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The study of the utilization of wuluh starfruit (*Averrhoa bilimbi* L.) in cottage cheese from goat milk prepared with acidification method based on physicochemical properties and organoleptic evaluation

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Abstract

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The use of organic acids from citrus plants such as lemon and lime as a coagulant in the making process of soft cheese has been widely practiced. However, the use of wuluh starfruit (*Averrhoa bilimbi* L.) is still very rarely done, especially in the making of cottage cheese from goat milk. Wuluh starfruit, which has a distinctive taste and aroma and is not shared by other citrus fruits, has the potential to be utilized in the making of cottage cheese. This study aimed to determine and study the effect of using a natural coagulating agent, wuluh starfruit juice as a coagulant in the process of making cottage cheese from goat milk from a local dairy farm. Completely Randomized Design (CRD) with six levels of treatment and three replications was used as the research design. The treatments were variations in the addition of wuluh starfruit juice, namely as follows: SKA0 = control, citric acid 0.4%, SKA1 = 10%, SKA2 = 20%, SKA3 = 30%, SKA4 = 40%, and SKA5 = 50%. Cottage cheese from treatment SKA3 was the most preferred by the panelists based on the organoleptic evaluation with an acceptability value of 5.66±0.84 (like moderately) and physicochemical properties of yield (26.43±1.13%), moisture (62.21±0.20%), ash (1.70±0.03%), protein (16.36±0.25), fat (18.28±0.19%), pH (3.66±0.02), vitamin C (224.36d±0.01 mg/kg), antioxidant activity (69.44±1,60%) and salt (50.33±0.58 ppm).

Keywords: antioxidants; citric acid; coagulant; curd yield; soft cheese

Introduction

Cheese is made through a process that involves the enzymatic coagulation of milk. Cheese is widely known as a nutritious food that is an excellent source of calcium, vitamin A, riboflavin, and vitamin B12 (Arlene et al., 2015). One type of milk that can be used as the main ingredient for making cheese is goat milk.

Goat milk, one type of milk, has gained economic prominence and worldwide popularity due to its use in the cheese industry. Fermented goat milk products, particularly yogurt, buttermilk, and cheese are trending in the world market because they are driven by medical needs and healthy food labels (Deshwal et al., 2020). Goat milk has advantages in fat content compared to cow milk, so it is very suitable as cheese.

Generally, cheese is divided into three types, namely hard cheese, semi-hard cheese, and soft cheese, with a moisture content of not more than 30-40% for hard cheeses, 35-45% for semi-hard cheese, and 45-75% for soft cheese (Manuelian et al., 2017). Soft cheeses made without ripening are called fresh cheeses. Fresh cheese is cheese made from fresh milk coagulated with enzymes or acids. Cottage cheese is an example of soft cheese (Farkye, 2004; Rasheed et al., 2016). Cottage cheese is classified as cheese that is made in a short time because it does not undergo ripening and does not use rennin as a coagulant so that it can be consumed immediately after production.

Coagulation of milk into cheese is not limited to using starter bacterial cultures that produce lactic acid but can also use several types of acids, such as acetic acid, citric acid, and lactic acid (Arifiansyah et al., 2014). Natural sources of citric acid, such as starfruit, can be an alternative as a coagulant in cheese making. Currently, the use of natural ingredients is increasingly preferred because it is considered safer and healthier as an antioxidant that prevents cancer.

Wuluh starfruit (*Averrhoa bilimbi* L.) is a green fruit whose utilization is still limited. Wuluh starfruit has a reasonably sour taste and is usually used as a cooking spice or herbal medicine. It contains citric acid, oxalic acid, tannins, saponins, glucose, sulfur, formic acid, peroxides, flavonoids, and triterpenoids (Suryaningsih, 2016). Previous studies used wuluh starfruit juice to make cottage cheese from cow milk. However, the process still uses rennet and has yet to study the effect of the addition of wuluh starfruit juice as a coagulant (Hanum et al., 2022). Thus, we were interested in studying the effect of adding starfruit juice on the physicochemical and organoleptic properties of cottage cheese from different kinds of milk, namely goat milk.

