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The Quality of Ice Cream with Cowpea Tempeh Extract and Porang Tuber Extract Paste as Stabilizer

Es Krim Ekstrak Tempe Kacang Tunggak dan Pasta Ekstrak Umbi Porang sebagai Penstabil

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ABSTRACT

Background: Ice cream contains a high saturated fat and uses commercial stabilizers which are detrimental to health. This study uses cowpea tempeh extract containing a low saturated fat and porang tuber extract paste as natural stabilizers.
Objectives: To determinate the effect of adding cowpea tempeh extract as a substitute for water and porang tuber extract paste as a replacement for carboxymethyl cellulose (CMC) and super polymer (SP) on the ice cream characteristics.
Methods: This study used a completely randomized design with four treatments based on the ratios amount of cowpea tempeh extract and porang tuber extract paste (%), 0:0 (K), 5:1 (A), 10:1.5 (B), and 15:2 (C). This study measured the protein content, fat content, solids content, sucrose content, total plate counts, Salmonella prevalence, melting rate, overrun and panelists' preference.
Results: The result of the ice cream testing shows that the protein content is 4.35%-7.47%, the fat content 8.68%-9.84%, the total solids content 23.53%-30.75%, the sugar content (sucrose) 20.67%-20.87%, the overrun 70.67%-100%, the melting rate 1019 seconds-1207 seconds, and the compliance with Indonesia National Standard dealing with the total plate counts and the Salmonella prevalence.
Conclusions: The best ice cream is obtained in the treatment C (15%:2%).

INTRODUCTION

Ice cream is a popular frozen food in the world and is liked by almost everyone[1]. Ice cream is a frozen food made of milk and other ingredients. The consumption rate of ice cream in Indonesia shows an increase from year to year. Ice cream contains high fat - about 12.5 g of fat[2]. In particular, milk contains a highly saturated fatty acid; it is 28% higher than meat, so it is not healthy[59]. Vegetable fats in making ice cream contain unsaturated fatty acids which are beneficial for health[3]. Therefore, cowpeas containing high protein and low fat can be used as an ingredient substitute for making ice cream[4].

Nuts are a good source of unsaturated fatty acids, minerals, vitamins, and several bioactive components. Regular nuts consumption can reduce the risk of cardiovascular disease and other chronic diseases[5]. Cowpea (*Vigna unguiculata*) is a type of bean that can be used as a substitute for soybeans[4]. Cowpea contains 22.90% protein[6]. Cowpea in many cultivars has a high content of fatty acids with double bonds[7]. Cowpea fat contains total fatty acids with double bonds 36.08%, total fatty acids without single bonds 20.66%, palmitic acid 24.33%, stearic acid 2.56%, oleic acid 20.66%, linoleic acid 31.3%, and linolenic acid 4.78%. Unsaturated fatty acids in cowpea can reduce cholesterol[8].

Cowpea contains anti-nutritional substances such as phytic acid[6]. The fermentation process of cowpea in the making of tempeh can reduce the phytic acid content because the phytase enzyme from the tempeh fungus can break down the phytic acid[9]. Tempeh also contains unsaturated fatty acids formed during the fermentation process[10].

Stabilizers play a crucial role in the ice cream-making process because they are responsible for determining the softness and texture, reducing large ice crystals, and maintaining the shape when melted[11]. The commonly used stabilizers are gelatin and CMC[12]. A long-term consumption of CMC can cause chronic inflammatory conditions such as colitis, metabolic syndrome, and colon cancer[13]. Natural stabilizers such as glucomannan found in porang tuber can be used as a replacement to improve the nutritional quality of ice cream[11].

Porang plants can grow in Indonesia. Porang tuber contains many glucomannan compounds[14]. Porang

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tuber exports in October 2020 reached 8,675 tons and it is an increase of 160%[15]. Porang tuber is underutilized by the people. Porang tuber flour can be used as an alternative to plant fat stabilizer because glucomannan is a thickening agent in stabilizing emulsions[12].

