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The Effect of Cowpeas (*Vigna Unguiculata*) Addition on the Organoleptic Quality, Protein Content, and Fat of Buffalo Milk Ice Cream

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ABSTRACT

Ice cream is a milk product that is popular in Indonesia. This study aimed to determine the effect of cowpeas (*Vigna unguiculata*) addition on the organoleptic quality, protein content, and fat content of buffalo milk ice cream. This study was conducted using a Completely Randomized Design (CRD) with four treatments: P0 (0%), P1 (10%), P2 (20%), and P3 (30%), each with five replications. Observed parameters included organoleptic quality (color, aroma, taste, and texture), as well as the protein and fat content of the ice cream. hedonic data were analyzed using the Kruskal–Wallis test, while chemical data were analyzed using ANOVA. The results showed that the addition of cowpeas extract had a significant effect ($p < 0.05$) on color, aroma, and taste, but not on texture. The best treatment was by addition 30% cowpeas. Furthermore, 30% cowpeas addition produced the lowest fat content at 4.38% and the highest protein content at 6.08%. It can be concluded that the addition of cowpeas up to 30% improves the nutritional value of buffalo milk ice cream.

Keywords: Buffalo milk, Cowpeas, Fat, Ice cream, Organoleptic, Protein

1. Introduction

Ice cream is a dairy product popular with the public for its soft texture, sweet taste, and refreshing sensation. Ice cream consumption in Indonesia continues to increase along with the development of the food industry and innovation in dairy-based products. Ice cream is a frozen product processed through an emulsification process, a mixture of milk or dairy products with other additives to form a stable structure of fat, water, and air. This structure significantly determines the final quality of the ice cream, especially in terms of texture and softness. A good emulsion formation process will produce ice cream that is creamy and doesn't melt easily. Therefore, selecting the right raw materials is a crucial factor in ice cream production. This explains the importance of ice cream formulation [1].

As an alternative, buffalo milk, particularly Murrah buffalo, has great potential as a raw material for ice cream. Buffalo milk is known to have a higher protein and fat content than cow's milk, resulting in a denser texture and richer flavor. Furthermore, the availability of buffalo milk offers considerable potential for development as a raw material for the food industry. Utilizing buffalo milk can also be a solution for diversifying milk-based products. Therefore, Murrah buffalo milk is worthy of consideration as a raw material for ice cream [2].

However, buffalo milk also presents several problems when processed into ice cream. The high fat and protein content can increase viscosity, complicating the homogenization process. Furthermore, these conditions can inhibit the formation of overrun, which plays a role in shaping the ice cream's texture. As a

result, the resulting ice cream tends to be denser and less fluffy. This problem needs to be addressed through appropriate formulation innovations [3].

One approach is to add plant-based ingredients such as cowpeas. Cowpeas can be processed into bean juice, which serves as an additional source of protein. Furthermore, bean juice can help improve the emulsion structure in ice cream. The use of these plant-based ingredients also supports the use of local food ingredients. Therefore, cowpeas have the potential to be used in ice cream formulations [4].

Cowpeas are a local food ingredient with a fairly good nutritional content. This content includes protein, carbohydrates, and several essential minerals for the body. Furthermore, cowpeas have a relatively low fat content compared to animal-based sources. This makes cowpeas a healthy food alternative. Therefore, their use can increase the nutritional value of food products [5].

Several studies have shown that adding cowpeas can increase the protein content of ice cream products. This addition does not significantly increase the fat content. Furthermore, the physical changes that occur are relatively mild. This suggests that cowpeas have potential as an additive in ice cream. Therefore, their use could support the development of functional food products [6].

However, research combining murrah buffalo milk with cowpea extract is still limited. Studies examining organoleptic quality, protein content, and fat content simultaneously are also scarce. This indicates a research gap that requires further exploration. Therefore, this study offers novel value in the development of ice cream products based on local ingredients. This research is expected to provide both scientific and practical contributions [4].