Materials and Methods

Materials and instruments

The primary raw material in this study was fresh goat milk obtained from Marapi Dairy Milk, Padang City, West Sumatra Province, Indonesia. Other raw materials used in the processing of cottage cheese are starfruit juice, citric acid (food grade), and salt (food grade). The chemicals used in the analysis consisted of aqua DM (Bratachem), selenium mix (Merck), boric acid (Pudak Scientific), sodium hydroxide (Merck), Tashiro indicator (Merck), hydrochloric acid (Merck), hexane (Bratachem), sulfuric acid (Smart Lab), DPPH (Sigma-Aldrich) and methanol (Merck).

The tools used in this research are mixer, oven, digital scale, filter cloth, plastic utensils, knife, pH meter, and glassware. All instruments used in the cheese-making process were sterilized at 121°C for 15 min in an autoclave (All American 75X). The instruments used for parameter testing are UV-Vis spectrophotometer (Thermoscientific Genesys 150), Kjeldahl testing device, soxhlet extraction device, laboratory oven (Memmert UN 110), furnace (Carbolite AAF 1100), pH meter (Hanna Instrument HI 2211) and saltmeter (Lutron YK-31SA) and other tools.

Coagulant solution preparation (Wuluh starfruit juice)

Wuluh starfruit weighed as much as one kg, washed with running water, and mashed using a blender. Separation of pulp and juice was done using a sieve. Microbiological properties and the purity of wuluh starfruit juice produced by this method were observed in the previous study (Sitompul et al., 2022). Wuluh starfruit juice can be added directly to milk The 0.4% citric acid coagulant solution was prepared by dissolving synthetic citric acid in aqua DM (w/v) and then stirred thoroughly.

Cottage cheese-making process

Fresh goat milk was pasteurized at 72°C for 20-30 s while stirring. The pasteurized milk was then cooled to a temperature of 35°C. Wuluh starfruit juice with five treatments was added gradually so the pH level did not drop too low. Milk temperature that is too high can cause the pH to increase. It would cause the coagulation process to be not optimal. In addition, high temperatures can cause the texture of the curd that is formed to be too smooth, making it easy to get carried away by the whey during the filtering process. As a control, 0.4% citric acid solution was used as a coagulant to replace starfruit juice. The curd formation occurs for ±30 min after the addition of coagulant (Ali et al., 2021; Rasheed et al., 2016).

The curd was then filtered with a filter cloth consisting of four layers for 60 min until the whey was no longer dripping. The curd that has been separated from the whey was then pressed for 15 min to remove the remaining water content. Cottage cheese is placed in packs and stored in a refrigerator at 7°C.

Research design

The research design used was a one-level Completely Randomized Design (CRD) with six levels of treatment and three replications. The data were analyzed using analysis of variance (ANOVA) with the F test and Duncan's New Multiple Range Test (DNMRT) advanced test at a 5% significance level.

In this study, cottage cheese from goat milk was produced by acidification method using starfruit juice. The treatments used were variations in the addition or concentration of wuluh starfruit juice, namely as follows:

SKA0: Control, citric acid 0.4%
SKA1: Wuluh starfruit juice 10%
SKA2: Wuluh starfruit juice 20%
SKA3: Wuluh starfruit juice 30%
SKA4: Wuluh starfruit juice 40%
SKA5: Wuluh starfruit juice 50%

Pure citric acid was used as a comparison or control of citric acid, which is the dominant organic acid compound contained in wuluh starfruit, which is 92.6–133.8 meq/100 g of total solids, far exceeding the content of oxalic acid, acetic acid, and other organic acids (Carangal et al., 1961; Wiradimadja et al., 2015). The addition of starfruit juice and pure citric acid was based on the amount of milk used. The product of the six treatments can be seen in Figure 1.

Fig. 1. Cottage cheese from from goat milk with variations in the addition of wuluh starfruit juice

Physicochemical Properties Analysis

The proximate analysis included moisture content using the gravimetry method with a laboratory oven, ash content using the dry ashing method with a furnace, fat content using the soxhlet extraction method, and protein content using the micro-kjeldahl method (Andarwulan et al., 2011).

The cheese pH was measured using an electrode pH meter. Vitamin C levels were measured using UV-VIS spectrophotometry by adjusting the wavelength range from 265 nm to 271 nm. The radical 1,1-diphenyl-2-picryl hydrazyl (DPPH) was used to determine the antioxidant activity of the cheese (Koleva et al., 2002). Samples from all treatments were put in equal volumes into DPPH, which had been dissolved in methanol (100 μM). After 15 min at room temperature, absorbance was measured at 517 nm by UV-Vis spectrophotometer. The cheese salt content was measured using a saltmeter/salinometer.

