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Chemical characteristics of juice of mangrove apple (*Sonneratia caseolaris*) added with sugar

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Abstract

Jambi Province possesses mangrove species that grow along the waters of the Kuala Tungkal area, West Tanjung Jabung Regency. One of the species is the mangrove apple (*Sonneratia caseolaris*), locally known as *pedada*. The fruit of this plant has a fairly good nutritional content, such as 221.97 IU of vitamin A, 5.04 mg of vitamin B, 7.65 mg of vitamin B2, and 56.74 mg of vitamin C. Proximate analysis of mangrove apples reported that the fruit has 84.76% water content (NW), 8.4% ash content (GW), 4.82% fat (GW), 9.21% protein (GW), and 77.57% carbohydrate (GW).

This study was carried out from May to July 2019, using a completely randomized design (CRD) with 6 treatments and 4 replications. In addition, the researcher applied a two-way ANOVA statistical analysis. Furthermore, the treatments studied were coded P1 (150 g of mangrove apple + 0% sugar), P2 (150 g of mangrove apple + 60% sugar), P3 (150 g of mangrove apple + 70% sugar), P4 (200 g of mangrove apple + 0% sugar), P5 (200 g of mangrove apple + 60% sugar), and P6 (200 g of mangrove apple + 70% sugar).

200 g of mangrove apple added with 70% sugar produced the best result. Based on chemical testing, mangrove apple contained 10.83% carbohydrates, 2.04% protein, 1.01% fat, 13.76% water, 0.07% ash content, 0.77% fiber, 36.96% vitamin C, 29.66% total sugar, and 90.10% antioxidant activity.

Based on chemical characteristics, the addition of sugar on the mangrove apple juice provides a positive result in which the best formula is 200 g of mangrove apple added with 70% sugar.

Keywords: Mangrove Apple; Chemical Characteristics; Juice; *Sonneratia caseolaris*

1. Introduction

Mangroves (mangroves) are ecosystems located in coastal areas that are affected by tides so that the floor is always flooded. Mangrove ecosystems are between the highest high tide levels to levels around or above mean sea level in protected coastal areas and support a variety of ecosystem services along coastlines in the tropics [1]. Indonesia has the most mangrove forest potential, with 3.7 million hectares, or 25% of the world's total mangrove forests, projected to be 16,530,000 hectares [2]. Jambi is one of the regions in Indonesia where mangrove forests have the potential to grow. In the Kuala Tungkal area of Tanjung Jabung Barat Regency, Jambi Province, mangrove plants grow virtually along the water's edge, and their fruit can be processed and used for a variety of purposes.

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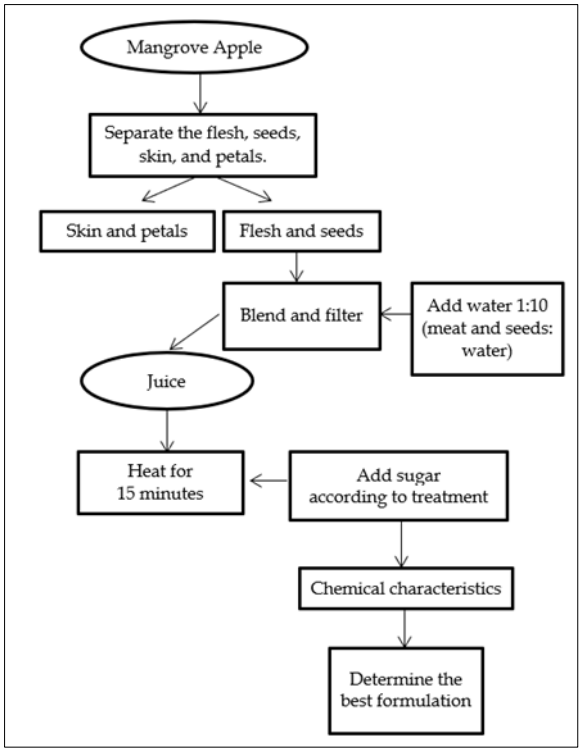
One of those mangrove species in Kuala tungkal is the mangrove apple, locally known as *pedada*. According to [3], numerous varieties of mangrove plants thrive along the river and can be processed and used for various purposes. *Sonneratia caseolaris* is one of the mangrove plants used for its fruit. *Sonneratia caseolaris* is a tree found in mangrove forests that grows vertically from the ground with deep breath roots [4]. *Sonneratia caseolaris* is located in various habitats that contain brackish water, which provides an ideal environment for the formation of mangrove forests. *Pedada* Fruit is produced by *Sonneratia caseolaris*. *Pedada* fruit has a ball-shaped bottom covered with flower petals and a stemmed end. *Pedada* fruit is entirely safe to consume and can be eaten immediately. *Pedada* fruit has a sour taste and a distinct scent, which contribute to the fruit's appeal [5]. The *pedada* fruit includes various beneficial compounds, including pectin [6]. Furthermore, this plant has elliptical leaves and elongated ends with finger-shaped leaf bones. Its fruit is not poisonous, can be consumed directly, and has the potential as an antioxidant because of contains several compounds, such as alkaloids, flavonoids, phytochemicals, glycosides, saponins, and phenols [7].

