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Original Paper

Effect of Proportion of Sorbitol and Sucrose with Pectin Concentration to Physicochemical and Sensoric Characteristics of Pedada Jam Gelato (*Sonneratia caseolaris*)

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***Abstract* — Gelato is a frozen dessert that has lower fat and overrun content and higher sugar content than ice cream. Sorbitol can affect the texture of gelato and has lower glycemic index and calories than sucrose. Sucrose provides sweetness without cooling effect therefore it can balance the sweetness of gelato. Pectin can affect the melting speed and produce better stability of product. The addition of pedada fruit jam was to improve aroma, taste and nutrition. This study aimed to determine the effect of proportion of sorbitol and sucrose with the concentration of pectin on the physicochemical and sensoric properties of pedada jam gelato. The experimental design used was completely randomized design with two factors. Factor I was the proportion of sorbitol and sucrose (13:2, 12:3, 11:4%) and factor II was the addition of pectin (0.3, 0.5, 0.7%). The analysis parametes were fat content, overrun, melting time, viscosity, total solids, total sugar, soluble fiber, reducing sugar and organoleptic scale scoring test (taste, color, aroma, texture). The best treatment was the proportion of sorbitol and sucrose 11:4% with pectin 0.5% which had fat content 1.77%, overrun 26.97%, melting time 18.07 minutes, total solids 43.19%, viscosity 1577 cP, total sugar 16.68%, soluble fiber 2.16% and reducing sugar 3.63%. The result of the organoleptic scale scoring test showed a taste of 4.32 (sweet), color 3.56 (moderate dark brown), texture 4 (soft), and aroma 3 (moderate pedada fruit aroma).**

Keywords* — *gelato, sorbitol, sucrose, pectin, pedada jam

I. INTRODUCTION

Gelato is a type of frozen dessert originating from Italy which rich in flavor and has lower fat and overrun content compared to ice cream. The difference between gelato and ice cream also from the ingredients used and their composition [9]. In addition, gelato tends to have a denser texture when compared to ice cream [5]. The formula in making gelato is 0-8% fat, 4-12% nonfat milk solids, 14-24% sugar and 0.3-8% other solids [11]. According to [34], standard fat content of ice cream in several countries such as Australia, the United Kingdom (UK), and the United States of America (USA) is 10%. Meanwhile, [11] stated that gelato has fat content of 0-8%. Fat content is one of the significant difference indicators between gelato and ice cream. According to [11], high fat content can increase the softness of the texture. Meanwhile, gelato has a low fat content but still has the characteristics of soft and dense texture.

Reference [13] stated that the soft texture of gelato is influenced by the high sugar content in gelato when compared to ice cream. In general, the sugar used in the manufacture of gelato is sucrose [17]. Sucrose provides calories and high glycemic index that causes restrictions for consumers who are concerned about their health or people with diabetes and obesity [12]. Reference [36] stated that foods with high sugar content are not recommended for diabetics because the number of cases and prevalence of diabetes has continued to increase over the last few years. However, sucrose is one of the determinants of texture in the manufacture of gelato because of its ability to lower the freezing point of a solution. The low freezing point is an important factor in reducing the number of large ice crystals, hence texture will be soft and prevent sandy texture [16]. If the sugar used is sucrose, it will tend to have a higher freezing point, and the resulting gelato will be hard. If sucrose is replaced with sugar which have a lower freezing point, it will result in less frozen water and softer gelato [27].

The soft texture of gelato will be preferred by consumers over the coarse texture gelato. To obtain a texture that is preferred by consumers, sucrose can be combined with sorbitol because sorbitol has the ability to lower the freezing point higher than sucrose, which is 1.9 and the sweet taste produced by sorbitol gives cold effect that is too strong [8]. In consequence, the addition of sucrose is expected to balance the sweetness of gelato without giving a cold effect.

Sorbitol has a calorific value of 2.6 kcal/g and has a lower glycemic index than sucrose. Sorbitol is safe for human consumption because it is *Generally Recognized as Safe* (GRAS) and has sweetness level of 0.5 to 0.7 times sucrose [8].

In the research of [29], the ratio of sorbitol and sucrose 13.5:1.5% in the manufacture of ice cream resulted significant decrease in melting time, increase in iceness (containing large ice crystals) and overrun. According to [13], the size of ice crystals that are too large can produce a coarse texture and the melting time will be faster therefore it will reduce consumer acceptance. Meanwhile, gelato is identical with a higher melting resistance than ice cream [11].