Therefore, this study aims to determine the characteristics of ice cream with cowpea tempeh extract as a substitute for water and porang tuber extract paste as a replacement of CMC and SP. The substitute of cowpea tempeh extract in the ice cream making is expected to obtain increase the double-bonded fatty acids and protein content. By adding porang tuber extract paste as a stabilizer, the ice cream may have good overrun and melting rates. Additionally, this will help to promote the utilization of underutilized porang tubers in Indonesian society.

METHODS

This research used a completely randomized design (CRD) with 4 treatments and 3 repetitions in each treatment. Cowpea samples were obtained from Gunung Kidul Regency, Special Region of Yogyakarta, Indonesia. The samples of dried porang tuber chips were obtained from farmers in Pandeglang, Banten Province, Indonesia. The experimental design of this study is shown in Table 1.

Table 1. Experimental Design

Repetition	Cowpea Tempeh Extract:Porang Tuber Extract Paste (%)			
	0:0 (K)	5:1 (A)	10:1.5 (B)	15:2 (C)
1	K1	A1	B1	C1
2	K2	A2	B2	C2
3	K3	A3	B3	C3

K = Control (0% Cowpea Tempeh Extract, 0% Porang Tuber Extract Paste), A = Treatment A (5% Cowpea Tempeh Extract, 1% Porang Tuber Extract Paste), B = Treatment B (10% Cowpea Tempeh Extract, Porang Tuber Extract Paste 1.5%), C = Treatment C (Cowpea Tempeh Extract 15%, Porang Tuber Extract Paste 2%)

To make cowpea tempeh extract, the cowpeas are soaked for 24 hours and then roasted for 10 minutes. The skin of the cowpeas is then peeled by soaking and rubbing, then the peeled cowpeas are steamed for 30 minutes. The tempeh yeast (Raprima) is added to cowpeas and the ratio of yeast: beans is 0.7:100. 100 g of cowpeas are packaged in 10x15 cm plastic clips that have been perforated with a toothpick and then incubated for 24 hours[9]. Tempeh is sliced in size 1cm - 2cm then blanched by steaming at 85°C-90°C for 2 minutes. The blanched tempeh is chopped and dried in an oven at 70°C for 6 hours, then ground using a grinder and sifted using a 60 mesh sieve[16]. Tempeh flour is put into an erlenmeyer flask and water is added with a ratio of 1:5 (w/v) before heated on a hot plate magnetic stirrer at the temperature of 70°C, speed 250 rpm, for 30 minutes, then filtered using a tea strainer[17]. Analysis of cowpea tempeh extract includes the content of fat (Soxhlet method)[18], protein (Kjeldahl method)[19], and total solids (gravimetric method)[20].

To make porang tuber extract paste, the dried porang tuber chips are ground with a grinder. Then the ground porang tuber is sieved using a 60-mesh sieve. After that, the porang tuber flour is put in an erlenmeyer flask and the water is added with a ratio of 1:25 (w/v) heated with a hot plate magnetic stirrer at a temperature of 90°C and speed 150 rpm, for 30 minutes, then filtered using a tea strainer. The porang tuber extract obtained was put into a rotary evaporator at a temperature of 90°C with a vacuum pressure of 40-80 mmHg for 30 minutes[21,22]. The analysis of porang tuber extract paste includes total solids[20] and glucomannan contents [23].

The ingredients of ice cream are cowpea tempeh extract, porang tuber extract paste, full cream milk powder, skimmed milk powder, CMC, granulated sugar, water, and SP. The process of making ice cream begins by mixing the ingredients, then pasteurizing it on a stove at the temperature of 70°C-80°C, and simultaneously stirring it for 15 minutes. The pasteurized dough is cooled in a stainless-steel bowl. After it is cooled, the dough is covered with plastic wrap and then stored for 1 hour in the freezer. The stored dough is stirred with a mixer for one minute then put into the ice cream maker[24]. The formula of ice cream is shown in Table 2.