Based on this description, this study aims to evaluate the effect of adding cowpeas on the organoleptic quality of buffalo milk ice cream. The observed parameters included organoleptic parameters, including aroma, taste, texture, and consumer acceptance, which also influenced the protein and fat content of the ice cream. Furthermore, this study also assessed the protein and fat content of the product. The results are expected to produce an innovative ice cream product with high nutritional value. This product is also expected to be widely accepted.

2. Method

2.1. Materials

The ingredients provided are pure buffalo milk, cowpeas as adding flavor to ice cream, granulated sugar to add sweetness, cornstarch as a stabilizer for ice cream, and salt to add savory taste, SP, sweetened condensed milk, and coconut milk.

2.2. Tools

The tools used include a saucepan for cooking the mixture, a blender for making the cowpea juice, a sieve for filtering, a thermometer for measuring the temperature during pasteurization, a stirrer for mixing the ingredients, a scale for measuring the amount of ingredients to be used, a hand mixer for homogenizing the mixture, a freezer for freezing.

2.3. Research design

This study used a completely randomized design (CRD) with four treatment levels and five replications. The details of the treatments provided in this study are as follows:

P0 = Buffalo Milk + 0% Cowpea Extract
P1 = Buffalo Milk + 10% Cowpea Extract
P2 = Buffalo Milk + 20% Cowpea Extract
P3 = Buffalo Milk + 30% Cowpea Extract

The statistical model used, according to [7], is as follows:

$$(Yij) = 1 + 1 + \Sigma ij)$$

Where:

Yij = Variable being analyzed
μ = General average value
Ti = Effect of the first treatment
Σij = Experimental error of the treatment

2.4. Research procedure

2.4.1. Making Cowpea Juice

Clean the cowpeas and soak them for 12 hours.
This softens the beans, reducing cooking time.

After the soaking process is complete, discard the water.
Then, steam the cowpeas at 80°C for 1 hour.
Finally, blend the cowpeas and add water.
Then, strain the ground cowpeas through a cloth to obtain the cowpea juice.

2.4.2.Making Ice Cream

The general process of making ice cream includes preparation, processing, freezing, packaging, and storage, as described by [8]. The steps are as follows:

First, prepare all the necessary tools and ingredients. Second, add the buffalo milk, sugar, thick coconut milk, sweetened condensed milk, cornstarch, and salt to a saucepan. Next, stir all the ingredients until thoroughly combined. Then, turn the stove on medium heat and cook the mixture, stirring constantly, until it boils and thickens, for approximately 15 minutes. Afterward, pour the mixture into an airtight container and store it in the freezer for approximately six hours until slightly frozen. Once the mixture has hardened, prepare a mixer, bowl, cowpea extract, and SP. Beat the mixture with the SP for approximately five minutes until fluffy. Next, add the cowpea extract (50g, 10g, and 150g), and stir until thoroughly combined. Finally, transfer the ice cream to a sealed container such as Tupperware and store it back in the freezer until completely frozen and ready to serve.

2.5. Observed Variable

2.6.1 Organoleptic Test

To determine the panelists' level of preference for ice cream with the addition of cowpea extract, an organoleptic test was conducted with 30 untrained panelists [9].
The results were calculated by summing all the data provided by the panelists, which were denoted by numbers.

Color

The organoleptic color test for buffalo milk ice cream with cowpea extract is a method for evaluating the color of the ice cream using the 17 senses of sight. This process begins with preparing the ice cream, which is served in a transparent container to ensure the color is clearly visible. The panelists then observe the ice cream under good lighting. Panelists provide assessments based on a specific scale to measure color intensity, brightness, and uniformity. After observation, the assessment results are collected and analyzed to obtain an average score, which is then interpreted to evaluate the quality and color preferences of ice cream.

According to [10], good ice cream color is normal, that is, it does not deviate, appears clean, uniform, and matches the ingredients. For ice cream made from buffalo milk with the addition of cowpeas, the resulting color generally ranges from creamy white to yellowish, which is still considered normal and acceptable to consumers.

Score for color is as follows: Very pale/white not typical of cowpeas :1 ; Pale/yellowish white typical of cowpeas :2 ; Quite creamy, typical of cowpeas: 3 ; Typical cowpea cream :4 ; Very typical cowpea cream (light brown) :5.