One of the ingredients for making gelato is stabilizer which providing emulsion stability in the product, increase viscosity, hardness and creaminess, prevent gelato from melting easily and inhibit the growth of ice crystals during storage, especially when temperature fluctuations occur and produce better product stability [13, 38]. The previous study [23] shows that the addition of pectin stabilizer can form smooth and homogeneous ice crystals on the hydrocolloid matrix in consequence longer melting resistance. Pectin is a type of hydrocolloid found in plant cell walls and most abundant in apple pulp and orange peels [21].

In this study, pedada fruit jam will be used as a flavoring in the manufacture of gelato with the aim of improving the taste and aroma that is too sour from pedada fruit and enhance the nutrition of gelato. Pedada fruit (*Sonneratia caseolaris*) is a type of mangrove fruit that grows abundantly in all coastal areas of Indonesia. In 100 g of pedada fruit jam contains 4.2 mg of vitamin B1, 1.94 mg of vitamin B2, 1.27 mg of vitamin A (RE) and 12.20 mg of vitamin C. Therefore, it was good to be added in gelato products [19].

Based on the statement above, the aim of this study was to determine the effect of the proportion of sorbitol and sucrose and the concentration of pectin on the physicochemical and sensoric properties of pedada jam gelato.

II. MATERIALS AND METHODS

A. Materials

The materials used in this study were fresh cow's milk obtained from Lidah Kulon, Surabaya City, Indonesia and sorbitol from Rajaya Market, eggs and sugar from Wiyung Market, pectin from Planet Kimia Market, and fruit jam from Somano Market. The reagent used in this study were distilled water, H_2SO_4, NaOH, HCl, methanol, acetic acid, KI, phenolphthalein, luff schoorl solution, Pb acetate, boiling stone, thiosulfate solution, anhydrous glucose, Nelson's reagent, arsenomolybdate reagent, iodine, DPPH solution, starch solution, petroleum ether, sodium phosphate buffer, alpha amylase, pepsin, pancreatin, acetone, ethanol, and celite.

B. Equipments

The equipments used for the gelato making process were mixer (Tokebi, Korea), ice cream maker (GEA-1530, China), freezer, refrigerator and other supporting equipment. The equipments used for analysis were petri dishes, weighing bottles and lids, analytical balances, beakers, burettes, erlenmeyer, babcock bottles, centrifuge (Funke Gerber Supervario), desiccators, ovens, measuring flasks, dropper pipettes, micro pipette, water bath, filter paper, pH paper, funnel, test tube, vortex, spectrophotometer, visco tester (VT Rion) and furnace.

C. Research Design

This study used an experimental design in the form of a *Completely Randomized Design* (CRD) factorial pattern with 2 factors, where the first factor was the proportion of sorbitol and sucrose (13:2, 12:3, 11:4%), and the second factor was the concentration of pectin (0.3, 0.5, 0.7%). The data obtained were processed using ANOVA to determine the effect of each treatment. Significantly different results were further tested using DMRT (*Duncan's Multiple Range Test*) 5%. The analysis was continued with the effectiveness index test to determine the best treatment for the physicochemical and sensoric properties of gelato.

D. Procedure

Production of pedada jam gelato

Gelato was made by mixing all ingredients including fresh milk 500 ml, pectin according to treatment (0.3, 0.5, 0.7%), egg yolk (4%), proportion of sorbitol and sucrose according to treatment (13:2, 12:3, 11:4%). Then pasteurized until the temperature reaches 80°C. After that, the pedada jam (20%) is added to the mixture that has been mixed and then stirred and cooled until it reaches room temperature. The next step, the dough is aged for 4 hours at a temperature of 0-5°C. The dough is put into an ice cream maker for air incorporation at temperature of -3 to -9°C for 30 minutes. The final process is freezing the gelato in a container and placing in the freezer for 24 hours.

E. Observation Paramaters

The observation parameters used in this study were the analysis of gelato including overrun and melting time [13], viscosity [32], fat content and total reducing sugar [31], total solids [37], total sugar [33], soluble fiber content [1], organoleptic scale scoring test (taste, color, aroma and texture) [12]. The best treatment was analyzed by antioxidant activity [30] and vitamin C content [31].

III. RESULTS AND DISCUSSION

Physicochemical analysis of pedada jam gelato

1) Overrun

Based on Fig. 1. showed that the lower proportion of sorbitol and higher proportion of sucrose with higher concentration of pectin produced gelato with lower overrun. This was because sucrose and pectin can increase the viscosity then it will inhibit the entry of air during the aeration process, hence overrun becomes lower.