Table 2. Formula of Ice Cream

Ingredients	Cowpea Tempeh Extract:Porang Tuber Extract Paste (%)			
	0:0 (K)	5:1 (A)	10:1.5(B)	15:2(C)
Full Cream Milk Powder (g)	50	50	50	50
Skim Milk Powder (g)	30	30	30	30
Cowpea Tempeh Extract (mL)	0	25	50	75
CMC (g)	0.5	0	0	0
Porang Tuber Extract Paste (g)	0	5	7.5	10
Sugar (g)	45	45	45	45
SP (g)	1	0	0	0
Water (mL)	500	475	450	425

K = Control (0% Cowpea Tempeh Extract, 0% Porang Tuber Extract Paste), A = Treatment A (5% Cowpea Tempeh Extract, 1% Porang Tuber Extract Paste), B = Treatment B (10% Cowpea Tempeh Extract, Porang Tuber Extract Paste 1.5%), C = Treatment C (Cowpea Tempeh Extract 15%, Porang Tuber Extract Paste 2%)

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The ice cream was analyzed in terms of the protein content, fat content, solids content, sucrose content, number of plates, Salmonella prevalence, quality, melting speed and development, and panelists' preferences. Chemical analysis of ice cream includes the fat content (Soxhlet method)[18], protein content (Kjeldahl method)[19], total solids (gravimetric method)[20], and total sucrose sugar content (refractive index method)[25]. The physical analysis of ice cream includes the melting rate and overrun value[20]. The microbiological analysis of ice cream includes a total plate number[26] and the prevalence of Salmonella[27]. The data were analyzed using the One-Way ANOVA method with a confidence level of 95% and to determine the level of significance among the treatments, the Post-hoc Duncan Multiple Range Test was carried out. The organoleptic analysis using a hedonic testing with 30 panelists in the age of 20 – 25 years was employed.

RESULTS AND DISCUSSIONS

Raw Ingredients Characteristics

The analysis of raw ingredients is carried out to determine the contents and nutritional quality. The chemical analysis of cowpea tempeh extract contains protein, fat, and solid contents. In addition, the chemical analysis of porang tuber extract paste includes the glucomannan content and total solids. The results of the raw material analysis are shown in Table 3.

Table 3. Chemical Characteristics of Raw Materials for Making Ice Cream

Raw Materials	Characteristics	Result
Cowpea Tempeh Extract	Protein Content	6.40 ± 0.20%
	Fat Content	2.20 ± 0.15%
	Total Solid	16.09 ± 0.71%
Porang Tuber Extract Paste	Total Solid	6.41 ± 0.08%
	Glucomannan Content	3.88 ± 0.20%

n (number of repetitions) = 3

Protein is a macronutrient responsible for the formation of biomolecules in cells and the bean-based tempeh has a high content of protein[28]. The protein content of cowpea tempeh extract in this study is 6.40%. It complies with the SNI for soy milk (01-3830-1995) - the minimum value of 2%[29]. It is higher than the result of the previous studies (4.27%[30] and 3.9%[31]).

Fat is a nonpolar macronutrient. The commonly consumed fat is in the form of triglycerides[32]. The fat content of cowpea tempeh extract in this study is 2.20%. It complies with the SNI for soy milk (01-3830-1995) - the minimum value of 1%[29]. It is lower than the result of the previous study of tempeh juice (2.34%)[31].

The total solids analysis includes the protein, fat, carbohydrate, mineral, and vitamin contents[33]. Total solids can be measured using the gravimetric method[33]. The total solids of cowpea tempeh extract in this study is 16.09%. It complies with the SNI 01-3830-1995 - the minimum value of 11.5%[29]. It is higher than the result of the previous study of tempeh juice (12.86%)[31].

Glucomannan is a hemicellulose polysaccharide with high viscosity because it can absorb large amounts of water and 1 g of glucomannan can absorb 100 g of water[14]. Glucomannan is a hydrocolloid that serves as an emulsifier and stabilizer[34]. The glucomannan content of the paste made from porang tuber extract paste is 3.88%, which is greater than the 1.2% found in earlier studies using konjac glucomannan paste to make canna starch[35]. The total solids of porang tuber extract paste are 6.41% and it is different from previous research of the konjac glucomannan paste in the making of canna starch (6%)[35].

