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Substitution of coconut milk and soybean tempeh flour to produce ice cream that qualified and healthy

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Abstract

Ice cream is generally processed from cow's milk which contains a lot of long-chain unsaturated fatty acids and animal protein so it is poorly for health. Some people also have lactose intolerance with cow's milk. Coconut milk contains medium-chain fatty acids which are very good for health. Tempeh is a vegetable protein that is easy to digest and very good for health. This study was aimed to know the best of coconut milk concentration and soybean tempeh flour proportion for ice cream from coconut milk. This study learned two factors that were arranged factorial. The first factor was soybean tempeh flour concentration that was consisted of 3 levels each of 5; 7.5; and 10% (w / total weight). The second factor was coconut milk concentration that was consisted of 3 levels each of 12.5; 15; 17.5% (w / total weight). The experimental design used a Randomized Block Design (RCBD). The results of the study were coconut milk with a concentration 17.5% and soybean tempeh flour with a concentration 5%, with a total solid of 28.60%; protein of 6,33%; fat of 6.33%; ice cream dough viscosity of 3.17 dPa.s; overrun of 10.26%; melting speed of 1.16% min⁻¹. Taste score 5.30 (likes); color score 5.35 (likes); flavour score 5.10 (likes); and texture scores 5.35 (likes).

Keywords: Ice Cream; Coconut Milk; Soybean; Tempeh

1. Introduction

Ice cream is a dairy frozen food product that made from milk and milk products, sweetener, stabilizer, emulsifier, and flavor enhancer [1]. Ice cream is one of the most popular dessert in the world. Ice cream production in 2003 reached more than 1 billion liters [2]. Ice cream consumption in 2019 reached 0.8 liters per capita every year. One of ice cream producer in Indonesia, in 2019 could produce 100 billion liters every year [3].

The main raw material of ice cream is milk. This condition causes some people cannot consume ice cream because the reason such as allergy, lactose intolerance and adhering to a vegetarian diet [4]. Therefore, needs for develop ice cream products based on vegetable ingredients.

Vegetable material that is potential to substitute milk as a source of fat is coconut milk. Fat content of coconut milk per 100 grams of material is 21.33 grams [5].

Coconut milk has been developed into Coconut Drink Powder (CDP). CDP is made from young coconut flesh or old and then was added young coconut water or old and was added maltodextrin then homogenized. Furthermore, it was dried using a spray dryer, so that was obtained coconut drink powder. The results showed that CPD was potential for further developed were formulas that were processed from old coconut water with the addition of 20% young coconut flesh [6]

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Fractionated coconut milk produces a fraction that is rich in lauric acid. The amount of lauric acid reaches 50.45%. Besides lauric acid, it also contains medium chain fatty acids such as caproic acid 0.11%, caprylic acid 5.52%, capric acid 6.46% and myristic acid 17.52% [7].

Lauric acid, capric acid and myristic acid were very useful as an anti-bacterial [8], it could inhibit the HIV viruses development [9].

Lauric acid from coconut milk can inhibit the growth of *Salmonella* sp., *E. Coli* and *Staphylococcus aureus* at a concentration of 3.13%. *Micrococcus* was inhibited at a concentration of 10%, *Bacillus stearothermophilus* 30% and *Pseudomonas* at a concentration of 50%. Lauric acid can kill *Salmonella* at a concentration of 3.13%, *E. coli* and *Staphylococcus aureus* 6.25%. *Micrococcus* at a concentration of 30%, *Bacillus stearothermophilus* 50% and *Pseudomonas* at a concentration of 70% [10].

The addition of coconut milk in production of ice cream has been done by several previous researchers. The combination of 75 g coconut milk and 25 g of cassava flour produces the best melting time ice cream of 19.44 minutes and a fat content of 46.41% [11].

The addition of avocado as much as 20% and pandan aromas as much as 2% produces the best ice cream with a moisture content of 36.33%, protein 1.61%, fat 23.53%, overrun 37.17%, melting speed 62.62 minutes, flavor values 5.35, colors 5.75, aromas 5.65 and textures 5.65 [12].

