The physicochemical properties and formulation of healthy drink from the fruits of Pedada (Sonneratia caseolaris) with natural dyes of Roselle (Hibiscus sadbariffa L.) and Beetroot (Beta vulgaris L.)

Edi Kurniawan1*, Meyci Trisna2, Nina Hartati3, Rajiyatul Muzni4, Nagita Audia Agnes Syuhada5, Tiara Andriani6

State Polytechnic of Sriwijaya
meyci.trisna@polsri.ac.id

Abstract. Innovations in food have contributed to the development of various types of beverages by increasing their added value. One of the beverage innovations that not only increases added value but also has benefits for good health is a healthy drink from pedada fruit. Pedada (Sonneratia caseolaris) is a fruit from a mangrove plant, with a content of every 100 g of pulp of pedada contains vitamin A of 221.97 IU, vitamin B 5.04 mg, vitamin B2 7.65 mg and vitamin C of 56.74 mg. Pedada fruit has many benefits for health, the content of alkaloid compounds, flavonoids, glycosides, saponins and phenols as antioxidants. In general, pedada fruit is still rarely processed by the community, because of its sour taste. In this study, the healthy drinks made were given the addition of natural dyes, namely roselle flowers and beets. The results of the organoleptic test showed that the overall healthy drink of pedada fruit was very popular, both in terms of colour, aroma and taste. While, the level of vitamin C contained in pedada fruit healthy drinks is 4.66% with the SNI standard of 300 mg/100 g or 0.3% while the average content of vitamin C in some orange juices available in the market is 50 mg/ 100 g. Moreover, the results of measuring cadmium (Cd) and lead (Pb) levels in fruit juice drink samples showed that the metal content was below the threshold value set by the Indonesian National Standard. Based on laboratory analysis carried out, the detected Cd and Pb levels are at a safe level and do not pose a risk to consumer health.

Keywords: Pedada, Sonneratia caseolaris, Natural dyes, Roselle, Hibiscus sadbariffa L., Beetroot, Beta vulgaris L., Vitamin C, Orgnoleptic, Cadmium, LeadFirst Keyword, Second Keyword, Third Keyword.

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1 Introduction

Mangrove plants play a very important role in maintaining the balance of the ecosystem on the coast. This plant also produces fruits that have high potential for health which is commonly called Pedada. Pedada (Sonneratia caseolaris) is one of the constituents of mangrove plants located along muddy beaches that have low salinity. The pedada fruit has a rounded shape with a tip that has a stalk. The base of this fruit is wrapped by pointed petals. The fruit has a diameter of between 6-8 cm and seeds number 800-1200 (Chen et al, 2009).

1.1. Buah Pedada (Sonneratia caseolaris)

Fig. 1. Pedada (*Sonneratia caseolaris*)

One of the products produced from pedada fruit is pedada fruit juice drink, which is a liquid obtained from the process of squeezing or crushing fresh ripe fruit (Susanty and Sampepana, 2017). However, the use of this pedada fruit has not been maximized because there are still many Indonesian people who do not know about the efficacy of consuming this fruit. The lack of public interest in the use of pedada fruit is due to the slightly pale color appearance and sour taste.

Adding dyes to the healthy drink from pedada fruit is one of many ways to add its aesthetic value and taste. A good colouring for consumption is those derived from plant extracts that are rich in anthocyanins. Roselle flowers are a type of plant that comes from the African continent. This plant also grows a lot in Indonesia. The flower, which belongs to the genus Hibiscus, has beautiful red flowers so it is often used as an ornamental plant.

Djaeni et. al (2017) reported that anthocyanins are one of the active substances found in roselle flowers. In line with the research reported by Inggrid et al. (2018), the extraction of anthocyanins from roselle flowers resulted in an anthocyanin level of 88.9 mg/L and a yield of 53.2%. The high level of anthocyanins in Roselle flowers can be used as a colouring agent for pedada fruit extract.

In addition to roselle flowers, beets can be used as a dyeing ingredient. One of the benefits of beets is as a natural dye in the manufacture of processed foods and beverages. Red beets contain a pigment called betalain. Betalain is an antioxidant group (Wirakusumah, 2007). The combination of the purple pigment betacyanin and the yellow pigment betaxanthin found in beets causes the fruit to be red.

