



Effect of Carboxyl Methyl Cellulose Addition and Heating Time on The Production of Keribang Barbant Jam (*Dioscorea alata* L.)

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Abstract

Keribang tubers are a prospective local food and can be used as food for claims and food diversification. Anthocyanins from keribang tubers can be processed into food products, one of them is made into jam. Jam is a food product with a gel consistency, therefore a thickening agent such as Carboxyl Methyl Cellulose (CMC) is needed. The purpose of this study was to determine the effect of adding CMC and heating time as well as the best combination to the physicochemical characteristics of keribang tuber jam. This research design used a Randomized Block Design (RAK) with two treatment factors, consisting of 3 treatments of CMC (0.5%; 0.75%; and 1%) and 2 treatments of heating time (15 minutes and 20 minutes), with 4 replications. Parameters observed were water content, total polyphenols, total dissolved solids, antioxidant activity, smearing power, and organoleptic tests. The best treatment was tested using the effectiveness index test. The results showed that CMC concentration treatment and heating time did not significantly affect the water content, total dissolved solids content, antioxidant activity, and spread ability, but significant on the total polyphenol content value in keribang tubers jam. The organoleptic test showed that the panelists preferred the keribang tubers jam with a CMC concentration of 0.5% and a heating time of 15 minutes in terms of color and texture. Based on the effectiveness index test, the best treatment for keribang tubers jam was 1% CMC concentration and 20 minutes of heating time.

Keywords: Keribang Tubers, Jam, Carboxyl Methyl Cellulose, Heating Time

Key Messages:

- The addition of 1% CMC and heating time of 20 minutes resulted in the best physicochemical properties and organoleptic acceptance of keribang tuber jam.

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1. Introduction

Keribang tubers (*Dioscorea alata* L.) is a carbohydrate-producing plant, and is a prospective local food and can be used as a claimed food and food diversification material, especially in West Kalimantan (1). The nutritional content contained in keribang tubers is water, carbohydrates, protein, fat, minerals (calcium, phosphorus, iron) and vitamins (B1, C). Keribang tubers contain lots of nutrients and functional components such as mucin, dioscin, allantoin, choline, essential amino acids, and anthocyanins (2).

Anthocyanins are believed to have a very good antioxidant effect because they can destroy free radicals and are more effective than vitamin E which has been known as a strong antioxidant (3). Anthocyanins and various forms of their derivatives can inhibit various oxidation reactions with various mechanisms (4). Keribang tubers which has anthocyanins can be processed into processed food products, one of them is made into jam. Jam is a type of processed food derived from fruit juice or fruit that has been crushed, added with sugar, and cooked until thickened (5). The formation of gel in jam is highly desirable.

During food processing, high heating can cause the anthocyanins contained in the material to be damaged, as well as the heating temperature, heating time, and the size of the material to be processed (6). The best process to prevent damage to antioxidants and other flavonoid compounds is processing with high temperatures, but in a short term. In the processing of jam products, the problem that often occurs is the problem of poor gel formation during cooking. The solution to this problem in making jam requires additional hydrocolloid types, one of them is Carboxyl Methyl Cellulose (CMC). CMC is a substance that can be used in food as a thickener and emulsion stabilizer. CMC can be synthesized from plant cellulose or cotton. CMC can bind water so that water molecules are trapped in the gel structure formed by CMC (7). CMC functions as an emulsion stabilizer, thickener, binder and gelling agent (8).

This keribang tuber jam is expected to have an attractive color when consumed, and has a high anthocyanin content. The addition of CMC is thought to affect the texture and color concentration of the jam to be made and the heating time is also thought to affect anthocyanin levels so that it can reduce the color properties of keribang tuber jam. Therefore, it is expected that the resulting keribang tuber jam product can produce good physicochemical value.

2. Methods

The main ingredients used in this study were keribang tubers obtained from Flamboyan Market and CMC from Centrum Cake Shop. Other ingredients for making jam are citric acid, vanilla, sugar and water. The analytical materials used were DPPH, ethanol, distilled water, aluminum foil, plastic cups, plastic zip locks, and plastic wrap. The tools used in jam processing are basins, scissors, choppers (Mitochiba), pans, wooden stirrers, electric stoves (Kuche), and stopwatch. The tools used for analysis were stationery, oven (Philip Harris Ltd. Shenstone), micropipette (Nesco Dragon Lab 100-1000 μ L), beaker glass, Erlenmeyer, UV-Vis spectrophotometer (Shimadzu UV-1201V), desiccator, analytical balance, (Mettler AE200), porcelain cup, vortex (Thermo Scientific), dropping pipette, measuring pipette, and cuvette.

