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The influence of sago flour addition as a stabilizing agent on the qualities of goat milk ice cream: A study of physicochemical and sensory evaluation

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ABSTRACT

Goat milk ice cream is an innovative and creamy alternative to traditional dairy-based frozen desserts. The ice cream made from goat milk has a smoother texture than cow's milk and a distinct taste profile that is rich and tangy. It is a growing trend in the artisanal and health-conscious food sectors, known for being easier to digest for people who have mild lactose intolerance or sensitivity to cow's milk. A common challenge encountered in its production, aside from the processing methods, is the need for an efficient and effective stabilizer to maintain the stability of goat milk ice cream. This study aims to assess the impact of adding various levels of sago flour to goat milk ice cream. The research focused on the ice cream production process from goat milk, along with tests for viscosity, melting time, moisture content, protein content, and organoleptic properties. The results showed that ice cream with 6% sago flour had a significantly higher viscosity (176.87 ± 1.67) and a significantly slower melting rate (80.33 ± 4.22) compared to the control sample (0% sago flour). Meanwhile, the water content values of added sago flour in ice cream were not much different from those of non-added sago flour. Also, the organoleptic tests to ensure the condition of the goat milk ice cream and the preferable taste to the panelists indicated 6% added sago flour showed the highest values in taste and texture. The 6% concentration was selected as optimal because it showed the highest values of sensory scores for taste and texture. For the parameters of color and aroma, no significant differences were found among the treatments. Thus, sago flour could be added to the ice cream as a stabilizer, resulting in a significant enhancement of the quality of goat milk ice cream and the development of alternative products for lactose-intolerant consumers.

Keywords: Ice cream, Goat milk, Stabilizer, Sago flour, Organoleptic

INTRODUCTION

Ice cream is defined by the United States Food and Drug Administration (FDA) as a frozen product made by freezing a pasteurized mixture of dairy ingredients, sweeteners, and optional additives, containing at least 10% milk fat and 20% total milk solids. Milk is considered one of the most nutritious food sources, with nearly perfect nutrient content and composition. It is regarded as one of the best sources of animal protein compared to other food products [1]. Various essential nutrients required by the human body are found in milk, which is why milk is considered an important food for human health. Milk consists of carbohydrates such as lactose, proteins, fats, vitamins, and minerals [2]. Milk contains L-glutamine amino acid, tryptophan amino acid, complete vitamins A, D, E, and K, as well as redundancy key minerals such as Ca, P, Mg and Na [3]. Naturally, milk contains bacteria that can originate from the teats, udder, and hair. Compared to other livestock products, milk is more perishable, which is why it requires proper and swift handling [4].

Goat milk ice cream is gaining traction as a viable substitute for conventional cow's milk ice cream, noted for its distinctive flavor and possible health advantages. Research conducted revealed that goat milk possesses higher fat and protein content compared to cow's milk, which enhances the creaminess of the ice cream [5]. Furthermore, emphasized the digestibility of goat milk, pointing out that its smaller fat globules and reduced lactose levels make it an appropriate choice for individuals with lactose intolerance [6]. The sensory attributes of goat milk ice cream were examined identified by its unique, mildly tangy flavor, appealing to consumers in search of novel alternatives to conventional cow's milk-based products [7]. Investigated methods to enhance the stability and quality of goat milk ice cream, assessing the impact of various stabilizers and emulsifiers on its texture and shelf-life [8]. Analyzed the environmental advantages of goat milk production, concluding that it typically has a lower ecological impact than cow dairy, positioning goat milk ice cream as a more sustainable option [9]. Lastly, explore the consumer

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acceptance, discovering that while the initial flavor of goat milk ice cream may be divisive, repeated exposure tends to enhance overall acceptance and satisfaction [10].