Pedada fruit has a sour taste, slightly chelate and has a very distinctive aroma that is the attraction of the fruit (Noor et al., 2006). Pedada fruit also has phytochemical components such as steroids, tripenoids, and flavonoids (Ahmed et al., 2010). This fruit has an average diameter of 6.05 cm with a seed count between 800-1200. The average weight of the pulp was 52.15 grams, while the average weight of the seeds, skin, and petals was 38.27 grams, 7.68 grams, and 6.20 grams, respectively. The edible part of the pedada fruit is the flesh and seeds, which make up about 73% of the total fruit. (Manalu and Salamah, 2013).

Pedada fruit has the highest yield in the fruit and seeds, reaching 73%, followed by the skin with 15%, and the petals with 12%. Pedada fruit has a chemical composition with a water content of 84.76%, ash 8.40%, fat 4.82%, protein 9.21% and carbohydrates 77.57%. In addition, pedada fruit also contains 14.67% crude fiber. (Bunyapraphatsara et al., 2003).

Table 1. Contents of pedada fruit

Plant sections	Chemical contents	References
Fruit	Flavonoid, luteolin 7-O-ß-glucoside	(Sadhu et al. 2005)
Fruit	Glucoside Flavonoid, alkaloid	(Varghese et al. 2010)
Trunk and twig	Flavonoid, steroid, triterpenoid, dan benzenecarboxylic derivatives	(Minqing et al. 2008)

1.2. Beetroot (Beta vulgaris L.)

Beets are the main source of red natural dye. It is rich in carbohydrates that are easily converted into energy, as well as containing iron which helps transport oxygen to the brain through the blood. The red colour of beets is due to a mixture of the purple pigment betacyanin and the yellow pigment betaxanthin. The content of these pigments is believed to have benefits in preventing cancer, especially colon cancer. Previous research has shown that beets have the potential to inhibit cell mutations in cancer patients (Astawan, 2008).

Fig. 2. Beetroot (*Beta vulgaris L.*)

According to Hairunnisa (2019), beets are a potential source of dietary fiber, various vitamins, and minerals that can act as a source of 21 antioxidants that help in the prevention of infections. Beets also contain carbohydrates, proteins, and fats that are beneficial for the health of the body. The use of beets in food products gives them a natural colour, because they contain betalain pigments, which are antioxidants. Betalain pigments are rarely used in food products compared to anthocyanins and beta-carotene.

1.3. Roselle (Hibiscus sabdariffa L.)

Roselle, also known as Hibiscus sabdariffa L., is a plant that is often found in tropical regions such as Java and Kalimantan, and belongs to the Malvaceae family. Roselle contains anthocyanins that function as natural antioxidants and can ward off free radicals. Anthocyanins are a class of organic chemical compounds that can be dissolved in polar solvents, and play a role in giving orange, red, purple, blue, to black colour to high-level plants. Roselle has various parts that can be used, such as flowers, fruits, seeds, leaves and tubers, making it suitable for various consumption and other uses. (Du et al., 2015).

Fig. 3. Roselle *(Beta vulgaris L.)*

Anthocyanins, part of the flavonoid group, are natural pigments characterized by a primary structure consisting of two aromatic rings of benzene (C_6H_6) linked by an oxygen atom with three carbon atoms. (Hambali et al., 2014). Anthocyanins have a structure characterized by a carbon skeleton ($C_6C_3C_6$) which is one of the hallmarks of

the base of anthocyanins is 2-phenyl-benzophyrylium of flavylium salts (Santoso & Estiasih, 2014). Anthocyanins, with a conjugated double bond system, act as antioxidants that are believed to have the potential to overcome degenerative diseases. The mechanism of radical capture is one of the ways anthocyanins work as antioxidants (Mardiah et al., 2009).

2. MATERIALS AND METHODS

2.1. Preparation

The implementation of research in the production of healthy drink using pedada fruit (Sonneratia caseolaris) as the main ingredient, with natural dyes of roselle flowers (hibiscus sadbariffa L) and beets (Beta vulgaris L). The design of this research includes the preparation of tools and materials, where ripe and non-rotten pedada fruits are selected, then peeled and the pulp is taken. Next, the smoothing, pedada, roselle flowers, and washed beets are blended until smooth. Then, filtration and extraction, in which the boiled water of Roselle flowers is used to strengthen the color, is then filtered to obtain a healthy drink. Filtration in this case was only to separate the fiber part with the smoothy part of the fruits, therefore, the healthy drink produced is easy to drink. Furthermore, the extraction as mentioned above was boiling the roselle flowers and beets to get the antioxidants and the colouring agent itself.

