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Addition of Sugar and CMC to the Characteristics of Arumanis Mango Jam (*Mangifera indica L.*)

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Abstract

Mango is a popular fruit nowadays, because it contains components that are good for health. Off grade mangoes that have a low selling price on the market still have the potential to be processed into a product, one of which is jam. The purpose of this research was to determine the characteristics of off grade mango fruit jam produced by adding sugar and CMC, and the appropriate level of addition of sugar and CMC to produce jam with the best characteristics. The experiment was performed using completely randomized design with two-factor, Factor I was sugar concentration 30% (S1), 45% (S2) and 60% (S3), Factor II was concentration of CMC addition in 0.25% (C1), 0.50% (C2), and 0.75% (C3). All experiments were conducted in triplicate for each treatment, for a total of 27 experimental units. The results showed that the higher of sugar addition increased the Total soluble solids, vitamin C content and browning index value but reduced the water content, while the higher CMC tended to reduce the water content and browning index value of arumanis mango jam. The addition of 60% sugar and 0.50% CMC produced the best off grade mangoes fruit jam with a Total soluble solids value of 67.567 ^{O}Brix, a vitamin C content of 128.960 (mg/g), a water content of 30.720% and was organoleptically favored by the panelists.

Keywords: CMC, Jam, off grades arumanis Mango, Sugar.

1. Introduction

Fruit is a healthy food that functions as a source of calories, vitamins and minerals that are needed by the human body [1]. Based on the rate of respiration, fruits can be divided into climacteric and non-climacteric fruits. Climacteric fruits present a peak in respiration and ethylene production after being harvested, while non-climacteric fruit does not experience such condition [2]. So generally climacteric fruits experience faster post-harvest damage. One of the Climacteric fruit that is oftenly found is mango.

Based on data, mangoes are the third largest national production fruit after bananas and oranges[3]. Indonesian mangoes also experienced a trend of increasing production from 2013 to 2017. The highest mango production occurred in 2014 where Indonesian mango production reached 2,431,330 tons. Even though it decreased to 1,814,540 tons in 2016, in 2017 mango production increased again to 2,203,789 tons. The average growth in mango production during this period was 21.45% per year [4]. Most of the mangoes production is traded in the form of fresh fruit for direct consumption. But oftenly there are some fruits that do not pass the market standards, such as overripe fruit, undersized, and the absence of color and fruit skin, that cannot be sold to the market. Fruit that does not fulfill these sales standards has very low economic value [5]. Even those fruit production is disposed of as waste during big harvest season. Therefore we need an alternative solution to increase the economic value of these mangoes.

Off grade quality mangoes which are always produced at every harvest still have high economic value if sold in processed form. Crushed mango flesh is rich in nutrition, contains various vitamins and minerals [6]. Food diversification technology is one of the steps to overcome the food crisis. Various forms of processed food are produced to optimize agricultural yields including concentrates, fruit juices and jams [7].

Jam is a product of crushed fruit which is cooked and mixed with sugar, with or without the addition of water which has a soft and plastic texture [8]. The production of fruit jam in this study utilized off-grade arumanis mangoes which were not included in the size specifications but with proper ripeness and good condition and not rotten as raw material. Utilization of off-grade fruit into jam products can also bring benefits because the resulting jam can also be stored for a relatively long time [9].

The success in making fruit jam is influenced by fillers. Fillers are food additives which are added to improve the quality of the product being made. The fillers in the manufacture of mango jam are sugar, citric acid and pectin [10]. However, when viewed from the price and how to get it, pectin tends to be expensive and difficult to obtain. Apart from pectin, Carboxy Methyl Cellulose or CMC has cheaper price and easier to obtain, can also be used as a thickener in making jam because it is able to bind water to form a gel structure in the product. The addition of sugar in making jam can increase t he viscosity of the resulting jam [11]. In addition, the use of sugar can also sharpen the apearance of color and help gelation of pectin [12]. Therefore, it is necessary to do this research to determine the addition of sugar and CMC and the right concentration to produce mango jam with the best characteristics.

2. Materials and Methods

This research was conducted from February to July 2022 at the Laboratory for Processing and Analysis of Agricultural Products, Faculty of Agriculture, Warmadewa University. The study used was a completely randomized design (CRD) factorial with two treatment factors, Factor I was the treatment of adding sugar as much as 30% (S1), 45% (S2) and 60% (S3), Factor II concentration of CMC addition of 0, 25% (C1), 0.50% (C2), and 0.75% (C3). From the two factors, 9 treatment combinations were triplicate for a total of 27 experimental units.

2.1 Sample Preparation

The off-grade mangoes used were obtained from Anyar Sari Market, West Denpasar. Then the fruits were sorted to separate the damaged or rotten fruit unsuitable for use. After that, wash the Arumanis mangoes with running water until their skin is clean of dirt. Then the next processes were peeling to separate the fruit from the skin and cutting the fruit to remove the fruit seeds. This size reduction also aims to facilitate the crushing process.