Taste

In this test, panelists will taste the ice cream and evaluate various flavors, including cowpea, sweet, and savory. The assessment is conducted by observing how the strong buffalo milk flavor and the distinctive cowpea flavor are balanced, and how well the two flavors work together. Panelists will also evaluate the aftertaste after the ice cream has melted.

Taste is an important organoleptic parameter in assessing ice cream quality. According to [10], a good ice cream taste is normal, namely sweet, savory, and creamy without any foreign flavors such as sour, bitter, or rancid. The balance of the composition of the 18 ingredients, such as fat and protein, significantly influences flavor formation and thus determines consumer acceptance.

Score for taste is as follows: Very atypical of cowpea juice :1 ; Not typical of cowpea juice :2 ; Somewhat typical of cowpea juice : 3 ; Typical of cowpea juice :4 ; Very typical of cowpea juice : 5.

Aroma

The organoleptic testing process for buffalo milk ice cream with cowpea extract begins with preparing the ice cream in a clean condition and free from any unpleasant odors. Panelists assess the taste using their sense of smell. In this test, panelists evaluate aroma characteristics, including clarity, intensity, and conformity to consumer expectations. The results of this test are then analyzed to determine the quality of the ice cream's aroma, which is crucial for the product's market appeal.
Aroma is an important organoleptic parameter in assessing ice cream quality. According to [10], a good ice

cream aroma is normal, meaning it has the characteristic smell of ice cream without any foreign odors such as sour, rancid, or other unpleasant odors. Aroma is strongly influenced by the raw materials and processing process, thus determining the level of consumer acceptance of the product.
Score for aroma is as follows : Not very typical of cowpea juice :1 ; Not typical of cowpea juice :2 ; Somewhat typical of cowpea juice :3 ; Typical of cowpea juice :4 ; Strongly flavorful of cowpea :5.

Texture

Texture is an important organoleptic parameter in assessing ice cream quality. According to [10], good ice cream texture is soft, smooth, and not coarse or grainy. Texture is influenced by the fat and protein content, as well as the freezing and churning processes, which determine the product's softness and stability.
The organoleptic texture test aims to assess the physical properties and mouthfeel of the product. Panelists are asked to taste the ice cream and rate its texture, including its softness and consistency. The assessment is made by observing how the ice cream melts in the mouth, whether it feels smooth or rough, and how well the ingredients are blended. The results of this test are recorded and analyzed to determine the quality of the ice cream's texture. Thus, the organoleptic texture test helps manufacturers understand consumer satisfaction with buffalo milk ice cream with added cowpea extract.
Score for texture is as follows : Very Coarse :1 ; Coarse :2 ; Somewhat Coarse :3 ; Soft ;4 ; Very Soft :5.

2.6.2. Fat Content Analysis

Fat content was analyzed using a Soxhlet method [11]. The sample was placed in a filter paper sleeve (W1). Next, the sample was placed in a fat sleeve, then into a fat flask whose weight was determined (W2). Connect the sample to a Soxhlet flask. After the sample is placed in the Soxhlet flask, it is flushed with the fat solvent (n-hexane) and refluxed for 6 hours. The fat solvent in the fat flask is then distilled until the fat solvent has completely evaporated. During the distillation process, the fat solvent is collected in the extractor chamber and removed to prevent it from returning to the fat flask. The fat flask is then dried in an oven at 105°C and placed in a desiccator until a constant weight is reached (W3).

2.6.3. Protein Content Analysis

Protein content was analyzed using the Kjeldahl method [11].
A 0.50 gram sample was weighed and placed into a 25-30 ml Kjeldahl flask. 0.90 grams of selenium and 2 ml of concentrated H2SO4 were added, then shaken and digested for 45 minutes. The flask was then cooled for 30 minutes and 4 ml of distilled water was added. The Kjeldahl flask was then placed in a distillation apparatus. An Erlenmeyer flask containing 15 ml of 4% boric acid and 3 drops of metal blue were placed directly under the condenser, with the tip of the condenser dipped into the saturated boric acid solution. The distillation was then carried out using a 40% NaOH solution. The distillation was titrated with a 0.166 N HCl solution until the color changed.