Comparison of tempeh milk: purple sweet potato = 12.5%: 17.5%) produces vegetable ice cream with a total solids of 44.81%, crude fiber 7.32% (wb), and antioxidant activity 1.33% DPPH per mg, overrun 80.43%, and resistance 44.28 minutes [13].

The addition of 25% coconut milk and 5% purple sweet potato porridge is the best treatment with 10.57% fat content, 1.90% protein content, 36.78% total solids, 24.33% overrun, 13.72 minutes melting time, purple (2.97), sweet (3.47), not rancid (2.30) and soft (2.90), favored by panelists with a score (2.87) [14].

According to [15], one of the key from ice cream quality is the percentage of fat. Fat makes soft ice cream in the mouth. In addition, the use of coconut milk as an ingredient can give a distinctive taste and aroma in ice cream products.

Vegetable ice cream that use of coconut milk as raw material still has shortcomings that is low protein levels. Protein content in coconut milk just only 2.02% [5]. Quality standard of ice cream based on the Indonesian National Standard (SNI) 01-0317-1995 is requires a minimum protein content of 2.70% (w / w). To increase protein content in ice cream which based on this coconut milk, it is necessary to add solid ingredients that contain high protein such as soybean tempeh flour. Soy tempeh flour that contain protein is 43.03% [16].

Tempeh has nutritional value that higher than soy. There were an increase in free amino acids during the fermentation process, which was between 7.3 to 30% [17]. The increase of amino acid will increase protein digestibility that reach 80 – 90%. During fermentation will also occur lipase, protease, amylase, and phytase enzyme production that could increase fat, protein, and carbohydrate digestion [18].

The amino acid in tempeh are dominated by arginine 6,58%. While lysine and methionine are very low respectively 0,95% and 0,15% [19]. Arginine tends can decrease cholesterol level, whereas methionine and lysine precisely can increase cholesterol [20]. Methionine and lysine are amino acid that widely contained in animal protein. While arginine is a lot in vegetable protein. Methionine is homosystein precursor that a risk factor for coronary heart disease [19]. So that, the addition of tempeh flour to the ice cream is very beneficial for healthy.

The addition too much of coconut milk concentration can create a soft ice cream texture but the melting rate becomes faster, and vice versa. In the addition too much of soy tempeh causes the ice cream texture becomes hard and difficult to melt, and vice versa.

Based on the description above, it is necessary to conduct research to determine the combination of coconut milk with soy tempeh flour as the main solid material for physical, chemical, and organoleptic characteristics of ice cream products.

2. Material and methods

This study was conducted in the Chemistry laboratory of Widyagama University of Malang and PT. Idolakto, Pandaan, Pasuruan. The main ingredients were fresh soybean tempeh and coconut milk in packaging (Brand “KARA”), shortening, lecithin, sugar, boiled water, and Na-CMC had been obtained from minimarket in Malang. The tools that were used in the ice cream manufacturing process were ice cream maker with brand Gaggia Gelatiera, freezer and refrigerator, centrifuge, distillator, analytical scale, gas stove, sieves, thermometer, pan, knives, basins, plastic containers / jars, and stirrer.

The research was conducted with two factors, there were 1: Soybean Tempe Flour and 2: Coconut Milk Concentration. The first factor contain of three levels, namely 5%, 7.5% and 10% (of ICM weight). The second factor contain of three levels: 12.5%; 15% and 17.5% (by ICM weight). This study used a Randomized Block Design (RCBD).

2.1. The Making of Soy Tempe Flour

Fresh soybean as raw material was thinly sliced. Then, it was heated with blanching method at a 90°C for 15 minutes in order to eliminate the unpleasant taste and aftertaste from the flour / tempeh that had been produced. After that it was cooled to room temperature. Sliced tempeh was dried in a cabinet dryer at 60°C for 24 hours. Tempeh that has been dried was crushed with a blender to get tempeh flour. Then, tempeh flour was sieved to obtain uniform particle size (100 mesh).

2.2. The Making of Coconut Milk Ice Cream

The ingredients were weighed according to the amount needed, namely sugar, 15% (w / total ICM weight), white butter 0.25% (w / total ICM weight), Na-CMC, 0.35% (w / total weight ICM), and soy lecithin 0.35% (w / total ICM weight). While soybean tempeh flour was varied to be 5%, 7.5% and 10% (of ICM weight).