The next session is making mango fruit puree by crushing the fruit. This process broke the fruit cell tissue to get the desired texture and consistency by maximizing the juice out of the cells. This crushing process utilizes a blender with a ratio of water: fruit (1: 2). At this stage, the collected mango puree is added with sugar (30%, 45%, 60%), CMC (0.25%, 0.50%, 0.75%), and citric acid 0.4%. The puree was then heated to 70°C for 20 minutes.

2.2 Analysis

To find out the characteristics of arumanis mango jam, several tests were carried out, namely total soluble solids with a hand refractometer (TSS), acidity (pH) using a pH meter, water content using

the oven method, vitamin C using a 695nm UV-Vis spectrophotometer, and browning index calculation using L*, a*, b* data obtained by colorimeter testing. The data were tested using the ANOVA analysis method. On objective data, the results of the single treatment variance showed a significant ($p<0.05$) to very significant ($p<0.01$) effect followed by the 5% BNT test and if the results of the treatment variances showed an interaction continued with the Duncan's Multi Range Test. Meanwhile, subjective data (color, aroma, texture, taste and overall acceptance) were analyzed using Duncan's Multi Range Test.

3. Results and Discussion

3.1 Objective variables

3.1.1 Total soluble solids

The results of the analysis of variance showed that the addition of sugar had a very significant effect ($P<0.01$), while the addition of CMC and its interactions had no significant effect ($P>0.05$) on the Total soluble solids of arumanis mango jam produced in this study.

Table 1
Average Value of Total soluble solids (°Brix) of Arumanis Mango Jam Due to Addition of Sugar and CMC Treatment

Treatment	CMC						Average	
	0.25%		0.50%		0.75%			
30% Sugar	43.433		47.900		47.800		46.378	c
45% Sugar	54.933		55.467		57.900		56.100	b
60% Sugar	63.867		67.567		63.867		65.100	a
Average	54.078	a	56.978	a	56.522	a		

Note :
1. The mean value followed by the same letter in the same row or column showed no significant difference ($P>0.05$).

Based on Table 1, the highest average Total soluble solids for arumanis mango jam was obtained in the treatment of adding 60% sugar, which was 65,100 °Brix, which was significantly different from the treatment of adding 30% sugar and adding 45% sugar with Total soluble solids each of 46,378 °Brix and 56,100 °Brix. The treatment with a CMC concentration of 0.50% tended to produce the highest Total soluble solids value of 56.978 °Brix which was not significantly different from the addition of 0.25% CMC and 0.75% of CMC with a Total soluble solids value of 53.856 °Brix and 56.078 °Brix respectively. In terms of value, the average of sugar added 60% in the manufacture of arumanis mango jam in this study appropriate to the Indonesian National Standard (SNI) for jam products in 2008, which is having a minimum Total soluble solids value of 65 °Brix.

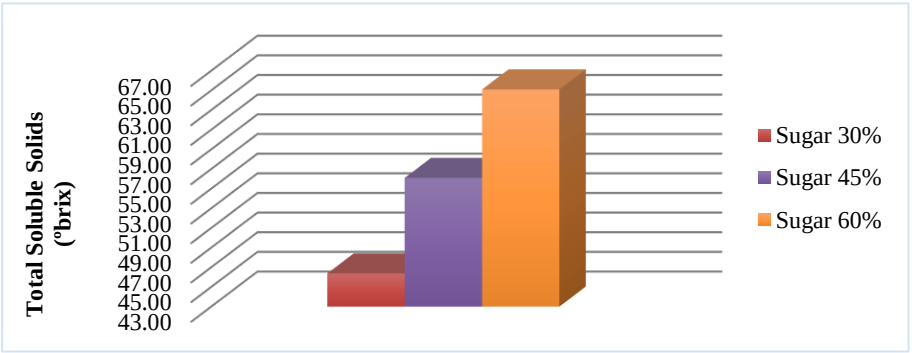

Figure1
Graph of Total soluble solids Due to the Addition of Sugar in the Making of Arumanis Mango Jam

Figure 1 shows that the higher increase value in the total soluble solids of arumanis mango jam is directly proportional to the more sugar added. This is in line with a similar study, where the increase in the amount of sucrose in the product was due to the greater the diffusion event caused by the greater amount of sucrose added, so that the amount of sugar measured would be even greater [13]. According to study, Total soluble solids can be used to represent the amount of sugar in foodstuffs[14]. But based on Table 1 the percentage of CMC added to the arumanis mango jam did not have a significant effect on the Total soluble solids contained. This is because CMC does not affect the amount of sugar content contained in a product [15].

3.1.2 Acidity (pH)

pH is the degree of acidity used to express the level of acidity or alkalinity possessed by a product. The results of the analysis of variance showed that the treatment of adding sugar and adding CMC had no significant effect (P>0.05) on the degree of acidity (pH) of the resulting arumanis mango jam. The average pH value of arumanis mango jam against the treatment of adding sugar and CMC can be seen in Table 2.