The fruit of mangrove apple (*Sonneratia caseolaris*) has a fairly good nutritional content, such as 221.97 IU of vitamin A, 5.04 mg of vitamin B, 7.65 mg of vitamin B2, and 56.74 mg of vitamin C. Several studies reported that the nutritional contents of mangrove apple are 84.76% water (NW), 8.40% ash content (GW), 4.81% fat (GW), 9.21% protein (GW), and 77.57% carbohydrate (GW) [8,9]. Due to the high nutritional content of apple mangrove fruit, further processing is carried out, one of which is by processing the commodity into fruit juice.

Fruit juice is a clear or slightly clear liquid, not fermented, obtained from pressing ripe and fresh fruits. Making fruit juice aims to increase the storability and added value of the fruit [10].

2. Material and methods

The tools used during the analysis were Erlenmeyer flask, measuring cup, biuret, funnel, pipette, boiling chips, Soxhlet extractor, filter paper, desiccator, tweezers, vacuum pump, mortar, Büchner funnel, beaker, porcelain cup, aluminum foil, test tube, ultrasonic water bath, volume pipette, and centrifuge, homogenizer, and UV-vis spectrophotometer. Meanwhile, the materials used for the analysis were concentrated H_2SO_4, 0.3 N H_2SO_4, 40% NaOH, 0.3 N and 1.5 N NaOH, mixed catalyst, distilled water, HCL p.a., 0.01 N $K_2Cr_2O_7$, 0.01 N $Na_2S_2O_3$, 4 N H_2SO_4, starch, KI, alpha-tocopherol, methanol, and 1.1-diphenyl-2-picrylhydrazyl (DPPH).



Modified from Ramadani et al. (2019)

Figure 1 Research flow of juice of mangrove apple added with sugar

2.1. Chemical Characteristics

2.1.1. Analysis of Carbohydrate Content (by difference)

In this analysis, the researchers calculated carbohydrate content (% NW) by using the formula of 100% - (water + ash + protein + fat) %, where NW is net weight.

2.1.2. Analysis of Protein Concentration (AOAC, 1980)

The researchers accurately weighed the sample to the amount of 0.3 g (I) and put it into the digestion flask. After that, the researchers added 0.2 g of mixed catalyst and 5 ml of concentrated H_2SO_4. The mixture was then heated in a fume hood. During this process, the researchers paid attention to the destruction process to make it not overflow. The destruction was stopped when the solution had bright green or clear color and then cooled in a fume hood. Next, the solution was put into a distillation flask and diluted with 60 ml of distilled water. Then, the researchers added a few grams of boiling chips. After that, the researchers prepared an Erlenmeyer flask containing 25 ml of 0.3 N H_2SO_4 and 2 drops of mixed indicator and connected it into the distillation system, namely the end of the pipe into the Erlenmeyer solution. Furthermore, the researchers poured slowly (through the walls of the flask) 20 ml of 40% NaOH and immediately connected it to the distillate. Distillation was carried out until N of the liquid was captured by H_2SO_4 in the Erlenmeyer flask. The Erlenmeyer flask containing the distillate was taken out and then titrated again with 0.3 N (J) NaOH. A change from blue to green indicated the endpoint of the titration. It was then compared with the blank titration (K).

2.1.3. Analysis of Fat Content (AOAC, 1984)

The researchers weighed the sample carefully to the amount of 1 g (L), wrapped it with fat-free filter paper, and then dried it in an oven at 105˚C for 5 hours. Next, the researchers cooled the sample in a desiccator and then weighed (M). After that, the sample was inserted into the Soxhlet extraction chute. The Soxhlet apparatus was filled with solvent through a condenser with a funnel. The cooling device flowed through the Soxhlet apparatus and the heater was also turned on. The extraction was carried out for 16 hours until the solvent on the Soxhlet apparatus looked clear. The sample was removed from the Soxhlet apparatus, dried in an oven at 105˚C for 5 hours, cooled in a desiccator, and then weighed (N).

2.1.4. Analysis of Water Content (AOAC, 1984)

The porcelain cup that had been washed clean was dried in the oven for ± 1 hour at a temperature of 105˚C. The cup was then cooled in a desiccator for about 10 – 20 minutes and then weighed (C). The sample was weighed to the amount of 0.5 – 1 g (D) and then put into a porcelain cup. The cup and sample were dried in an oven at 105˚C for ± 12 – 16 hours. Next, the cup and sample (E) were removed from the oven and cooled in a desiccator for 10 – 20 minutes until a constant weight was obtained.

