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

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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 curd while the other component in a liquid phase 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 long time to be able to create acidic conditions [2]. Another problem 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 unripened cheese processing method carried out to accelerate the creation of acidic conditions in milk. Acidic food-grade ingredients. fruit, flowers or other plant parts that are acidic can be added to 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 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 of that mineral components is calcium which occurs due to protein dissociation which causes Colloidal Calcium Phosphate (CCP) to dissociate from casein micelles and will 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 can 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 can produce a cheese texture with a harder texture [6]. Based on these conditions, this research is needed to determine the type of fruit extract as an acidifier and the concentration of calcium chloride

ABSTRACT

This research aimed 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 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 an acidulant (A) which consists of three levels. that was wuluh starfruit 30% (A1), lime 7.5% (A2), lemon 7.5% (A3) and concentration of calcium chloride (B) which consists of three levels (0.01% (B1), 0.02% (B2), and 0.03% (B3)). Parameters observed included pH, titratable 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 of fruit extract as an 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, 17.8% protein, 12.45 of hardness, and taste not sour, not fruity, moderate yellowish-white color, and not hard.
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 a relatively short ripening time due to the absence of ripening process during processing and has a fat content of less than 4% which is often consumed as an alternative low-fat diet menu [7]. This cheese is usually used by the community in making cakes and bread side dishes. The basic principle of cheese processing is casein coagulation by adding a proteolytic enzyme that will work specifically to cut off 105-phenylalanine and 106-methionine which are located on kappa-casein thus the stability of casein micelles will be disturbed [8].

Acidulant addition aimed 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 Ref. [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 the milk. and reducing the colloid stability of milk.

1.2.2. Direct Acidification

The direct acidification process is a traditional method of making unripened cheese which is carried out with the aim of shortening time for the creation of 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 reaching 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 acids 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 process of coagulation 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 the addition of an acidifier with over low pH causes the solubility of casein into whey 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 is 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 the 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

This study aims 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. HCI petroleum ether. Kjeldahl tablets. Bromine Cresol Green-Methyl Red indicator. saturated Ammonium oxalate. 0.1N NaOH and Aquades.

The tools used include a pH meter. soxhlet. Kjeldahl flask. burette. furnace. oven. static and clamps. analytical balance. texture analyzer. pH meter. thermometer. juice extractor. hot plate analytical balance. Erlenmeyer. 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% of 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 α = 5%. using DNMRT advanced test.

<table>
<thead>
<tr>
<th>Fruit extract</th>
<th>Calcium chloride concentration (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.01%</td>
</tr>
<tr>
<td>(B1)</td>
<td>(B2)</td>
</tr>
<tr>
<td>Wuluh Starfruit extract (A1)</td>
<td>A1B1</td>
</tr>
<tr>
<td>Lime extract (A2)</td>
<td>A2B1</td>
</tr>
<tr>
<td>lemon extract (A3)</td>
<td>A3B1</td>
</tr>
</tbody>
</table>

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 from the dregs.
2.3.2. lime extract processing

1.5 kg of lime is washed until clean, then cut it in 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 in 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 the 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 the 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

Parameter analysis includes 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 extract.

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 color, 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 2.

Table 2. pH value and titratable acidity of fruit extract

<table>
<thead>
<tr>
<th>Fruit extract</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pH value</td>
</tr>
<tr>
<td>Wuluh starfruit extract</td>
<td>1.90 ± 0.03</td>
</tr>
<tr>
<td>Lime extract</td>
<td>2.54 ± 0.02</td>
</tr>
<tr>
<td>Lemon extract</td>
<td>2.73 ± 0.02</td>
</tr>
</tbody>
</table>

Based on the data in Table 2, 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 titratable 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 titratable 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 H₂O⁺ ions.

3.1.2. Cottage cheese analysis

The physicochemical analysis consists 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 pH value of cottage cheese is 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 a 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 Ca²⁺ ions in milk. The formation of calcium phosphate due to the binding of Ca²⁺ ions to casein micelles after the addition of CaCl₂ 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 citric acid which is the main component of the fruit extract. A 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 is 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 Ref. [15], cheese with a high pH value will be more difficult to separate the whey. Hence, many components of the curd will dissolve easily with the whey.
From Table 3 it is known that the moisture content of cottage cheese is 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 Ref. [22]. Cheese with lower calcium content has a higher water content than cheese with a high calcium content. In the use of the 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 sides 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 a high pH value will have a higher water holding capacity than cheese with a low pH value.

A higher concentration of calcium chloride will lower the moisture content of cottage cheese. According to Ref. [24] after the addition of calcium, the cheese will be more prone to synergies 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 Ref. [20] the maximum moisture content of cottage cheese is 80%. While according to Ref. [25] cheese is considered soft if it has an average moisture content of 55 – 80%.

The result of the protein content of cottage cheese is 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 to Ref. [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 Ref. [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 forming a compact cheese structure.