Table 2
The Average Value of Arumanis Mango Jam pH Against the Addition of Sugar and CMC Treatment

	CMC			Average
	0.25%	0.50%	0.75%	
Sugar 30%	3.347	3.480	3.503	3,443 a
Sugar 45%	3.410	3.440	3.540	3,463 a
Sugar 60%	3.487	3.510	3.607	3,534 a
Average	3.414 a	3.477 a	3.550 a	

Note : The mean value followed by the same letter in the same row showed no significant difference (P>0.05).

In table 2 the treatment of adding 60% sugar tends to have the highest average pH value of arumanis mango jam, which is equal to 3.534 which is not significantly different from the treatment of adding 30% sugar and adding 45% sugar with a pH of 3.443 and 3.534 respectively. This is in line with the addition of 0.75% CMC concentration which tends to produce the highest average pH value of 3.550 which is not significantly different from the treatment of 0.25% CMC addition and 0.50% CMC addition with pH values of 3.414 and 3.477 respectively.

In general, the average pH value of arumanis mango jam produced has fulfilled optimum conditions for gel formation in jam making. This is reinforced by the statement that the desired pH in making jam is in the range of 3.10-3.46 [16]. The increase in pH occurs due to CMC which contains carboxyl groups and is easily hydrolyzed so that it can increase the Ph value of the jam [17]. This increase in pH is in line with the statement that the addition of CMC causes the pH to increase because CMC is a salt of a strong base content and a weak acid so that the solution will be more alkaline [18]. Jam with different additions sugars produce different levels of acidity. The higher the addition of sugar causes the acidity value tends to increase [19].

3.1.3 Levels of Vitamin C

The results of the analysis of variance showed that the addition of sugar had a very significant effect (P<0.01), while the addition of CMC and its interactions had no significant effect (P>0.05) on Vitamin C levels (mg/g) of arumanis mango jam. In table 3, the highest average value of Vitamin C content (mg/g) of arumanis mango jam was obtained in the treatment of adding 60% sugar, the value is 109.668 (mg/g), which was not significantly different from the treatment of adding 45% sugar, which was equal to 95.453 (mg/g). But significantly different from the treatment of adding 30% sugar, that is 75.679 (mg/g). While the addition of 0.50% CMC tends to produce the highest Vitamin C (mg/g) reached to 99.911 (mg/g) which is not significantly different from the addition treatment of 0.25% CMC and the addition of 0.75%

CMC, with Vitamin C (mg/g) values were 85.106 (mg/g) and 95.783 (mg/g) respectively. Vitamin C is a water-soluble vitamin [20]. Vitamin C is stable in acidic media, but easily degraded by heat in neutral and alkaline media [21].

Table 3
The Effect of Addition of Sugar and CMC Treatment on the Average Value of Vitamin C Arumanis Mango Jam (mg/g)

	CMC			Average
	0.25%	0.50%	0.75%	
Sugar 30%	62.307	78.230	86.500	75.679 b
Sugar 45%	91.310	92.543	102.507	95.453 a
Sugar 60%	101.700	128.960	98.343	109.668 a
Average	85.106 a	99.911 a	95.783 a	

Note : The mean value followed by the same letter in the same row showed no significant difference (P>0.05).

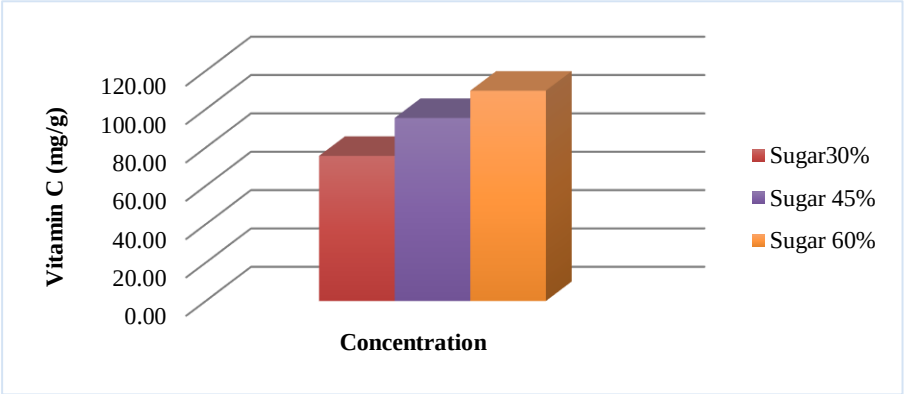

Figure 2
Graph of Vitamin C (mg/g) Due to the Addition of Sugar in the Production of Arumanis Mango Jam

In this study, the increase in vitamin C levels was in line with the increase in the concentration of added sugar. This was caused by sugar functioning as a dehydrating agent, which attracted water molecules bound to pectin molecules so that it would affect the balance of pectin and water [22]. Increasing the addition of sugar is thought to be able to maximize the performance of the stabilizer in this study, CMC retained the water molecules and water-soluble compounds such as vitamin C and prevent oxidation during the cooking process so that indirectly the levels of vitamin C in the product will be higher. In an acidic environment, the dehydroascorbic acid lactone ring breaks down to form a diketogulonate compound so that vitamin C is protected by the addition of a sugar compound [23].