2.1.5. Analysis of Ash Content (AOAC, 1980)

The porcelain cup that had been washed clean was dried in the oven for ± 1 hour at a temperature of 105˚C. The cup was then cooled in a desiccator for about 10 – 20 minutes and weighed (F). The sample was weighed to the amount of 3 g (D) and then put into a porcelain cup. After that, the researchers heated the sample contained in a porcelain dish on a Bunsen burner until it was smokeless. Next, the porcelain cup containing the sample was heated again in a furnace at 600˚C. Then, the researchers let the sample heated for 4 – 5 hours or until the color of the sample changed to white. The furnace was then turned off and the cup in the furnace was left until the temperature dropped to 120˚C before being transferred to the desiccator. After the temperature was normal, the cup was weighed carefully (H).

2.1.6. Analysis of Crude Fiber Content (AOAC, 1984)

The researchers dried the filter paper in an oven at 105˚C for one hour and then weighed it (O). The sample was weighed to the amount of 1 g (P) and put into a beaker. The researchers then added 50 ml of 0.3 N H_2SO_4 and boiled the sample for 30 minutes. After 30 minutes, the researchers quickly added 50 ml of 1.5 N NaOH and boiled it again for another 30 minutes. The liquid was filtered through filter paper of known weight in a Büchner funnel connected to a vacuum pump. The filter paper along with the residue was washed successively with 50 ml of hot H_2O, 0.3 N H_2SO_4, and acetone. The filter paper containing the residue was put into a clean and oven-dried porcelain dish. The cup containing the sample was dried in an oven at 105 ℃ until a constant weight was obtained. After that, it was cooled in a desiccator and then weighed (Q). Next, the sample was heated in the cup until it was smokeless. After that, the cup and its contents were put in a 600 ℃ furnace for 3-4 hours. After the contents of the cup turned into white ash, the cup was then removed from the furnace. It was then cooled in a desiccator and weighed (R).

2.1.7. Analysis of Vitamin C Using Iodometric Method (SNI 01-2891-1992)

The researchers weighed the sample to the amount of 200 g then crushed it until becoming pulp. Furthermore, the crushed sample was weighed again to the amount of 20 g. It was then dissolved with distilled water in a 100 ml flask to the limit mark. After that, the solution was filtered and the filtrate was pipetted to the amount of 25 ml. For the first stage, the researchers standardized 0.1 N $Na_2S_2O_3$ with 0.1 N $K_2Cr_2O_7$. Next, the burette was filled with 0.1 N $Na_2S_2O_3$ and then 10 ml of 0.1 N $K_2Cr_2O_7$ was put into the Erlenmeyer flask. After that, the researchers added 5 ml of KI 55 and 5 ml of 4 N H_2SO_4 and then closed the lid firmly. Next, it was titrated with 0.1 N $Na_2S_2O_3$ until becoming light yellow and then was added with 1% starch as an indicator until turning blue. It was titrated again with 0.1 N $Na_2S_2O_3$ until the blue color disappeared. After that, the result was analyzed using the formula of (V1 N1) $Na_2S_20_3$ = (V2 N2) $K_2Cr_2O_7$. For the second stage, the researchers standardized 0.01 N I2 with $Na_2S_2O_3$ by filling the burette with 0.01 N I2. After that, the researchers put 10 ml of $Na_2S_2O_3$ into a 250 ml Erlenmeyer flask and added 1 ml of 1% starch indicator. It was then titrated with 0.01 N I2. After that, the result was analyzed using the formula of (V1 N1) I2 = (V2 N2) $Na_2S_2O_3$.

2.1.8. Analysis of Total Sugar Content Using Luff Schoorl Method (AOAC, 1995)

Determination of the Reducing Sugar Levels Before Inversion

The researchers weighed the sample to the amount of 3 – 5 g and then dissolved it in a 250 ml volumetric flask. Next, it was added with distilled water until the limit mark. After that, it was put into 2 pieces of 250 ml Erlenmeyer flasks. 25 ml of solution from two flasks were pipetted. One was added with 10.2 ml of distilled water as a blank. One another was added with 10 ml of Luff Schoorl solution, stirred until homogeneous, added with 20 ml of distilled water, refluxed for 10 minutes, cooled with running water, added with 10 ml of 6 N H_2SO_4, stirred until homogeneous, added with 1 g of KI, and then stirred again until homogeneous. After that, it was titrated with standard thiosulfate solution until turning light yellow. Next, it was added with 2.5 ml of 1% starch solution. Titration was then continued until the blue color disappeared.

Determination of the Reducing Sugar Levels After Inversion

The researchers pipetted 25 ml of the experimental solution for reducing sugar. It was then put into a 250 ml Erlenmeyer flask and was added with 100 ml of distilled water and 10 ml of 25% HCl. Next, it was heated in a hot water bath at a temperature of 70 – 80°C for 10-15 minutes. After that, it was immediately cooled in running water and then added with 5 drops of phenolphthalein indicator. Furthermore, it was neutralized by adding little by little 30% NaOH solution until turning pink. It was then added with 1% acetic acid until returning to its original color. The sample was put into a 250 ml measuring flask and then added with 10 ml of Luff Schoorl solution and 20 ml of distilled water. It was then refluxed for 10 minutes, cooled with cold running water, added with 10 ml of 6 N H_2SO_4, stirred until being homogeneous, added with 1 g of KI, and then stirred again until being homogeneous. After that, it was titrated with thiosulfate solution until the color was light yellow. Then, the researchers added 2 ml of 1% starch solution. The titration was continued until the blue color disappeared.