2.6.4. Data analysis

The data obtained were analyzed using analysis of variance (ANOVA) based on a Completely Randomized Design (CRD) consisting of four treatments and three replications. The mathematical model used was as follows:

$$Yij = \mu + \alpha i + \varepsilon ij$$

Description:

$Yij = observation\ value\ of\ the\ i-th\ treatment\ and\ j-th\ replication$
$\mu = overall\ mean$
$\alpha i = effect\ of\ the\ i-th\ treatment$
$\varepsilon ij = experimental\ error\ associated\ with\ the\ i-th\ treatment\ and\ j-th\ replication$

Differences among treatment means were further tested using Duncan's Multiple Range Test (DMRT) when significant effects were detected.

3. Result and Discussion

Based on Table 1, the average hedonic quality value for buffalo milk ice cream color shows a tendency to increase with the addition of cowpea extract, with a mean range of 1.13-2.04. The lowest color value was obtained in treatment P0 at 1.13. Furthermore, in treatment P1, the value increased to 1.59. A further increase was seen in treatment P2 at 1.85, and reached the highest value in treatment P3 at 2.04. This indicates that the higher the concentration of cowpea extract added, the panelists' preference for the color of the ice cream tends to increase. Treatment P0 showed a significant difference compared to the other treatments, while P1 was also significantly different from P2 and P3. However, treatments P2 and P3 did not show a significant difference,

although the average value of P3 was higher. This indicates that increasing the cowpea extract concentration from 20% to 30% did not significantly impact panelists' color perception. Thus, the best treatment numerically was P3, but statistically, P2 and P3 were at the same level of acceptance.

Table 1. Results of the Organoleptic Color Quality Test

Treatment	Replication					Mean ± SD
	I	II	III	IV	V	
P0	1.06	1.16	1.18	1.16	1.08	$1.13^{a} \pm 0.05$
P1	1.58	1.34	1.34	1.64	1.38	$1.59^{b} \pm 0.24$
P2	2.00	1.72	1.72	1.86	1.94	$1.85^{c} \pm 0.11$
P3	2.06	1.88	1.88	2.06	2.10	$2.04^{d} \pm 0.08$

Color is an important organoleptic parameter because it can influence consumer appeal and acceptance of a food product. Based on [12], the color of good ice cream is normal, namely white to cream, clean, uniform, and does not deviate from the characteristic color of its ingredients. Color assessment indicators in the hedonic test include brightness, color uniformity, color intensity, and suitability to product characteristics. Colors that are too pale or too dark can decrease panelists' preference. Visually, an increase in color value from P0 to P3 indicates a color change from pale white to yellowish cream. This is due to the presence of natural pigments in cowpeas, such as flavonoids and phenolic compounds, which impart a creamy to brownish color to the processed product [13]. When the concentration of cowpea extract is increased, the color intensity becomes more pronounced, resulting in a more favorable appearance for the panelists. The resulting color in treatments P2 and P3 was considered more attractive because it aligns with the expectations of a plant-based product.

The interaction between cowpea extract and buffalo milk also affects the final color of the ice cream. Buffalo milk has a deep white base color due to its high fat and protein content, so when combined with cowpea extract, it produces a more homogeneous creamy color [14]. The addition of cowpea extract also increases the amount of dissolved solids, which can affect turbidity and light reflection, resulting in a creamier and more attractive color. This explains why treatments with higher concentrations achieve better scores. The lack of significant differences between P2 and P3 is thought to be due to saturation of the panelists' visual perception.

At a concentration of 20%, the resulting color was sufficiently clear and in keeping with the product's characteristics, so increasing it to 30% no longer resulted in significant visual changes. This aligns with research by [15] which states that significant color changes generally occur at low to medium substitution levels. Furthermore,[16] also stated that increasing the amount of plant-based ingredients only increases color attractiveness to a certain extent.