Based on the results, according to [28], stated that the addition of pectin will increase the consistency of the mixture and prevent the entry of air into the mixture, hence overrun tends to be lower. This is supported by [16], macromolecular carbohydrates contribute to the stability and structure of the foam during the stirring and freezing process in the ice cream maker which affects the increase in viscosity of the ice cream due to the formation of bonds that block air bubbles . Because of this, overrun will be decrease. This is supported by [22] that along with the addition of hydrocolloid concentration, the

dough becomes thicker and the surface tension of the gel increases. The higher surface tension will inhibit the entry of air into the dough then overrun will be low. The higher proportion of sucrose and the lower proportion of sorbitol can decrease overrun. This was because sucrose had a higher viscosity than sorbitol, hence the higher addition of sucrose will increase viscosity of the material, thus limiting the mobility of water molecules because the space between particles in the ice cream maker is getting narrower.

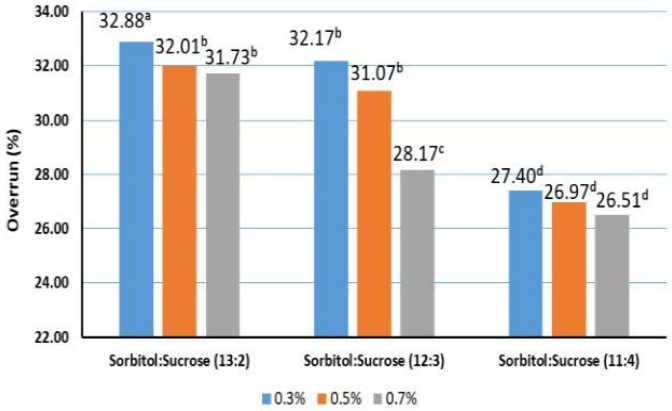

Fig. 1. Overrun of pedada jam gelato

2) Viscosity

Based on Fig. 2. showed that the lower proportion of sorbitol and higher proportion of sucrose with higher pectin concentration produced gelato with higher viscosity. This was because sucrose had a higher viscosity and molecular weight than sorbitol. According to [13] that sweeteners have high molecular weight will increase the viscosity of the ice cream. Sorbitol had molecular weight of 182 while sucrose had molecular weight of 342.

In addition, pectin was able to form a gel and bind water therefore water molecules were trapped in the gel structure formed. This is in accordance with the statement of [7] that the addition of pectin can increase the viscosity of the ice cream mixture by increasing the gel structure in the liquid.

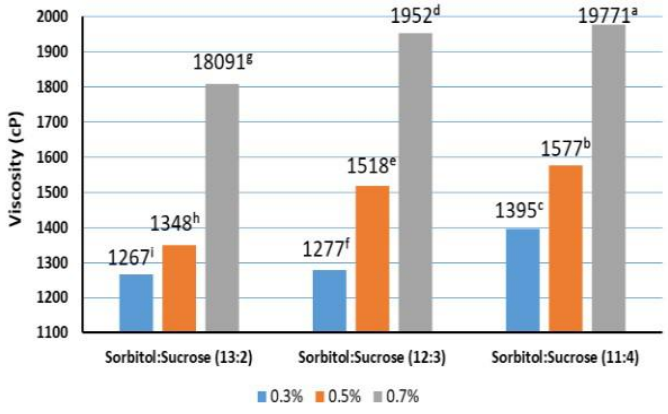

Fig. 2. Viscosity of pedada jam gelato

3) Melting Time

Based on Fig. 3. showed that the lower proportion of sorbitol and higher proportion of sucrose with higher concentration of pectin produced gelato with higher melting time. This is because the addition of sucrose and pectin will increase the viscosity, in line with the increasing melting resistance.

According to [28], stated that increasing serum microviscosity had an impact on the time of water diffusion from the inside of the concentrated serum phase and flows to the outside of gelato in consequence melting time will be longer. If more pectin is added, the crystals formed will be more controlled and form smooth and homogeneous crystals on the hydrocolloid matrix. For this reason, melting resistance will be increase [23].

