The Effect of Different Concentrations of Carboxy Methyl Cellulose Addition on Chemical and Organoleptic Characteristics of Red Guava (Psidium guajava) Jam Sheet

by Yoyok Budi Pramono

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RESEARCH PAPER

The effect of different concentrations of carboxy methyl cellulose addition on chemical and organoleptic characteristics of red guava (*Psidium guajava*) jam sheet

*Pramono, Y.B., Rizqiati, H. and Luthfiyanti, E.

Food Technology Study Program, Faculty of Animal and Agriculture Sciences, Diponegoro University, Jl. Prof. H. Soedarto, S.H., Tembalang Semarang, 50275 Indonesia

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Abstract

The purpose of this study was to determine the effect of different carboxy methyl cellulose (CMC) concentrations on the chemical and sensory characteristics of jam sheet products (pH value, moisture content, water activity, total dissolved solids and preference test), and to determine the best CMC concentration as food additives for jam sheet products. This study used a completely randomized design (CRD) with five treatments and 4 replications. The treatment applied was the addition of different concentrations of CMC i.e., P0: CMC 0%, P1: CMC 0.25%, P2: CMC 0.5%, P3: CMC 0.75%, and P4: CMC 1.0%. The results showed that there was a significant effect of increasing the concentration of CMC on the pH value, water content, water activity, total dissolved solids and the red guava jam preference test.

1. Introduction

The lifestyle of people who are increasingly advanced and modern, demands a practical and instant lifestyle, including the problem of food processing, including the consumption of bread at breakfast. Bread is one of the practical and filling breakfast menus. Consumption of white and sweet bread in Indonesia in 2017 was around 1.16 kg/capita/year, while in 2018 it rose to 3.15 kg/capita/year (Food Security Agency, 2019). Bread consumption in Indonesia is expected to increase every year. This directly also increases the demand for complementary ingredients for bread, one of which is jam, including fruit jam.

Fruits are agricultural commodities that are mostly produced by Indonesia as an agricultural country. Red guava is one of the plants that can grow all year round in tropical climates like Indonesia. Central Java is the province with the largest guava fruit producer in Indonesia, which is around 105,630 tons (Central Bureau of Statistics, 2019). Red guava fruit is very popular with the public because of its soft flesh, thick flesh, sweet taste and affordable price. So far, the abundant yield of guava fruit is often consumed as fresh fruit or processed into processed products. Processed products made from red guava fruit include red guava juice, red guava diamonds, red guava syrup, red guava setup, cake, red guava "dodol" and red guava fruit jam. Red guava jam is a processed product of red guava fruit that has been crushed, added with sugar and cooked until thick or semi -solid.

The presentation of jam is usually by spreading the jam on the bread and then baking it. This impractical presentation becomes a problem in the use of jam as a complement or filling for food. Jam sheet is one solution to answer the convenience of serving jam as a complementary food ingredient. The process of making jam sheet involves mixing mashed fruit pulp with water with a certain amount of sugar and one type of stabilizer then cooking and cooling it to form a sheet. The texture of the resulting jam sheet should not be too soft and stiff. Therefore, additional ingredients are needed to strengthen the texture (Chairi *et al.*, 2014). Making jam sheets is a modification of spread jam into sheets that are compact, plastic, and non-sticky to meet public demand for jam products that are more practical in their presentation (Putri *et al.,* 2013). However, behind the more practical presentation of jam sheet, there is another problem, i.e., the stability of the texture of the jam hence it becomes compact and plastic. The addition of a stabilizer is a solution to provide texture stability to jam sheet products.

*Corresponding author.
Email: *yoyokbudipramono@lecturer.undip.ac.id*

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One type of stabilizer that can be used to improve texture is carboxy methyl cellulose (CMC). CMC in food acts as a water-binding agent and gelling agent creates a firm texture in the food. The addition of CMC is used to form a colloidal dispersion system, which will increase the viscosity and trap suspended particles in the system (Sun *et al*., 2019). The added stabilizer of jam sheet can provide a compact, plastic and non-sticky jam sheet product. In addition to providing practical solutions for jam consumption, the manufacture of jam sheet is also expected to increase its attractiveness and economic value as well as an innovative effort to diversify red guava processed products. The purpose of this study was to determine the effect of different carboxy methyl cellulose (CMC) concentrations on the chemical and sensory characteristics of jam sheet products (pH value, moisture content, water activity, total dissolved solids and preference test), and to determine the best CMC concentration as food additives for jam sheet products.

2. Materials and methods

2.1 Experimental methods

A completely randomized design (CRD) with twenty units of experiments was used in this experiment. There were 5 treatments and 4 replications. The addition of CMC stabilizer concentration, i.e., 0%, 0.25%, 0.5%, 0.75% and 1.0%.

2.2 Preparation of guava pulp

The process of making red guava pulp is carried out according to Listin *et al*. (2019) with a modification, i.e. the red guava fruit is peeled to separate the skin and flesh. Red guava fruit that has been peeled, and washed with tap water to remove the remaining dirt that is still attached to the fruit. Clean red guava fruit was cut to reduce size and facilitate the crushing process. The red guava fruit and water were blended in a ratio of 1:1. After being crushed, the fruit filtrate was filtered through a sieve to separate the seeds to obtain a red guava pulp.