Ice cream is a processed product made from milk and mixed with various ingredients commonly referred to as the ice cream mix, which includes cream, skim milk, stabilizers, emulsifiers, sweeteners and flavoring agents. These ingredients help produce smooth ice cream with a distinct aroma and texture improvement. The content in 100 g of ice cream includes 210 kcal of energy, 4 g of protein, 12.5 g of fat, and 20.6 g of carbohydrates, along with small amounts of natural antioxidants such as vitamin C and A. The ice cream production process involves freezing ice cream powder or a mixture of milk, animal or vegetable fats, sugar, and other food ingredients, along with permitted food additives such as gelatin [11]. However, a key challenge is the formation of large ice crystals and rapid melting, which impair texture and stability. Furthermore, goat's milk ice cream can have a strong, tangy flavor that limits its appeal. Therefore, this study explores the use of sago flour as a natural stabilizer to improve texture and potentially moderate this distinctive flavor profile. Color is one of the visual components that can be physically observed in food. Color was initially used to determine the quality of food and has since been used to assess taste, texture, nutritional value and microbiological properties [12].

Table 1 Ingredients for goat milk ice cream with the addition of sago flour.

No	Ingredients Composition	Treatment (%)			
		T0	T1	T2	T3
1	Goat milk	75	75	75	75
2	Non-dairy creamer	10	10	10	10
3	Sugar	13	13	13	13
4	Vanilla	0.5	0.5	0.5	0.5
5	Carboxymethyl Cellulose (CMC)	0.5	0.5	0.5	0.5
6	Gelatin	1	1	1	1
7	Sago flour	0	2	4	6

Sago flour is a starch obtained by processing the pith of the sago palm (*Metroxylon sp.*). It is a source of carbohydrates and contains other components such as minerals and phosphorus [13]. Sago flour is classified as gluten-free and can be used to make various types of cakes or as an additive in other food products. Sago flour is also a good source for glucose production, as 90% of its content is carbohydrates, making it highly suitable for producing glucose in significant amounts. The type of carbohydrate found in sago flour is starch [14].

To enhance the goat milk ice cream production, sago flour can be added to ice cream quality as it acts as a stabilizer during production via adding directly to the goat milk. Differences between ice cream containing sago flour and ice cream without sago flour were assessed through comparative analysis. Analysis included viscosity, melting rate, water content, protein content, and taste to assess sago flour's effects.

MATERIALS AND METHODS

Materials

The production of goat milk ice cream involved the following ingredients: goat milk, sourced directly from local farmers in the Randuagung area, Singosari, Malang, in frozen form; non-dairy creamer; gelatin quick stabilizer; granulated sugar; powdered vanilla; carboxymethyl cellulose (CMC) and sago flour. Based on the composition per 100 grams, sago has a high carbohydrate content (85.6 g) with an energy value of 355 kcal but is low in protein (0.6 g) and fat (1.1 g). Sago also contains several minerals, including calcium (91 mg), phosphorus (167 mg), and iron (2.2 mg).

Ice cream preparation

The sago ice cream was done by following table 1. Sago flour is added to goat milk and pasteurized. Hot milk is added to soluble sugar. The following ingredients are added gradually after the goat milk reaches room temperature and stirred for 15 minutes. The sago ice cream mixture is left for 24 hours in the refrigerator. The ice cream is stirred for 15 minutes to stir the mixture before being rotated in a GEA brand ice cream maker. The machine's key specifications include a voltage of 220-240 V, a frequency of 50/60 Hz, and a power consumption of 150 W. It has a cylinder capacity of 1.5 L and a production capacity of 1.5 L/hr. The machine operates using R600a refrigerant and maintains a temperature of -6°C. Its physical characteristics are a weight of 11 kg and dimensions of 425 x 285 x 262 mm. Sample ice cream is taken for analysis.

Experimental design

The experimental design in this study was used a completely randomized design (CRD) with a factorial pattern. All samples were assessed viscosity,

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water content, protein content, melting rate, and organoleptic evaluation.