The design of this study used a randomized block design (RBD) which consisted of two factorials, namely the addition of CMC (A) with three treatments and heating time (B) with two treatments. This research was conducted in 4 replications, thus obtaining 24 experimental units. Factor 1 addition of CMC: a1 = 0,5%; a2 = 0,75%; a3 = 1%. Factor 2 heating time: b1 = 15 minute; b2 = 20 minute.

Making Keribang Tuber Porridge (9)

Keribang tubers were peeled and washed to remove dirt, then it were steamed for 30 minutes. After steaming, the next step is to weigh the ingredients, namely 100 grams of keribang tubers. The material that has been weighed is put into the chopper and add 200 mL of water.

Making Keribang Tuber Jam (10)

100 grams of keribang tuber pulp is weighed, then poured into pan and added sugar, citric acid, vanilla, and CMC with treatments including 0.5%, 0.75% and 1%. After mixing all the ingredients, the jam is heated for 15 minutes and 20 minutes and stirred until it thickens. After that, the packaging then becomes the product of keribang tuber jam.

Water Content Analysis (11)

Water content was carried out using the oven method. Analysis of the water content starts from weighing the sample which has been mashed as much as 2 grams in a weighing bottle whose weight is known. Then dried in the oven at 100°C for 3 hours. After that it was cooled in a desiccator and weighed. After that it was cooled in a desiccator and weighed. Reheated in the oven for 30 minutes and cooled in a desiccator, then weighed again. This treatment was repeated until a constant weight was achieved with a weighing difference of less than 0.2 mg. The calculations:

$$\text{Water content} = \frac{\text{wet weight} - \text{weight after drying}}{\text{wet weight}} \times 100\%$$

Total Polyphenols (12)

Total polyphenol levels were determined by the differential pH method using spectrophotometry performed by Cheng and Breen. Analysis of total polyphenol levels was carried out for measurement and calculation of total anthocyanin concentrations. The first thing to do is sample preparation, starting from making a solution with a pH of 1.0 and 4.5. Preparation of a pH 1.0 solution was made using 0.465 grams of KCl, then dissolved with distilled water in a 250 mL volumetric tube to the limit and added HCl until the pH reached 1.0. Preparation of a pH 4.5 solution was made using 8.2 grams of sodium acetate, then dissolved with distilled water in a 250 mL volumetric tube to the limit and added HCl to a pH of 4.5. After preparing the buffer solution, the next step is to prepare the sample to be tested, one jam sample is weighed twice as much as 2 grams and then dissolved in a buffer solution of pH 1.0 and 4.5. The dissolved sample was then filtered using filter paper to filter the precipitate, then the absorbance of each sample was measured spectrophotometrically at the maximum absorption wavelength of 510 nm and at a wavelength of 700 nm (as absorbance correction) with a solution of pH 1.0 and pH 4, 5. The total anthocyanin content is calculated by the formula:

$$\% \text{ Anthocyanin} = \frac{\text{absorbance} \times \text{MW} \times \text{DF}}{\epsilon \times L}$$

$$\text{Absorbance} = (A_{510} - A_{700}) \text{ pH } 1,0 - (A_{510} - A_{700}) \text{ pH } 4,5$$

Total Dissolved Solids (11)

Total dissolved solids of jam will be determined using a refractometer. Calculation of total dissolved solids was carried out by dropping 1 drop of sample which had been diluted with distilled water (1:3 ratio) on the prism of the refractometer and then allowed to stand for 1 minute to reach the desired temperature. Dark and light boundaries are set precisely and clearly in the middle of the lens. Total dissolved solids are read from the lenses of two refractometers with units of measurement (°Brix).