Overall, the addition of cowpea extract had a positive effect on the color of buffalo milk ice cream. Treatment P3 showed the highest value, but because it was not significantly different from P2, the 20% concentration can be considered a more efficient treatment in improving the hedonic quality of color. The color produced in this treatment still falls within the normal color category according to the Indonesian National Standard (SNI), namely a uniform and attractive yellowish cream. Thus, the combination of buffalo milk and cowpeas produces an ice cream product with good visual quality and is acceptable to consumers.

Table 2. Results of the Organoleptic Taste Quality Test

Treatment	Replication					Mean ± SD
	I	II	III	IV	V	
P0	1.12	1.06	1.08	1.02	1.00	$1.06^{a} \pm 0.04$
P1	1.92	2.48	2.74	2.86	3.06	$2.61^{b} \pm 0,39$
P2	3.28	3.32	3.52	3.54	3.48	$3.43^{c} \pm 0.11$
P3	3.98	4.06	4.04	4.22	4.24	$4.11^{d} \pm 0.10$

Based on Table 2, the average hedonic quality score for buffalo milk ice cream flavor shows a tendency to increase with the addition of cowpea extract, with a mean range of 1.06-4.11. The lowest taste score was obtained in treatment P0 at 1.06. Furthermore, in treatment P1, it increased to 2.61. A further increase was seen in treatment P2 at 3.43, and reached the highest value in treatment P3 at 4.11. This indicates that the higher the concentration of cowpea extract added, the panelists' preference for the ice cream flavor tended to increase. All treatments showed significant differences. This indicates that each increase in cowpea extract

concentration significantly affected the hedonic quality of ice cream flavor. Therefore, treatment P3 was the best, with the highest average score compared to the other treatments.

Based on [12], a good ice cream flavor is "normal," meaning it has the typical sweet, savory, and creamy flavor of ice cream without any off-flavors such as sour, bitter, or rancid.

Taste assessment indicators in the hedonic test include flavor balance, flavor intensity, and the suitability of the flavor to the characteristics of the ingredients. A flavor that is too weak or too strong can decrease panelists' preference.

An increase in the flavor score from P0 to P3 indicates that the addition of cowpea juice enriches the ice cream's flavor. In the P0 treatment, the ice cream flavor tends to be simpler and dominated by a milky flavor. As the cowpea juice concentration increases, savory, sweet, and slightly nutty flavors emerge, becoming stronger and preferred by panelists. This is due to the protein, fat, and volatile compounds in cowpeas, which contribute to flavor formation.

The interaction between cowpea juice and buffalo milk also plays an important role in flavor formation. Buffalo milk, with its high fat content, is able to bind flavor compounds, resulting in a stronger creamy sensation [17]. Furthermore, the heating process in the production of cowpea juice can reduce the activity of the lipoxygenase enzyme, thereby reducing the unpleasant aftertaste. This results in the ice cream's taste remaining acceptable to panelists even when the cowpea concentration reaches 30%.

The results of this study align with previous research showing that the addition of plant-based ingredients can improve the taste of ice cream. [18] reported that substituting plant-based ingredients can enhance the savory flavor of the product. Therefore, the use of cowpea as an additive can increase flavor complexity and consumer acceptance.

Overall, the addition of cowpea juice has a positive effect on the hedonic quality of buffalo milk ice cream. Treatment P3 showed the highest value and was significantly different compared to the other treatments, thus being categorized as the best treatment. The resulting flavor still falls within the normal range according to the Indonesian National Standard (SNI), namely savory, sweet, and creamy, with no off-flavors. Therefore, the use of up to 30% cowpea extract improves the flavor and is well-received by consumers.