Viscosity

The viscosity test followed the method used by AOAC [15,16]. Viscosity was measured using a viscometer, 100 ml of sago ice cream was prepared to liquid in a beaker. Installed the beaker in the digital viscometer. Data were recorded from the viscometer (optimal measurement with a scale reading 15% - 90%). Note the viscosity value listed on the tool.

Melting rate

The melting rate test was conducted using the Marshall, Douglas, and Richard method [17]. The temperature and humidity of the room are measured. An ice cream sample was taken using a spoon to obtain a sample with equivalent weight 50 g and it was put in a container and then frozen in the freezer for 24 hours. The sample was taken from the freezer to be placed at room temperature and left until all the samples have melted. The time required for all samples to melt was recorded and then statistics were analyzed.

Water content

The procedure for water content testing followed ASTM-D 5142-02a [18]. A gram of ice cream was dried in an oven at 103 ± 2°C until the weight of the sample has become constant. After the sample has been oven-dried, the sample is cooled by being placed in desiccator for 15 minutes until a stable temperature was reached. Weighed using the calculation formula for the water content.

$$\%WC = \frac{WW-DW}{DW}\ x\ 100\%$$

Where, WC was water content, WW was wet weight (g) and DW was dry weight of furnace (g).

Organoleptic test

The organoleptic evaluation was conducted following the procedure outlined by Susilawati, Nurainy, and Nugraha [19]. wherein a panel of 30 trained assessors evaluated the samples for attributes including color, aroma, taste, and texture using a 5-point hedonic scale.

Protein content

The protein content was analyzed following the method by Muliani, Rais, and Indrayani [20], the 10 g sample was placed into an Erlenmeyer flask, followed by the addition of distilled water, saturated potassium oxalate solution, and phenolphthalein (PP) indicator; the mixture is homogenized and allowed to stand for 2 minutes before being titrated with 0.1 N sodium hydroxide (NaOH) until a persistent pink color appears, indicating the endpoint; subsequently, 2 mL of 40% formaldehyde is added, causing the solution to return to its original color, after which additional PP indicator is introduced, and the solution is titrated again with 0.1 N NaOH until the pink color reappears, signifying the second endpoint. Levels can be calculated using the formula.

$$\%N = \frac{Titration\ volume\ formol\ x\ N\ NaOH\ x\ 14.008}{sample\ weight\ (g) x\ 10}\ \text{x}\ 10$$

Where, molecular weight of nitrogen is 14.008 and Conversion Factor (CK) of milk is 6.38. We got formol titration volume from (v. titration 1 + v. titration 2) -v. titration blank. For determination of protein content (%) = %N x CK Milk.

Statistical analysis

The data obtained were analyzed using analysis of variance (ANOVA) using IBM SPSS version 23.0 (IBM Corporation, New York, USA). If significant differences were found, Duncan's Multiple Range Test (DMRT) was conducted. The linear model for the Completely Randomized Design (CRD) was assumed.

Table 2 Physicochemical of goat milk ice cream with the addition of sago flour.

Treatment	Viscosity (cP)	Melting Rate (minutes/50g)	Water Content (%)	Protein Content (%)
T0 (0% of sago)	65.96±1.27^{a}	59.99±2.86^{a}	67.00±2.35^{a}	2.10±0.12^{a}
T1 (2% of sago)	124.67±1.72^{b}	65.63±2.79^{a}	62.80±1.79^{b}	2.71±0.16^{b}
T2 (4% of sago)	134.51±1.66^{c}	76.71±4.32^{b}	62.40±1.34^{b}	2.83±0.05^{b}
T3 (6% of sago)	176.87±1.67^{d}	80.33±4.22 ^{b}	62.00±2.12^{b}	2.92±0.05^{b}