Coconut milk solution was made by dissolving a certain amount of coconut milk in packaging into boiled water according to the desired concentration. The concentration of coconut milk solution was varied to 12.5%; 15%; and 17.5% (w / w) of total weight = ICM (1 liter).

All ingredients that have been weighed according to the amount needed were mixed, and then added coconut milk solution until the total weight of the mixture reached 100% (w / w). The mixture of ingredients was heated (cooked) over a fire while stirring until all ingredients dissolved. The temperature was maintained at 40°C so that the coconut milk emulsion did not break. The mixture continued to be heated until reached a temperature of 50 °C and then pasteurized at 80°C for 25 seconds until the temperature reached 65°C. After the pasteurization process was carried out, the heating process was stopped.

The process was continued by homogenizing the mixture using a mixer at I speed (110 rpm) for 10 minutes. The ice cream mixture (Ice Cream Mix / ICM) then was fleshed (stored) in a refrigerator at 4°C for 16 hours. Furthermore, the ice cream mixture (Ice Cream Mix / ICM) was foamed in Ice Cream Maker with a temperature of -1°C for 15 minutes.

The foamed of ice cream dough was packaged in a closed container and frozed in a freezer at -5°C for 3 hours. After the freezing process was complete, ice cream could be tested for fat content, protein content, total solids, melting speed, overrun, organoleptic, color, taste, aroma, texture.

Research data were analyzed using analysis of variance. If there were differences then continued the LSD test.

3. Results and discussion

3.1. Characteristics of Raw Materials

Raw materials analysis of coconut milk and soybean tempeh flour had been carried out to find out some chemical and physical characteristics of these materials. The average raw material analysis results were presented in Table 1.

Table 1 Chemical and Physical Characteristics Analysis of Tempe Flour and Coconut milk.

Parameters	Tempe Flour Soybean	Coconut Milk
Protein Level (%)	40.73	4.13
Fat level (%)	12.50	24.33
Water content (%)	3.67	70.92
Total Solids (%)	96.33	29.08
Viscosity (Pa.s)	-	2.08

3.2. Chemical Characteristics of Coconut Milk Ice Cream

3.2.1. Total Solid

The total of coconut milk ice solids that was produced due to variations of coconut milk solution concentration and the proportion of soy tempeh flour were presented in Table 2

Table 2 Total of Coconut Milk Ice Cream Solids in Variation Concentration Of Coconut Milk And Soy Tempe Flour

Coconut Milk Concentration (%)	Soy Tempeh Flour Concentration (%)	Total Solid (%)
12.5	5	27.10 a
15.0	5	27.41 ab
17.5	5	28.60 bc
12.5	7	29.67 c
15.0	7	31.42 d
17.5	7	33.12 e
12.5	10	33.03 ef
15.0	10	34.45 ef
17.5	10	37.68 g

Table 1 showed that, in 5% of soybean tempeh flour, an increasing in the coconut milk solution concentration almost did not increased of total solids. But in 7.5% of soybean tempeh flour and 10%, an increasing of coconut milk solution concentration had increased of total solids. It was because by increasing coconut milk solution concentration, so that the amount of protein, carbohydrates and fats would increasing the total solids in ice cream.

According to [21], the increased of total solids was the result of an increasing all dough components presentation. Total solids was solid components that made a material like fat, protein, carbohydrates, and ash. The increased in total solids was expected could produce an ice cream texture smoother because it would cause inhibition of the crystal growth mechanism [22].

3.2.2. Protein levels

The increasing of the coconut milk amount would increasing the protein level of coconut milk ice cream (Table 3). This coconut milk was contain protein so that it would increasing protein level in vegetable ice cream. Raw materials analysis result (table 1) stated that coconut milk that was used contains protein level of 4.13%.

Table 3 Protein Level of Coconut Milk Ice Cream in Variation Coconut Milk Concentration

Coconut Milk Concentration (%)	Protein Level (%)
12,5	7.62 a
15.0	7.72 ab
17.5	7.92 b

The higher of soybean tempeh flour concentration, so that the protein levels of coconut milk ice cream would also increase (Table 4). The average of protein levels of coconut milk ice cream that was produced due to variation of soybean tempeh flour concentration were presented in Table 4.