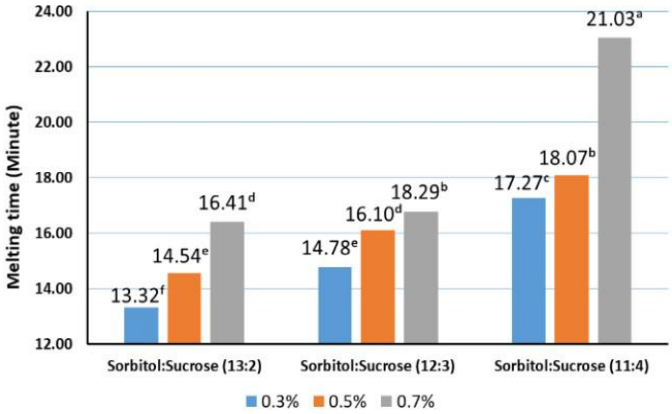

Fig. 3. Melting time of pedada jam gelato

4) Total solids

Based on Fig. 4. showed that the lower proportion of sorbitol and higher proportion of sucrose with higher pectin concentration produced gelato with higher total solids. This was because sucrose and pectin can form a gel where pectin will form fine fibers that trap water hence the amount of free water decreases and the total solids increases. This is in accordance with the statement of [35] that pectin can bind water through hydrogen bonds, sucrose will play a role in dehydration process which makes the hydrogen bonds in pectin stronger and forms a double helix conformation to form a solid three-dimensional structure. This three-dimensional structure will retain water and make the total solids increase.

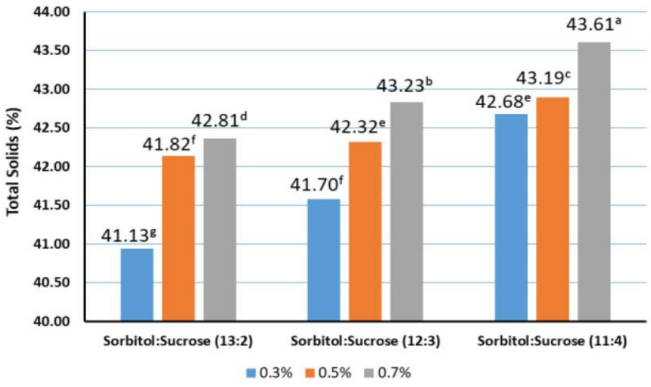

Fig. 4. Total solids of pedada jam gelato

5) Fat content

Based on Table 1. The result of fat content was not significant interaction (p≥0.05) between the proportions of sorbitol and sucrose with the concentration of pectin, and each treatment had no significant effect because both sorbitol, sucrose and pectin did not contain fat. According to [2], that the addition of pectin had no effect on fat content because the stabilizer did not contain fat. The result of fat content had no effect because the source of fat used in the manufacture of gelato in this study comes from cow's milk and egg yolk which are fixed variables. Based on the results of gelato fat content is in accordance with [11], that gelato had a fat content of 0-8%. The results of this study had lower fat content value than the results of research by [17] on the manufacture of rose petal jam gelato which ranged from 5.20-5.28%. This is because the addition of other fat sources that make the fat content increase, such as commercial creams. The more cream are added, the more gelato fat will increase.

Table 1. Fat content of pedada fruit jam gelato

Treatment		Fat content (%)
Sorbitol : Sucrose	Pectin (%)	
13:2	0.3	1.75 ± 0.02
	0.5	1.86 ± 0.09
	0.7	2.03 ± 0.24
12:3	0.3	1.98 ± 0.12
	0.5	2.01 ± 0.08
	0.7	2.09 ± 0.02
11:4	0.3	1.97 ± 0.17
	0.5	1.77 ± 0.03
	0.7	2.05 ± 0.26

6) Total sugar

The total sugar in proportion of sorbitol and sucrose treatments was significantly different. Based on Table 2., indicate that the higher proportion of sucrose and lower proportion of sorbitol can increase the total sugar. This is in accordance with [20] that sugar content increases along with the increase in sucrose added to gelato. In addition, [25] stated that sorbitol was part of carbohydrates that gives sweet taste but did not include total sugar.

Table 2. Total sugar of pedada jam gelato with proportion of sorbitol and sucrose treatments

Sorbitol:Sucrose	Total sugar (%)
13:2	13.88 ± 0.66[a]
12:3	15.75 ± 0.73[b]
11:4	16.68 ± 0.40[b]

The mean values followed by the same letter are not significantly different. (p≤ 0.05).

Based on Table 3. shows that the addition of pectin had no significant effect on the total sugar of gelato. According to [15], stated that pectin can bind water, increasing the addition of pectin can increase bound water consequently it will indirectly bind sugar which was easily soluble in water.