Table 3. Results of the Organoleptic Aroma Quality Test

Treatment	Replication					Mean ± SD
	I	II	III	IV	V	
P0	1.06	1.06	1.18	1.00	1.08	$1.08^{a} \pm 0.06$
P1	2.16	2.82	2.70	2.60	2.76	$2.61^{b} \pm 0.24$
P2	2.86	2.82	3.52	3.48	3.38	$3.21^{c} \pm 0.31$
P3	3.70	3.88	4.24	4.08	4.28	$4.04^{d} \pm 0.22$

Based on Table 3, the average hedonic value for buffalo milk ice cream aroma shows a tendency to increase with the addition of cowpea extract, with a mean range of 1.08-4.04. The lowest aroma value was obtained in treatment P0 at 1.08. Furthermore, in treatment P1, the value increased to 2.62. A further increase was seen in treatment P2 at 3.21, and the highest value was reached in treatment P3 at 4.04. This indicates that the higher the concentration of cowpea extract added, the panelists' preference for the ice cream aroma tended to increase. All treatments showed significant differences. This indicates that each increase in cowpea extract concentration significantly affected the hedonic value of ice cream aroma. Therefore, the best treatment was P3, which had the highest average value compared to the other treatments.

Based on **[**12], a good ice cream aroma is a normal aroma, meaning it has the distinctive smell of ice cream without any foreign odors such as sourness, rancidity, or other unpleasant odors. Indicators for aroma assessment in the hedonic test include aroma intensity, the suitability of the aroma to the ingredients, and the absence of off-flavors. An aroma that is too weak or too strong can affect the panelists' preference.

An increase in aroma values from P0 to P3 indicates that the addition of cowpea extract enriches the ice cream aroma. In the P0 treatment, the aroma was dominated by a neutral milky aroma. As the cowpea extract concentration increased, a mild and increasingly strong peanut aroma emerged, but it was still preferred by the panelists. This is due to the presence of volatile compounds such as aldehydes, ketones, and alcohols, which contribute to the formation of the distinctive peanut aroma [19].

The interaction between cowpea extract and buffalo milk also plays a role in improving the aroma quality. Buffalo milk, with its high fat content, is able to bind volatile compounds, making the aroma more stable and lasting longer [17]. Furthermore, the heating process used to make cowpea juice inactivates the lipoxygenase enzyme, which is the primary cause of the unpleasant aroma of legumes. This results in the ice

cream aroma remaining clean, smooth, and unaffected even when the cowpea concentration is increased by up to 30%.

The results of this study align with previous research showing that the addition of legume-based ingredients can improve the aroma quality of food products. Several studies have reported that increasing the concentration of plant-based ingredients can enrich the aroma without causing unpleasant odors when processed properly. This indicates that cowpea has potential as an additive that can improve the aroma quality of ice cream.

Overall, the addition of cowpea juice has a positive effect on the hedonic quality of buffalo milk ice cream aroma. Treatment P3 showed the highest value and was significantly different compared to the other treatments, thus being categorized as the best treatment. The resulting aroma still falls within the normal range according to the Indonesian National Standard (SNI), possessing a distinctive ice cream aroma combined with a mild peanut aroma without any off-putting odors. Therefore, the use of up to 30% cowpea extract significantly improves aroma quality and is well-received by consumers.

Table 4. Results of the Organoleptic Texture Quality Test

Treatment	Replication					Mean ± SD
	I	II	III	IV	V	
P0	3.92	3.86	3.84	4.12	3.94	3.94 ± 0.10
P1	4.02	4.02	4.02	3.86	4.08	4.00 ± 0.07
P2	3.92	4.12	3.98	4.06	3.70	3.96 ± 0.14
P3	3.90	4.02	3.98	4.04	3.82	3.95 ± 0.08

Based on Table 10, the average hedonic quality score for buffalo milk ice cream texture was relatively stable across treatments, with a mean range of 3.94-4.00. The texture score for treatment P0 was 3.94, then increased slightly to 4.00 in P1. Furthermore, the score was 3.96 in P2, and 3.95 in P3. This indicates that the addition of cowpea extract did not significantly change the panelists' preference for the ice cream texture.

None of the treatments showed any significant differences. This indicates that increasing the cowpea extract concentration from 0% to 30% did not significantly affect the hedonic quality of the ice cream texture. Therefore, all treatments had relatively similar texture acceptance levels among panelists. Based on **[**12], good ice cream texture is soft, smooth, and not grainy or coarse. Texture assessment indicators in the hedonic test include the level of softness, smoothness, cohesiveness, and the absence of large ice crystals. A texture that is too hard, rough, or watery can reduce panelists' preference.

