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Improved Tamarillo (*Cyphomandra betacea Sendtn*) Fruit Juice Quality with Carboxymethyl Cellulose Extracted from Cassava Peel (*Manihot esculenta Crantz*)

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ABSTRACT

The utilization of Carboxymethyl Cellulose (CMC) from cassava peel (*Manihot esculenta Crantz*) through the quality of Tamarillo (Cyphomandra betacea Sendtn) juice was carried out through three stages. The first stage is α-cellulose isolation from cassava peel powder using an acid method and then comparing it with commercial cellulose using FTIR analysis. The second stage is an α-cellulose conversion into CMC by alkalization (using isopropanol and NaOH), carboxymethylation (using NaMCA), neutralization (using CH_3COOH 90% and ethanol), purification (using distilled water followed by centrifugation and the addition of acetone which produces CMC with positive results), and then comparing isolated CMC with commercial CMC by using FTIR analysis. The last stage is Tamarillo fruit juice preparation with and without CMC addition. At this stage, the concentration of CMC was carried from 0%, 0.25%, 0.5%, 0.75%, 1%, and 1.25%. The resultant juice was analyzed for its quality by stability (letting it stand for 24 hours), pH (with a pH meter), viscosity (with an Ostwald viscometer), vitamin C content (using the iodimetry method), antioxidant activity (using the free radical scavenging method with a solution and using a UV-VIS spectrophotometer), and organoleptic (tests on 30 untrained panellists). The best results were obtained from Tamarillo juice containing 1.25% CMC, which has 73% stability, pH 4.49, viscosity of 77.79 cP, vitamin C content of 25.32 mg/100 g and antioxidant activity of 59%. Organoleptic test results showed that fruit juice with the addition of 0.75% CMC was the most preferred result by panellists based on aroma, taste, texture, and color.

Keywords: Carboxymethyl Cellulose, Cassava Peel, Cellulose, Fruit Juice

ABSTRAK

Pemanfaatan Carboxymethyl Cellulose (CMC) dari kulit ubi kayu (*Manihot esculenta Crantz*) terhadap mutu sari buah terong belanda (Cyphomandra betacea Sendtn) dilakukan melalui tiga tahap. Tahap pertama adalah proses isolasi α-selulosa dari serbuk kulit ubi kayu dengan metode asam kemudian dianalisis menggunakan analisis FTIR dengan membandingkan hasil analisis FTIR yang didapat dengan hasil analisis FTIR pada selulosa komersil sehingga menunjukkan bahwa senyawa tersebut adalah molekul selulosa. Tahap kedua adalah proses pembuatan CMC yaitu alkalisasi menggunakan isopropanol dan NaOH, proses karboksimetilasi menggunakan NaMCA, netralisasi menggunakan CH_3COOH 90% dan ethanol serta pemurnian menggunakan aquades diikuti proses sentrifugasi dan penambahan acetone yang menghasilkan CMC dengan hasil positif pada analisa kualitatif, kemudian menganalisa peak FTIR pada CMC yang diisolasi dengan CMC komersil. Tahap terakhir adalah proses pembuatan sari buah. Pada tahap ini, CMC yang ditambahkan dalam pembuatan sari buah divariasikan konsentrasinya mulai dari 0%; 0,25%; 0,5%; 0,75%; 1% dan 1,25%. Sari buah yang dihasilkan dilakukan analisa kualitas yaitu stabilitas dengan mendiamkannya selama 24 jam, pH dengan alat pH meter, viskositas dengan alat viskometer ostwald, kadar vitamin C dengan metode iodimetri, aktivitas antioksidan dengan metode peredaman radikal bebas dengan larutan serta mengunakan spektrofotometer UV-VIS dan uji organoleptik pada 30 panelis tidak terlatih. Hasil penelitian terbaik diperoleh dengan penambahan konsentrasi CMC 1,25% dengan hasil uji kualitas stabilitas 73%, pH 4,49, viskositas 77,79 cP, kadar vitamin C 25,32 mg/100 g dan aktivitas antioksidan 59%. Hasil uji organoleptik menunjukkan bahwa sari buah dengan penambahan CMC 0,75% merupakan hasil yang paling disukai panelis berdasarkan aroma, rasa, tekstur dan warna.

Keyword: Karboksimetil Selulosa, Kulit Ubi Kayu, Sari Buah, Selulosa

1. Introduction

Food Additives (FA) are substances that do not include essential food ingredients. FA, with or without nutritional value, is intentionally added to food during manufacture, processing, treatment, packaging, or storage. It is expected to produce or affect food properties directly or indirectly. In the Regulation of the Minister of Health (Perkemenkes) of the Republic of Indonesia Year 2012 Number 033 and Regulation of the Food and Drug Supervisory Agency (BPOM) Year 2019 Number 11 explains that FA is a material added to food to affect the nature or form of food [1].