Organoleptic evaluation

Organoleptic evaluation is a method to determine panelists' responses to cottage cheese products. The organoleptic evaluation was carried out with four parameters: color, aroma, texture, and taste. The level of panelists' responses for a product is influenced by taste, aroma, texture, and color (Restuning, 2012). The evaluation was identified using a 7-point hedonic scale: 1 = dislike extremely, 2 = dislike moderately, 3 = dislike slightly, 4 = neither like nor dislike, 5 = like slightly, 6 = like moderately, and 7 = like extremely.

Results and Discussions

Physicochemical Properties

Yield is the ratio of the dry weight of the extract to the amount of raw materials (Senduk et al., 2020; Yuniarifin et al., 2006). The cheese yield was obtained by weighing the weight of the resulting cheese and dividing it by the weight of the fresh milk used as percentage. The yield of goat milk cottage cheese produced from the six treatments is shown in Table 1. From Table 1, it can be concluded that the more additions of wuluh starfruit juice, the higher the cheese yield produced from goat milk.

Table 1. Physicochemical properties of cottage cheese from goat milk with variations in the addition of wuluh starfruit juice

Parameters	Treatments					
	SKA0	SKA1	SKA2	SKA3	SKA4	SKA5
Yield, %	21.10±1.36	15.48±1.42	16.12±0.98	26.43±1.13	32.13±1.51	36.81±1.69
Moisture, %	53.87^{a}±0.07	53.60^{a}±0.35	57.64^{b}±0.03	62.21^{c}±0.20	64.44^{d}±0.29	67.15^{e}±0.08
Ash, %	1.75^{b}±0.07	2.21^{d}±0.04	1.88^{c}±0.04	1.70^{b}±0.03	1.60^{a}±0.01	1.53^{a}±0.01
Protein, %	19.08^{f}±0.10	18.55^{e}±0.23	17.18^{d}±0.20	16.36^{c}±0.25	15.33^{b}±0.18	15.30^{a}±0.01
Fat, %	26.33^{f}±0.40	22.58^{e}±0.38	21.33^{d}±0.32	18.28^{c}±0.19	17.29^{b}±0.34	15.30^{a}±0.34
pH	5.04^{d}±0,01	6.33^{f}±0,01	6.10^{e}±0.01	3.66^{c}±0.02	2.81^{b}±0.00	2.36^{a}±0,01
Vitamin C, mg/kg	132.86^{a}±0.01	159.28^{b}±0.01	180.38^{c}±0.02	224.36^{d}±0.01	268.59^{e}±0.34	277.18^{f}±0.00
Antioxidant Activity, %	38.24^{a}±0.50	40.58^{a}±1.55	64.97^{b}±2.33	69.44^{c}±1,60	75.02^{d}±0.67	79.54^{e}±0.39
Salt, ppm	57.00^{d}±0.58	39.00^{a}±1.00	46.00^{b}±1.15	50.33^{c}±0.58	58.33^{d}±0.58	68.00^{e}±0.00

[a,b,c] Means within a row with different superscript letters are significantly different between treatments

The curd is the result of precipitation or coagulation of casein contained in milk. Protein coagulation that occurs is maximized along with the decrease in pH, which is directly proportional to the increase in the concentration of added starfruit juice. Wuluh starfruit contains an organic acid (citric acid), which has a low pH, so it can precipitate casein in goat milk. Coagulation under optimum acid conditions will lead to an increase in enzyme performance in forming a compact and sturdy curd. Under these optimum acidic conditions, while the curd is filtered and chopped, less fat and casein are lost with the whey, so more fat can be retained for higher cheese yields (Adrianto et al., 2020; Wisaniyasa & Prayekti, 2016).

The cheese yield obtained from the control treatment, SKA0 (citric acid 0.4%), was 21.10%. This value is the average yield of cheese obtained by acidification method for pure citric acid coagulant agent. This value is under the treatment of SKA3, SKA4, and SKA5. The increase in the concentration of starfruit juice in each treatment was directly proportional to the yield of curd produced. The most curd obtained was with the addition of 50% starfruit juice (SKA5) because the acidity level was closer to the isoelectric point of milk casein (Wardhani et al., 2018). The increase in cheese yield is also influenced by the moisture content bound to the casein network in the resulting product.