2.2. Formulation of Pedada Fruit Extract with Roselle Flowers and Beetroot

The skin of the pedada fruit and beet fruit is peeled and then cleaned. The pulp of pedada fruit is separated from the seeds. Mash all ingredients. The ratio of materials and water is 1 : 1 (w/v). The formulation of the healthy drink of pedada fruit with the addition of roselle flower extract and beet fruit was made with variations in table 2.

Table 2. Formulation of pedada fruit : roselle flower : beetroot

Variation	Pedada extract (mL)	Roselle flower extract (mL)	Beetroot extract (mL)
A	20	-	-
B	20	-	10
C	20	2	10
D	20	4	8
E	20	6	6
F	20	8	4
G	20	10	2
H	20	10	0

2.3. Organoleptic

Organoleptic test is using human senses to determine the acceptance of products. There are several organoleptic analyses or tests in this study, including color, aroma and taste. These three tests are carried out to find out the best formula of several compositions that have been designed. After obtaining the results of each organoleptic test parameter, the overall results will also be determined based on the three test results so that the best formula is obtained according to the panelists.

The panelists are the people with various educational backgrounds, occupations, genders and ages, so it is assumed that the results obtained have represented the taste of the community. They will also become the market for this product or partner in socializing the use of Pedada fruit which has not been processed optimally and is only wasted on the banks of rivers in several areas in Riau Province.

2.4. Vitamin C analysis by titration

Pipette as much as 5 mL of pedada fruit extract, then put it into Erlenmeyer. Add 10 mL of aquades. Added phenolphthalein indicators. Titration with NaOH solution to the titration endpoint and repeated twice. The volume of titrants used is recorded.

2.5. Cadmium (Cd) and Lead (Pb) analysis with AAS (SNI 3719:2014)

Weigh 10 – 20 g of test specimen (W) carefully in porcelain/platinum/quartz cups. Place the cup containing the sample on top of the electric heater and heat it gradually until it is smokes free. Continue the assimilation in the kiln (450 ± 5) ºC until the ash is white, free of carbon. If the ash is not yet free of carbon which is marked by a greyish colour, moisten it with a few drops of water and add drop by drop of concentrated HNO_3 approximately 0.5 – 3 mL.

Dry the cups on the electric heater and put them back in the oven at (450 ± 5) ºC, then continue heating until the ashes turn white. The addition of concentrated HNO_3 can be repeated if the ash is still greyish. Dissolve the white ash in 5 ml of HCl 6 N, then dissolve it with 10 mL of HNO_3 0.1 N and put it in a measuring flask of 50 mL then adjust it to the line mark with aquabides (V), if necessary, strain the solution using filter paper into a polypropylene bottle.

Prepare the blank solution with the addition of the same reagent and treatment as in the sample. Read the absorbance of the working raw solution and the sample solution against the blank using AAS at a maximum wavelength of about 228 nm for Cd and 283 nm for Pb. Create a calibration curve between the metal concentration (µg/mL) as the X-axis and the absorbance as the Y-axis.

$$\text{Metal content (mg/kg)} = \frac{C}{W} \times V \qquad (1)$$

Description:

C = concentration of metals from the calibration curve, expressed in micrograms per millilitre (µg/mL)

V = final solution volume (mL)

W = sample weight (g)

3. RESULTS AND DISCUSSION

3.1. Organoleptic

Organoleptic testing is carried out to evaluate the sensory characteristics of a fruit juice beverage product through human senses, namely sight, smell, taste, touch, and hearing (for certain analysis). This test involves panellists subjectively assessing various aspects such as the colour, aroma, and taste of the drink.

In this test, several panellists were given samples of healthy drinks that were tested. The assessment is carried out on the colour, using visual observation to ensure that the colour of the drink matches the expectations or colours of interest. Colours that are considered fresh and natural indicate good quality products.