One of the FAs is Carboxymethyl Cellulose (CMC), a cellulose derivative through alkalization and carboxymethylation processes. In the Regulation of Indonesia Minister of Health (Perkemenkes) Year 2012 Number 033 concerning FA and Regulation of the Food and Drug Administration (BPOM) Year 2019 Number 11 also explains that CMC functions as an emulsifier, thickener, volume enhancer, and stabilizer. CMC is one of the additives that is often used in the world of health, pharmacy, nutrition, food, and beverages which can be synthesized from various plants such as coconut fronds, kincung stems, empty palm bunches, durian peel, banana stems, elephant grass, bagasse, water hyacinth, corn stalks, salak seeds and so on [2].

Indonesia produces an immense amount of cassava in agriculture, which can lead to an abundance of cassava peels as agricultural residues. Cassava production of 19.5 million tons with a land area of 1.24 million ha can produce cassava peels reaching 3.9 million tons. Cassava peels are a readily available and inexpensive source of cellulose that contains 80-85% of the weight of cassava peels [3].

Cassava peel in Indonesia is abundant, while its utilization and processing are still lacking, especially in North Sumatra. Therefore, in producing cellulose derivatives that are good in terms of economy and application in the food sector, it is necessary to convert cassava peel cellulose into Carboxymethyl Cellulose (CMC) through alkalization and carboxymethylation processes [4]

In this study, the authors are interested in making cassava peel (*Manihot esculenta Crantz*) as a raw material for making CMC and applying it to Tamarillo (*Cyphomandra betacea Sendtn*) juice. Tamarillo plants are found in North Sumatra, especially in the Karo Regency area. The public widely consumes tamarillo juice because of its delicious taste and many health benefits. Tamarillo is rich in protein, vitamins (C, E, and B6), provitamin A, low calories, and several minerals (such as calcium, copper, iron, potassium, and magnesium) [5].

However, stored fruit juice often experiences clouding, while clouding is one of the assessments of the appearance of fruit juice. Therefore, stabilizing agents are added to prevent the precipitation of colloidal particles in fruit juice during storage. CMC as a stabilizer is more effective than gum arabic or gelatin in maintaining the quality of fruit juice during storage [6].

Based on the description above, the author is interested in researching the utilization of Carboxymethyl Cellulose CMC from cassava peel (*Manihot esculenta Crantz*) toward the quality of Tamarillo juice (*Cyphomandra betacea Sendtn*).

2. Materials and Methods

2.1. Equipment

The equipment used in this study includes a hot plate stirrer, centrifugation, analytical balancer, desiccator, FT-IR, thermometer, pH meter, Ostwald viscometer, UV-Vis spectrophotometer, Whatman No. 42 filter paper, glass tools, blenders, burets, drop pipettes, reaction tubes, ovens, universal indicators, aluminium foil, magnetic bars, stative, and clamps.

2.2. Materials

The material used in this study were Cassava peel, Tamarillo, distilled water, HNO_3 65%, $NaNO_2$, NaOH pellet, Na_2SO_3, NaOCl 12%, isopropanol, NaMCa, CH_3COOH glacial, ethanol, acetone, $CuSO_4.5H_2O$, 1-Naftal, H_2SO_4 98%, DPPH, sugar, amylum 1%, and standard solution of I_2 0.01 N.

2.3. Preparation of 3.5% HNO_3 Solution

HNO_3 65% solution was measured as much as 53.8 mL with a measuring cup into a 1000 mL volumetric flask; distilled water was added to the limit mark and then homogenized.

2.4. Preparation of 2% NaOH Solution

NaOH pellets were weighed as much as 20 g with an analytical balance, put into a beaker glass, dissolved with distilled water, put into a 1000 ml measuring flask, added distilled water to the limit mark, and then homogenized.

2.5. Preparation of 2% Na_2SO_3 Solution

Na_2SO_3 powder was weighed as much as 10 g with an analytical balance, put into a beaker glass, dissolved with distilled water, put into a 500 ml measuring flask, added distilled water to the limit mark, and then homogenized.

2.6. Preparation of 1.75% NaOCl Solution

The 12% NaOCl solution was measured as much as 145.8 mL with a measuring cup, put into a 1000 mL measuring flask, added distilled water to the limit mark, and then homogenized.

2.7. Preparation of 17.5% NaOH Solution

NaOH pellets were weighed as much as 175 g with an analytical balance, put into a beaker glass, dissolved with distilled water, put into a 1000 mL measuring flask, added distilled water to the limit mark, and then homogenized.

2.8. Preparation of 1.2N $CuSO_4$ Solution

$CuSO_4.5H_2O$ powder was weighed as much as 14.97 g with an analytical balance, put into a beaker glass, dissolved with distilled water, put into a 100 mL measuring flask, added distilled water to the limit mark, and then homogenized.