The moisture content is an important quality parameter that determines the water-holding capacity of the casein tissue to maintain a good texture of cheese (Li et al., 2022). The moisture content of cottage cheese from goat's milk is presented in Table 1. The moisture content of cottage cheese products ranges from 53% to 67%. Therefore, the cheese produced in this study was characterized as soft cheese. From Table 1, it can be seen that the more addition of wuluh starfruit juice, the higher the value of moisture content in cottage cheese.

The addition of the wuluh starfruit juice in the making of cottage cheese from goat milk influenced the increase in moisture content in each treatment. Each treatment increased along with differences in the addition of wuluh starfruit juice to goat milk. Wuluh starfruit is a fruit that contains much moisture. Wuluh starfruit has a moisture content of 94.78% (Eren et al., 2015). The high moisture content is influenced by the number of single water molecules or groups of water bound to the pectin surface through hydrogen bonds between -OH groups on pectin molecules and H atoms of water molecules (Roikah et al., 2016).

Ash is a mineral element or inorganic substance that does not burn during combustion (Winarno, 2008). The decrease in ash content is accompanied by an increase in moisture content. The higher the water content, the lower the ash content, and *vice versa*. The more addition of wuluh starfruit juice in goat milk, the lower the ash content produced in the cottage cheese. The more addition of wuluh starfruit juice, the lower the ash content. The ash content value in the control (SKA0) was almost as high as the addition of starfruit juice in the SKA3 treatment.

Protein is a nutrient that is very important for the body because this substance functions as a building block and regulator (Winarno, 2008). The more addition of wuluh starfruit juice to goat milk, the value of protein content in cottage cheese decreased. The value of protein content decreased compared to the control (SKA0). When a protein is subjected to external stress, such as being heated or exposed to an acid (e.g. citric acid), the weak hydrogen bonds are broken. This condition causes the protein to change. Proteins that are defective due to denaturation have a looser structure, are more random, and are mainly insoluble (Asrullah et al., 2012). The protein contained in cheese is easily digestible because the protein breakdown process in cheese occurs appropriately.

Fat content in cottage cheese decreased along with the addition of wuluh starfruit juice in goat milk. The value of fat content decreased in all treatments compared to the control (SKA0). The decreased fat content in cottage cheese was accompanied by an increase in the value of the moisture content. This argument follows the statement that the factors that play a role in accelerating fat breakdown are air, light, temperature, and moisture conten (Salihat & Putra, 2021b; Triyanto et al., 2013). The higher the moisture content of the cheese, the lower the fat content in the cheese.

The decreased quantity of fat was presumed to be due to heating, causing fat oxidation. This results in reduced fat content in cottage cheese. The use of acid also affects the low fat because acid can cause hydrolysis of fat. This can reduce the fat content in cheese (Novianti et al., 2018). Proximate composition of cottage cheese from goat milk with six treatments can be observed in Figure 2.

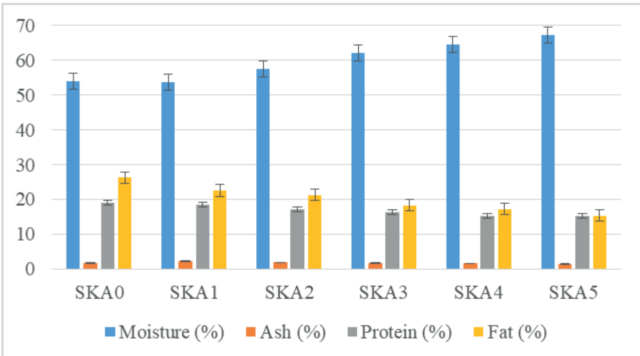

Fig. 2. Proximate composition of cottage cheese from goat milk with six treatments

When milk is mixed with acidic components, these components will release hydrogen ions, which causes a decrease in pH. This can cause casein micelles to dissolve and form calcium ions (Ca^{+}). These ions will penetrate other structures of casein micelles and form strong internal calcium chains. Ultimately, curd formation occurs (Arlene et al., 2015).

pH or degree of acidity is used to express the acidity or alkalinity of a substance. Acidity is the concentration of hydrogen ions in water solvent (Perwira et al., 2018). The higher pH value indicates that the acidity level is lower and vice versa. The lower the pH value, the higher the acidity level (Saputra, 2018). The pH value of cottage cheese from goat milk decreased with the increasing addition of wuluh starfruit juice. The unripe wuluh starfruit juice has a pH of around 1.99. Meanwhile, fresh goat milk has a pH of around 6.63. The addition of wuluh starfruit juice will cause casein in the goat milk to coagulate into curd. The lower the pH, the more maximal coagulation occurs, which impacts increasing the yield of curd obtained.