The result 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 Ref. [29] the acidification process will cause an increase in fat bound in the curd. the more acidic 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 was 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 Ref. [30] that the higher acidity of milk will greater the possibility of a 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 Ref.
[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 Ca²⁺ ions thus the
addition of calcium chloride directly can increase the
concentration of Ca²⁺ and CCP ions in cheese processing. This
is in accordance with the statement of Ref. [33] the addition of
calcium chloride has a positive effect, including an increase in
the concentration of Ca²⁺ and colloidal calcium phosphate.

The result of the calcium content of cottage cheese is 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 cause demineralization of
calcium. Therefore, the calcium content of cottage cheese
decreases. The addition of a weak acid such as citric acid will
produce photons that can 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 a
pH of less than 4.9.

Increasing the concentration of calcium chloride causes an
increase in calcium levels in the form of Ca²⁺ ions or CCP in
cottage cheese. According to [36] Calcium in cheese was present
in the colloidal phase as colloidal calcium phosphate (CCP) in
casein micelles or bound as phosphoserine residues as Ca²⁺ 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 is used.
the ability of the curd to excrete whey will increase thus texture
of the curd will be denser and more compact [37]. However, the
texture of the 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 the
hardness value of cottage cheese using star fruit extract to 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 Ca²⁺ ions or bound as CCP. This
was in accordance with the statement of [38] that calcium with a
higher concentration will increase cross-linking between casein
micelles thus forming a harder cheese texture.

### 3.2. Sensory Analysis

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

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

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Taste</th>
<th>Colour</th>
<th>Aroma</th>
<th>Hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1B1</td>
<td>2.28±</td>
<td>1.76±</td>
<td>2.36±</td>
<td>3.20±</td>
</tr>
<tr>
<td></td>
<td>0.653±</td>
<td>0.779±</td>
<td>0.810±</td>
<td>0.735±</td>
</tr>
<tr>
<td>A1B2</td>
<td>2.16±</td>
<td>1.84±</td>
<td>2.52±</td>
<td>3.28±</td>
</tr>
<tr>
<td></td>
<td>0.577±</td>
<td>0.624±</td>
<td>0.823±</td>
<td>0.707±</td>
</tr>
<tr>
<td>A1B3</td>
<td>2.24±</td>
<td>2.04±</td>
<td>2.88±</td>
<td>3.56±</td>
</tr>
<tr>
<td></td>
<td>0.707±</td>
<td>0.676±</td>
<td>0.666±</td>
<td>0.714±</td>
</tr>
<tr>
<td>A2B1</td>
<td>3.00±</td>
<td>3.32±</td>
<td>3.04±</td>
<td>3.12±</td>
</tr>
<tr>
<td></td>
<td>0.645±</td>
<td>0.577±</td>
<td>0.707±</td>
<td>0.583±</td>
</tr>
<tr>
<td>A2B2</td>
<td>3.00±</td>
<td>3.28±</td>
<td>2.96±</td>
<td>3.23±</td>
</tr>
<tr>
<td></td>
<td>0.663±</td>
<td>0.653±</td>
<td>0.707±</td>
<td>0.770±</td>
</tr>
<tr>
<td>A2B3</td>
<td>3.20±</td>
<td>3.36±</td>
<td>3.12±</td>
<td>2.20±</td>
</tr>
<tr>
<td></td>
<td>0.678±</td>
<td>0.653±</td>
<td>0.554±</td>
<td>0.831±</td>
</tr>
<tr>
<td>A3B1</td>
<td>2.40±</td>
<td>3.60±</td>
<td>2.64±</td>
<td>2.40±</td>
</tr>
<tr>
<td></td>
<td>0.872±</td>
<td>0.653±</td>
<td>0.757±</td>
<td>0.764±</td>
</tr>
<tr>
<td>A3B2</td>
<td>2.52±</td>
<td>3.76±</td>
<td>2.72±</td>
<td>2.52±</td>
</tr>
<tr>
<td></td>
<td>0.500±</td>
<td>0.688±</td>
<td>0.737±</td>
<td>0.653±</td>
</tr>
<tr>
<td>A3B3</td>
<td>2.56±</td>
<td>3.68±</td>
<td>2.56±</td>
<td>2.44±</td>
</tr>
<tr>
<td></td>
<td>0.690±</td>
<td>0.645±</td>
<td>0.768±</td>
<td>0.651±</td>
</tr>
</tbody>
</table>

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 the 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 in 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. terpinol. bisaboline. and terpenoids
which were able to give a distinctive citrus aroma. Likewise with
the use of the 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 at 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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Analysis result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total coliform (APM/g)</td>
<td>&lt; 3.0</td>
</tr>
<tr>
<td>Total yeast and mold (koloni/g)</td>
<td>0.33×10³</td>
</tr>
</tbody>
</table>

Based on Table 5. It shows that the total coliform in cottage cheese is less than 3 APM/g and the total yeast mold is 0.33 × 10³ colonies/g. Based on the Ref. [20] the maximum permitted the 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 an acidulant and the addition of calcium chloride significantly affected the pH value, total titratable 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 titratable 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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REFERENCE


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