2.9. Preparation of 1-Naphthol Solution

1-Naphthol powder was weighed as much as 0.50 g with an analytical balance, put into a beaker glass, dissolved with 96% ethanol solution, put into a 100 ml measuring flask, added 96% ethanol solution to the limit mark, and then homogenized.

2.10. Preparation of Cassava Peel Powder

The cassava peel was cleaned and washed under running water, then cut into small pieces. After that, it was dried in the sun and then pulverized using a blender.

2.11. Isolation of α-Cellulose from Cassava Peel

75 g of cassava peel powder was put into a beaker glass, added HNO_3 3.5% as much as 1000 mL and $NaNO_2$ as much as 10 mg, heated at 90ºC for 2 hours while stirring on a hot plate, then filtered and the residue was washed until the pH was neutral. Next, 375 ml of 2% NaOH and 375 mL of 2% Na_2SO_3 were added, heated at 50ºC for 1 hour while stirring on a hot plate, then filtered, and the residue was washed to neutral pH. Next, 500 ml of 1.75% NaOCl was added, heated at 70ºC for 30 minutes while stirring on a hot plate, then filtered, and the residue was washed to neutral pH. Next, 500 ml of 17.5% NaOH was added and heated at 80ºC for 30 minutes while stirring on a hot plate, and the residue was washed until the pH was neutral. Next, 500 ml of 1.75% NaOCl was added, heated at 70ºC for 15 minutes while stirring on a hot plate, filtered, and the residue was washed until the pH was neutral. Next, it was dried in an oven at 60 ºC, stored in a desiccator, and characterized using FT-IR.

2.12. Preparation of Carboxymethyl Cellulose

α-Cellulose as much as 5 g was put into a beaker glass with 100 mL of isopropanol. The mixture was heated at 30ºC for 1 hour on a hot plate. While stirring, 20 ml of 17.5% NaOH was slowly added. Next, 6 g of sodium monochloroacetate was added and heated at 50ºC for 2 hours. Then, the slurry mixture was soaked with methanol for one night, neutralized with CH_3COOH 90% to obtain pH 6-8, and filtered. Then, it was washed with 70% ethanol five times, filtered, dried in an oven at 60ºC for 24 hours, and stored in a desiccator.

2.13. Purification of Carboxymethyl Cellulose

CMC, as much as 5 g, was put into a beaker glass, dissolved with 100 ml of distilled water, and heated at 80ºC for 10 minutes while stirring on a hot plate. The mixture was then centrifuged for 1 minute at 4000 rpm, separating the precipitate from the solution. CMC was added with 100 ml of acetone, filtered, and dried in an oven at 60ºC for 4 hours. Then, it is stored in a desiccator and characterized using FT-IR.

2.14. Qualitative Analysis of Carboxymethyl Cellulose

CMC, 0.5 g was put into a beaker glass with 50 ml of distilled water, then heated at 60-70ºC for 20 minutes on a hot plate while stirring until the solution was homogeneous. Then, it cooled and divided into 3 test tubes.

Tube 1: 5 ml of solution was put into a test tube with 10 mL of acetone and was shaken gently. If (+), a white flocculant is produced.

Tube 2: 5 ml of solution was put into a test tube with 5 mL of 1.2N $CuSO_4$ and was shaken gently. If (+), a light blue flocculant is produced.

Tube 3: 1 ml of solution was put into a test tube with 1 ml of distilled water and five drops of 1-Naphthol solution, then the tube was tilted while flowing 2 ml of H_2SO_4. If (+), a purplish red ring is produced.

2.15. Preparation of Tamarillo Fruit Juice

Tamarillo fruit was washed under running water, the pulp removed, and mashed with a blender. Then water was added 1: 2 (1 kg of tamarillo pulp: 2 litres). The juice obtained is filtered, 200 g of sugar is added, then cooked until cooked while stirring until the sugar dissolves.

2.16. Addition of Carboxymethyl Cellulose

Tamarillo juice 200 ml was added with CMC with concentrations of 0.25%, 0.5%, 0.75%, 1%, 1.25%, and without the addition of CMC as a control. Then, the quality of the tamarillo juice was tested.

2.17. Quality Analysis of Tamarillo Juice Stability

100 ml of tamarillo juice was put into a measuring cup and left for three days until the layers formed. The same thing was done to the tamarillo juice with CMC concentration variations of 0.25%, 0.5%, 0.75%, 1%, and 1.25%. Then, the % stability value was calculated.

2.18. Degree of Acidity (pH)

Tamarillo juice was put into a beaker glass, dipped the pH meter electrode, and left until a stable reading was obtained. The same was done to the aubergine juice with CMC concentration variations of 0.25%, 0.5%, 0.75%, 1% and 1.25%.

