Effect of CMC and arabic gum in the manufacture of jackfruit velva (*Artocarpus heterophyllus*)

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Abstract Velva is one type of frozen dessert which is made from fruit/vegetable with ice cream maker, low fat and high fiber content. Jackfruit is a raw material for the manufacture of velva because of the high fiber content of 2.31 gr. The use of a stabilizers combination of CMC and arabic gum in the manufacture of velva will provide a better gel mix than single use. The purpose of this research is to know the influence of variation of CMC and arabic gum stabilizer on the characteristics (physical, chemical, and sensory) of jackfruit velva (*Artocarpus heterophyllus*) and determine variations in the most appropriate combinations of stabilizers to produce jackfruit velva with the best quality. This research applied Completely Randomized Design consist of one factor which is the combination of CMC and arabic gum levels in the making of jackfruit velva with two replicates and two replications of the analysis. The data obtained then analyzed statistically using one way analysis of variance (ANOVA), when there is a significant difference, then followed by Duncan's Multiple Range Test (DMRT) at significance level of 0.05. The results of this study concluded that the jackfruit velva with the addition of various concentrations of CMC and arabic gum is significantly affecting the taste, texture and overall parameters, but no significant difference on the color and flavor parameters of jackfruit velva. Based on the results of physical characteristics, chemical and sensory jackfruit velva with the addition of a stabilizing concentration of CMC and arabic gum 1: 1 result in best jackfruit velva. The best jackfruit velva with stabilizing the concentration of CMC and arabic gum 1: 1 contains a water content of 61.95%, dietary fiber 2.231%, total dissolved solids 20.38 ^{o}Brix, overrun 19.709%, meltdown 28.215 minutes. As for the color attribute score 3.72; Taste 4; flavor 3.60; Texture 3.68, and overall 3.88.

1. Introduction

Velva is one type of frozen dessert which is made from fruit/vegetable with ice cream maker, low fat and high fiber content. This product is made from a puree of fruits, sugar, sucrose and stabilizer which are frozen so as to obtain a smooth texture resembling ice cream [1].

Jackfruit is a raw material for the manufacture of velva because of the high fiber content of 2.31gr. Jackfruit production in Indonesia in 2014 according to the Ministry of Agriculture amounted to 644,291 tons. Jackfruit has a sweet taste and a spesific flavor, that has the potential to be developed as a processed food product.

The use of stabilizers is important in the production of velva fruit. According to [2], the main function of the stabilizer is to bind water in the mixture, so that the formation of large ice crystals can be avoided and also to maintain the shape and texture of the product during storage. There are different types of stabilizers used in the manufacturing of velva fruit. The common stabilizers used in the manufacture of ice cream and frozen desserts are CMC, gelatin, sodium alginate, carrageenan, arabic gum and pectin. Selection of the stabilizer on its effect on overrun and texture [1].

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CMC (Carboxyl Methil Celullose) is the most important cellulose derivative in food applications. Its main function is to bind water, give viscosity in aqueous phase and stabilize other components or prevent sineresis [3]. According to [4], the use of CMC as a stabilizer does not require aging time to produce perfect stability so as to shorten production process time.

Arabic gum is the sap of the acacia tree (*Acasia senegal*). The sap is dried, sated and then process to be powdered. Arabic gum is a heteropolysaccharide complex, consisting of D-galactopranose, L-ramnopiranosa, L-Arabinopiranosa, L-Arabinofuranose and D-glucoronic acid and a small amount of protein (2%) [5]. Arabic gum easily soluble in hot or cold water but not soluble in alcohol or other organic solvents. Gum Arabic is used as a stabilizer for desserts such as ice cream and sherbet for its ability to absorb water.