Antioxidant Activity (13)

Determination of the antioxidant activity of keribang tuber jam was carried out by modifying the method of Sugiat et al. Keribang tuber jam is made with a concentration of 500 ppm. 1 mL of jam solution was taken and put into a container, then 1 mL of DPPH solution (100 ppm) was added. Add 4 mL of methanol, then homogenize using a vortex. This solution was incubated at room temperature for 30 minutes. Furthermore, the absorption was measured at a wavelength of 517 nm. The percentage of inhibition is calculated using the following formula:

$$\% \text{ Inhibition} = [1 - (A \text{ Sample} / A \text{ Control})] \times 100\%$$

Spread Ability (14)

Spreadability is the ease with which the jam is spread on one glass. A sample of 3 grams is flattened along 2 cm on the tip of a basting knife. The sample is smeared on the topical area to the farthest distance that can be achieved. The farthest distance is the distance that the sample can reach without the spread being interrupted. The farthest distance that the sample can reach is measured with a ruler.

Organoleptic Test (14)

The organoleptic test was carried out using the preference test method. The scale used in this preference test is a numerical scale, with conversion values as follows: 1 = do not like it; 2 = do not like it much; 3 = like it; 4 = more like it; 5 = very like it

The panelists used in this organoleptic test were 30 students of Food Science and Technology, Faculty of Agriculture, Tanjungpura University, Pontianak..

3. Results

Water Content

The results of ANOVA analysis showed that the CMC treatment and the interaction of the two treatments had no significant effect on the water content of the keribang tubers jam, while the heating time had a significant effect on the water content of the keribang tuber jam. The results of the water content of each treatment and the Tukey test can be seen in Table 1.

Table 1. Water Content of Keribang Tubers Jam

CMC (%)	Water Content (%)
0,5	48,10±4,60
0,75	50,02±4,75
1	48,59±2,93
Heating Time (Minutes)	Water Content (%)
15	50,34±3,28 ^a
20	47,46±4,42 ^b

Tukey 5% = 5,81

*Note: numbers followed by the same letters are not significantly different based on the Tukey test at the 95% level of confidence

Total Polyphenols

The results of ANOVA analysis showed that the CMC treatment, heating time, and the interaction of the two treatments had a significant effect on the total polyphenol content of the keribang tuber jam. The results of total polyphenol levels and the Tukey test for each treatment can be seen in Table 2.

Table 2. Total Polyphenols of Keribang Tubers Jam

CMC (%)	Total Polyphenols (%)
0,5	2,26±0,53 ^b
0,75	2,21±0,66 ^b
1	3,28±1,24 ^a
Heating Time (Minutes)	Total Polyphenols (%)
15	2,09±0,39 ^b
20	3,08±1,13 ^a

Tukey 5% = 0,61

CMC (%) and Heating Time (Minutes)	Total Polyphenols (%)
0,5; 15	2,08±0,61 ^b
0,75; 15	2,02±0,33 ^b
1; 15	2,17±0,25 ^b
0,5; 20	2,37±0,50 ^b
0,75; 20	2,47±0,87 ^b
1; 20	4,40±0,50 ^a

Tukey 5% = 0,88

*Note: numbers followed by the same letters are not significantly different based on the tukey test at the 95% level of confidence

Based on Table 2, the total polyphenol content has an increasing trend with increasing CMC and heating time in keribang tuber jam. The lowest total polyphenol content (2.02%) was found at 15 minutes interaction with 0.75% CMC concentration, while the highest total polyphenol content (4.40%) was at 20 minutes interaction with 1% CMC concentration.

Total Dissolved Solids

The results of ANOVA analysis showed that the CMC treatment had a significant effect on the keribang tuber jam, while the heating time and interaction of the two treatments had no significant effect on the total dissolved solids content of the keribang tuber jam. The results of the total dissolved solids content and the Tukey test for each treatment can be seen in Table 3.

Table 3. Total Dissolved Solids of Keribang Tubers Jam

CMC (%)	Total Dissolved Solids (°Brix)
0,5	7,25±0,58 ^a
0,75	7,43±0,50 ^{ab}
1	7,65±0,75 ^b
Tukey 5% = 0,57	
Heating Time (Minutes)	Total Dissolved Solids (°Brix)
15	7,65±0,75
20	7,71±0,76

* Note: numbers followed by the same letters are not significantly different based on the tukey test at the 95% level of confidence

Antioxidant Activity

The results of ANOVA analysis showed that the CMC treatment, heating time, and the interaction of the two treatments had no significant effect on the antioxidant activity of the keribang tuber jam. The results of the antioxidant activity of each treatment can be seen in Table 4.