RESULTS AND DISCUSSION

Viscosity

Viscosity showed the thickness of a substance in the sago flour to goat milk ice cream. The variables observed based on the test results, it was found that the treatment involving different percentages of sago flour significantly affected the viscosity of the goat milk ice cream. Table 2 showed a consistent increase in the average viscosity values corresponding to the percentage of sago flour added. The average viscosity values of goat milk ice cream across the four treatments ranged from 65.96±1.27 to 176.86±1.67 cP. The highest average viscosity was observed in the 6% sago treatment, with a value of 176.86±1.67 cPas, while the lowest average viscosity was observed in the

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control treatment, T0, at 65.96±1.27 cP. The viscosity of ice cream was found that the addition of sago flour to goat milk ice cream had a highly significant effect on the viscosity values of the ice cream ($P < 0.01$).

Goat milk ice cream with the addition of 6% sago flour had the highest viscosity value, which was affected by the increasing concentration of the stabilizer. The pre-mix ice cream powder used contains stabilizers and emulsifiers, which improve the cohesiveness and viscosity index [7 McGhee C, Jones]. The incorporation of sago flour into milk during pasteurization enhances the viscosity and texture of ice cream due to the gelatinization of its starch components, primarily amylose and amylopectin. This process involves the swelling of starch granules and leaching of amylose when heated in the presence of water, leading to increased water absorption and a thicker consistency. Such gelatinization improves the body and melting resistance of ice cream, contributing to a creamier texture and better stability during storage [20].

In addition to functioning as a stabilizer, sago flour also serves as a thickening agent, which can increase the viscosity of the ice cream in line with the higher percentage of addition due to the increased weight produced. Sago flour can increase viscosity due to the rise in molecular weight because of varying concentrations [21]. The higher the percentage of sago flour added, the stronger the friction between the molecules in the goat milk ice cream. The viscosity of ice cream can affect the movement of water molecules, causing the space between particles in the ice cream to either narrow or expand [22,23].

Melting rate

The treatment involving different percentages of sago flour significantly affected the melting rate of goat milk ice cream. Table 2 showed that the percentage of sago flour added is directly proportional to the melting time of goat milk ice cream. The higher the percentage of sago flour added, the longer the melting time of the goat milk ice cream. The average melting time of the goat milk ice cream across the four treatments ranged from 59.99±2.86 to 80.33±4.22 minutes/50g. The treatment with the longest average melting time was with the addition of 6% sago flour, taking 80.33±4.22 minutes/50g, while the fastest melting time was observed in the control treatment, T0, without sago flour, at 59.99±2.86 minutes/50g. Based on the results of the analysis of variance, it was found that the addition of sago flour to goat milk ice cream had a highly significant effect on the melting time of the ice cream ($P < 0.01$).

The melting rate is the time required for ice cream to melt completely at room temperature after being frozen in the freezer [24]. Melting rate is one of the variables that can be used to assess the quality of ice cream. High-quality ice cream is resistant to melting. The melting rate of ice cream can be influenced by the ingredients used in its manufacture, such as skim milk solids as a source of protein, fresh milk, and modified stabilizers. Comparable to other research papers, the higher the concentration of stabilizers, the slower the melting will be [7,25]

The melting rate of ice cream is greatly influenced by the ingredients used in the ice cream mix. Good quality ice cream is resistant to melting when served at room temperature [26]. Ice cream melting is caused by a decrease in its freezing point. The melting rate is also influenced by stabilizers, emulsifiers, ingredient concentrations, processing conditions, and storage conditions. The melting rate is closely related to viscosity, water content, and texture. The melting time of ice cream is related to the total solids content in ice cream and is also closely related to its texture and viscosity. The higher the viscosity and the lower the water content, the longer the melting time will be [27]. Increasing the concentration of additional ingredients in the mixture can cause more ice cream particles to be bound, so that the melting time is longer, and the melting rate is slower [28].