2.19. Viscosity

The Ostwald viscosimeter was assembled so that 10 ml of Tamarillo juice was inserted using a rubber ball, and the solution was sucked until it reached the limit mark. Then, the time required for the solution to drop from the upper to the lower limit (repeated three times). The same was done to the aubergine juice with CMC concentration variations of 0.25%, 0.5%, 0.75%, 1%, and 1.25%. Then, the viscosity was calculated.

2.20. Vitamin C Content

10 mL of Tamarillo juice was put into a 100 mL measuring flask, distilled water was added until the limit mark, and then homogenized. Next, 25 ml of the solution was put into an Erlenmeyer, 1 mL of 1% amylum was added, and then titrated using 0.01 N standard iodine solution until a color change occurred. The volume of iodine used was recorded and repeated three times. The same was done to Tamarillo juice with CMC concentration variations of 0.25%, 0.5%, 0.75%, 1%, and 1.25%. Then, the vitamin C content was calculated.

2.21. Manufacture of DPPH 0.5 mM Peraction Solution

20 mg of DPPH powder was weighed and then dissolved in methanol to 100 mL.

2.22. Production of blanco solution C = 50 μg/ml

The 0.5 mM of DPPH solution was piped to 1 mL, inserted into a 5 mL pumpkin, and then filled with the volume of methanol to the mark line to obtain a concentration of 50 μg/mL.

2.23. Measurement of the Absorption Wavelength

Maximum DPPH The 50 μg/mL DPPH solution is homogenized with a vortex, inhabited for 30 minutes, and measured absorption at 400-800 nm, the visible light wavelength.

2.24. Antioxidant Testing

The 0.1 g sample was dissolved in 10 ml of distilled water, pipetted as much as 0.6 ml, and then put into a 5 ml volumetric flask. Into each volumetric flask was added 1 ml of 0.5 mM DPPH (1,1,-diphenny-2-picryllhydrazyl) solution, then sufficed with methanol until the mark, homogenized with a vortex, allowed to stand for 30 minutes, then measured the absorption using a Uv-Visble Spectrophotometer at a wavelength of 516 nm.

2.25. Organoleptic Test

Organoleptic tests were conducted using the Hedonic (favorability test) on 30 untrained panellists aged 20 - 23. Each panellist assessed aroma, taste, texture, and color using a rating scale of 1, 2, 3, 4 and 5. With the understanding: value 1 means immensely dislike, value 2 implies dislike, value 3 means somewhat like, value 4 means like, and value 5 means very like.

3. Results and Discussion

3.1. Isolation of α-Cellulose from Cassava Peel

Through the process of delignification, bleaching, and purification of cassava peel samples, white α-cellulose was produced. From 75 g of cassava peel powder, 6.59 g of pure α-cellulose was obtained (assumed to be 8.79% of the initial mass). The a-cellulose isolation results obtained can be seen in Figure 1.

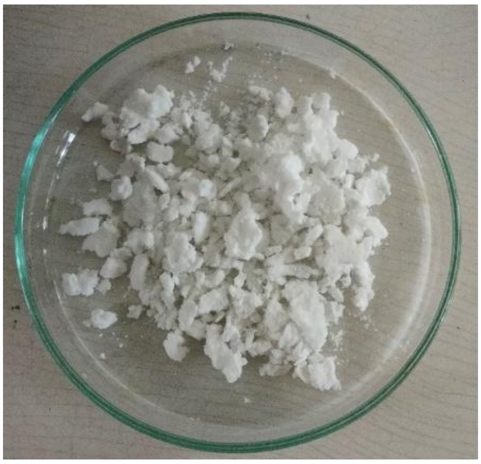


Figure 1: α-cellulose of cassava peel

3.2. Preparation of Carboxymethyl Cellulose

The α-cellulose obtained was then alkalized with isopropanol and 17.5% NaOH, carboxymethylated using sodium monochloroacetate, neutralized with 90% CH_3COOH, purified by washing with ethanol and methanol, and further purification by centrifugation which will then produce white CMC powder. As much as 5 g of α-cellulose powder used had 3.5 g of pure CMC. The results of making CMC can be seen in Figure 2.

Figure 2: CMC from α-cellulose of cassava peel

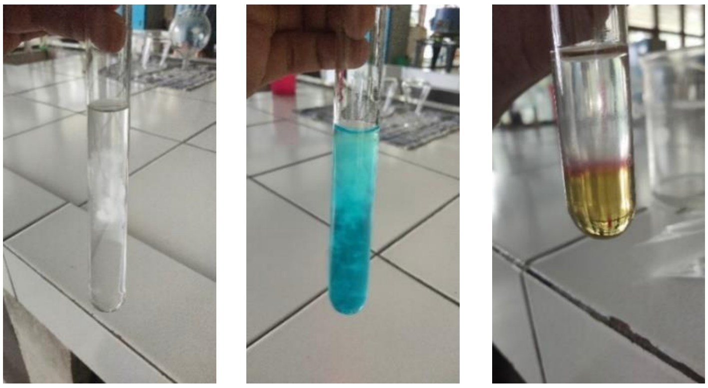
3.3. Qualitative Analysis of Carboxymethyl Cellulose

The resulting CMC is then analyzed through qualitative analysis by adding other chemicals so that the desired changes occur according to existing references. The reagents used are:

Tube 1: The addition of acetone produces white flocculant

Tube 2: Addition of 1.2N $CuSO_4$ solution produces light blue flocculant

Tube 3: The addition of distilled water + 1-Naphthol + H_2SO_4 gives a purplish red ring. This proves that the CMC produced gives positive results, which can be seen in Figures 3a, 3b and 3c.