Table 4. Antioxidant Activity of Keribang Tubers Jam

CMC (%)	Antioxidant Activity (%)
0,5	5,08±2,62
0,75	5,63±2,12
1	4,58±2,59
Heating Time (Minutes)	Antioxidant Activity (%)
15	5,39±2,40
20	4,81±2,45

Spread Ability

The results of ANOVA analysis showed that the CMC treatment, heating time, and the interaction of the two treatments had no significant effect on the spread ability of keribang tuber jam. The results of the topical power of each treatment can be seen in Table 5.

Table 5. Spread Ability of Keribang Tubers Jam

CMC (%)	Spread Ability (cm)
0,5	9,12±1,45
0,75	9,38±1,08
1	9,03±1,44
Heating Time (Minutes)	Spread Ability (cm)
15	9,62±1,59
20	8,74±0,72

Organoleptic Test

The results of Friedman test showed that there was a difference in the average keribang tubers jam in each treatment with CMC concentration and heating time. The average hedonic test value of keribang tuber jam with time and texture parameters can be seen in Table 6.

Based on Table 6, the results of the panelists' assessment of color and texture showed that the keribang tubers jam obtained from the 6 treatments gave different values. The results of the average rating of 30 panelists using the hedonic method through organoleptic testing, the panelists gave a score of keribang tubers jam from 2.80 to 3.86 (less like) for the color parameter. The results of the organoleptic test for color showed that the most preferred color by the panelists was keribang tubers jam in the treatment with 0.5% CMC concentration and 15 minutes of heating time with a score of 3.86 (liked), and the least preferred was keribang tubers jam in the treatment CMC concentration of 1% and 20 minutes of heating time with a score of 2.80 (don't like it). These different scores are due to the warm-up time.

Table 6. Organoleptic Test of Keribang Tubers Jam

Treatment (%; minutes)	Average Hedonic Test Value of Keribang Tuber Jam	
	Color	Texture
0,5 ; 15	3,86	3,70
0,75 ; 15	3,53	3,30
1 ; 15	3,30	3,30
0,5 ; 20	2,86	2,67
0,75 ; 20	2,83	2,30
1 ; 20	2,80	2,16

Effectiveness Index Test

The results of the effectiveness index test showed that the best treatment was found at 1% CMC concentration and 20 minutes of heating time. The value of the effectiveness index test for various treatments can be seen in Table 7.

Table 7. Effectiveness Index Test

Treatment (%; minutes)	Treatment Value
0,5 ; 15	0,49
0,75 ; 15	0,47
1 ; 15	0,44
0,5 ; 20	0,28
0,75 ; 20	0,30
1 ; 20	0,48

* Note: (BOLD) the best treatment.

4. Discussion

Water plays an important role in food ingredients because water can affect the appearance, texture and taste of food. High water content can affect the durability of materials, shorten shelf life, and facilitate the growth of microorganisms (3). High water content can make it easier for bacteria, mold and yeast to multiply, so changes will occur in food ingredients (3). Based on SNI (2008) (15), the maximum water content value contained in fruit jam is 35%, so keribang tubers jam doesn't meet the requirements of SNI. The water content of keribang tubers jam is affected by the length of heating time, this is because the water content of the jam will decrease during the heating process. The process that occurs is that the heat generated by heating enters the material and then

replaces the water content that comes out into steam. Long heating time can cause free evaporation of water, so it can reduce the water content of the jam. High water content can form the texture of the jam but reduce the durability of the jam (14). The results of the water content in this keribang tuber jam have results that are close to the results of research by Siagian et al. (14) in pineapple jam which showed that the water content ranged from 43.99-63.17% with a CMC concentration of 0.5-1.5% and a cooking time of 20-30 minutes.

Spread ability is the ability of a jam to be spread evenly on bread. Jam with good spread ability can be spread on the surface of the bread easily to produce an even spread (16). The spread ability of the jam is related to the texture and viscosity of the jam (17). Spread ability is the most influential quality attribute in determining the quality of jam, which has good gel consistency and spreadability (18). Spread ability is related to the water content and viscosity of the jam. If the water content of the jam is low, the resulting viscosity will be high and difficult to spread. The addition of CMC which increases in each treatment can result in a decrease in the water content of the jam, so that the spreadability of the resulting jam is high (19).