3.1.4 Water Content

The results of the analysis of variance showed that the addition of sugar had a very significant effect (P<0.01), while the addition of CMC had a significant effect (P<0.05) but the interaction of sugar and CMC added had no significant effect (P>0.05) on water content (%) of the arumanis mango jam. The average value of water content (%) of arumanis mango jam to the treatment of adding sugar and CMC can be seen in Table 4.

The average value of water content (%) in Table 4 shows that arumanis mango jam with the addition of 60% sugar produced the lowest water content (%), that is 30.826%, which was significantly different from the treatment of adding 30% sugar and adding 45% sugar with each value were 48.012% and 38.240%. Based on the data above, the average value of the water content test is produced by treatment

60% added sugar on manufacture arumanis mango jam has fulfilled the requirements of SII No.173 (1978), with a recommended maximum water content of 35%.

Table 4
The Average Value of Moisture Content (%) of Arumanis Mango Jam Against the Treatment of Adding Sugar and CMC

	CMC						Average	
	0.25%		0.50%		0.75%			
Sugar 30%	51.220		47.247		45.570		48.012	a
Sugar 45%	39.513		40.053		35.153		38.240	b
Sugar 60%	31.223		30.720		30.533		30.826	c
Average	40.652	a	39.340	ab	37.086	b		

Note : The mean value followed by the same letter in the same row showed no significant difference (P>0.05).

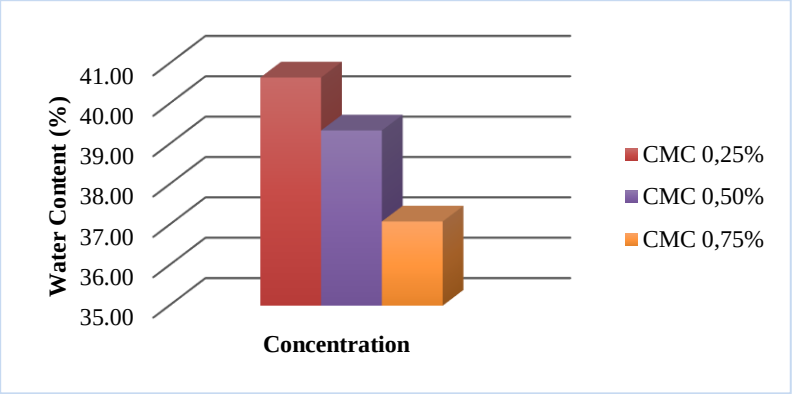

Figure 3
Graph of water content (%) Due to Addition of Sugar Treatment in Making Mango Arumanis Jam

The decrease in the water content of the jam occurred in line with the increase in the concentration of added sugar. This is due because sucrose has high sulobility which is able to bind water. The ability of sucrose to bind water causes the water contain decreasing [24].

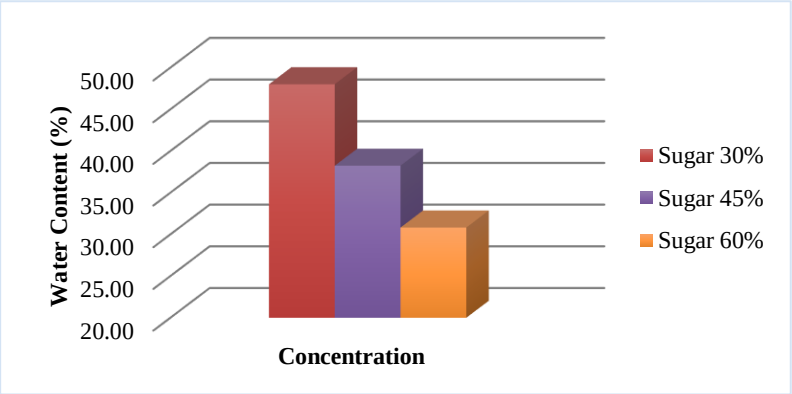

Figure 4
Graph of water content (%) Due to the Addition of CMC in the Making of Mango Arumanis Jam

The addition of 0.75% CMC resulted in the lowest water content (%) which was not significantly different from the treatment of adding CMC of 0.50%, but significantly different from the addition of CMC of 0.25%. The decrease in water content of arumanis mango jam is related to the CMC concentration given. CMC as thickening agent is able to bind water so that water molecules are trapped in the gel structure formed by CMC [25]. So that the increasing concentration of CMC decreases the water content

of produced Arumanis mango jam. However, the average water content value of the addition of CMC to arumanis mango jam in this study did not fulfill the requirements of SNI No.173 (1978) with a maximum value of 35%.

