification. the possibility of calcium demineralization will increase. This causes hardness value of cottage cheese using star fruit extract have a higher value. because the concentration of organic acids in star fruit extract is lower than the other two fruit extracts. Hence. calcium in cheese is retained as Ca^{2+} ions or bound as CCP. This was in accordance with the statement of Ref. [38] that calcium with a higher concentration will increase cross-linking between casein micelles thus form a harder cheese texture.

3.2. Sensory Analysis

To determine the effect of treatment on the sensory properties of cottage cheese on taste. colour. aroma. and hardness test was conducted by distributing questionnaires to the panelists.

Table 4. Panelists average preference for the sensory attributes of cottage cheese

Treatment	Taste	Colour	Aroma	Hardness
A1B1	2.28± 0.653^{a}	1.76± 0.779^{a}	2.36± 0.810^{a}	3.20± 0.735^{b}
A1B2	2.16± 0.577^{a}	1.84± 0.624^{a}	2.52± 0.823^{a}	3.28± 0.707^{b}
A1B3	2.24± 0.707^{a}	2.04± 0.676^{a}	2.88± 0.666^{a}	3.56± 0.714^{b}
A2B1	3.00± 0.645^{b}	3.32± 0.577^{b}	3.04± 0.707^{b}	3.12± 0.583^{a}
A2B2	3.00± 0.663^{b}	3.28± 0.653^{b}	2.96± 0.707^{b}	2.32± 0.770^{a}
A2B3	3.20± 0.678^{b}	3.36± 0.653^{b}	3.12± 0.554^{b}	2.20± 0.831^{a}
A3B1	2.40± 0.872^{a}	3.60± 0.653^{b}	2.64± 0.757^{a}	2.40± 0.764^{a}
A3B2	2.52± 0.500^{a}	3.76± 0.688^{d}	2.72± 0.737^{a}	2.52± 0.653^{a}
A3B3	2.56± 0.690^{a}	3.68± 0.645^{c}	2.56± 0.768^{a}	2.44± 0.651^{a}

Based on Table 4. The treatment of star fruit extract and calcium chloride 0.02% resulted in the lowest taste score of 2.6 "not sour". while the average value of the highest taste score in the treatment of lime extract and calcium chloride 0.03% was 3. 20 “quite sour”. The sour taste in cheese arises due to the content of organic acids that make up the fruit extract used. The higher composition of organic acids will increase the sour taste of cheese. lime juice contains citric acid of 7-8% of the weight of the meat which causes a sour taste [39].

Based on Table 4. the treatment of star fruit extract and calcium chloride 0.01% resulted in lowest aroma score of 2.36 "no fruity scent". while the average value of the highest aroma score was in the treatment of lime extract and calcium chloride 0. 03% i.e. 3.12 “quite fruity”. The use of fruit extracts during the process of acidification of milk makes a difference to the aroma of the resulting cheese. Lime contains volatile compounds that affect the aroma of cheese. as much as 7% of essential oils such as citral. limonene. fenchon. terpineol. bisabolene. and terpenoids which were able to give a distinctive citrus aroma. Likewise with the use of lemon extract. the presence of volatile limonene compounds produces cheese with a distinctive lemon aroma [40]

Based on Table 4. the treatment of star fruit extract and calcium chloride 0.01% resulted in the lowest color score of 1.76 "very not white". while the average value of the highest color score was in the treatment of lemon orange extract and calcium chloride 0. 02% which was 3.84 “white”. The starfruit extract produces cheese with a greenish color due to the high concentration of starfruit extract added. where the starfruit contains the green pigment chlorophyll leaves which produce a green color [41] While the use of lime and lemon extracts both produce cheese with a white color due to the presence of carotenoid compounds contained in lime and lemon. According to [40] lemon juice contains beta carotene which was the main ingredient in forming a yellowish color in milk.

Based on Table 4. showed that the treatment of lime juice extract and calcium chloride 0.01% resulted in the lowest hardness score of 2.12 "not hard". while the average value of the highest aroma score was in the treatment of star fruit extract and calcium chloride 0.03% i.e. 3.56 “quite hard”. The addition of calcium chloride is one of the factors that affect the hardness of cottage cheese. The high concentration of calcium can reduce the hydration ability of cheese proteins due to increased interactions between proteins. Hence. the protein was present in solid form and less moisture because most of the water will be lost with the whey [24]. The composition of organic acids that make up lime and lemon has a higher amount thus cottage cheese using both fruit extracts has a fairly low pH value. When the pH value was low. a demineralization process will occur. thereby reducing the calcium content of the cheese and reducing the hardness of the cottage cheese. The use of citric acid in the initial acidification process of milk will reduce the amount of calcium in cheese which produced cheese with a softer texture.

Based on the results of the effectiveness index test on the physicochemical and organoleptic characteristics of cottage cheese. the best treatment results were obtained using lemon fruit extract with the addition of 0.02% calcium chloride. The results of the best treatment then continued with coliform bacteria testing and determining the number of yeasts. The test results can be seen in Table 5.

Table 5. the results of testing the best treatment of cottage cheese

Parameter	Analysis result
Total *coliform* (APM/g)	< 3.0
Total yeast and mold (koloni/g)	$0.33x10^1$

Table 5 shows that the total coliform in cottage cheese is less than 3 APM/g, and the total yeast mold is 0.33 x 10^1 colonies/g. Based on the [20], the maximum permitted number of coliform bacteria is 10 APM/g. while the maximum amount of mold and yeast is 10 g. so that the resulting cottage cheese meets the standard. The pasteurization process at a temperature of 63˚C for 30 minutes is carried out to kill bacteria that can damage the texture and taste of cheese, such as coliform bacteria [42].

4. CONCLUSION

The use of various types of fruit extracts as acidulant and the addition of calcium chloride significantly affected the pH value. total titrated acid. yield. water content. protein content. fat content. calcium content. hardness. taste. aroma. color. and hardness of cottage cheese. The best treatment in this study was cottage cheese with the use of lemon extract and the addition of 0.02% calcium chloride with a pH value of 5.14. total titrated acid 2.99. yield 24.98%. water content 62.04%. protein content 27.735. fat content 6.91%. calcium content 1.152 mg/100 g. hardness 12.73 N. taste score 2.52 (not sour). aroma 2.72 (not fruity). color 3.76 (fairly white). hardness 2.52 (not hard).

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