There was a questionnaire given to panellists for the colour organoleptic test, the total number of panellists who filled out was 26 people, from various educational backgrounds, occupations and ages. There were eight variations in the composition of natural dyes added to the healthy drink of pedada fruit juice, variation B was the variation with the most preferred colour, with the highest values of 2.54 (fig. 4). A value of 1 was a "regular" colour, a value of 2 was "attractive" and a value of 3 was "very attractive".

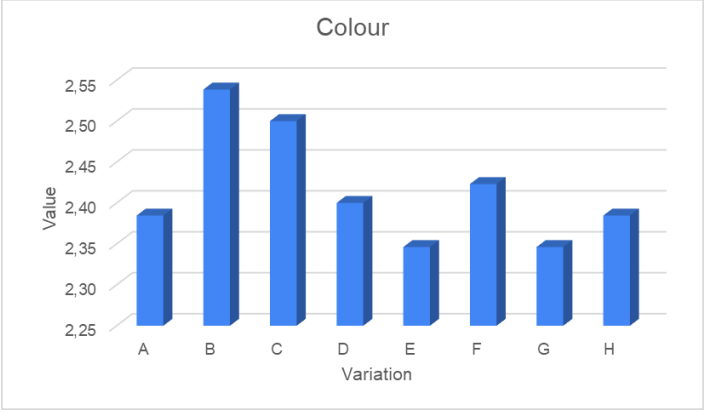

Fig. 4. Organoleptic results of colour

The aroma test was carried out to evaluate the fragrance of the drink, whether the fruity aroma was strong, fresh and distinctive without any unwanted odors and to find out the aroma that the panellists liked the most. The results obtained from the organoleptic aroma test that the variation with the best aroma is the D variety, with a value of 2.46 as can be seen in figure 5.

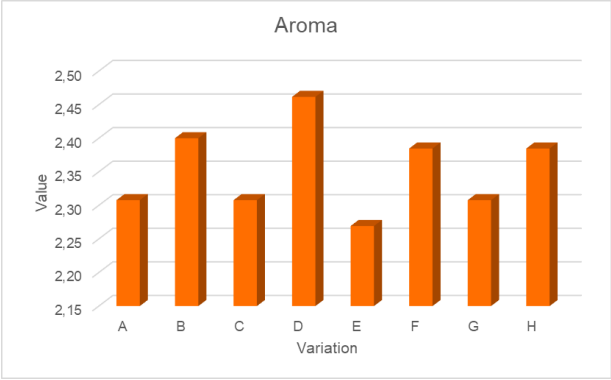

Fig. 5. Organoleptic results of colour

Another organoleptic test was the taste test, where panellists taste the drink to assess the balance of sweet, sour, and bitter flavors, as well as identify whether the taste matches the expected and the taste that the panellists generally prefer the most. The best variation of this test was the H variation, with a value of 2.46 (fig. 6).

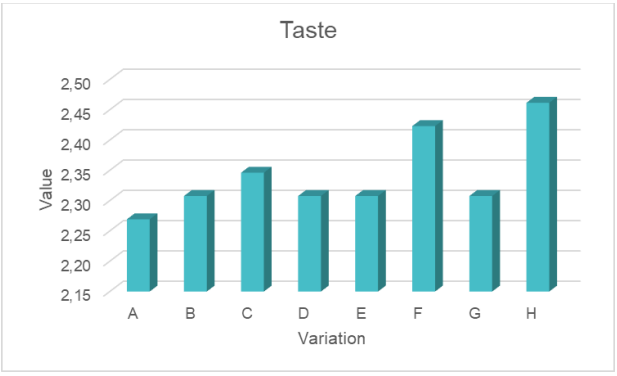

Fig. 6. Organoleptic results of taste

The results of organoleptic testing provide important information regarding consumer preferences and the sensory quality of the product. Overall, the best choice by the panellist was B variation with 2,42 points as it shows in figure 7.