A decrease in the pH value of all treatments (SKA1-5) and control (SKA0) can be observed in Figure 3. Treatment of SKA0 using 0.4% citric acid coagulant produced cottage cheese with a pH of 5.04. The SKA2 treatment (addition of 20% wuluh starfruit juice) had a pH of 6.01, closest to the control. However, the decrease in the pH of goat milk from 6.63 (initial) to 6.01 caused the casein coagulation that occurred was not optimal and had an impact on the low yield of cottage cheese. The SKA5 treatment had the lowest pH value, which was 2.36. The maximum coagulation of milk casein occurred in the SKA5 treatment, as evidenced by the highest cheese yield, 36.81%. However, a pH value that is too low will have a negative impact on the panelists' preference for taste parameters.

The levels of vitamin C from the five treatments with the addition of wuluh starfruit juice had a value of 159.28-277.18 mg/kg. Meanwhile, the vitamin C of cheese from the

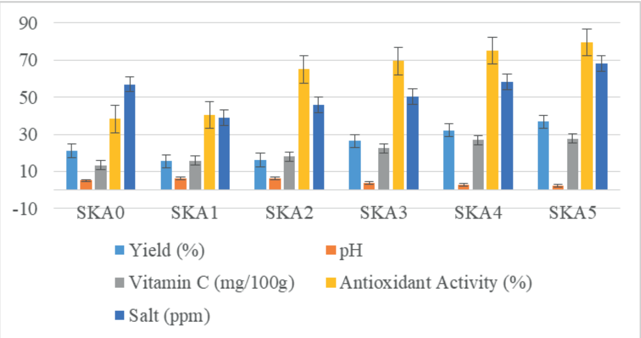

Fig. 3. Physicochemical composition of cottage cheese from goat milk with six treatments

control treatment (SKA0) was 132.86 mg/kg. The increase in the concentration of wuluh starfruit juice is directly proportional to the increase in vitamin C levels contained in cottage cheese. This increase is because unripe wuluh starfruit has high levels of vitamin C, 520-616 mg/kg (Anam & Marianti, 2021; Saraswati & Setyaningsih, 2018). The decrease in vitamin C levels of cheese from all treatments was considerable compared to vitamin C in unripe wuluh starfruit. The reduced levels of vitamin C were caused by the cheese-making process, which involved heating in the form of pasteurization.

When compared with the control (SKA0), the five treatments (SKA1-5) had higher levels of vitamin C. This is related to the significant addition difference between the concentration of citric acid (0.4%) and wuluh starfruit juice (10-50%) in cheese making. The level of vitamin C in cheese is higher when the concentration of wuluh starfruit juice added is higher, which is indicated by the sour taste of wuluh starfruit. This follows the characteristics of ascorbic acid, the IUPAC name of vitamin C, which has acidic properties, so the more acidic the fruit, the higher the vitamin C content (Yuliati & Kurniawati, 2017). Sour taste is also related to the level of ripeness and sweetness. The sweet taste resulting from the breakdown of ascorbic acid into glucose causes a decrease in vitamin C levels in the fruit (Ulya et al., 2018). As a result, the ripe starfruit is not effectively used as a coagulation agent in the making of cottage cheese using the acidification method.

Antioxidants are compounds that can inhibit the oxidation process caused by free radicals in the body. Antioxidant agents work by capturing free radicals, so they do not have the opportunity to attach and damage DNA in the body (Budaraga & Salihat, 2020; Salihat & Putra, 2021a). An increase in the concentration of wuluh starfruit juice in the making of cottage cheese causes an increase in antioxidant activity, because starfruit contains organic acid compounds that are rich in antioxidants in the form of ascorbic acid (Yanti & Suksmayu Saputri, 2019).

The increase in antioxidant activity is also related to pH value. A decrease in the pH value can be an indicator of an increase in antioxidant activity. High antioxidant activity in cottage cheese can positively impact body health. However, the relationship between antioxidant activity and pH value should be considered so as not to cause health problems because the acidity level is too high.