Ice Cream Characteristics

Cowpea tempeh extract as a substitute for water and porang tuber extract paste as a replacement for CMC and SP can affect the characteristics of ice cream. To determine whether they have a positive impact on the ice cream's qualities, its overall characteristics are examined. Compared to ice cream without substitution and replacement, ice cream with substitute and replacement offers greater qualities (Table 4).

Table 4. Ice Cream Characteristics

Parameter	Unit	Cowpea Tempeh Extract:Porang Tuber Extract Paste (%)			
		0:0 (K)	5:1 (A)	10:1.5 (B)	15:2 (C)
Chemical					
Protein Content	%	4.35 ± 0.06^{a}	5.38 ± 0.07^{b}	6.47 ± 0.08^{c}	7.47 ± 0.05^{d}
Fat Content	%	8.68 ± 0.18^{a}	9.16 ± 0.13^{b}	9.46 ± 0.10^{c}	9.84 ± 0.08^{d}
Total Solid	%	23.53 ± 0.60^{a}	25.54 ± 0.56^{b}	28.19 ± 0.37^{c}	30.75 ± 0.37^{d}
Sugar (Sucrose)	%	20.67 ± 0.31^{a}	20.73 ± 0.20^{a}	20.80 ± 0.64^{a}	20.87 ± 0.31^{a}
Physical					
Overrun	%	100 ± 0^{a}	88.23 ± 1.15^{b}	80.60 ± 1.04^{c}	70.67 ± 0.37^{d}
Melting Rate	Second	1019 ± 27.00^{a}	1047.67 ± 31.76^{a}	1110.33±19.22^{b}	1207.33±21.13^{c}
Microbiology					
Total Plate Counts	CFU/mL	1.20x10^{2} ± 2.00^{a}	2.67x10^{2} ± 2.52^{ab}	4.17x10^{2}±3.06^{b}	7.10x10^{2}±23.81^{c}
Salmonella Prevalence	-	Negative	Negative	Negative	Negative
Organoleptic					
Color	-	3.30	3.10	2.90	2.90
Aroma	-	2.90	2.67	2.73	2.97

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Parameter	Unit	Cowpea Tempeh Extract:Porang Tuber Extract Paste (%)			
		0:0 (K)	5:1 (A)	10:1.5 (B)	15:2 (C)
Taste	-	3.20	2.93	2.97	3.43
Texture	-	2.80	2.87	3.13	3.27

K = Control (0% Cowpea Tempeh Extract, 0% Porang Tuber Extract Paste), A = Treatment A (5% Cowpea Tempeh Extract, 1% Porang Tuber Extract Paste), B = Treatment B (10% Cowpea Tempeh Extract, Porang Tuber Extract Paste 1.5%), C = Treatment C (Cowpea Tempeh Extract 15%, Porang Tuber Extract Paste 2%), Numbers with different letters in the same column indicate significant differences at the 95% confidence level, n = 3.

The protein contents of ice cream in treatments K, A, B, and C are 4.35%, 5.38%, 6.47%, and 7.47% respectively. The result shows a significant difference. Further, the protein content in the treatments meets SNI (01-3713-1995) - the minimum value of 2.7%[38] (Table 4). The protein level rises by using cowpea tempeh extract as a replacement. The protein content (6.40%) of the cowpea tempeh extract is responsible for the rise. The increase of the protein content in this study is in accordance with research on tempeh - ginger ice cream[39].

The fat contents of ice cream in treatments K, A, B, and C are 8.68%, 9.16%, 9.46%, and 9.84% respectively and were significantly different. This result of this study is in compliance with SNI (SNI 01-3713-1995) - the minimum value of fat content of 5%[38]. The milk fat contributes significantly to the creamy flavor and soft texture of ice cream[36]. The rise can be attributed to the 2.20% fat content of the cowpea tempeh extract. The fat profile is in accordance with the result of the tempeh-ginger ice cream[39].

The total solids contents in treatments K, A, B, and C are 23.53%, 25.54%, 28.19%, and 30.75% respectively and the differences are significant. The result is in accordance with the SNI (01-3713-1995) - the minimum total solids content of 3.4%[38]. Total solids contribute to softening the texture, providing a firm texture, providing higher nutritional content, and reducing excessive coldness. Excessive total solids will cause the ice cream to become heavy, wet, sticky, and less cold[36].