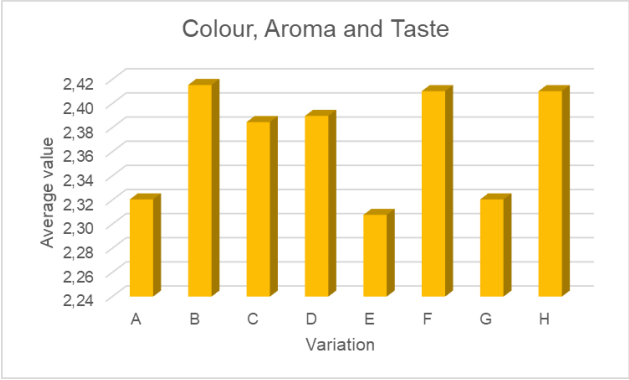

Fig 7. Organoleptic results of colour, aroma and taste

3.2. Vitamin C analysis by titration

The importance of vitamin C in healthy drinks and its benefits for the body, was the main factor in the importance of this analysis. In accordance with the procedure that has been described in the previous chapter, the vitamin C analysis in this study was carried out by titration or a simple method. The level of vitamin C contained in healthy drinks of pedada fruit was 4.66% with an SNI standard of 300 mg/ 100 g or 0.3%. Therefore, it can be concluded that the vitamin C in this healthy drink has met the standards and will be beneficial for health.

3.3. Cadmium (Cd) and Lead (Pb) analysis with AAS (SNI 3719:2014)

3.3.1. Cadmium (Cd) analysis

Heavy metal of Cadmium (Cd) analysis in healthy drink samples was carried out using the Atomic Absorption Spectrophotometry (AAS) method. Based on food safety standards regulated by the Indonesian National Standard (SNI) 7387:2009 concerning the maximum limit of heavy metal contamination in food, the maximum threshold for Cadmium (Cd) content allowed in beverages is 0.05 mg/L. Thus, the measurable concentration of Cadmium in healthy drinks is far below the threshold value that determined by SNI. These results show that the fruit juice drinks tested are safe to consume and do not contain Cd heavy metal contamination that has the potential to harm health.

Table 3. Cadmium (Cd) analysis

No.	1	2	3
Sample codes	Blanko	U164_1	U164_2
Absorbance	0.0022	0.0074	0.0072
C (µg/L)	-0.1914	0.0361	0.0347
V (mL)		50	50
W (g)		0.5004	0.5006

Cd (mg/kg)	0.0036	0.0035
Average (mg/kg)	0.0035	

3.3.2. Lead (Pb) analysis

The results of the lead (Pb) measurement content in healthy drink samples showed that the metal content was below the threshold value set by the Indonesian National Standard (SNI). Based on laboratory analysis carried out, the detected Pb levels are at a safe level and do not pose a risk to consumer health.

The maximum threshold for Pb metal content in beverages is a precautionary measure against contamination that can be harmful. In this case, the measurement results confirmed that the tested healthy drinks have met food safety standards, indicating that the producer has successfully maintained product quality and followed applicable regulations. This condition provides a guarantee that the healthy drinks that are tested are safe for consumption and do not contain Pb metal levels that exceed the permissible limit.

Table 4. Lead (Pb) analysis

No	1	2	3
Sample codes	Blanko	U164_2	U164_3
Absorbance	0.0114	0.0147	0.0152
C (µg/L)	-26.533	0.2131	0.2453
V (mL)		50	50
W (g)		0.5004	0.5006
Pb (mg/kg)		0.0213	0.0245
Average (mg/kg)		0.02	

4. CONCLUSIONS

The results of this research, which was mostly carried out in Siak Regency, Riau Province, illustrate the overall use of pedada fruits that are only become waste and that is not used by the community. Pedada fruit with enough phytochemical content to be used as a healthy drink when mixed with other natural ingredients, thus providing added value to the product produced. A deeper exploration of the health benefits offered by the inclusion of beetroot and roselle. These ingredients as mentioned above enhance the drink's nutritional profile. Beets are a potential source of dietary fiber, various vitamins, and minerals that can act as a source of 21 antioxidants that help in the prevention of infections. Beets also contain carbohydrates, proteins, and fats that are beneficial for the health of the body, as well as anthocyanins from the roselle flowers.

The organoleptic test also showed that the product had good quality in terms of colour, aroma and taste with an overall value of 2.37 of 3. Furthermore, the vitamin C analysis carried out obtained results that met the minimum vitamin C content that must be contained in a healthy drink according to SNI. Moreover, the results of measuring cadmium (Cd) and lead (Pb) levels in healthy drink samples showed that the metal content was below the threshold value set by the Indonesian National Standard. Based on laboratory analysis carried out, the detected Cd and Pb levels are at a safe level and do not pose a risk to consumer health.

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