Table 3. Total sugar of pedada jam gelato with pectin concentration treatments

Pectin concentration (%)	Total sugar (%)
0,3	15.86 ± 1.36[a]
0,5	15.56 ± 1.21[a]
0,7	14.90 ± 1.45[a]

The mean values followed by the same letter are not significantly different. (p≤ 0.05).

7) Soluble fiber

Soluble fiber in proportion of sorbitol and sucrose treatments was significantly different. Based on Table 4., indicate that the higher proportion of sorbitol and lower proportion of sucrose can increase the soluble fiber content. This was because sorbitol had properties similar to fiber, which was a low-digestible carbohydrate. Low-digestible carbohydrates are carbohydrates that are not absorbed completely in the small intestine but will be partially fermented by good bacteria in the large intestine [14].

Table 4. Soluble fibre of pedada jam gelato with proportion of sorbitol and sucrose treatments

Sorbitol:Sucrose	Soluble fiber (%)
13:2	2.99 ± 0.38[a]
12:3	2.59 ± 0.17[b]
11:4	2.11 ± 0.25[b]

The mean values followed by the same letter are not significantly different. (p≤ 0.05).

Based on Table 5. shows that the higher pectin concentration can increase soluble fiber content. This is because pectin is one of the constituent components of soluble fiber. Accordance with [21] that pectin is a component of soluble dietary fiber from the polysaccharide group, hence the higher addition of pectin will get high soluble dietary fiber.

Table 5. Soluble fiber of pedada jam gelato with pectin concentration treatments

Pectin concentration (%)	Soluble fiber (%)
0,3	2.33 ± 0.45[a]
0,5	2.60 ± 0.43[a]
0,7	2.76 ± 0.45[a]

The mean values followed by the same letter are not significantly different. (p≤ 0.05).

8) Total reducing sugar

Based on Table 6. The result of reducing sugar total was not significant interaction (p≥0.05) between the proportions of sorbitol and sucrose with the concentration of pectin, and each treatment had no significant effect. According to [8] stated that sorbitol was not classified as sugar reduction because sorbitol did not have a free carbonyl group. Sucrose consists of α-D glucopyranosyl units linked to the β-d fructofuronacil, where the end of reducing bond will bind to the end of the reducing bond, consequently it acts as non-reducing sugar and did not have a free carbonyl group (aldehyde) [10].

Table 6. Reducing sugar content of pedada fruit jam gelato

Treatment		Total reducing sugar (%)
Sorbitol : Sucrose	Pectin (%)	
13:2	0,3	3,39 ± 0,17
	0,5	3,15 ± 0,17
	0,7	3,04 ± 0,34
12:3	0,3	3,63 ± 0,84
	0,5	3,63 ± 0,17
	0,7	3,51 ± 0,00
11:4	0,3	3,87 ± 0,50
	0,5	3,63 ± 0,17
	0,7	3,39 ± 0,17

Organoleptic Scale scoring test

Based on Table 7, there is significant effect between treatments on texture scoring scale test. The lowest value was found in proportion of sorbitol and sucrose 13:2% with 0.3% pectin had not soft gelato texture, while the highest value was found in proportion of sorbitol and sucrose 11:4% with 0.7% pectin had soft gelato texture. This is because the use of sorbitol will greatly lower the freezing point when compared to sucrose, hence it will affect the texture of the gelato [39]. Gelato which had a lower freezing point will cause less water to freeze when the gelato is removed from the freezer. The shelf life of gelato becomes shorter because it is more susceptible to increasing crystal size during temperature fluctuations [12]. Gelato texture is greatly influenced by the size of ice crystals formed. Gelato had a soft texture due to the formation of small ice crystals. In addition, according to [3], the stabilizer also prevent the growth of ice crystals due to temperature fluctuations during storage then the gelato texture will be soft.

Based on Table 7, there is not significant effect between treatments on aroma scoring scale test. The average aroma of gelato was between 3-3.28. The scoring value stated that all gelato treatments had a moderate pedada fruit aroma. Based on Table 7, there is significant effect between treatments on color scoring scale test. The average color of gelato was between 3-3.56 which means moderate dark brown. This is because, according to [24] stated that the higher concentration of pectin added, the darker product will be. In addition, color and aroma of gelato are strongly influenced by the addition of pedada jam, which was constant variable in this study. According to [19, 6], stated that pedada fruit jam had dark brown color and had delicious and sour aroma.