The substitute of cowpea tempeh extract increases the total solids content. The increase is due to the total solid's contents of cowpea tempeh (16.09%). There is a notable correlation between the rise in the total solids content of ice cream and the addition of increased cowpea extract throughout the production process. This result is in line with previous research of tempeh – ginger ice cream[39]. The total solid contents of cowpea tempeh extract are protein, carbohydrate fat, fiber, ash, thiamine, riboflavin, and niacin[40].

The addition of porang tuber extract paste increases the total solids content of the ice cream. The 6.41% total solids content of the porang tuber extract paste is the cause of the rise. According to this study, there is a substantial difference between the amount of porang tuber extract paste used during the ice cream-making process and the amount of total solids in the final product. The total solids contents of porang tuber extract paste include glucomannan, starch, protein, fat, calcium oxalate, and ash[41].

The sucrose sugar contents in treatments K, A, B, and C are 20.67%, 20.73%, 20.80%, and 20.87% respectively. The differences are not significant. The result shows that the sucrose sugar content of ice cream meets the SNI (01-3713-1995) - the minimum value of sucrose sugar content of 8%[38]. Sugar is an important component of ice cream which is included in the solid component of ice cream[37]. An absence of variations in the amount of sucrose added throughout treatments contributes to the absence of significant changes in the ice cream's sucrose sugar content.

Overrun is the degree of expansion of the ice cream mix. Overrun is an important parameter because it determines the quality of ice cream[42]. Overrun is a calculation of the air incorporated in the frozen food products, and it is calculated as a percentage of the increase of the volume of final frozen compared to the ice cream mix prior to the freezing[36]. The physical characteristics of ice cream are shown in Table 4 and Figure 1.

The overrun of ice cream in the treatments K, A, B, and C are 100%, 88.23%, 80.60%, and 70.67% respectively and the differences are significant. The results show that the overrun of the control treatment meets the normal standard and the overrun of the treatments A, B, and C meets the premium standard of ice cream. The normal standard of overrun is 100% – 120% and premium standard is 60 – 90%[36]. The overrun of ice cream in treatments A, B, and C decreased compared to the control treatment due to the substitute of cow tempeh flour extract which increases the total solids content of the ice cream. As a result, ice cream becomes denser and can not expand easily. The result of this study is in accordance with the previous study confirming that the increase of the total solids contents of the ice cream implies a decrease of the overrun [36].

The overrun of ice cream is reduced by adding porang tuber extract paste because it contains glucomannan compounds serving as stabilizers. Stabilizing compounds can bind water and increase the viscosity of the ice cream mixture. The theory stated that the higher the stabilizer concentration, the softer the texture [42]. The softer texture of ice cream is due to glucomannan's ability as an emulsifier. Glucomannan can inhibit coalescence, thereby preventing the withdrawal of droplets formed[43]. Previous research showed that increasing the concentration of the stabilizer used will tend to reduce the overrun value[44,45]. Besides, previous research also showed that the konjac glucomannan can inhibit the air incorporation into the dough and further cause a decrease in the volume of the dough so that the overrun of ice cream decreases[46].

The melting rate of ice cream is the time needed to melt completely at room temperature. It is determined by the components of the ice cream formula[42]. The melting rate of ice creamin the treatments K, A, B, and C are 1019 seconds, 1047.67 seconds, 1110.33 seconds, and 1207.33 seconds respectively. The result showed

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that the melting rate of ice cream in all treatments meets the good melting rate standard (900 seconds – 1500 seconds)[47]. The increase in melting rate was due to the addition of substitution cowpea tempeh flour extract which increases the total solids contents of the ice cream, and the viscosity of the ice cream mixture[42], but reduces the overrun. Therefore, the ice cream texture becomes denser.

The melting rate also increased due to the addition of porang tuber extract paste. Porang tuber extract paste contains glucomannan serving as a stabilizer responsible for binding the water, increasing the viscosity, and firming the texture so that the ice cream does not melt easily. The result of the study is in line with the previous finding confirming the effect of adding porang tuber flour on the increase of the melting rate of ice cream[48]. Recent studies showed that the konjac glucomannan can increase the ability to bind water and further strengthen the texture so that the melting rate of ice cream increases[46].