The addition of arabic gum aims to prevent the formation of larger ice crystals by binding large quantities of water. Ice cream used arabic gum as a stabilizer generally does not melt quickly [6]. The use of a stabilizers combination of CMC and arabic gum in the manufacture of velva will provide a better gel mix than single use, it can produce good quality Velva. The purpose of this research is to study the influence of variation of CMC and arabic gum stabilizer on the characteristics (physical, chemical, and sensory) of jackfruit velva (*Artocarpus heterophyllus*) and determine variations in the most appropriate combinations of stabilizers to produce jackfruit velva with the best quality.

2. Methods

2.1 Materials

The ingredients used in this work including Jackfruit, water, sugar, citric acid. Food grade hydrocolloids; CMC (Carboxyl Methyl Cellulose) and arabic Gum. The ingredients used to produce jackfruit velva.

The chemical test materials used for analysis in the study, among others, the test dietary fiber by using buffer Na-phosphate 0.1M pH 7, alpha amylase enzyme, 1% pepsin enzyme, 1N hydrochloric acid (HCl), sodium hydroxide (NaOH) 1 N , 95% ethanol, acetone (CH3) ¬2¬CO, beta amylase enzyme, Test water content using toluene

2.2 Velva Preparation

The first stage is Stripping jackfruit and jackfruit seeds disposal. Then the jackfruit is washed and cut into pieces. The jackfruit pieces then blancing at 90^{o}C for 5 minutes. The jackfruit pieces are then crushed with a blender until it becomes a fruit pulp. The subsequent addition of citric acid is 0.1% by weight of puree which has been dissolved in water. The mixture is stirred for approximately 15 minutes. The homogeneous mixture is then frozen with a 4°C refrigerator for 24 hours to allow the stabilizer to bind the free water present. The next stage is freezing by using ice cream maker for 30 minutes and stored in the freezer temperature -12^{o}C. According to the formulations shown in Table 1

Table 1 Jackfruit Velva Formulation

Ingredients (g)	Comparison of CMC and Arab Gum (%)				
	F1 0:1	F2 1:3	F3 1:1	F4 3:1	F5 1:0
Jackfruit	200	200	200	200	200
Water	100	100	100	100	100
Sucrose	50	50	50	50	50
Citrit acid	0,3	0,3	0,3	0,3	0,3
CMC	0	0,75	1,5	2,25	3
Arabic Gum	3	2,25	1,5	0,75	0

2.3 Physical and Chemical Analysis

According to Masrshal and Arbuckle (1986), overrun was estimated using a standard 50 ml cup, according to the equation as follows:

$$\% \text{ Overrun} = \frac{\text{Volume of ice cream} - \text{volume of mix}}{\text{volume of mix}} \text{ x } 100\%$$

Melting property was analyzed at 25 ±2ºC. Measurements were made by taking one spoon velva (± 5 gram) -20^{o}C on the plate. Velva allowed to melt at room temperature (27^{o}C) and measurement using stopwatch [7].

Jackfruit velva were allowed to melt at room temperature at 25^{o}C before they were subjected to total soluble solid analysis. Total soluble solid was determined using a refractometri. Dietary fiber analysis was estimated according to the method described by multienzim, while water content according to the method by thermovolumetri.

2.4 Sensory Evaluation

Sensory evaluation was carried out using 5-point hedonic scale [8]. The panelist suggests personal likes or dislikes, in addition to his favorite level.

2.5 Weighting Evaluation

Determination of the best formula using compensatory method [9]. The decision making process of the best formula is done by weighting technique of additive. The principle of testing on the method is by giving weight on each characteristic in accordance with the importance of the characteristics of the resulting formula

2.6 Statistic Analysis

The data obtained then analyzed statistically using one way analysis of variance (ANOVA), when there is a real difference, then followed by Duncan's Multiple Range Test (DMRT) at significance level of $\alpha = 0.05$.