2.2. Analysis of Antioxidant Activity Using DPPH Method

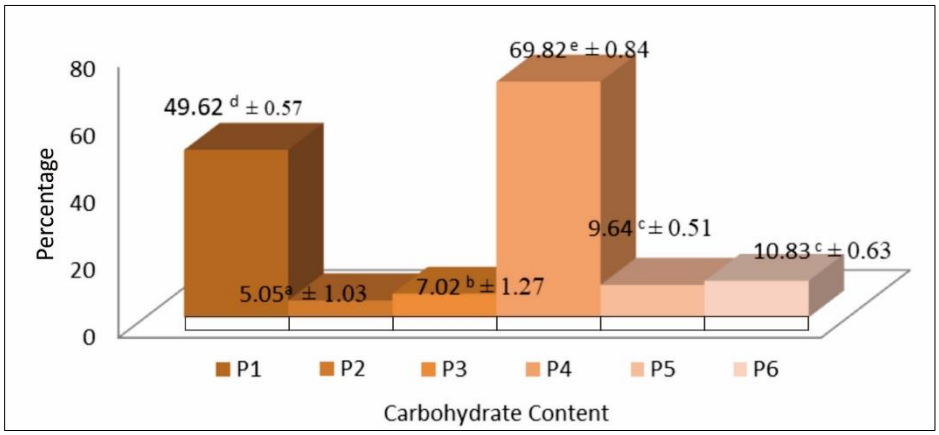
The researchers measured the absorbance from DPPH radicals which decreased due to the presence of antioxidant compounds using a UV-vis spectrophotometer at the maximum absorption wavelength that had been set previously. In this study, it was the reaction between DPPH radicals and antioxidant compounds in the juice of mangrove apple fruit. Antioxidant compounds changed the color of the DPPH radical from violet to yellow because of their ability to bind unpaired free electrons from free radical compounds. The free radical method (DPPH) is a method used to determine the antioxidant activity of a material [11].To determine the antioxidant activity, 0.2 ml of the sample solution was pipetted with a micropipette into the vial and then added with 3.8 ml of 50 M DPPH solution. The solution mixture was homogenized and left for 30 minutes in the darkroom. Absorption was measured with a UV-vis spectrophotometer at a wavelength of 517 nm. For the positive control, the researchers applied α-tocopherol. The researchers also conducted the same thing for the experimental samples. For this analysis, the researchers measured the % inhibition.

3. Results and discussion

3.1. Carbohydrate Content

The fruit of mangrove apples contains a lot of carbohydrates but mostly consists of fiber. In addition, the calorie content of the juice of this fruit is quite high. The results of the analysis of the carbohydrate content in the juice of this fruit indicated an increase for each treatment. Based on Figure 2, the percentages in samples P1 and P4 (49.62% and 69.82%) were significantly higher than that of samples P2, P3, P5, and P6 (5.05 – 10.83%). In samples P2 and P3 (5.05% and

7.02%), the researchers found a significant difference. Meanwhile, in samples P5 and P6 (9.64% and 10.83%), the researchers found no significant difference. This is in line with a study conducted by [12] reporting that the juice of mangosteen treated by being steamed and soaked in sugar solution and being extracted using a blender and juicer had a carbohydrate value ranging from 7.14 ± 0.06% to 7.83 ± 0.08%. This indicates that the carbohydrate content of the juice of mangosteen is quite high. The carbohydrate content comes from the original mangosteen fruit content and the addition of sucrose during the manufacturing process.



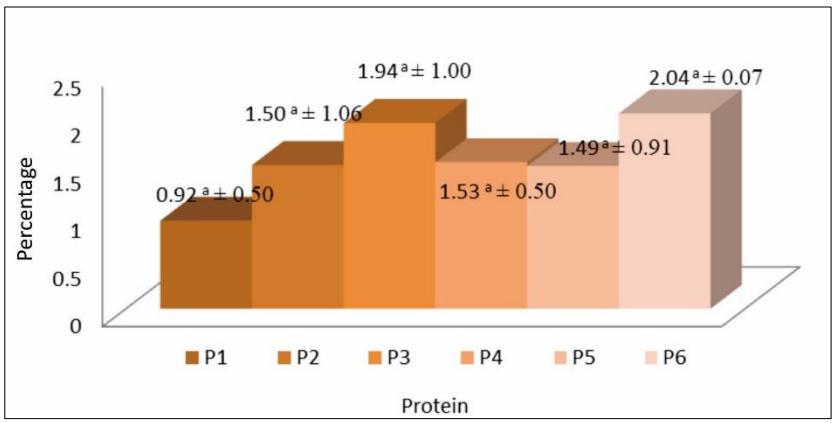
Note: P1 (150 g of mangrove apple + 0% sugar); P2 (150 g of mangrove apple + 60% sugar); P3 (150 g of mangrove apple + 70% sugar); P4 (200 g of mangrove apple + 0% sugar); P5 (200 g of mangrove apple + 60% sugar); P6 (200 g of mangrove apple + 70% sugar).