2.3 Preparation of red guava jam sheets

This was carried out according to the method described by Septiani *et al*. (2013) with a modification, i.e., 60% red guava pulp was added with 0.5% citric acid while cooking at a temperature of 90-95^{o}C for 5 mins. Next, 5% margarine and 40% granulated sugar were added based on the research of Ismail *et al*. (2015), and CMC solution was added according to the treatment. CMC was added with various concentrations (0%, 0.25%, 0.5%, 0.75%, and 1.0%) which were prepared by adding each concentration to 50 mL of hot water at a temperature of 95^{o}C and stirred until homogeneous. All ingredients were mixed and stirred until homogeneous, cooking the jam was done for 20 mins. The finished jam was pressed and formed on parchment paper. Next, the jam was put in a cabinet dryer for 20 hrs at a temperature of 55˚C. After the drying process, the jam was cooled. Then, the jam sheet was cut to a size of 8 × 8 × 0.5 cm.

2.4 Data analysis

Analysis of the test data used on the pH value, water content, total dissolved solids and water activity were statistically analysed using the analysis of variance (ANOVA) test with a significance level of $p<0.05$ to determine whether there was a significant effect between the addition of CMC concentration. Further tests were carried out using Duncan's Multiple Range Test (DMRT) to determine whether there was a significant difference between the treatments given. The results of the preference test were analyzed statistically using Kruskal Wallis with a significance level of $p<0.05$ to determine whether there was a significant effect between the addition of CMC concentration on colour, taste, aroma, texture and overall. Further tests were carried out using Mann-Whitney to determine whether there was a significant difference between the treatments given. Data analysis was processed by computer program SPSS 26.0 for Windows.

3. Results and discussion

Based on the results in Table 1 it is observed that the addition of CMC with different concentrations showed a significant effect ($p<0.05$) on the pH value, the moisture content, the total dissolved solids value, the value of the water activity and sensory of the resulting sheet of red guava jam.

3.1 pH Value

The pH value provides information on the degree of acidity or alkalinity of a product. Determination of the pH value is based on the concentration of H^+ ions in the solution. Based on Table 1, it can be seen that the pH value increased along with the added CMC concentration. Jam with the addition of 1% CMC concentration treatment showed a higher pH value than all other treatments.

Jam with the addition of different concentrations of CMC will produce different levels of acidity. The higher the concentration of CMC added, the acidity value tends to increase. CMC contains a carboxyl group which it can increase the acidity of the product. Khairunnisa *et al*. (2015) reported that the higher the addition of CMC concentration would increase the hydrolyzed carboxyl group meanwhile increased the pH of the jam.

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3.2 Moisture content

The difference in water content indicates that the addition of CMC concentration can affect the water content of the resulting product. The highest water content was found in the addition of 1% CMC concentration, which is because the higher the concentration added, the more CMC hydroxyl groups that bind water. This is in accordance with the opinion of Filipčev *et al.* (2021) that hydrocolloids containing hydroxyl groups have the ability to bind water making the bound water will be retained and difficult to evaporate.

3.3 Total dissolved solids

The total dissolved solids show the number of dissolved substances in the solution. Based on Table 1, it is known that there is a dynamic trend in the value of total dissolved solids along with the addition of CMC which is added to the red guava jam sheet. The total dissolved solids with the highest addition of 1% CMC concentration gave the highest dissolved solids value of 22.40%. In line with Astuti *et al.* (2016) the higher the concentration of hydrocolloids added, the more dissolved solids in the water therefore it will increase the total dissolved solids. CMC has good sugar-binding ability, therefore the higher the concentration of added CMC, the more the total dissolved solids of the product will increase. According to Russ *et al.* (2014), CMC as a stabilizer is able to bind sugar, water, organic acids and other components well, therefore it will increase the trapped suspended solids.

3.4 Water activity

Based on Table 1, it is observed that the higher the addition of the given CMC concentration, the water activity value of the jam sheet will also increase. The lowest a_w value was obtained in the P0 treatment with the addition of 0% CMC concentration, i.e., 0.50. The highest a_w value was obtained in the P3 treatment with the addition of 0.75% CMC concentration, i.e., 0.56. The increased water activity of jam sheet was due to the ability of CMC to bind water. According to Filipčev *et al.* (2021), CMC is a hydrocolloid that contains many polar hydroxyl groups capable of binding water. The increase in water activity was due to CMC having a rather weak ability to bind water. Khairunnisa *et al.* (2015), studied the increase in watermelon a_w fruit leather was due to the weak water-holding capacity of the hydrocolloids used.

3.5 Sensory evaluation

Sensory information provides information related to consumer acceptance of the product and explores possible opportunities for a new product on the market, or the need for reformulation (Sánchez *et al*., 2021).