Heating time can also affect the spreadability of keribang tuber jam. This is because heating for too long can cause the jam to become hard and conversely if the jam is cooked too short it will produce runny jam, so the longer the heating the jam spreads too (20). Keribang tuber jam with a heating time of 15 minutes produces jam that has good spreadability, which is not too broken and not runny. However, the keribang tuber jam with a heating time of 20 minutes produces jam that has spreadability that is difficult to spread, this is because the texture of the resulting jam is too chewy and also very sticky. The results of the topical power of keribang tuber jam have results that are close to the results of research by Nafi et al. (21) in the koro sword jam which showed the results of its spreading power ranged from 11.47-16.82 cm with a heating time of 10 minutes and a temperature of 80-90°C.

Total dissolved solids are a number of materials dissolved in a solution consisting of organic and inorganic compounds. Total dissolved solids are generally expressed in a percentage of sucrose sugar and can affect the physical and chemical properties of a product, such as freezing point, boiling point, viscosity and solubility. (22). The total dissolved solids are affected by the increase in CMC, this is because an increase in the amount of CMC added can bind free water which can increase the water content of the jam so that the dissolved solids are also greater (23). CMC has the ability to bind water which is greater than other stabilizers (24). The results of total dissolved solids contained in keribang tubers jam had lower dissolved solids when compared to research on beetroot jam with the addition of cinnamon by Wardani et al. (10) which obtained total dissolved solids levels ranging from 42.54-50.73 °Brix with a CMC concentration of 1-1.5% with a heating time of 50 minutes.

Based on Table 2, the total polyphenol content has an increasing trend with increasing CMC and heating time in keribang tuber jam. The lowest total polyphenol content (2.02%) was found at 15 minutes interaction with 0.75% CMC concentration, while the highest total polyphenol content (4.40%) was at 20 minutes interaction with 1% CMC concentration. The results of the total levels of polyphenols in keribang tuber jam have results that are close to those of Attahmid et al. (25) in chocolate jam in West Sulawesi which showed total polyphenol content ranging from 2.34-2.6% with 12 hours of heating time at 50°C. Anthocyanins are water-soluble pigments that give large amounts of the red, blue and purple colors to fruits and vegetables. The stability of anthocyanins can be affected by temperature. The rate of breakdown or degradation of anthocyanins can increase during an increase in heating temperature. Thermal degradation causes loss of color in anthocyanins which eventually causes browning (26).

CMC is a derivative of cellulose so it has properties similar to cellulose, namely its hydrophilic nature. This hydrophilic nature affects the maximum binding power (27). Research by Ćorković et al. (27), showed that the maximum binding capacity of polyphenols to CMC was 4% and the higher the CMC content added, the higher the polyphenol content.

Heating time can affect the anthocyanin levels of keribang tubers jam. This is shown in the color of the

jam which originally had a bright reddish purple color to red-brown, and indicates that the anthocyanin content contained in the jam has been damaged (25). Research by Ali (25) also stated that the decrease in color stability was caused by high temperatures so that damage to anthocyanin pigments could occur.

The total polyphenol content of keribang tubers jam has an increasing trend with increasing CMC concentration and heating time, this is thought to be caused by the addition of CMC which is still below 4% and the heating temperature used when cooking keribang tuber jam is safe for anthocyanins, namely 70°C, so long heating time can retain the anthocyanins contained in keribang tuber jam. Citric acid contained in keribang tuber jam can also affect anthocyanin, this is because citric acid can cause more and more anthocyanin pigments to be extracted and absorbance measurements will show an increasing amount of anthocyanin (25).

Polyphenols are the components responsible for the antioxidant activity in fruits and vegetables (28). Polyphenols function as antioxidants that can stabilize free radicals by complementing the lack of electrons possessed by free radicals, and inhibit the chain reaction of the formation of free radicals. One of the polyphenolic compounds that functions as an antioxidant is anthocyanin. Anthocyanin is an antioxidant compound that is unstable when exposed to heat, resulting in kerian jam with very low antioxidant activity. During jam processing, the effect that will occur on the antioxidant content is anthocyanin degradation which can be caused by high cooking temperatures and long cooking times (29). The process of steaming keribang tubers is thought to decrease antioxidants, this is because steaming can reduce anthocyanin levels in keribang tubers. The results of this study are supported by the statement of Azizah et al. (30), namely the steaming process can result in lower antioxidant content in vegetables that have been processed than fresh vegetables. The results of antioxidant activity in keribang tuber jam had lower results when compared to the results of research by Asben et al. (31) in passion fruit jam which showed the results of antioxidant activity ranging from 16.55-40.49% with a heating time of 10 -20 minutes at a temperature of 50°C.