3.1.5 Browning Index (Bl)

The browning index (Bl) is one of the most common browning indicators in food products that contain sugar [26]. The browning index can be obtained by calculating the L* a* b* value of a product which is analyzed using a colorimeter. The results of the analysis of variance showed that the addition of sugar and the addition of CMC in the manufacture of arumanis mango jam had a very significant effect ($P<0.01$) on the browning index of the resulting arumanis mango jam, but had no significant effect ($P>0.05$) on the interaction of the two. The average value of the browning index of arumanis mango jam to the treatment of adding sugar and CMC can be seen in Table 5.

Table5
The Average Browning Index Value of Arumanis Mango Jam Against the Addition of Sugar and CMC Treatment

	CMC			Average	
	0.25%	0.50%	0.75%		
Sugar 30%	55.343	50.443	41.410	49.066	c
Sugar 45%	98.600	99.040	96.877	98.172	b
Sugar 60%	159.410	159.010	147.883	155.434	a
Average	104.451 a	102.831 a	95.390 b		

Note : The mean value followed by the same letter in the same row showed no significant difference ($P>0.05$).

In table 5, the highest average browning index value for arumanis mango jam was obtained in the treatment of 60% sugar addition, that is 155.434, which was significantly different from the treatment of 30% sugar addition and 45% sugar addition each were 49.066 and 98.172, respectively. In the cooking process, sugar undergoes a caramelization process so that a browning or brownish yellow reaction is formed [27]. The more sugar added to the product, the more substrate that is in contact with heat so that it is involved in the browning reaction causes the color of the product to become darker [28].

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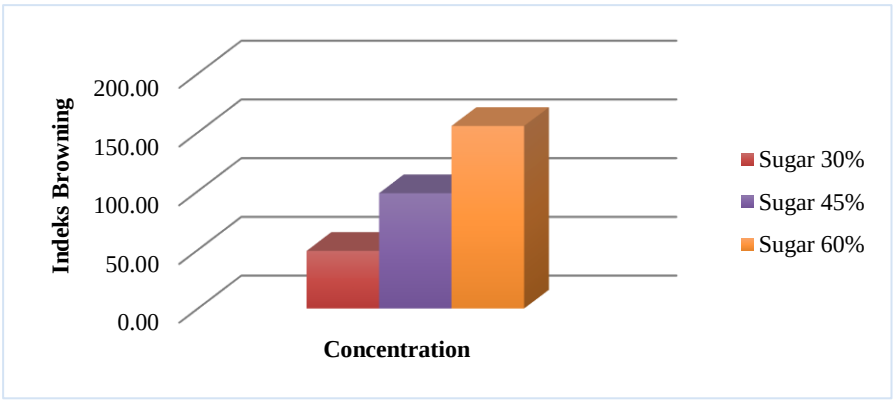

Figure 5
Graph of Browning Index (BI) Due to Addition of Sugar in the Making of Mango Arumanis Jam

From table 5 it can be seen that the addition of CMC 0.25% tends to produce the highest average browning index reached of 104.451 which is not significantly different from the treatment of adding CMC of 0.50% which is 102.831 but is significantly different with the addition of CMC of 0.75% that is 95.390. The higher concentration of CMC added decreases the average of Arumanis mango jam browning index value. The presence of the hydrocolloids addition can absorb water and the ability of CMC to withstand

the oxidation of the color present in the jam during processing causes a decrease in the browning index [17]. The more CMC added to the treatment, the lower the color value and the higher the color fading [17].

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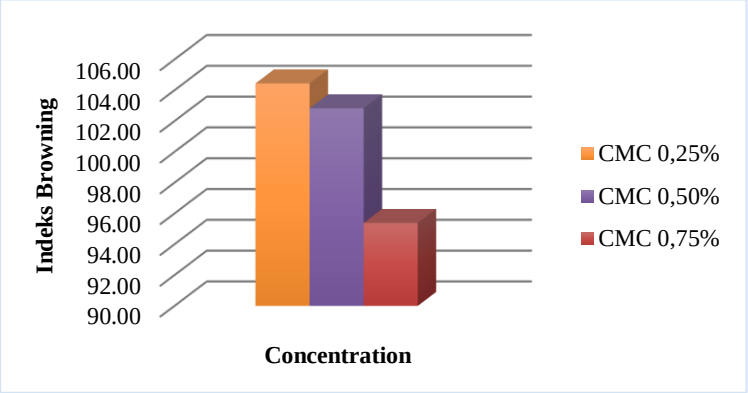

Figure 6
Graph of Browning Index (BI) Due to the Addition of CMC in the Making of Arumanis Mango Jam

3.2 Subjective variables

The type of organoleptic test in this study was the hedonic test (scoring method) using 25 untrained panelists. Each panelist will be given nine samples which will be tested for their level of preference for five sensory attributes, that are color, aroma, texture, taste and overall acceptance. The sample used was arumanis mango jam product with nine different treatments. The scale used is a value or nominal scale starting from one to seven. These include: 1 (dislike very much), 2 (dislike), 3 (rather dislike), 4 (neutral), 5 (rather like), 6 (like) and 7 (very like).