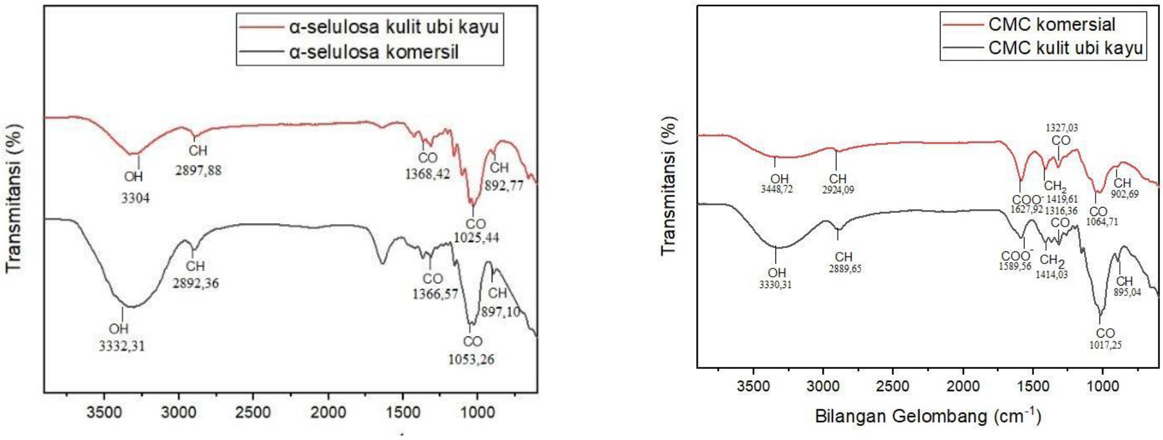


(a) (b) (c)

Figure 3: (a) Addition with acetone, (b) Addition with 1.2 N $CuSO_4$, (c) Addition with distilled water + 1-Naphthol + H_2SO_4

3.4. Function Group Analysis Using FT-IR Spectrophotometer

The analysis of α-cellulose from cassava peel, commercial α-cellulose, CMC from cassava peel, and commercial CMC using FTIR spectroscopy can be seen in Table 1, Figure 4(a) and 4(b). Fourier Transform Infra-Red (FT-IR) analyzes the chemical structure by identifying the functional groups in each sample analyzed. There is no significant difference From the FTIR analysis for the α-cellulose spectra of cassava peel and α-commercial cellulose because both are derived from cellulose. From the FTIR spectra, there are broadened bands in the 3304 cm^{-1} and 3332.31 cm^{-1} absorption regions, which indicate the presence of O-H stretch vibrations of alcohols in cellulose molecules, followed by C-H stretch vibrations of alkane chains in the 2897.88 and 2892.36 cm^{-1} absorption regions. In addition, vibration peaks are also seen in the absorption regions of 1368.42, 1366.57, 1025.44, and 1053.26 cm^{-1}, indicating C-O stretches in cellulose rings. At the same time, the C-H swing vibrations of cellulose are found in the 892.97 and 897.10 cm^{-1} absorption regions, which indicate the presence of β-glycoside bonds in the structure. From the FTIR results, it can be concluded that true α-cellulose of cassava peel and commercial α-cellulose are cellulose compounds.



(a) (b)

Figure 4: (a) FTIR results of cassava peel α-cellulose and commercial α-cellulose, (b) FTIR results of cassava peel CMC and commercial CMC.

There is no significant difference in the analysis of functional groups using FTIR for the spectra of cassava peel CMC and commercial CMC. From the FTIR spectra, there are broadened bands in the absorption areas of 3330.31 and 3448.72 cm^{-1}, which indicate the presence of O-H stretch vibrations of alcohols in cellulose molecules, followed by C-H stretch vibrations of alkane chains in the absorption areas of 2889.65 and 2924.09 cm^{-1}. In the absorption areas of 1589.56 and 1627.92 cm^{-1}, carboxyl derived from sodium monochloroacetate is then supported by absorption peaks at wave numbers 1414.03 and 1419.61 cm-1 indicating the presence of COO- strain vibrations indicating vibrations of CH2- methylene groups from the addition of sodium monochloroacetate. The absorption peaks at wave numbers 1017.25 and 1064.71 cm^{-1} which show vibrations of the symmetrical (C-O) group, and the absorption peaks at wave numbers 1316.36 cm-1 and 1327.03 cm-1, which show vibrations of the (C-O) stretching group in the cellulose ring. The C-H swing vibrations of cellulose are found in the 895.04 and 902.69 cm^{-1} absorption regions, indicating the presence of β-glycoside bonds, which link glucose units in the structure [7].