The total plate counts consist of bacteria, mold, and yeast. Total plate counts refer to the hygienic and sanitary quality of the making process are related to microbiological quality and the criteria of food acceptability[49]. In addition, Salmonella is a pathogenic bacterium in food, and it can cause Salmonellosis. The Salmonella contamination is an indication of poor sanitary quality in the food making[27]. Milk and dairy products can be contaminated by Salmonella sp., so it is necessary to identify Salmonella sp. in milk and dairy products to prevent foodborne diseases[50].

The total plate counts of ice cream in treatments K, A, B, and C are 1.20 x 10^2 CFU/mL, 2.67 x 10^2 CFU/mL, 4.17 x 10^2 CFU/mL, and 7.10 x 10^2 CFU/ mL respectively (Table 4). The result is in accordance with the SNI (01-3713-1995) - the maximum value of total plate counts of 2.0 x 10^5 CFU/ g[38]. The addition of cowpea tempeh extract counts increases the total plate counts. Cowpea tempeh is a fermented product, and it can increase the total plate counts because tempeh fermentation increases the number of microbes. It is in line with the research confirming that fermented food products such as yogurt generally have higher total plate counts[51] and it is also the case on the mashed corn with a longer fermentation time[52]. The addition of porang tuber extract paste does not increase the total plate counts because it is not a fermentation product. It is in line with research on the addition of porang flour to yogurt ice cream[53].

The salmonella prevalence in ice cream is negative in the treatments K, A, B, and C. These results found that ice cream in all treatments meets the SNI (01-3713-1995)[38]. The absence of Salmonella bacterial contamination in ice cream indicated the good quality of the ingredients and the good sanitary and hygienic qualities in the ice cream making [54].

Organoleptic testing is sensory evaluation using the senses of sight, touch, smell, and taste[55]. The hedonic testing is a score-based evaluation of a product to determine the panelists' preference [56]. The results of the ice cream scoop are shown in Figure 1.

Figure 1. Appearance of Ice Cream for Each Treatment.

Color is the easiest organoleptic parameter to observe by the panelists. The color scores of ice cream in the treatments K, A, B, and C are 3.30, 3.10, 2.90, and 2.90 respectively (Table 4). The control treatment obtained the highest score. Treatments B and C shared the same score. The substitution in the ice cream formula caused the color of the ice cream to become brown and decreased the color scores in treatments A, B, and C compared to the control treatment. The brown color of the ice cream stems from the brown color of tempeh flour and the gray-brown color of porang tuber extracted paste. The brown color in treatments A, B, and C was less attractive than the brown color in the control treatment. Adding the amount of tempeh flour to the product tends to make it less appealing visually since it will become browner in color.

Aroma is an important parameter in organoleptic tests because aroma can increase the interest in consuming a product before the tasting. The color scores of the treatments K, A, B, and C ice cream are 2.90, 2.67, 2.73, and 2.97 respectively. Treatment C obtained the highest score, and treatment A got the lowest score. The substitutes in the ice cream formula decreased the aroma score in treatments A and B compared to the control treatment but increased the aroma score in treatment C. The decreased score is likely attributed to the distinctive mixed aroma of tempeh and milk in treatments A and B. Treatment C with the highest concentration of cowpea tempeh extract had a dominant tempeh aroma and it is probably the reason why treatment C was the most preferred by the panelists. The aroma of the ice cream is minimally impacted by the addition of porang tuber extract paste, as the extract's aroma is not typically intense or sharp. Tempeh has a distinctive aroma due to the nuts compound and the aroma is produced due to the fermentation process[58] and porang flour in yogurt ice cream does not show any significant differences in aroma parameters[53].