3. Results and Discussion

3.1 Physico-chemical analysis of jackfruit velva.

3.1.1 Overrun

The table 1 show the use of a combination of CMC and arabic gum in jackfruit velva production, gives the highest average overrun of 25.015% in the formulation of F2 (1: 3), because CMC and arabic gum are polysaccharides. According to [10], Hydrocoloid polysaccharides will bind water molecules, which causes increased water phase viscosity in both cream and foam, thus protecting the whole system against sineresis and ultimately resulting in foam stabilization. The high foam on the overrun shows that more air is trapped, giving higher foam expansion [11].

The value of carrots velva overrun is 11.05% - 19.79% using a combination of CMC and gum arab stabilizers [12]. The value of the jackfruit velva overrun with the addition of a combination of CMC and gum arab stabilizer averaged 16.15% - 25.02%, the results obtained are not much different from the overrun value of the reference velva.

3.1.2 Meltdown

The table 1 show The highest average meltdown was produced by F3 using a combination of CMC and arabic gum stabilizer (1: 1) of 28.22 minutes while the lowest average meltdown was obtained by F5 using a 1% CMC stabilizer of 21.13 min. According to [13] the combination of stabilizers CMC and gum arab can optimize the water binding power so that the dough viscosity increases and the melting power becomes slower. The ability of the stabilizer to bind the water causes the water molecules trapped in the gel structure formed by the stabilizer so that the dough viscosity increases and the meldown of the ice cream increases [7].

The value of the reference carrot velva meltdown is between 20.25 -27.00 minutes using a combination of CMC and gum arab stabilizers [12]. The value of the meltdown of the jackfruit velva with the addition of a combination of CMC and arabic gum stabilizer averaged 21.13 - 28.22 minutes. The results obtained were not much different from the meltdown value of the reference velva.

3.1.3 Total Disolved Solids

An increase in the value of dissolved solids is also associated with a decrease in water content (Vail ea al., 1978). The average total of the highest dissolved solids was produced by F2 using a combination of stabilizer CMC and arabic gum (1: 3) of 22.00 ^{o}Brix while the average total of the lowest dissolved solids was produced by F5 using a 1% CMC stabilizer of 19.00 ^{o}Brix . The use of a combination of CMC and arabic gum stabilizers in the making of jackfruit velva higher total soluble solids than single stabilizer use, this is because the stabilizer used contributes to the increase in total soluble solids in the jackfruit jackfruit.

3.1.4 Water Content

Based on testing of water content of jackfruit velva, all formulations (F1, F2, F3, F4 and F5) showed significant differences between treatments. The combination of CMC and arabic gum 0: 1 has the highest moisture content compared with other formulations of 65.31%. While the formulation of F5 (comparison of combination of CMC and arabic gum 1: 0) yielded the lowest value of 60.12%. The increased use of CMC concentrations will provide a low moisture value, according to [14], the increase in CMC concentration in solution can lead to a rise in viscosity. The high viscosity is due to the available water being mostly trapped in the material matrix due to the influence of the stabilizer, the stabilizer having to bind the free water so that the measured water content is lower.

3.1.5 Dietary Fiber

Based on the testing of dietary fiber against jackfruit velva all formulations (F1, F2, F3, F4 and F5) showed significant differences between treatments. Showed that the jackfruit velva in the formulation F1 (comparison of combination of CMC and gum arabic 0: 1) had the lowest value of dietary fiber compared with the other formulation of 0.9785%. While the formulation of F4 (comparison of combination of CMC and gum arab 3: 1) yielded the highest value of 2.74%. The fiber in the jackfruit velvet comes from puree, sugar and stabilizer.