Table 1. Wavelengths of various functional groups of cassava peel α-cellulose, commercial α-cellulose, cassava peel Carboxymethyl Cellulose (CMC) and commercial Carboxymethyl Cellulose (CMC)

Wave number (cm^{-1})					
α-cellulose from Cassava Peel	**commercial α-cellulose**	**CMC from Cassava Peel**	**Commercial Carboxymethyl Cellulose**	**Vibration**	**Functional Group**
3304	3332.31	3330.31	3442.72	Streching	O-H
2897.88	2892.36	2889.65	2924.09	Streching	C-H
-	-	1589.56	1627.92	Acymetric	COO^-
-	-	1414.03	1419.61	Bending	CH_2
1368.42	1366.57	1316.36	1327.03	Stretching	C-O
1025.44	1053.26	1017.25	1064.71	Symmetric	C-O
892.77	897.10	895.04	902.69	B-glycosidic	C-H

3.5. Preparation of Tamarillo Fruit Juice

The material used in making fruit juice in this study is Tamarillo fruit. In this study, the juice was made through variations in the use of CMC, namely 0.25%, 0.5%, 0.75%, 1%, 1.25% and without the addition of CMC. Tamarillo juice with the addition of CMC concentration variations can be seen in Figure 5.

Figure 5: Tamarillo juice with the addition of various concentrations of CarboxymethylCellulose (CMC)

3.6. Quality Analysis Results of Tamarillo Juice Stability

The addition of CMC can cause an increase in stability value generated by the number of Na + CMC ions that bind particles suspended in fruit juice, such as proteins, to form a gel structure. The ionic nature of Na + CMC makes it able to attract particles that are also suspended. In addition, CMC can thicken and stabilize the solution due to its reaction with water and protein. The low stability of fruit juice without adding CMC stabilizer is because all particles suspended in the fruit juice also precipitate [6]. The test results on fruit juice showed that the highest stability during the storage process was obtained when adding a CMC stabilizer of 1.25 % with a stability of 73%.

In comparison, the lowest stability was obtained in the treatment without adding a CMC stabilizer (control), with a stability of 56%. The results showed that adding CMC concentration can increase the stability of the juice. The results of the stability of Tamarillo juice with variations of CMC addition can be seen in Table 2.

Table 2: Stability results of aubergine juice with various CMC additions

CMC addition Variation (%)	**Stability (%)**
Kontrol	56
0.25	58
0.5	61
0.75	69
1	71
1.25	73

3.7. Degree of Acidity (pH)

In measuring acidity (pH), the measured value is the concentration of H+ value, which shows the amount of dissociated acid. Carboxymethyl Cellulose (CMC) is a hydrocolloid gum that contains many carboxyl groups and is readily hydrolyzed to increase the pH value of fruit juice. Furthermore, it is also said that the higher the concentration of CMC given can increase the hydrolyzed hydroxyl groups, causing an increase in pH value [6]. The test results on fruit juice showed that adding CMC stabilizer 1.25% had the highest pH value of 4.49, while the treatment without the addition of CMC stabilizer (control) had the smallest value of pH 3.72. The results showed that adding CMC concentration can increase the pH value of fruit juice. The effects of the pH of Tamarillo juice with variations of CMC addition can be seen in Table 3.

Table 3: Results of pH of Tamarillo juice with the variation of CMC addition

CMC addition Variation (%)	pH
Kontrol	3.72
0.25	3.98
0.5	3.99
0.75	4.15
1	5.35
1.25	4.49

3.8. Viscosity

The addition of CMC can cause an increase in viscosity value because CMC is hydrophilic and dispersed in water and can absorb water so that water cannot move freely, causing an increase in viscosity [8]. The test results on fruit juice showed that the treatment of adding a CMC stabilizer of 1.25% had the highest viscosity value of 77.79 cP. In contrast, the treatment without adding a CMC stabilizer (control) had the smallest viscosity value of 1.75 cP. The results showed that adding CMC concentration can increase the viscosity value of fruit juice [9]. The effects of viscosity in Tamarillo juice with variations of CMC addition can be seen in Table 4.