Figure 2 Carbohydrate Content

Carbohydrates in *pedada* fruit juice are caused by the use of basic ingredients for making *pedada*. Fresh pedada fruit which contains nutrients per 100 grams of fresh *pedada* fruit, namely vitamin A 221.97 IU, vitamin B 5.04 mg, vitamin B2 7.65 mg and vitamin C 56 ,74 mg. The results of the analysis in other studies showed proximate levels in *pedada* fruit, namely: water content (bb) 84.76%, ash content (bk) 8.4%, fat content (bk) 4.82%, protein content (bk) 9, 21% and carbohydrate content (bk) 77.57% [8].

3.2. Protein

This section presents the results of the analysis of the protein content from the juice of mangrove apples added with sugar. Based on Figure 3, the percentages in samples P1 to P6 (0.92% – 2.04%) had no significant difference in each sample of the juice of mangrove apple. This is in line with a study conducted by [12] reporting that the protein value of the juice of mangosteen treated by being steamed and soaked in sugar solution and being extracted using a blender and juicer was ranging from 0.04 ± 0.01% to 0.18 ± 0.01%. The juice of mangosteen treated by being steaming had a higher protein value than the juice of mangosteen treated by being soaked in a sugar solution.



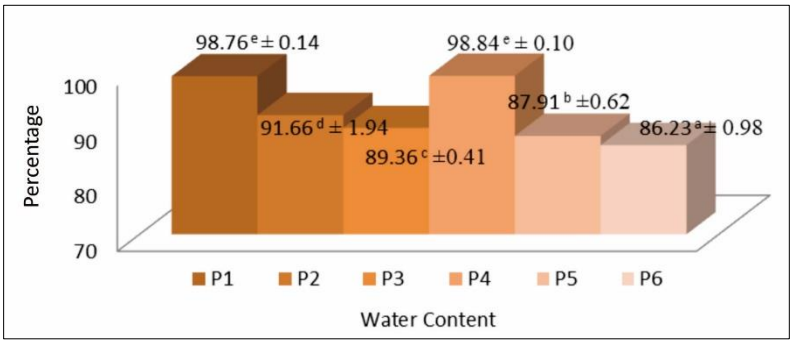
Note: P1 (150 g of mangrove apple + 0% sugar); P2 (150 g of mangrove apple + 60% sugar); P3 (150 g of mangrove apple + 70% sugar); P4 (200 g of mangrove apple + 0% sugar); P5 (200 g of mangrove apple + 60% sugar); P6 (200 g of mangrove apple + 70% sugar).

Figure 3 Protein Content

Pedada fruit juice has 0.93 percent protein, 4.88 percent fat, and 0.135 percent total sugar due to the usage of *pedada* raw ingredients, which contain 0.93 percent protein, 4.88 percent fat, and 0.135 percent total sugar. Flavonoids, tannins, polyphenols, saponins, and terpenoids are among the phytochemical components found in it [6].

3.3. Water Content

The water content in samples P1 (98.76%) and P4 (98.84%) had no significant difference compared to samples P2 (91.66%), P3 (89.36%), P5 (987.91), and P6 (86.23%) which had a significant difference in each of these samples. This is in line with a study conducted by [12] presenting that the water content value of the juice of mangosteen treated by being steamed and soaked in sugar solution and being extracted using a blender and juicer had a carbohydrate value ranging from 91.90 ± 0.11% to 92.54 ± 0.32%. This indicates that the water content in the juice of mangosteen is quite high.



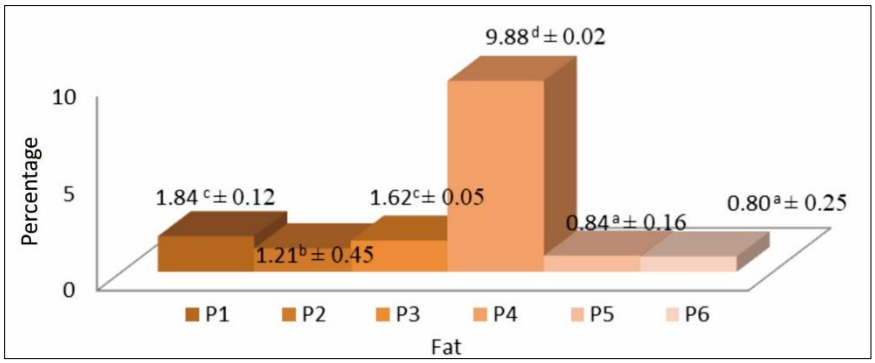
Note: P1 (150 g of mangrove apple + 0% sugar); P2 (150 g of mangrove apple + 60% sugar); P3 (150 g of mangrove apple + 70% sugar); P4 (200 g of mangrove apple + 0% sugar); P5 (200 g of mangrove apple + 60% sugar); P6 (200 g of mangrove apple + 70% sugar).