Table 4 Average of Protein Level of Coconut Milk Cream in Variation of Soy Tempe Flour Concentrations

Soy Tempeh Fluor Concentration (%)	Protein Level (%)
5.0	6.21 a
7.5	7.79 b
10.0	9.22 c

This was because soy tempeh flour had protein content. Based on the analysis result of raw materials (Table 1) soybean tempeh flour that was used contains 40.73% protein. As the main raw material, both of these ingredients would contribute to protein in vegetable ice cream.

In the process of making ice cream, the functions of protein was to stabilize the fat emulsion after homogenization, add flavor, help foaming, increase and stabilize the water binding ability which affects the thickness of the ice cream and produce a soft texture, and increase overrun without affecting the texture and softness of the ice cream [1]. Besides its function on the physical properties of ice cream, the protein content was also expected to increase the nutritional value of ice cream.

3.2.3. Fat level

Increasing the amount of coconut milk would be increasing the fat level of coconut milk ice cream while the increase of soy tempeh flour did not affect in the fat levels of vegetable ice cream. Average of the fat level in vegetable ice cream due to the variation of coconut milk solution concentration was presented in Table 5.

Table 5 Average The Fat Levels of Coconut Milk Ice Cream in Variations Coconut milk Concentration

Coconut Milk Concentration (%)	Fat Level (%)
12.5	5.82 a
15.0	6.28 ab
17.5	6.45 b

The increased of fat levels in ice cream was occurred because of coconut milk contained fat. The results of raw materials analysis (Table 1) stated that coconut milk that was used contain 24.33% of fat, so that in the making of this coconut milk ice cream, coconut milk was the main source of fat. The use of coconut milk solution with a concentration of 12.5-17.5% as a raw material, certainly would contribute to fat in vegetable ice cream, so that the used of the amount of fat source as raw material was greater, the fat content in a product would increase.

According to [1], that fat had an important role in the ice cream quality, namely increasing of ice cream nutritional value, adding flavor, producing a soft texture, helping to given form and density, and providing a good melting properties.

3.2.4. Overrun

The higher of coconut milk solution concentration that was used would reduce the overrun of vegetable ice cream dough. The average overrun of coconut milk ice cream dough that was produced due to variations in coconut milk concentration was presented in table 6.

The decrease in overrun was caused by the increasing of fat levels in ice cream. The size, amount and physical condition of the fat globules in the ice cream dough determined the rate of foaming and the foam stability that was formed. A small amount of fat globules could increase the foaming of dough which did not contained of fat foamed quickly, but produced of foam that was easy to shrink after being frozen. However, the use of fat in more amount would reduce the ability of the dough to foam (whipping ability) [23].

Table 6 Average Overrun of coconut milk ice cream due to variations of Coconut milk Concentrations

Coconut Milk Concentration (%)	Overrun (%)
12.5	14.45 a
15.0	13.41 a
17.5	10.48 b

The protein source in coconut milk ice cream came from soybean tempeh flour. During the fermentation process of soybeans into tempeh, proteins were decomposed into free amino acids by the proteolytic activity of the *R. oligosporus* [24]. Decomposition of protein into free amino acids caused soy protein to lose its functional properties in foaming form.

3.2.5. Melting Rate

The increasing of coconut milk concentration would reduce the speed of melting vegetable ice cream or ice cream melted faster. The average melting rate of coconut milk ice cream that were produced due to variations in coconut milk solution concentrations were presented in table 7.

Table 7 Average Melting Rate of Coconut Ice Cream in Variation of Coconut Milk Solution Concentration

Coconut milk Concentration (%)	Melting Rate (minutes)
12.5	1.34 a
15.0	1.05 b
17.5	0.91 b

The decrease in melting rate was thought because an increase in fat levels along with increasing of coconut milk solution concentration. In this case, the sidelines of the air acted as an insulator and fat would stabilize the foam structure, so that the melting rate was faster. [1] stated that a good ice cream was resistant to melting when served at room temperature.