The absence of significant differences in texture scores indicates that the addition of cowpea juice does not disrupt the physical structure of the ice cream. This is due to the relatively low viscosity of cowpea juice, which does not significantly change the emulsion system and ice crystal formation. The protein and carbohydrate content in cowpeas is not high enough to significantly modify the ice cream matrix structure. Therefore, the ice cream texture remains soft and stable despite the addition of plant-based ingredients.
Furthermore, the high fat content of buffalo milk plays a dominant role in the formation of ice cream texture. Fat functions to smooth the texture, reduce the formation of large ice crystals, and provide a creamy sensation. This high fat content keeps the ice cream's structure stable, even with the addition of up to 30% cowpea extract [17] Therefore, the primary factor determining texture in this study was buffalo milk rather than additional ingredients.

The results of this study align with previous research, which showed that the addition of plant-based ingredients does not always significantly affect ice cream texture. Textural changes typically occur when the added ingredients have a high viscosity or high starch content. Cowpeas, due to their light, non-gel-forming characteristics, maintain a stable texture. This indicates that cowpeas can be used as an additional ingredient without compromising the product's texture.

Overall, the addition of up to 30% cowpea extract did not significantly impact the hedonic quality of buffalo milk ice cream. All treatments showed a texture that met Indonesian National Standards (SNI) standards, namely, soft, smooth, and non-grainy. Thus, using cowpeas can increase nutritional value without compromising texture, thus maintaining consumer acceptance.

Based on Table 5, the average fat content of buffalo milk ice cream showed variation between treatments, with a mean range of 4.38-9.38%. The lowest value was obtained in treatment P3 at 4.38%. Furthermore, the value in treatment P2 was 6.49, slightly higher in P0 at 6.52, and the highest value in treatment P1 at 9.38%. This indicates that the addition of cowpea extract has different effects on the fat content of ice cream. It increases at low concentrations, but decreases at high concentrations. There is a

significant difference (P<0.05) between the treatments. Treatment P1 was significantly different from the other treatments, while P0 was not significantly different from P2. This indicates that the addition of cowpea extract at certain levels has a significant effect on the fat content, especially at low (10%) and high (30%) concentrations.

Table 5. Fat Content Test Results for Buffalo Milk Ice Cream with Added Cowpea Extract

Treatment	Replication					Mean ± SD
	I	II	III	IV	V	
P0	6.38	6.98	6.43	6.28	6.55	$6.52^{b} \pm 0.27$
P1	9.82	9.65	8.91	8.81	9.70	$9.38^{c} \pm 0.48$
P2	6.25	6.24	6.61	6.51	6.84	$6.49^{b} \pm 0.25$
P3	4.22	3.86	4.21	4.68	4.93	$4.38^{a} \pm 0.42$

Based on the research by [12], the minimum fat content in ice cream is 5%. Research results showed that treatments P0, P1, and P2 met this standard, while treatment P3 fell below the standard. This indicates that using high amounts of cowpea extract can reduce the fat content below the specified limit.

This change in fat content is related to the composition of the ice cream ingredients. In treatment P1, the increase in fat content is thought to occur due to the balance between buffalo milk fat and the non-fat components of cowpea extract, which helps form a more stable emulsion. Cowpea protein acts as an emulsifier, holding the fat globules together, resulting in a more even fat distribution [20].

Furthermore, increasing the total solids in the mixture can also increase the measurable fat proportion in the product [21].

In contrast, in treatments P2 and especially P3, there was a significant decrease in fat content. This is due to the low fat content of cowpeas, so increasing their amount causes a dilution effect on the fat in the ice cream. According to [22], legume-based ingredients generally have a higher protein and carbohydrate content than fat, so their use in ice cream formulations tends to reduce the product's fat content.

These results align with several previous studies. [23] reported that adding red beans to ice cream reduced the fat content from 7.12% to 4.85% at high concentrations.

[24] research also showed that substituting mung beans in goat's milk ice cream reduced the fat content to below 5%.