Based on Table 7, there is significant effect between treatments on taste scoring scale test. The lowest value was found in proportion of sorbitol and sucrose 13:2% with 0.7% had moderate sweet taste. The highest value was found in proportion of sorbitol:sucrose of 11:4% with 0.3% had sweet taste. This was because sorbitol and sucrose had different levels of sweetness, sucrose had a sweetness level of 1 while sorbitol is 0.6 times of sucrose. Pectin as a stabilizer will hold the sweet taste, therefore it will affect the taste of the gelato produced. This is in accordance with [4] that pectin gels can increased hardness and viscosity therefore being less intensely flavoured. Increasing the amount of pectin produces more binding sites a barrier to flavor diffusion and interacts with flavor volatiles [18].

Table 7. Scale scoring test of pedada fruit jam gelato

Treatment		Texture	Taste	Color	Aroma
Sorbitol : Sucrose	Pectin (%)				
13:2	**0,3**	$2,80 \pm 0,87^{f}$	$3,44 \pm 0,77^{f}$	$3,00 \pm 0,71^{c}$	$3,00 \pm 1,08^{a}$
	0,5	$3,40 \pm 0,82^{e}$	$3,52 \pm 0,65^{f}$	$3,04 \pm 0,79^{c}$	$3,08 \pm 0,76^{a}$
	0,7	$3,68 \pm 0,75^{d}$	$3,32 \pm 0,75^{f}$	$3,00 \pm 0,76^{c}$	$3,00 \pm 0,91^{a}$
12:3	**0,3**	$2,92 \pm 0,95^{f}$	$3,92 \pm 0,64^{c}$	$3,00 \pm 0,87^{c}$	$3,00 \pm 1,00^{a}$
	0,5	$3,88 \pm 0,93^{c}$	$3,88 \pm 1,01^{d}$	$3,16 \pm 0,62^{c}$	$3,08 \pm 1,04^{a}$
	0,7	$3,52 \pm 0,65^{e}$	$3,80 \pm 0,91^{e}$	$3,08 \pm 0,76^{c}$	$3,04 \pm 0,79^{a}$
11:4	**0,3**	$3,16 \pm 0,90^{f}$	$4,36 \pm 0,49^{a}$	$3,12 \pm 0,78^{c}$	$3,04 \pm 0,79^{a}$
	0,5	$4,00 \pm 0,76^{b}$	$4,32 \pm 0,69^{b}$	$3,56 \pm 0,70^{b}$	$3,00 \pm 1,00^{a}$
	0,7	$4,04 \pm 0,78^{a}$	$3,88 \pm 0,67^{d}$	$3,52 \pm 0,71^{a}$	$3,28 \pm 0,84^{a}$

The mean values followed by the same letter are not significantly different. ($p \leq 0,05$).

Scoring scale: Texture: 1. Not very soft; 2. Not soft; 3. Moderate soft; 4. Soft; 5. Very soft

Taste : 1. Not very sweet; 2. Not sweet; 3. Moderate sweet; 4. Sweet; 5. Very sweet

Color : 1. Not very dark brown; 2. Not dark brown; 3. Moderate dark brown; 4. Dark brown; 5. Very dark brown

Aroma: 1. Not very pedada fruit aroma; 2. Not pedada fruit aroama; 3. Moderate pedada fruit aroma; 4. Pedada fruit aroma; 5. Very pedada fruit aroma

Best treatment analysis of pedada jam gelato

The results of the effectiveness index test on the physicochemical and sensoric properties of gelato jam pedada which had the highest score was gelato at the proportion of 11% sorbitol and 4% sucrose with 0.5% pectin concentration was the best treatment. Based on Table 8. the best gelato treatment had vitamin C content 17.38 mg/100 g and antioxidant activity 12.11%. Vitamin C levels and antioxidant activity are influenced by the raw material for making gelato which is pedada fruit jam.

Table 8. Best treatment analysis result of pedada fruit jam gelato

Parameter	Analysis result
Vitamin C (mg/100 g)	17,38 ± 0,07
Antioxidant activity (%)	12,11 ± 0,16

IV. CONCLUSION

The proportions of sorbitol and sucrose and the concentration of pectin have significant interactions with overrun, melting time, viscosity, total solids, taste, texture and color of scale scoring tests. There was not significant interaction on fat content, reducing sugar content and aroma of sclae scoring test. The proportions of sorbitol and sucrose and the concentration of pectin each gave a significant effect on soluble fiber content and total sugar of gelato. The best treatment in this study was proportion of 11% sorbitol and 4% sucrose with 0.5% pectin.

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