Table 4: Viscosity results of aubergine juice with various CMC additions

CMC addition Variation (%)	Viscosity (cP)
Kontrol	1.75
0.25	2.03
0.5	4.57
0.75	41.26
1	50.80
1.25	77.79

3.9. Vitamin C Content

The test results on fruit juice showed that the treatment of adding CMC stabilizer 1.25% had the highest vitamin C content of 25.32 mg/100 g. In contrast, the treatment without adding CMC stabilizer (control) had the smallest vitamin C content of 20.12 mg/100 g. Adding Carboxymethyl Cellulose (CMC) can cause high levels of vitamin C due to the withdrawal of more colloidal particles in the fruit juice. With the withdrawal of these particles, less free oxygen causes oxidation reactions in the fruit juice. Meanwhile, the low level of vitamin C in the control treatment was caused by the amount of free oxygen in the fruit juice, causing high oxidation reactions and lowering vitamin C levels [6]. The results showed that adding CMC concentration can increase vitamin C levels in fruit juice. The results of the vitamin C content of Tamarillo juice with variations of CMC addition can be seen in Table 5.

Table 5: Vitamin C measurement results of fruit juice with various CMC additions

CMC addition Variation (%)	Vitamin C content (mg/100 g)
Kontrol	20.12
0.25	21.31
0.5	21.72
0.75	23.64
1	24.97
1.25	25.32

3.10. Antioxidant Activity

The test results on fruit juice showed that adding 1.25% CMC stabilizer had the highest antioxidant activity of 59%. The treatment without adding CMC stabilizer (control) had the smallest antioxidant activity of 43.6%. In the DPPH test, the silencing of DPPH radicals is followed by monitoring the decrease in absorbance at the maximum wavelength that occurs due to the reduction of radicals by antioxidants (AH), which is characterized by a change in the purple color of the solution to a pale yellow color. DPPH is a stable free radical compound because the compound can experience resonance. If the resonance of a compound increases, then the molecular energy is lower, making the compound more stable [10]. The results of the antioxidant activity of Tamarillo juice with variations of CMC addition can be seen in Table 6.

Table 6: Antioxidant results of Tamarillo juice with the variation of CMC addition

CMC addition Variation (%)	**Antioxidant Activity (%)**
Kontrol	43.6
0.25	45
0.5	48.6
0.75	52.6
1	57
1.25	59

3.11. Organoleptic Test

Based on SNI 01-2346-2006, organoleptic or sensory testing is a test that uses human senses as a tool to assess product quality. Organoleptic test data is carried out by giving samples to 30 untrained panellists in the age range of 20 - 23 years. The parameters carried out are aroma, taste, texture and color using a rating scale of 1, 2, 3, 4 and 5. With the understanding: value 1 means very dislike, value 2 means dislike, value 3 means somewhat like, value 4 means like and value 5 means very like [11]. The results of the organoleptic test of Tamarillo juice with variations in the addition of CMC can be seen in Table 7.

Table 7. Organoleptic test results of Tamarillo juice with variations in CMC addition

Panel	Aroma						Rasa						Tekstur						Warna					
is	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F
1	5	5	4	5	3	5	5	5	3	4	4	3	3	2	5	5	4	5	2	2	3	4	5	5
2	5	5	5	4	4	4	5	4	5	5	5	5	5	5	5	5	5	4	3	3	5	5	3	4
3	4	4	4	5	5	4	5	3	3	4	4	4	3	2	4	3	4	4	2	5	5	4	5	5
4	3	5	5	4	3	5	4	5	5	4	5	5	5	4	5	5	5	4	3	3	3	5	5	4
5	5	4	4	5	5	5	4	2	4	2	2	4	4	5	3	3	2	2	5	5	5	4	3	5
6	3	5	2	2	3	2	4	3	3	4	5	5	5	3	4	4	4	4	4	3	4	2	5	2
7	2	4	5	3	5	5	4	4	5	4	4	4	2	5	5	5	5	2	3	5	5	5	2	5
8	5	2	2	5	4	2	3	3	2	3	2	5	2	3	2	3	3	3	2	2	2	3	2	2
9	2	5	5	2	5	4	4	2	5	3	5	3	4	5	4	4	4	4	5	5	5	4	4	5
10	5	4	4	5	5	5	4	5	4	5	4	4	4	3	3	5	4	5	4	2	4	3	5	3
11	4	5	3	4	4	5	5	4	5	4	5	5	2	2	5	4	4	5	5	5	4	2	3	5
12	5	4	5	5	5	4	5	5	3	5	4	4	4	5	4	5	4	5	5	4	5	5	5	3
13	4	5	4	3	2	5	3	3	5	2	3	5	3	3	4	4	3	4	4	4	4	4	2	5
14	2	3	3	5	2	5	4	4	2	5	2	4	4	5	4	4	2	3	5	5	4	5	5	2
15	5	2	5	3	3	5	4	5	2	4	5	5	5	4	2	4	4	2	4	4	5	4	4	5
16	4	5	4	3	5	3	3	3	5	5	5	4	3	3	3	3	3	3	2	3	3	5	5	4
17	4	2	5	5	4	5	4	3	2	3	3	2	5	5	4	5	3	3	3	5	5	5	4	4
18	5	5	5	5	5	4	4	5	4	5	5	5	4	4	3	4	3	4	4	4	4	4	5	5
19	4	4	4	4	5	5	3	4	5	5	4	4	2	4	4	4	4	3	5	4	5	4	3	3
20	5	3	5	5	4	3	5	5	4	3	3	3	5	5	5	5	4	4	2	5	5	5	5	4
21	2	5	4	4	5	2	3	5	2	5	2	3	3	4	4	4	3	3	5	5	5	5	4	5
22	4	3	5	5	2	2	4	2	4	5	5	2	4	2	4	4	3	2	4	4	4	4	2	3
23	3	5	3	5	5	5	4	5	5	2	4	3	4	4	5	2	2	3	3	2	4	4	2	5
24	5	5	5	4	4	4	5	2	4	3	2	3	4	5	4	4	3	2	4	4	5	5	5	4
25	5	4	4	5	5	3	4	4	5	5	5	3	4	4	5	4	4	3	5	5	4	5	5	5
26	4	5	5	3	4	5	5	5	3	5	4	4	4	2	5	4	3	4	4	5	4	5	4	4
27	5	3	3	5	3	3	4	4	4	5	3	5	5	4	3	4	4	4	5	4	4	5	4	5
28	3	4	5	4	5	3	3	5	5	2	5	2	5	4	4	4	2	2	4	4	2	5	5	3
29	4	3	5	5	5	5	4	3	3	2	3	2	5	4	4	5	2	3	5	5	4	4	4	5
30	5	4	5	4	3	3	4	5	4	5	4	5	4	4	4	5	3	4	5	4	5	5	5	3