Furthermore [25] found that increasing the amount of plant-based ingredients consistently reduced the product's fat content in soy-based ice cream. This indicates that the trend of decreasing fat content due to the substitution of plant-based ingredients is a common phenomenon.

Overall, the addition of cowpea extract significantly affected the fat content of buffalo milk ice cream. Treatment P1 produced the highest fat content, while P3 produced the lowest. However, treatment P2 can be considered optimal because it still meets SNI standards and provides a balance between fat content and the use of plant-based ingredients. Therefore, cowpea extract has the potential to be used as an ingredient to produce ice cream with a lower fat content without significantly reducing product quality.

Table 6. Protein Content Test Results for Buffalo Milk Ice Cream with Added Cowpea Extract

Treatment	Replication					Mean ± SD
	I	II	III	IV	V	
P0	5.29	4.73	4.74	4.94	5.18	$4.98^{a} \pm 0.25$
P1	4.92	5.03	5.23	5.19	5.05	$5.08^{a} \pm 0.13$
P2	5.52	5.56	5.36	5.57	5.65	$5.53^{b} \pm 0.11$
P3	6.01	6.06	6.05	6.03	6.26	$6.08^{c} \pm 0.47$

Based on Table 6, the average protein content of buffalo milk ice cream showed an increase with the addition of cowpea extract, with an average range of 4.98-6.08%. The lowest value was obtained in treatment P0 at 4.98%. Furthermore, in treatment P1, it increased slightly to 5.08, then further increased in treatment P2 at 5.53, and reached the highest value in treatment P3 at 6.08%. This indicates that the higher the addition of cowpea extract, the protein content of the ice cream tends to increase. There was a significant difference (P<0.05) between the treatments. Treatment P0 was not significantly different from P1, but was significantly different from P2 and P3. Meanwhile, P2 and P3 also showed significant differences from each other. This

indicates that the addition of cowpea extract at low levels did not result in a significant increase, but at medium to high levels it did have a significant effect on protein content. Based on [12], the minimum protein content for ice cream is 2.7%. The results showed that all 43 treatments met this standard, with protein levels ranging from 4.98% to 6.08%. This indicates that buffalo milk ice cream with the addition of cowpea extract has good nutritional quality in terms of protein content. The increase in protein content in treatments P2 and P3 was due to the protein contribution from cowpeas, a source of vegetable protein with a relatively high protein content. The addition of cowpea extract to the ice cream formulation increased the total protein content of the mixture. According to [26] the use of legume-based ingredients in processed food products can significantly increase protein content. Furthermore, the high protein content is also influenced by the base ingredient used, namely buffalo milk, which has a relatively high protein content of around 3.8-4.5% [27]. These results align with several previous studies. [4] reported that the addition of cowpeas to ice cream increases protein levels significantly as concentration increases. [28] also reported that the protein content of ice cream with the addition of cowpea juice can reach 6.61%. Additionally, research [29] stated that the protein content of ice cream is very high influenced by the protein content of the raw materials used, both from animal and vegetable sources. This shows that the combination of milk buffalo and cowpeas provide a synergistic effect in increasing protein content.

Overall, the addition of cowpea juice provides real influence on the protein content of buffalo milk ice cream. P3 Treatment produces the highest protein content, while P0 is the lowest. However, P2 treatment can be considered as the optimal level because it has provides a significant increase in protein with a balanced formulation the good one. Thus, the use of cowpea extract has the potential as a vegetable protein source to increase the nutritional value of ice cream without compromising product quality.

4. Conclusions

The addition of cowpea (Vigna unguiculata) extract significantly affected the organoleptic quality of buffalo milk ice cream, including color, flavor, aroma, protein content, and fat content, but had no significant effect on texture. The best treatment was obtained with a 30% addition of cowpea extract and has the potential to be used in order to improve the quality and nutritional value of buffalo milk ice cream.

Suggestion

It is recommended to use cowpea extract in the range of 20-30% in buffalo milk ice cream production because it provides the best organoleptic quality and increases protein content. Future research should examine formulation optimization to balance the reduction in fat content and include analysis of the product's physical properties and shelf life for more comprehensive results.

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