Table 6.
Significance of the Effect of Adding Sugar and CMC on Panelist Assessment of Organoleptic Tests in the Making of Arumanis Mango Jam

Treatment	Sample Code	Averages and Notations									
		Color		Aroma		Texture		Flavor		Whole	
Sugar 30% and CMC 0.25%	S1C1	548	c	4.68	cd	5,68	bc	4,20	c	5,16	e
Sugar 30% and CMC 0.50%	S1C2	5,52	bc	4,28	d	5,52	bc	4,12	c	5,20	e
Sugar 30% and CMC 0.75%	S1C3	5,68	bc	4.76	cd	4.72	d	4,44	c	5,24	de
Sugar 45% and CMC 0.25%	S2C1	5,64	bc	4.56	cd	5.56	bc	4.56	c	5,72	cd
Sugar 45% and CMC 0.50%	S2C2	6.00	ab	5.00	bc	5,44	bc	5,48	b	6.08	bc
Sugar 45% and CMC 0.75%	S2C3	6,16	a	5.80	a	5,20	cd	5.84	b	5.80	bcd
Sugar 60% and CMC 0.25%	S3C1	6.00	ab	5,32	ab	5.84	b	5.80	b	6,16	abc
Sugar 60% and CMC 0.50%	S3C2	5.80	abc	5,76	a	6,64	a	6,60	a	6,64	a
Sugar 60% and CMC 0.75%	S3C3	5,60	bc	5,48	ab	6,52	a	5.80	b	6,32	ab

Based on the results of Duncan's Multi Range Test which was carried out in this study, the average value of the panelist preference level for color, aroma, texture, taste and overall acceptance of arumanis mango jam with added sugar and CMC treatment can be seen in Table 6.

3.2.1. Color

Color is a very important quality attribute in ingredients and food products [29]. The results of the analysis of variance showed that the addition of sugar and CMC had a significant ($P<0.05$) effect on hedonic color assessment. The results of Duncan's further test in table 6 shows the treatment with additions 45% sugar and 0.75% CMC produced the highest preference value which was not significantly different

with the addition of 45% sugar and 0.50% CMC, the treatment of 60% sugar addition and 0.25% CMC, then the treatment of 60% sugar addition and CMC 0.50% but significantly different from other treatments.

The average color preference for arumanis mango jam in this study ranged from 4.48 to 6.16 (neutral-like). Panelists generally like jam that has a reddish yellow color. The color of the jam is also affected by the browning process of the added sugar component. The non-enzymatic browning reaction known as caramelization causes the color to tend to be darker in the product, thereby reducing the brightness level. [30].

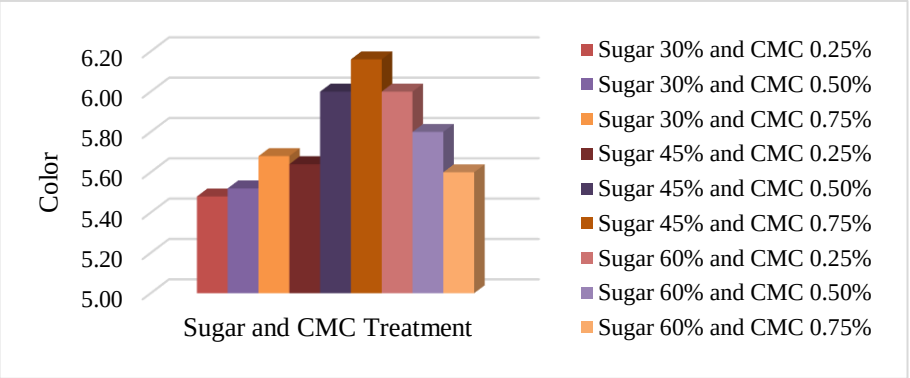

Figure 7
Color Sensory Assessment ChartConsequenceTreatment of Addition of Sugar and CMC in the Making of Arumanis Mango Jam

In Figure 7, it can be seen that the level of preference of the panelists in the color sensory test has increased and then decreased with increasing addition of sugar where the addition of sugar with a concentration of 30% generally produces jam with a bright yellow color while the addition of 45% sugar produces jam with a reddish yellow color which tends to be preferred. This panelist is characterized by an increase in the average value on the graph. However, the addition of 60% sugar gave a final product that was too concentrated so that the jam looked brown. This caused a decrease in the hedonic preference value for jam color by the panelists.

3.2.2. Aroma

Aroma is the most difficult sensory property to classify and describe. Aroma is one of the most important organoleptic indicators in determining the acceptance of a food ingredient, because through aroma, panelists or consumers will know the ingredients contained in the food product that is made and know whether or not the food ingredient is consumed [31].