Based on Table 6, the results of the panelists' assessment of color and texture showed that the keribang tubers jam obtained from the 6 treatments gave different values. The results of the average rating of 30 panelists using the hedonic method through organoleptic testing, the panelists gave a score of keribang tubers jam from 2.80 to 3.86 (less like) for the color parameter. The results of the organoleptic test for color showed that the most preferred color by the panelists was keribang tubers jam in the treatment with 0.5% CMC concentration and 15 minutes of heating time with a score of 3.86 (liked), and the least preferred was keribang tubers jam in the treatment CMC concentration of 1% and 20 minutes of heating time with a score of 2.80 (don't like it). These different scores are due to the warm-up time.

Color is an important component to determine the acceptability of a food ingredient. Determination of the quality of a food ingredient generally depends on color, because color appears first (3). The color of the keribang tuber jam produced at the 15-minute heating time produced a purple color that was brighter and was preferred by the panelists, while the color of the keribang tuber jam at the 20-minute heating time produced a purple color that was slightly dark brown. The dark color of the jam is caused by one of the weaknesses of anthocyanins, namely the rate of destruction (degradation) of anthocyanins tends to increase during an increase in temperature. Thermal degradation causes loss of color in anthocyanins which eventually causes browning (32).

Good jam must have a good texture, meaning not too runny. The texture of the keribang tuber jam produced at a CMC concentration of 0.5% and a heating time of 15 minutes was the thickest jam texture but the most watery among all samples, while the texture of the keribang tuber jam produced at a CMC concentration of 1% and a heating time of 20 minutes was the jam texture. the thickest and more difficult to smear than all samples. This is because the gel formed from CMC and sugar provides a strong texture (33). This increase in viscosity also occurs because the added CMC has the ability to bind water, so that water molecules are trapped in the texture of the gel formed. (34).

On effectiveness index test, the texture and color of keribang tuber jam gets the highest weight because if the texture of the jam is too thick or hard, the jam will be difficult to spread on bread and is found in one of the SNI attributes of jam. Color ranks first in the weighting of the effectiveness index to determine consumer preferences for the quality of jam products and is found in one of the SNI attributes.

Water content is in third place because based on SNI (2008), the water content that must be present in jam is a maximum of 35%. The higher the water content, the faster the quality of the keribang tuber jam will deteriorate. The level of total dissolved solids ranks fourth because based on SNI (2008), the total dissolved solids that must be present in jam is at least 65%. The topical power value is in fifth place in the weighting of the effectiveness index. The desired spread is jam that has a long spread without breaking when it is spread on the bread. The antioxidant activity of keribang tuber jam comes from the polyphenol content found in keribang tubers, namely anthocyanins, so that the total polyphenol content is the final weight after antioxidant activity is expected to have high antioxidant content and have benefits when consumed.

The results of the effectiveness index test showed that the best treatment was at a CMC concentration of 0.5% and a heating time of 15 minutes with an antioxidant activity of 5.55%, a total polyphenol content of 2.08%, a moisture content of 50.30%, a total dissolved solids content of 8, 55°Brix, smear power 9.67 cm, texture with a favorite result of 3.70, and color with a favorite result of 3.86. Based on the results of this effectiveness index test, the research hypothesis was rejected.

5. Conclusion

Based on the results of ANOVA analysis, CMC concentration and heating time did not significantly affect water content, total dissolved solids content, antioxidant activity, and spread sability, but CMC concentration and heating time had a significant effect on the total polyphenol content of keribang tubers jam. Organoleptic tests showed that the average panelist preferred keribang tuber jam with 0.5% CMC concentration and 15 minutes of heating time in terms of color and texture. Based on the effectiveness index test, the best treatment for keribang tuber jam was jam with 1% CMC concentration and 20 minutes of heating time, so the research hypothesis was rejected.

The antioxidant activity and total content of polyphenols has a very small content, so it is necessary to add a co-pigmentation agent that has a less sour taste in order to increase the antioxidants and anthocyanins of jam. It is hoped that the manufacture of keribang tuber jam will not conduct research on the addition of CMC, this is because the keribang tuber jam has results that are not much different at each addition. In addition, it is desirable to make jam with a cooking temperature of 100°C so that the jam has a low water content and lasts longer.

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