The more addition of wuluh starfruit juice, the salt content increased. The increase in salt content in cheese making with acid is accompanied by a decrease in the pH value (Rati et al., 2017). The lower the pH value, the higher the salt content in the cheese. The lower the pH, the more difficult the salt will be to dissolve, which causes precipitation. This causes the salt reading at the time of measurement to be high.

Salt in cheese-making functions in the release of whey from coagulants, regulation of water content, cheese acidity, ripening, and flavor formation (Foster et al., 1957). The role of salt in cheese making has three main functions: contributing to flavor, a source of sodium, and preservation (Fauzia, 2016). With the increased addition of starfruit juice, the salt content increased. The increase in salt content in cheese making with acid is accompanied by a decrease in the pH value (Rati et al., 2017). The lower the pH value, the higher the salt content in the cheese obtained. The lower the pH, the more difficult the salt will be to dissolve, which causes precipitation. This causes the salt reading at the time of measurement to be high.

It can be concluded that the more addition of wuluh starfruit juice to goat milk, the higher the value of salt content in the cheese. In the SKA1 and SKA2 treatments, the salt content was lower than in the control treatment (SKA0). At the same time, the SKA3-5 treatment had a higher salt content than the control treatment.

The physicochemical composition of cottage cheese from goat milk with six treatments can be seen in Figure 3.

Organoleptic evaluation

Taste is the most crucial parameter in consumer acceptance of a product. Taste is different from aroma and involves the five senses of the tongue. Several factors can influence taste, such as chemical compounds, temperature, concentration, and interaction with other flavor components (Winarno, 2008). The taste of a product is a combination of aroma and taste. If food is detected by the senses of taste, panelists can distinguish one different type of food (Komansilan et al., 2019). The resulting cottage cheese product had a characteristic sour taste of organic acids (citric acid). The increase in the concentration of wuluh starfruit juice caused the cheese to become more sour. The addition of salt can reduce the taste that is too sour and create a savory taste typical of cheese. The savory taste was obtained from the addition of table salt in each treatment (Kusumawati, 2008).

The data obtained showed that the higher the addition of wuluh starfruit juice, the panelist acceptance rate decreased. This is because wuluh starfruit has a sour taste that affects the taste of the cheese. However, from the panelists' acceptance data, it can be concluded that the addition of wuluh starfruit has been accepted by the panelists on a scale of 5.24 to 4.32, which means that the panelists already like the taste of the cheese.

The panelists' highest evaluation of the taste was found in the SKA3 treatment (with the addition of 30% wuluh starfruit), which was 6.56 (like moderately) with a balanced combination of sour and salty flavors. The panelists' lowest evaluation was the SKA5 treatment (with the addition of 50% wuluh starfruit), which was 4.32 (neither like nor dislike) with a taste that was too sour. For comparison, cottage cheese produced with 0.4% citric acid coagulant (SKA0) has a value of 5.24 (like slightly).

Aroma is influenced by the sense of smell. In general, four types of odors can be received by the nose: fragrant, sour, rancid, and charred. Aroma is also caused by chemical stimulation, which is responded to by the olfactory nerves in the nasal cavity (Banville et al., 2015). The aroma test was carried out by giving an assessment using the sense of smell, and then the panelists gave a value to the aroma aspect on the questionnaire.

The more addition of wuluh starfruit resulted in a decrease in the acceptance of the aroma of the cheese. Wuluh starfruit juice contains volatile citric acid so that it can be detected by panelists. Cheese is a dairy product produced by the fermentation of lactose, citrate, and other organic compounds into various acids, esters, alcohols, and volatile flavor and aroma-forming compounds (Setyawati, 2013).

The aroma contained in cottage cheese comes from the raw materials that appear in the heating process, such as the aroma of milk and wuluh starfruit juice. The typical citric acid of wuluh starfruit has an unpleasant aroma (Syarifah, 2020). The increased concentration of starfruit, which was used as a coagulant, causes the unpleasant aroma to be more potent.

The panelists' highest evaluation of the aroma found in the SKA3 treatment (with the addition of 30% wuluh starfruit) was 6.16 (like moderately). In the SKA3 treatment, the unpleasant aroma of wuluh starfruit can be suppressed by the aroma of milk, which produces a combination of the aroma of milk and a fresh, sour aroma. Meanwhile, the panelists' lowest evaluation of the cheese aroma was the SKA5 treatment (with the addition of 50% wuluh starfruit), which was 4.36 (neither like nor dislike), where the unpleasant aroma was more dominant than the milk aroma. As a comparison, the SKA0 treatment (addition of 0.4% citric acid), which did not have a distinctive aroma of starfruit, has a value of 4.84 (like slightly).