Water content

The percentage of sago flour added had a highly significant effect on the water content of the goat milk ice cream. From table 2 showed an inverse relationship between the percentage of water content and the percentage of added sago flour. The higher the percentage of sago flour added, the lower the water content in the goat milk ice cream. The average water content of goat milk ice cream across the four treatments ranged from 62.00±2.12 to 67.00±2.35. The treatment with the highest average water content was T0, without the addition of sago flour, at 67.00±2.35, while the treatment with the lowest average water content was with 6% sago flour, at 62.00±2.12. Based on the results of the analysis of variance, it was found that the addition of sago flour to goat milk ice cream had a highly significant effect on the water content of the ice cream ($P < 0.01$). The significant improvements in viscosity and sensory properties observed with the addition of sago flour can be attributed to its fundamental role as a starch-based functional ingredient. During the treatment of the ice cream mix, sago starch undergoes gelatinization, absorbing free water and swelling to form a gel matrix.

The water content composition of ice cream refers to SNI 01-3713-1995, which specifies a range of 62-68% [29,30]. The water content of goat milk ice cream with the addition of sago flour in treatments 0%, 2%, 4% and 6% fall within this SNI range. Goat milk ice cream with the highest percentage of sago flour, specifically with 6% sago flour, had the lowest water content, while its protein content increased. Protein content is influenced by the amount of air

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lost from the material, the greater the air loss, the higher the protein content [31].

Water content also has a close correlation with viscosity and melting rate. The lower the water content in ice cream, the thicker the ice cream will be so that its viscosity will increase and as a result the melting time will be longer. In contrast to viscosity and melting time which have a direct relationship with the percentage of sago flour added, water content shows an inverse relationship with the percentage of sago flour added. For viscosity and melting time, the higher the percentage of sago flour added, the higher the value obtained. However, for water content, the higher the percentage of sago flour added, the lower the water content [32]. Stabilizers dispersed in the liquid phase will bind a large amount of water while forming a gel structure that prevents the free movement of water molecules. The membrane formed will protect the ice components from external factors and limit the movement of water in the emulsion [33].

Protein content

The protein content of the goat milk ice cream was highly significantly affected by the percentage of sago flour added. From table 2 showed that the percentage of added sago flour is directly proportional to the protein content in goat milk ice cream. The average protein content of goat milk ice cream across the four treatments ranged from 2.10±0.12% to 2.92±0.05% The treatment with the highest average protein content was with the addition of 6% sago flour, resulting in a value of 2.92±0.05% while the lowest average protein content was observed in the control treatment, T0, without sago flour, at 2.10±0.12% Based on the results of the analysis of variance, it was found that the addition of sago flour to goat milk ice cream had a highly significant effect on its protein content ($P < 0.01$). This apparent increase is likely a concentration effect, where the addition of sago flour increases the total solid content, thereby reducing the water content and effectively concentrating the protein derived from goat milk.

Protein is one of the important macronutrients and biomolecules needed by humans at all ages. Protein is needed by the body to support the growth and maintenance of existing tissues, regulate body processes, and provide energy. In addition to having many benefits for humans, protein also functions as an emulsifier [34]. Ingredients that contain a lot of protein, such as milk, can facilitate the emulsifying process in making ice cream [23].

The average research results that meet the minimum protein content of 2.7% based on SNI 01-3713-1995 are 2%, 4%, and 6% formulations. However, the T0 formulation (without the addition of sago flour) has not met the minimum requirements according to SNI 01-3713-1995. This may be due to the relatively low protein content in sago flour, which is around 0.6 g per 100 g of sago flour. Therefore, the more sago flour added, the higher the protein content in the ice cream. The increase in protein content in probiotic goat milk ice cream is directly proportional to the increasing percentage of added ingredients. This is due to the contribution of protein content to the added ingredients, where the higher the dry matter of the raw materials, the higher the protein content in the ice cream [35]. Protein content is also closely related to other variables used in this study, such as water content and melting rate. Protein can affect the melting rate and total solids of ice cream [36].