Figure 4 Moisture Content

Because a very large volume of water is added to the *pedada* fruit juice during the manufacturing process, the water content is relatively high. The water content of a food product will affect its growth, texture, taste and durability [13]. *Pedada* fruit has a water content of 84,76% [8].

3.4. Fat

Figure 5 showed that the percentages of fat content from the juice of mangrove apples added with sugar in samples P1 (1.84%), P3 (1.62%), P5 (0.84%), and P6 (0.80%) did not indicate a significant difference. However, a significant difference was found in sample P3 (1.62%). Furthermore, sample P4 (9.88%) was found significantly higher than the other samples. This is in line with a study conducted by [14] showing that the addition of soursop juice concentration had a very significant effect ($p < 0.01$) on fat content. Furthermore, the average fat content of pasteurized milk ranged between 0.10 and 0.97.



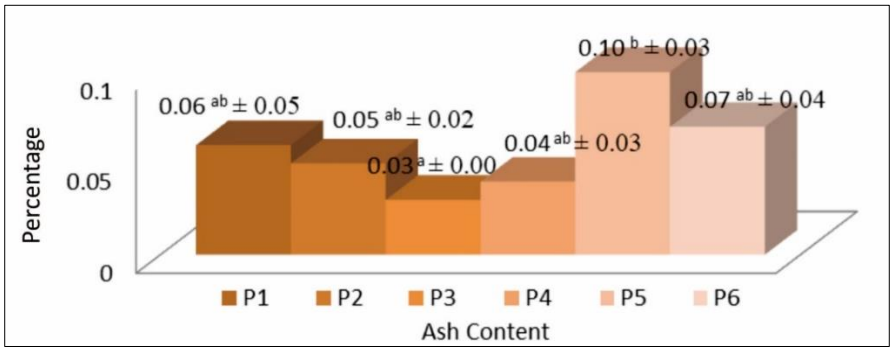
Note: P1 (150 g of mangrove apple + 0% sugar); P2 (150 g of mangrove apple + 60% sugar); P3 (150 g of mangrove apple + 70% sugar); P4 (200 g of mangrove apple + 0% sugar); P5 (200 g of mangrove apple + 60% sugar); P6 (200 g of mangrove apple + 70% sugar).

Figure 5 Fat Content

Pedada fruit juice has a high-fat level since it is made from raw *pedada* fruit, which includes 0.93 percent protein, 4.88 percent fat, and 0.135 percent total sugar. *Pedada* fruit also contains phytochemicals such flavonoids, tannins, polyphenols, saponins, and terpenoids [6].

3.5. Ash Content

Figure 6 reveals that there is no significant difference between samples P1 and P6 (0.06 percent – 0.07 percent) of *pedada* fruit juice. However, there was a substantial difference between sample P3 (0.03 percent) and sample P5 (0.10 percent) *pedada* fruit juice. The ash content of the *pedada* fruit flesh is 8.4 percent, according to [8]. Ash content is related to the mineral content of a material. The principle of producing dry ash content has the principle of oxidizing all organic substances at high temperatures, which is around 500-600C and then weighing the substances left behind after the combustion process [15].



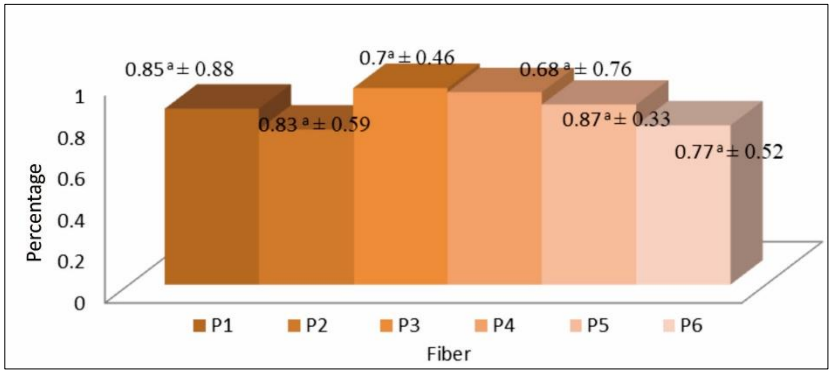
Note: P1 (150 g of mangrove apple + 0% sugar); P2 (150 g of mangrove apple + 60% sugar); P3 (150 g of mangrove apple + 70% sugar); P4 (200 g of mangrove apple + 0% sugar); P5 (200 g of mangrove apple + 60% sugar); P6 (200 g of mangrove apple + 70% sugar).