Table 7 Description:

A	=	Tamarillo juice (control)	D	=	Eggplant juice + CMC 0.75%
B	=	Eggplant juice + CMC 0.25%	E	=	Eggplant juice + CMC 1%
C	=	Eggplant juice + CMC 0.5%	F	=	Eggplant juice + CMC 1.25%

Aroma

The results of the organoleptic test of the aroma of Tamarillo juice show that the addition of variations in the concentration of CMC to the juice does not affect the aroma of the juice because CMC has no taste. CMC is a substance with a white or slightly yellowish color and is odourless and in the form of fine granules or powder that is hygroscopic. In addition, CMC can hold the aroma of the fruit juice. CMC is a hydrocolloid that can function as a binding agent so that the distinctive aroma of fruit juice can be bound by CMC [12]. The results show that the variation of adding 0.75% CMC is a variation that the panellist highly favours.

Taste

The results of the organoleptic test for the taste of Tamarillo juice show that the addition of 0.75% Carboxymethyl Cellulose (CMC) is a very preferred treatment variation. The added treatment variation produces a sweet to very sweet taste caused by strong colloidal particle bonds so that the sucrose and fructose components in the juice are still present. The high sweetness produced can reduce the level of panellists' liking for fruit juice, especially panellists who do not like a delightful taste. The low rating scale in the control was caused by the presence of colloidal particles in the fruit juice that precipitated because there was no stability in the material. Thus causing excellent oxidation and producing a taste that is less favoured by panellists [6].

Texture

The results of the texture organoleptic test on Tamarillo juice show that the addition of 0.75% CMC is a very preferred variation. The addition of Carboxymethyl Cellulose (CMC) can cause an increase in viscosity value because CMC is hydrophilic and dispersed in water and can absorb water, so that water cannot move freely and causes an increase in viscosity, which affects the texture of the juice [8].

Color

The results of the color organoleptic test on Tamarillo juice show that the addition of 0.75% Carboxymethyl Cellulose (CMC) has a very preferred color. The high color score in the addition of CMC 0.75% is due to CMC, which functions to bind colloidal particles suspended in fruit juice so that they do not settle easily so that they can attract panellists [6].

4. Conclusion

The process of making Carboxymethyl Cellulose (CMC) from α-cellulose isolated from cassava peel is done through two stages, namely alkalization and carboxymethylation. The first stage, namely alkalization, was carried out using NaOH solution, followed by the second stage, namely carboxymethylation (etherification) using sodium monochloroacetate. From 75 g of cassava peel powder, 6.59 g of α-cellulose was obtained. Then, from 5 g of α-cellulose, CMC was obtained as much as 3.5 g. Next, the addition of Carboxymethyl Cellulose (CMC) influences the quality of Tamarillo juice, which can be seen from the difference in quality test results for each addition of CMC concentration variation. From the research results, the best results were obtained in the addition of a CMC concentration of 1.25%, which had a stability of 73%; pH of 4.49; viscosity of 77.79 cP; vitamin C of 25.32 mg/100 g and antioxidant activity of 59%. In the organoleptic test, the addition of 0.75% CMC was the most preferred variation by panellists based on aroma, taste, texture and color.

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6. Conflict of Interest

Authors declare no conflicts of interest

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