Organoleptic test

The variables observed in the organoleptic test, including color, taste, aroma, and texture, were studied to assess panelists' acceptance of goat milk ice cream with added sago flour. This study employed a preference test using a five-point hedonic scale to evaluate the goat milk ice cream focusing on the parameters of color, taste, aroma, and texture with different concentrations of added sago flour.

Table 3 Organoleptic test of goat milk ice cream with the addition of sago flour.

Treatment	Color	Taste	Aroma	Texture
T0 (0% of sago)	2.68±0.53^{a}	3.56±0.84^{a}	4.00±0.68^{a}	3.69±0.86^{a}
T1 (2% of sago)	2.78±0.80^{a}	3.90±0.81^{a}	4.01±0.82^{a}	3.95±0.67^{b}
T2 (4% of sago)	2.84±0.80^{a}	4.00±0.80^{b}	4.11±0.70^{a}	4.01±0.70^{b}
T3 (6% of sago)	2.87±0.94^{a}	4.06±0.85^{b}	4.18±0.72^{a}	4.08±0.75^{b}

Different superscripts (a, b) within the same column indicate highly significant differences among treatments ($P < 0.01$)

1. Color

The organoleptic quality score for the color parameter of goat milk ice cream with different concentrations of added sago flour was analyzed and showed no significant differences among the treatments. The analysis of variance showed that the different percentages of sago flour addition did not significantly affect the color scores of goat milk ice cream ($P > 0.05$). Table 3 showed that the varying percentages of sago flour addition resulted in a more yellowish product. The average color scores ranged from 2.68±0.53 to 2.87±0.94. The treatment

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with the addition of 6% sago flour, produced goat milk ice cream with a color that was relatively well-liked by the panelists, with the highest average score of 2.87±0.94. The T0 treatment (0% sago flour) received the lowest average color score (2.68 ± 0.53); however, statistical analysis revealed that the differences in color scores among all treatments were not significant ($p > 0.05$).

In this study, the addition of sago flour to goat milk ice cream had a significant impact on the color parameter in the organoleptic test. The color of the goat milk ice cream in T0, the control treatment, was less favored by the panelists, while with the addition of 6% sago flour, produced a color that was liked by the panelists. The color of a product can also be influenced by the addition of other food ingredients. In this study, for example, the addition of sorghum flour affected the color of the ice cream, turning it brown [37].

2. Taste

The organoleptic quality score for the taste parameter of goat milk ice cream with different concentrations of added sago flour was analyzed and showed significant differences among the treatments. The analysis of variance results showed that the different percentages of added sago flour had a highly significant effect on the taste scores of goat milk ice cream ($P < 0.01$). Table 3 indicates that the differing percentages of sago flour addition made the taste of the product more favored by the panelists. The average taste scores ranged from 3.56±0.84 to 4.06±0.85. The treatment with the addition of 6% sago flour, resulted in the most liked taste by the panelists, with the highest average score of 4.06±0.85. On the other hand, T0, the control treatment without any sago flour, had the least liked taste, with the lowest average score of 3.56±0.84.

Taste is the most important factor in determining a consumer's decision to accept or reject a product. Even if other parameters such as color, aroma, etc., are favorable, the product will still be rejected if it does not taste good or is not liked by consumers. Taste differs from aroma or smell because taste relies more on the sense of taste, specifically the tongue. There are four basic tastes commonly known: sweet, bitter, salty, and sour, while other tastes are a combination of these. Various chemical compounds can produce different tastes, meaning that the taste of a food product is determined by the chemical compounds it contains [38].

The improved taste preference for ice cream with sago flour can be attributed to its functional role as a natural bulking agent and texture modifier. Sago contributes to a cleaner flavour profile and a more desirable mouthfeel. In ice cream, the perception of taste is highly influenced by the body and texture of the product. Sago flour, by increasing the viscosity of the mix and improving the melting resistance, likely provides a creamier and smoother mouthfeel. This enhanced texture positively affects the overall hedonic perception, making the characteristic tangy flavour of goat's milk more balanced and acceptable to the palate. The use of such starch-based ingredients helps in delivering a full, clean flavour, which is crucial for consumer acceptance [39].