Figure 6 Ash Content

The presence of ash in *pedada* fruit juice is related to the use of *pedada* fruit basic ingredients which have nutritional content per 100 grams of fresh *pedada* fruit. Pedada fruit contains vitamin A 221.97 IU, vitamin B 5.04 mg, vitamin B2 7.65 mg and vitamin C 56.74 mg. The results of the analysis in other studies showed proximate levels in *pedada* fruit, namely: water content (bb) 84.76%, ash content (bk) 8.4%, fat content (bk) 4.82%, protein content (bk) 9, 21% and carbohydrate content (bk) 77.57% [8].

3.6. Fiber

Figure 4.6 showed that samples P1 to P6 (0.85% – 0.77%) indicated no significant difference in each sample of the juice of mangrove apple. This is in line with a study conducted by [16] on tamarillo soft drinks. They found that a fiber content value from the control treatment was 0.11% with a sugar concentration of 0%. The fiber content value then got increased, in which the highest point was 0.17% at a sugar concentration of 30%. This is due to the fact that the fiber content of *pedada* fruit, which is employed as raw material, is already quite high when compared to other raw materials [17]. *Pedada* fruit contains a large amount of dietary fiber, with insoluble dietary fiber accounting for 53.90 percent and soluble dietary fiber accounting for 9.80 percent, according to [9].



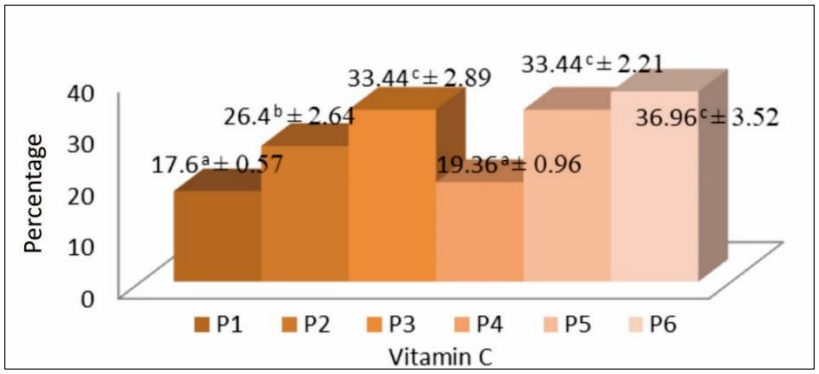
Note: P1 (150 g of mangrove apple + 0% sugar); P2 (150 g of mangrove apple + 60% sugar); P3 (150 g of mangrove apple + 70% sugar); P4 (200 g of mangrove apple + 0% sugar); P5 (200 g of mangrove apple + 60% sugar); P6 (200 g of mangrove apple + 70% sugar).

Figure 7 Fiber Content

According to [18], fiber is good for the digestive system since it helps with bowel motions. As a result, there are numerous foods that are high in fiber.

3.7. Vitamin C

Results indicated different percentages in samples P1 to P6. Samples P1 (17.60%) and P4 (19.36%) had no significant difference compared to sample P2 (26.40%) where a significant difference was found in this sample. In addition, samples P3 (33, 44%), P5 (33, 44), and P6 (36, 96%) indicated no significant difference and presented an increase from the other samples. This is in line with a study conducted by [16] reporting that the vitamin C content in tamarillo was 0.0716%. After being processed into soft drinks, the higher change was found at a sugar concentration of 30% with an average vitamin C content of 0.0265%. It was followed by sugar concentrations of 20%, 10%, and 0% (the lowest with vitamin C content of 0.0201%). After being processed into soft drinks, changes in the vitamin C content in soft drinks varied. This was due to the addition of granulated sugar in the drink. *Pedada* fruit contains 6.74 mg of vitamin C, meaning that if it is processed into food products it will produce foods rich in vitamin C. This can also help stabilize the vitamin content in *pedada* syrup if the product is handled properly the greater the water content, the more Vitamin C will be. easily degraded [19]. The oxidation process of vitamin C can also be accelerated in the presence of heat, light, and heavy metal cations, such as copper and iron. Therefore, food processing using copper or iron equipment loses its ascorbic acid content faster than those made from aluminum [20,21,22,23,24].

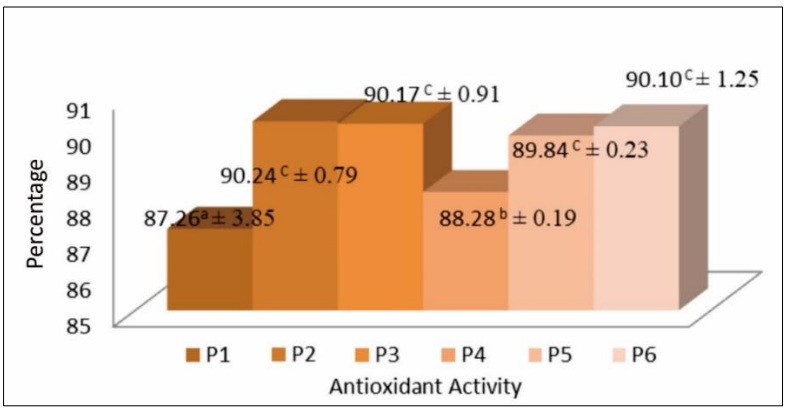


Note: P1 (150 g of mangrove apple + 0% sugar); P2 (150 g of mangrove apple + 60% sugar); P3 (150 g of mangrove apple + 70% sugar); P4 (200 g of mangrove apple + 0% sugar); P5 (200 g of mangrove apple + 60% sugar); P6 (200 g of mangrove apple + 70% sugar).