The appearance of food is determined mainly by moisture and fat content. The texture changes can be caused by loss of moisture or fat content, breaking of emulsions, and hydrolysis of proteins (Fellows, 2022). The cheese texture was strongly influenced by the fat in goat milk, which was the main ingredient of this cottage cheese. The milk's high-fat content will cause the cheese texture to become soft (Legowo, 2009). Thus, the fat coagulated by organic acids in wuluh starfruit juice determines the softness of the cheese texture. The higher the addition of wuluh starfruit juice, the cottage cheese product produced is softer and has an impact on the higher level of panelist acceptance.

The highest texture value was found in the SKA5 treatment (addition of 50% wuluh starfruit) with a value of 6.44 (like moderately). In comparison, the lowest texture value was found in the SKA1 treatment (addition of 10% starfruit wuluh), which was 4.64 (like slightly).. This means that the panelists' acceptance rate is on a normal to very like scale. As a comparison, the SKA0 treatment (addition of 0.4% citric acid) had a value of 5.08 (like slightly).

Color is an evaluation that uses the sense of sight. Color factor determines whether food is delicious or nutritious because it is considered and affects the evaluation (Winarno, 2008). Variations in the concentration of wuluh starfruit juice affected the color of the cottage cheese. The color of the cheese produced was dominated by the color of the main ingredient, goat milk. In addition, the addition of wuluh starfruit juice as a coagulant also affected the cheese. The chlorophyll pigment in the fruit causes the resulting cheese product to have a greenish-white color (Khan et al., 2007; Knee, 2007).

The highest evaluation of the color was found in the SKA1 treatment (addition of 30% wuluh starfruit juice), which is 6.04 (like moderately) because the cheese had an almost pure white color. At the same time, the lowest value was found in the SKA5 treatment (addition of 50% wuluh starfruit juice), which was 3.76 (neither like nor dislike) because the cottage cheese had a color dominated by green. As a comparison, the SKA0 treatment (addition of 0.4% citric acid) had a higher value than the SKA1 treatment due to the absence of the addition of wuluh starfruit, so there was no greenish color in the resulting cottage cheese.

Overall organoleptic evaluation (color, aroma, texture, and color) of goat milk cheese was carried out by 25 semi-trained panelists. The highest value was found in the SKA3 treatment (addition of star fruit wuluh 30%) with a scale of 5.66 (like moderately). Organoleptic properties of cottage cheese from goat milk with variations in the addition of wuluh starfruit juice can be observed in Table 2.

Conclusions

The utilization of wuluh starfruit juice as a coagulant showed affects on the physicochemical properties and organoleptic evaluation of cottage cheese from goat milk. It can be concluded that the more addition of wuluh starfruit juice in the making process of cottage cheese from goat milk, the resulting cheese will have better physicochemical characteristics. However, by organoleptic evaluation, it can be concluded that the cottage cheese product from the SKA3 treatment (the addition of 30% wuluh starfruit juice) was the most preferred by the panelists, with an acceptance value of 5.48±0.38. Microbiological properties, heavy metals, and shelf life of this cottage cheese product can be carried out for further research.

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Table 2. Organoleptic properties of cottage cheese from goat milk with variations in the addition of wuluh starfruit juice

Parameters	Treatments					
	SKA0	SKA1	SKA2	SKA3	SKA4	SKA5
Taste	5.24±1.05	4.92±1.35	5.64±0.95	6.56±0.58	4.84±0.99	4.32±0.80
Aroma	4.84±1.34	4.92±1.29	5.48±1.16	6.16±0.94	4.72±1.43	4.36±1.04
Texture	5.08±1.19	4.64±1.04	4.96±0.84	5.16±1.18	5.52±1.33	6.44±0.65
Color	6.12±0.88	6.04±0.93	5.84±1.03	4.76±1.30	3.96±1.14	3.76±0.78
Acceptability	5.32±0.56	5.13±0.62	5.48±0.38	5.66±0.84	4.76±0.64	4.72±1.18

The evaluation was identified using a 7-point hedonic scale (1 = dislike extremely, 2 = dislike moderately, 3 = dislike slightly, 4 = neither like nor dislike, 5 = like slightly, 6 = like moderately and 7 = like extremely).

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