Increasing of soy tempeh flour also decreased of vegetable ice cream melting rate. The average of coconut milk ice cream melting rate due to variations soybean tempeh flour proportions were presented in Table 8.

Table 8 Average Melting Rate of Coconut Milk Ice Cream in Variation Concentration

Soy Tempeh Flour Concentration (%)	Melting Rate (minute)
5.0	1.42 a
7.5	1.10 b
10.0	0.77 c

Table 8 showed ice cream was faster to melt with the increased of soybean tempeh flour that was used. This was caused the increasing of soy tempeh flour proportion that was used, the total ice cream solids would increase as well. In the increasing of this total solids caused the foam cavities in the ice cream were bigger so that the melting rate was faster. [25] stated that the speed of ice cream melting was greatly influenced by total solids.

3.3. Vegetable Ice Cream Characteristics

3.3.1. Taste Preference

The average score of panelist preference for the coconut milk ice cream taste due to variations in coconut milk solution concentrations and soybean tempeh flour proportions was ranged between 3.95-5.30 (somewhat dislike to like).

The level of panelist preference for coconut milk ice cream taste increased with the increasing coconut milk solution concentration. and decreased with increasing soy tempeh flour proportion.

Panelist did not like tempeh taste in ice cream because it still felt unpleasant and bitter (rather bitter). Panelists prefer ice cream with a combination of using 17.5% coconut milk solution and 5.0% soy tempeh flour because of the high concentration of coconut milk solution so that it could disguise the undesirable taste of soy tempeh flour.

[26] stated that the components of coconut milk (especially fat and protein) were able to form a distinctive taste and aroma. This taste and aroma could not be replaced by other ingredients so that the consumption of coconut milk remained extensive until now.

3.3.2. Aroma Preference

The average score of panelist preference for coconut milk ice cream aroma due to variations in coconut milk solution concentration and soy tempeh flour proportion ranged from 4.55-5.10 (neutral-like).

The level of panelist preference towards coconut ice cream tends to increase with an increase in coconut milk solution concentration, but had a tendency to decrease due to an increase in soy tempeh flour proportion. Just like with the taste scoring, panelist prefer ice cream with a high concentration of coconut milk solution because it could disguise the unpleasant aroma of soy tempeh flour. [26] stated that components of coconut milk (especially fat and protein) were able to form distinctive flavors and aromas. This taste and aroma could not be replaced by other ingredients so that the consumption of coconut milk remained extensive until now.

3.3.3. Texture Preference (Mouthfeel)

The total mean of panelist preference for texture due to variations in coconut milk solution concentration and soybean tempeh flour proportion ranged from 4.80 to 5.70 (neutral-like).

The level of panelist preference on the texture of coconut milk ice cream that produced was more increase with an increase in coconut milk solution concentration and soy tempeh flour proportion. The more increase of coconut milk, panelist were more like, and the higher of soybean tempeh flour concentration, the more disliked by the panelist.

The increasing of coconut milk solution concentration and soy tempeh flour proportion that were used would result in an increase of fat content. An increase of fat content in ice cream would improve the texture of ice cream. According to [27], with a comparison of all factors, a high percentage of fat would give a soft texture where the fat was spread evenly with a homogeneous and small size. The increasing of the protein content in ice cream would increase the total solids so that it would improve the texture and melting rate on ice cream.

4. Conclusion

The coconut milk concentration gave a significant effect on the total solids, protein level, fat level, viscosity of the dough, overrun, and melting rate parameter. The soybean tempeh proportion had a significant effect on the total solids, protein level, viscosity of dough, and melting rate parameter. But it did not had a significant effect on the fat level parameter.

The best treatment in ice cream concentration of 17.5% coconut milk solution and 5.0% soy tempeh flour. Physical and chemical characteristics of the ice cream was to contain a total solid of 28.60%; 6.33% protein; 6.33% fat; viscosity of ice cream dough 3.17 dPa.s; overrun 10.26%; melting rate 1.16 minutes. Flavor 5.30 (like), color 5.35 (like), aroma 5.10 (like) and texture 5.35 (like).

Compliance with ethical standards

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Disclosure of conflict of interest

Authors declare that they have no conflict of interest.

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