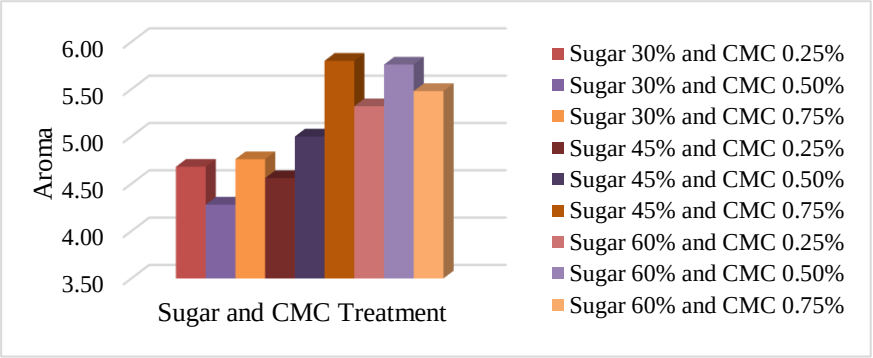

Figure 8
The Effect of Addition of Sugar and CMC Treatment on the Aroma of Arumanis Mango Jam

The results of the analysis of variance showed that the addition of sugar and CMC gave very significant effect (P<0.01) on the hedonic aroma assessment. The results of Duncan's further test in table 6 shows the average value of texture preference for arumanis mango jam ranged from 4.28 to 5.60 (neutral-like). The treatment with additions 45% sugar and 0.75% CMC produced the highest preference value which was not significantly different with the addition of 60% sugar and 0.50% CMC, the treatment of 60% added sugar and 0.25% CMC, then the treatment of adding 60% sugar and 0.75% CMC but significantly different from other treatments.

Data in Figure 8 shows that panelists preferred jam with 30% sugar concentration compared to jam with 45% sugar and jam with 60% added sugar. This indirectly shows that the more added sugar, the hedonic sensory aroma of Arumanis mango jam tends to increase. The aroma of arumanis mango jam is influenced by the sweet aroma that comes from the caramelization process that occurs during the heating process. In addition, sugar also plays a role in improving taste and aroma by forming a balance between sour, bitter and salty tastes [32]. Based on SNI 3746:2008, the characteristics of the aroma of jam is that it has a normal aroma standard, that is, if you smell the distinctive smell of jam from the ingredients used [33].

3.2.3. Texture

Based on the data from the analysis of variance, it showed that the addition of sugar and CMC had a very significant effect (P<0.01) on the hedonic texture assessment. The results of Duncan's further test in table 6 shows the treatment with additions 60% sugar and 0.50% CMC produced the highest average preference value with a value of 6.64 (very like) which was not significantly different from the 60% sugar addition treatment and 0.75% CMC, but significantly different from other treatments.

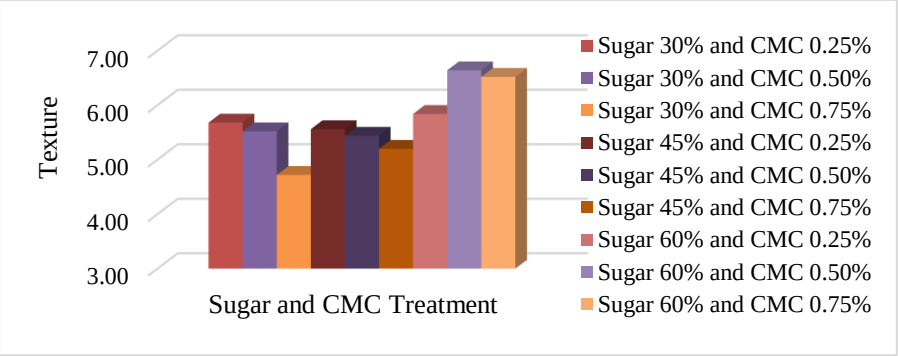

Figure 9
The Effect of Sugar Addition and CMC Treatment on the Texture of Mango Arumanis Jam

In this study, the average value of texture preference for arumanis mango jam ranged from 4.48 to 6.64 (neutral- very like). With an average value that tends to increase with increasing concentration of sugar and CMC used, the addition of sugar and CMC with the highest concentration resulted in the jam with the highest acceptability. This is inseparable from ability of sugar which can fill the pore layers in the jam, when jam heated, the water content will come out and evaporate to be replaced by sugar [34]. This increase in viscosity also occurs because CMC is added in the manufacture of jam which has the ability to bind water, so that water molecules are trapped in the gel texture formed [17].

3.2.4. Flavor

Flavor is most important parameter of the sensory which is basic for decision making by consumers, from flavor it can be known the value of a food product. Panelists acceptance of taste influenced by many factors, including chemical compounds, temperature, concentration and interactions between flavor components contained in food [35].