Table 2. Effect of combination concentration variation of CMC and arabic gum stabilizer on physicochemical characteristics of jackfruit velva

Characteristics	Formulation				
	F1	F2	F3	F4	F5
water content (%)	65.31[c]	63.4[b]	61.95[b]	61.67[ab]	60.12[a]
dietary fiber (%)	0,979[a]	1,825 [c]	2,231 [d]	2,743 [e]	1,56 [b]
total dissolved solids (^{o}Brix)	21,33[cd]	22,00[d]	20,38[b]	20,83[bc]	19,0[a]
Overrun (%)	16,476[a]	25,015[b]	19,709[a]	20,147[a]	16,15[a]
Meltdown (Minutes)	25,75 [c]	25,967[c]	28,215[d]	22,172[b]	21,13[a]

Information:
[*]: F1: Jackfruit velva with stabilizer concentration CMC and arabic gum 0:1
F2: Jackfruit velva with stabilizer concentration CMC and arabic gum 1:3
F3: Jackfruit velva with stabilizer concentration CMC and arabic gum 1:1
F4: Jackfruit velva with stabilizer concentration CMC and arabic gum 3:1
F5: Jackfruit velva with stabilizer concentration CMC and arabic gum 1:0
[**]: The numbers followed by different letters in the same column show a real difference in the siq a = 0.05 level

3.2 Sensory Evaluation

Sensory testing is very important in product development because it determines consumer acceptance of the product. A score test is also called scoring. The scoring is to score the value or to place the sensory miti value on the material tested at the quality level or hedonic scale level. Test scoring can be done on research of very specific sensory properties, such as, texture, color, taste, flavor [15].

The result of the analysis of variance in Table 3 shows that for the jackfruit velva all formulations (F1, F2, F3, F4 and F5) were not significantly different between the treatments on the color parameters. The results of the analysis of jackfruit velvet with color parameters in research on the Japanese pumpkin velva products with the addition of stabilizers CMC and arabic gum at various levels of concentration does not cause different effects on the color of products in various treatments.

The result of variance analysis in Table 3 shows that for the jackfruit velva all formulations (F1, F2 F3, F4 and F5) are significantly different between the treatments on the taste parameter. The tendency of adding a stabilizer to the soursop velva, with a certain concentration can improve the taste, but the addition of more stabilizers will decrease the value of organoleptic flavor. According to [14], CMC affects the threshold of flavor. At a certain concentration there is a decrease in sweet taste threshold and a rise in sour and bitter taste. The results of the analysis of variance in Table 3 show that for the jackfruit velva all formulations (F1, F2 F3, F4 and F5) did not differ significantly between treatments of flavor parameters.

Table 3. Influence of Variation of Concentration of Addition of CMC and Gum Arab to Sensory Character of Velva Jackfruit

Formulation	Parameters				
	Color	Taste	Flavor	Texture	Overall
F1	3.76[a]	3.64[bc]	3.52[a]	3.20 [abc]	3.76 [c]
F2	3.52[a]	3.20[ab]	3.36[a]	2.64 [a]	3.16 [ab]
F3	3.72[a]	4.00[c]	3.60[a]	3.68 [c]	3.88 [c]
F4	3.36[a]	3.28[ab]	3.56[a]	3,48 [cb]	3.40 [bc]
F5	3.32[a]	2.84[a]	3.24[a]	3.00 [ab]	2.76 [a]

[*]:F1: Jackfruit velva with stabilizer concentration CMC and arabic gum 0:1
F2: Jackfruit velva with stabilizer concentration CMC and arabic gum 1:3
F3: Jackfruit velva with stabilizer concentration CMC and arabic gum 1:1
F4: Jackfruit velva with stabilizer concentration CMC and arabic gum 3:1
F5: Jackfruit velva with stabilizer concentration CMC and arabic gum 1:0

[**]: The numbers followed by different letters in the same column show a real difference in the siq a = 0.05 level

***: Score 5 = really likes, 4 = likes, 3 = neutral, 2 = dislikes, 1 = very dislike

substances that can cause flavor and color in food, but hydrocolloids can have a synergistic effect on adding flavors to the emulsion [6].

The result of the analysis of variance in Table 3 shows that for jackfruit velva all formulations (F1, F2 F3, F4 and F5) are significantly different between treatments on Texture parameters. An increase in CMC concentration in solution can also lead to an increase in the viscosity of the dough. With increasing viscosity, more water is bound. So that the formation of rough ice crystals more can be avoided and the resulting texture is soft. According to [4], the stabilizer is effective for producing a soft texture through its ability to bind water in a mixture of velvety batter. Soft texture can also be obtained when much air is trapped in the dough during freezing, resulting in a high overrun.