3. Aroma

The analysis of variance results showed that the different percentages of added sago flour did not significantly affect the aroma scores of goat milk ice cream ($P > 0.05$). Table 3 indicated that the different percentages of sago flour addition did not influence the product's aroma. The average aroma scores ranged from 4.00±0.68 to 4.18±0.72. The treatment with the addition of 6% sago flour, had the most favored aroma among the panelists, with the highest average score of 4.18±0.72. In contrast, the T0 treatment, without any sago flour, had the least favored aroma, with the lowest average score of 4.00±0.68.

The aroma of ice cream is a combination of taste and smell, designed to match consumer preferences. In general, aroma and taste are inseparable and complement each other. Differences in aroma can also be influenced by the storage conditions of the product [40]. In the third treatment, goat milk ice cream received the highest score because the characteristic fishy smell of goat milk had started to fade, giving way to a creamier aroma. This may be due to the high percentage of added sago flour, specifically 6%. In contrast, in the control treatment, a stronger goat milk aroma remained detectable, which may have contributed to lower preference scores. As a result, the control treatment received the lowest average score.

Ice cream is served in a frozen or cold form, making its aroma difficult to distinguish, as the scent does not easily evaporate. The aroma of ice cream is only faint because ice cream is a frozen food, and the substances contained within it do not volatilize [41]. Aroma testing is one of the most important parameters in consumer decision-making. Aroma testing is crucial as it provides a quick assessment of a product by consumers [42].

4. Texture

The analysis of variance results showed that the different percentages of added sago flour had a highly significant effect on the texture scores of goat milk ice cream ($P < 0.01$). Table 3 indicates that varying percentages of sago flour addition resulted in a softer texture that was more favored by the panelists. The average texture scores ranged from 3.69±0.86 to 4.08±0.75. The treatment with the addition of 6% sago flour produced ice cream with a soft texture that was preferred by the panelists, achieving the highest average score of 4.08±0.75. On the other hand, T0, the control treatment without any sago flour, had a less

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smooth texture and was less favored by the panelists, with the lowest average score of 3.69±0.86.

Texture is the result of a combination of physical properties such as shape, quantity, size, and material-forming elements, perceived by the senses of taste, touch, and even sight, making it a distinctive characteristic of a food [43]. The three structural elements of complex food composition are geometrical (graininess, brittleness), mouthfeel (oily, watery), and mechanical (hardness, elasticity) [44]. Sago flour contains gelatin and undergoes gelatinization at 72°C, which ceases at 76°C. The gelatin can also serve as a stabilizing agent. The most used stabilizer is agar-agar, which can effectively emulsify and stabilize ice cream. The better the emulsification, the more stable the ice cream, resulting in a better and smoother texture [45]. A perfect emulsion effectively binds the water present during the production and freezing of the ice cream, preventing the water in the emulsion from crystallizing, which yields ice cream with a smooth texture.

CONCLUSIONS

The results of the study showed that the addition of sago flour was effective in maintaining the quality of ice cream as shown in the results of the addition at level 6% which reduced the water content due to an increase in total solids. while increasing the texture and preference for taste. The addition of sago flour also increased the viscosity and protein content, while resulting in a slower melting rate, as well as increasing the panelists' preference for the taste and texture of goat milk ice cream. This study demonstrates that the addition of sago flour significantly enhances the quality of goat milk ice cream. The improvement in physicochemical stability, evidenced by increased viscosity and decreased melting rate (Table 2), along with enhanced sensory properties such as texture and preferable taste (Table 3), leads to the conclusion that sago flour is an effective stabilizer for this product.

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