Colour is the first sensory property seen directly by the panellists (Sutiono *et al.,* 2022). The addition of CMC did not show any significant difference in the colour parameters. This is because CMC is white and when dissolved in water it turns clear. According to Jongwuttanaruk *et al.* (2019), CMC is a hydrocolloid in the form of a powder, has a white colour and does not have a special aroma. Besides being caused by the use of white CMC, the colour of the red guava jam produced is bright red which comes from the red guava fruit itself. Kamaluddin and Handayani (2018), revealed that the fruit leather product produced has the same colour as the colour of the fruit used because it uses a white hydrocolloid type. The use of a good stabilizer has properties that will not change the original colour of the product. This is supported by Sulistijowati *et al.* (2021), who reported that the characteristics of a good stabilizer to be added to food products are odourless, colourless, and solid therefore it will not affect the resulting product.

Taste is a determining factor in consumer acceptance of a product. The taste parameter is the most influencing

Table 1. Results of chemical and sensory test of red guava jam sheet.

Parameter	CMC Concentrations				
	0%	0.25%	0.50%	0.75%	1%
pH value	3.52±0.09^{a}	3.84±0.04^{b}	4.00±0.06^{c}	4.29±0.76^{d}	4.51±0.56^{e}
Moisture Content	10.66±0.53^{a}	11.93±0.41^{ab}	10.78±1.95^{a}	13.17±0.31^{bc}	14.89±1.54^{c}
Total dissolved solids	19.9±1.36^{ab}	19.95±0.50^{ab}	19.47±0.51^{ab}	17.47±0.94^{a}	22.25±4.00^{b}
Water Activity	0.50±0.03^{a}	0.52±0.02^{a}	0.52±0.03^{a}	0.56±0.01^{b}	0.55±0.01^{b}
Colour	2.80±1.13^{a}	4.03±0.65^{b}	3.50±0.99^{bc}	3.23±0.91^{a}	3.36±0.83^{bc}
Flavour	3.03±1.13^{a}	3.40±0.98^{a}	3.53±0.88^{ab}	3.00±0.73^{ac}	2.93±0.72^{ac}
Aroma	2.86±0.80	3.09±0.71	3.00±0.93	2.83±0.82	2.83±0.77
Texture	3.56±0.91^{a}	3.26±0.89^{ab}	3.06±0.89^{b}	2.43±0.95^{c}	2.30±0.79^{c}
Overall	3.00±0.78^{a}	4.00±0.85^{a}	3.00±0.91^{a}	3.00±0.86^{ab}	3.00±0.71^{ab}

Values are presented as mean±SD. Values with different superscripts within the same row are statistically significantly different ($p<0.05$).

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factor for consumer acceptance, followed by aroma and colour parameters. The taste of the red guava jam comes from the red guava fruit and the added sugar (Megido *et al.,* 2016), and this observation was in agreement with Linggawati *et al.* (2020), who reported that CMC has no taste and that the taste of red guava jam is influenced by the interaction between sugar and added citric acid.

The value of sensory aroma from Table 1 shows that the sensory with aroma parameters are still in the category of moderately favoured by the panellists. The addition of different concentrations of CMC did not show any significant difference in the aroma parameters. This is because CMC and added sugar do not have a distinctive aroma. Khairunnisa *et al*. (2015) reported that the addition of different concentrations of CMC has no effect on the fruit leather produced because CMC has a neutral aroma. This is also reinforced by the opinion of Zaidiyah *et al.* (2021), whereby the addition of a stabilizer that does not have a distinctive aroma, therefore it will not affect the resulting product.

Sheet red guava jam with the addition of 0% CMC has a texture that is not too dry, not too sticky or chewy, while the texture of red guava jam with a concentration of 1% CMC has a texture that is not dry but the softness is reduced. The higher the added CMC concentration, the lower the preference value for the texture of red guava jam. This is presumably because the addition of CMC will increase the hardness. According to the study by Fitriana *et al.* (2021), the greater the amount of hydrocolloid added, the denser the gel matrix therefore it can reduce the hollow structure, reduce elasticity and increase hardness.

The addition of different CMC concentrations showed an effect but was not significantly different from the overall parameters. Where the higher concentration of CMC added tends to decrease the panellist's preference for the overall properties of sheet red guava jam. Septiani *et al.* (2013) reported that the addition of hydrocolloid concentration decreased the panellists' preference level, besides that the addition of hydrocolloids had an effect but was not significantly different on the overall because the assessment of the parameters of colour, taste, and texture, in general, had an effect but not significantly different.

4. Conclusion

Based on the research data, it can be concluded that the addition of CMC concentration in the jam sheet affects the pH value, total dissolved solids, water content and water activity. Meanwhile, the sensory addition of CMC affects colour, taste, texture, and overall. For the value of aroma preference, the addition of CMC does not have a significant effect. The best treatment obtained was the addition of 0.5% CMC concentration which resulted in the optimum pH value for gel formation, relatively low water content and a_w value, high total dissolved solids and the sensory attribute of red guava jam flavour which the panellists liked.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5