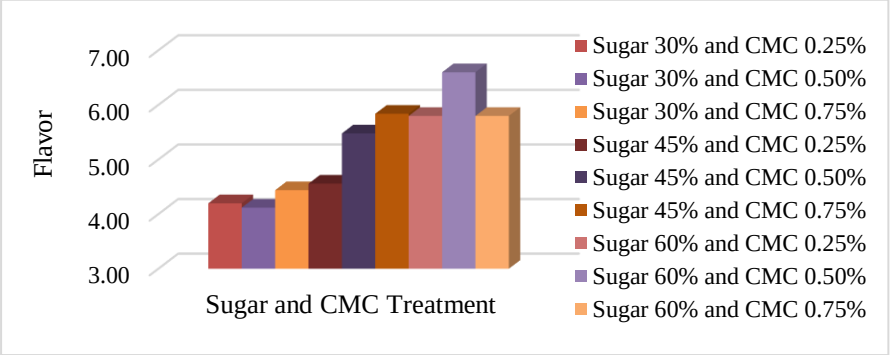

Figure 10
Graph of Sensory Assessment of Taste Due to Treatment of Addition of Sugar and CMC in the Making of Mango Arumanis Jam

In the results of the analysis of variance showed that the addition of sugar and CMC gave very significant effect (P<0.01) on hedonic taste assessment. Based on the results of Duncan's further test in Table 6, it shows that the treatment of 60% added sugar and 0.50% CMC produced the highest preference value which was significantly different from other treatments.

The average preference flavor value for arumanis mango jam ranged from 4.12 to 6.60 (neutral – like). The highest level of preference is found in treatment with 60% addition sugar and 0.50% CMC by value average 6.60 (like-very like). While the lowest is at addition treatment by 30% sugar and 0.50% CMC with an average value of 4.12 (neutral – rather likes).

The increase in hedonic flavor preferences is influenced by the concentration of sugar and CMC added in the product processing process. Where the addition of sugar will automatically increase the sweet taste of the jam as well improve flavor and aroma by establishing a balance between sour, bitter and salty tastes [32]. The addition of CMC is able to form a layer that can coat the flavor particles, as well as protect them from oxidation, evaporation and absorption of water from the air so that the taste is preferred by panelists. In the food industry, CMC is used as an aroma, stabilizer, emulsifier which is better than carrageenan, gum arabic and pectin [36].

3.2.5. Overall Acceptance

Based on the results of the analysis of variance on the overall acceptance of arumanis mango jam with the addition of sugar and CMC tended to give very real effect (P<0.01). The results of duncan's further test in table 6 shows the treatment with additions 60% sugar and 0.50% CMC produced the highest acceptance value which was not significantly different from the treatment of 60% sugar and 0.25% CMC, the treatment of 60% added sugar and 0.75% CMC, but significantly different from other treatments.

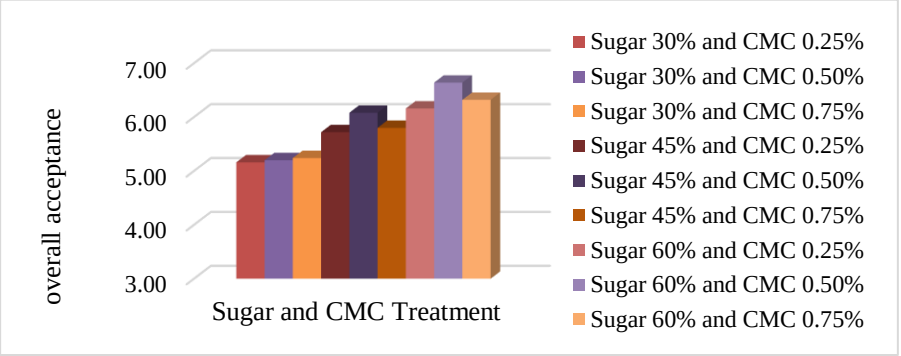

Figure11
Graph of Overall Acceptance Assessment As a result of Addition of Sugar and CMC Treatment in the Making of Arumanis Mango Jam

The average value of receiving arumanis mango jam ranged from 5.16-6.64 (rather like – very like). The highest level of acceptance is found in treatment with 60% additions sugar and 0.50% CMC by average value 6.64 (like-very like). While the lowest is at 30% addition treatment sugar and 0.25% CMC with an average value of 5.16 (rather like - like). The highest acceptance value is not significantly different between additions 60% sugar and 0.50% CMC with the addition of 60% sugar and 0.25% CMC, as well as the 60% added sugar and 0.75% CMC treatment, showed that the treatment was well received by the panelists.

3. Conclusion

The results showed that the higher addition of sugar increased the Total soluble solids, vitamin C content and browning index value but reduced the water content, while the higher addition of CMC tended to decrease the water content and the browning index value of arumanis mango jam. The addition of 60% sugar and 0.50% CMC produced the best mango fruit jam with a Total soluble solids value of 67.567 ^{O}Brix, a vitamin C content of 128.960 (mg/g), a water content of 30.720% and was organoleptically favored by the panelists.

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