Taste holds a crucial role in organoleptic analysis as it serves as the primary criterion for gauging the overall preference for a food product. The ice cream taste scores in the treatments K, A, B, and C are 3.20, 2.93, 2.97, and 3.43 respectively. Treatment C obtained the highest score, and treatment A gained the lowest score. The addition of cowpea tempeh extract decreased the taste scores in treatments A and B, but it increased the taste

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scores in treatment C. The lower color scores in treatment A and B were likely attributed to the distinctive taste due to the mixture of tempeh and milk. The ice cream of treatment C had the highest amount of cowpea tempeh extract, and it had a dominant distinctive taste of tempeh. Treatment C is likely the most preferred by the panelists because the addition of porang tuber extract paste does not significantly impact the taste of the ice cream. The porang tuber extract paste has a mild flavor. The result of this study is in line with the previous finding stating that the distinctive taste of tempeh is due to the fermentation process[58] and that adding porang flour in the adequate amount to yogurt ice cream gives a delicious taste because the taste of porang flour is not dominant[53].

Texture is a parameter affecting the mouthfeel of a product. The ice cream texture scores in the treatments K, A, B, and C are 2.80, 2.87, 3.13, and 3.27 respectively. Treatment C gained the highest texture score, and the control treatment obtained the lowest score. Adding a replacement ingredient to the ice cream formula tends to raise the texture score, as it leads to an increase in the total solids content[37] in the ice cream which would improve the texture of the ice cream for the better, ultimately resulting in softer quality ice cream. The addition of porang tuber extract paste is the most significant factor in improving the quality of ice cream. Porang tuber extract paste contains a stabilizing compound in the form of glucomannan which can improve the texture quality and soften the ice cream. Further, the panelists are familiar with porang tuber. The result of the study is in line with the previous finding stating that adding porang flour to yogurt ice cream at the adequate among softens the texture[53].

Overall, the rank of average ice cream scores from highest to lowest are treatment C, control treatment, treatment B, and finally treatment A. Treatment C used cowpea tempeh extract of 15% and the porang tuber extract paste of 2%. Treatment C had the highest aroma, taste, texture, and average scores compared to the other treatments. Therefore, it can be concluded that the ice cream of treatment C is the most preferred by the panelists.

Best Ice Cream Treatment Analysis

Treatment C has the best chemical quality because it has the highest protein content, and the fat content is not too high compared to the increase in protein content compared to the control. The total solids content in treatment C was the highest compared to treatments A and B. The sucrose sugar contents in all treatments are the same.

Treatment C had the best physical quality. It achieved the best melting rate, even with the lowest overrun value. This results in ice cream that has a pleasingly soft texture, which can be attributed to the increased total solids obtained from the substitute ingredients used in the ice cream formula. The physical quality of the ice cream also improves due to the addition of porang tuber extract paste containing glucomannan as a stabilizer. The microbiological analysis of the ice cream in treatment C showed the highest total plate counts compared to the other treatments. The ice cream in all treatments complies with the SNI 01-3713-1995 and the Salmonella colonies were not found.

The organoleptic testing of treatment C showed the highest scores of aromas, taste, and texture. The average scores of the organoleptic testing of treatment C were also the highest. Therefore, treatment C is in the first rank. The organoleptic testing proved that treatment C ice cream is the ice cream with the highest level of preference or can be said to be the most liked by the panelists. The ice cream of treatment C with the addition of 15% cowpea extract and 2% cowpea extract paste is the best one. The advantages of this study are the use of natural stabilizers and emulsifiers that are safer for consumer health than synthetic materials. In addition, the use of cowpea tempeh extract for the addition of bioactive peptides. The disadvantage of this study is that the preparation of porang tuber extract paste takes a long time.

CONCLUSIONS

Cowpea tempeh extract as the substitute for water and porang tuber extract paste as the replacement for CMC and SP can increase the protein, fat, and total solids contents significantly. In addition, these substitutions can improve the texture of the ice cream and the panelists' liking. The ice cream in treatments A, B, and C increases the total plate counts, but it is still in compliance with the SNI. To enhance the ice cream quality, the best amount of cowpea tempeh extract addition is 15 % and porang tuber extract paste is 2 % to improve the ice cream quality.

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AUTHOR CONTRIBUTIONS

ARS: conceptualization, investigation, methodology, writing-original and editing original draft; YRS: conceptualization, supervision, methodology, writing-review and editing; FSP: supervision, methodology, writing-review and editing.

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