Figure 8 Vitamin C levels

3.8. Total Sugar

The results indicated that total sugar in samples P1 to P6 (31.78% – 29.66%) was not significantly different in each sample of the juice of mangrove apple. The addition of sugar resulted in a sweet taste so that the generated taste was not too sour when consumed. According to [25] Sugar is heated to a very high temperature, the sugar will turn into a clear liquid, over time it will turn yellow and then brown until it is really brown, so this process is called caramelization. This caramelization can improve the taste and color of the food.



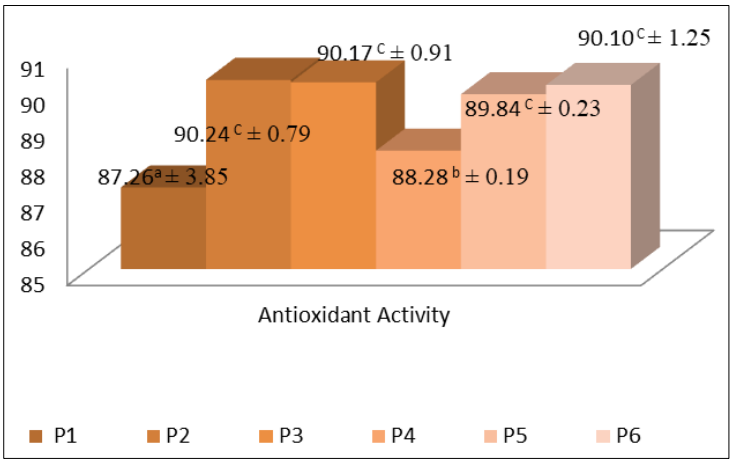
Note: P1 (150 g of mangrove apple + 0% sugar); P2 (150 g of mangrove apple + 60% sugar); P3 (150 g of mangrove apple + 70% sugar); P4 (200 g of mangrove apple + 0% sugar); P5 (200 g of mangrove apple + 60% sugar); P6 (200 g of mangrove apple + 70% sugar)

Figure 9 Total Sugar Content

Pedada fruit juice has a high total sugar level due to the utilization of raw *pedada* fruit, which includes 0.93 percent protein, 4.88 percent fat, and 0.135 percent total sugar. *Pedada* fruit also contains phytochemicals such flavonoids, tannins, polyphenols, saponins, and terpenoids [6].

3.9. Antioxidant Activity

The results of the analysis of the antioxidant activity in samples P1 (87.26%) and P4 (90.17%) indicated a significant difference between these samples. Meanwhile, in the sample P2 (90.24%), P3 (90.17%), P5 (89.84%), and P6 (90.10%), the researchers found no significant difference.



Note: P1 (150 g of mangrove apple + 0% sugar); P2 (150 g of mangrove apple + 60% sugar); P3 (150 g of mangrove apple + 70% sugar); P4 (200 g of mangrove apple + 0% sugar); P5 (200 g of mangrove apple + 60% sugar); P6 (200 g of mangrove apple + 70% sugar).

Figure 10 Antioxidant Activity

This was because, in all samples, the value of antioxidant activity got increased. The high and low antioxidant activity of the sample using the DPPH radical scavenging method was found from the percentage of inhibition. The greater the percentage of sample initiation is, the higher the antioxidant activity will be. Results of the analysis of the antioxidant activity in the juice of mangrove apples indicated a value that was almost close to the α-tocopherol inhibition value, namely 96.26% [26].

The antioxidant activity of *pedada* fruit juice is related to the use of raw *pedada* fruit which has a high enough antioxidant content, such as ascorbic acid 40 mg/100 g, beta-carotene 9.96 mg/100 mg, and tannins 22.65% [27].

Foods rich in antioxidants are very good for consumption by someone who has impaired glucose tolerance because these foods are able to reduce the glycemic response in the body [6]

4. Conclusion

The best sample of the juice of mangrove apple (*Sonneratia caseolaris*) based on the chemical characteristics was found on the sample P6 (200 g of mangrove apple + 70% sugar) resulting in a carbohydrate content value of 10.83%, protein content value of 2.04%, fat content value of 1.01%, water content value of 13.76%, ash content value of 0.07%, fiber content value of 0.77%, vitamin C content value of 36.96%, total sugar value of 29.66%, and antioxidant activity value of 90.10%.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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