The result of the analysis of variance in Table 3 shows that for the jackfruit velva all formulations (F1, F2 F3, F4 and F5) are significantly different between treatments against the Overall parameter. Overall, the combination of CMC and gum arab pentasbil in jackfruit velvet products was significantly different from taste, texture and overall parameters, whereas on color and aroma parameters.

3.3 Weighting Evaluation

Weighting is a decision-making technique in a process that involves multiple factors simultaneously by weighting each of these factors. Weighting can be done objectively statistically or subjectively by setting it based on certain considerations. The weighted sum is a compensatory method, which can mean that the worst criterion score is compensated for the best score. This method is a special form of Multi Attribute Value Theory (MAVT) [16].

Based on Table 4 the results of the assessment given on each test parameter of jackfruit fruit velvet characteristic, the highest final score is found on the addition of CMC concentration and 1: 1 gum arabic with the score of 0.7389. This indicates that the concentration of CMC and arabic gum 1: 1 produced the physical, chemical and sensorial characteristics of the best jackfruit velvet and can be accepted by panelists. Jackfruit Velva with CMC and arabic gum concentration 1: 1 (F3) has moisture content of 61.95%, food fiber 2.231%, Total soluble solid 20.38 obrix, overrun 19.709%, melt 28.215 minutes . As for the color attribute score 3.72; Taste 4; Aroma 3.60; Texture 3.68, and overall 3.88.

Table 4. Weighted Jackfruit Velva Test Value of each Formulation

Karakteristik	BV	BN	Formulation									
			F1		F2		F3		F4		F5	
			DV	NH	DV	NH	DV	NH	DV	NH	DV	NH
Water content (%)	1	0.100	0.0	0.000	0.368 0154	0.037	0.647	0.0647	0.701	0.070	1.000	0.100
Dietary fiber (%)	1	0.100	0	0.000	0.480	0.048	0.710	0.071	1	0.100	0.330	0.033
Total Disolve ^{o}Brix	1	0.100	0.777	0.078	1	0.100	0.460	0.046	0.61	0.061	0.0	0.0
Overrun (%)	1	0.100	0.037	0.004	1	0.100	0.402	0.040	0.451	0.045	0.0	0.0
Meltdown	1	0.100	0.652	0.065	0.683	0.068	1	0.100	0.147	0.015	0.0	0.0
Color	1	0.100	1	0.100	0.455	0.045	0.909	0.091	0.091	0.009	0.0	0.0
Taste	1	0.100	0.690	0.069	0.310	0.031	1	0.100	0.379	0.038	0.0	0.0
Flavor	1	0.100	0.778	0.078	0.333	0.033	1	0.100	0.889	0.089	0.0	0.0
Texture	1	0.100	0.538	0.054	0	0.000	1	0.100	0.808	0.081	0.346	0.035
Overall	1	0.100	0.893	0.089	0.357	0.036	1	0.100	0.571	0.057	0.0	0.000
Sum	10			0.536		0.499		**0.8128**		0.565		0.168

Description: BV = Variable Weight BN = Normal Weight, DV = Dimensionless Value, NH = Value Result

4. Conclucion

Based on physicochemical testing of jackfruit velva with addition of various concentrations of CMC and arabic gum, significantly different to the parameters of overrun, total dissolved solids, meltdown, dietary fiber and water content of jackfruit velva. Based on sensorial testing of jackfruit velva with the addition of various concentrations of CMC and arabic gum are significantly different to taste, texture and overall parameters. But no significant difference to the color parameters and aroma of jackfruit velva. Based on the results of physical, chemical and sensory characteristics of jackfruit velva with addition of CMC and arabic gum concentration 1:1 yields the best jackfruit velva and acceptable to consumers.

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