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Natural food colourant of beetroot skin (*Beta vulgaris L*): characterisation study

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Abstract. The culinary industry is now growing, where the use of food colourant is widely used as an additive. To produce attractive colours in food, many manufacturers use synthetic colourant. The use of synthetic colourant will endanger health because synthetic colourant contains heavy metals. Supports UNNES vision, which is to become a conservation-minded university. In this study, the theme of the use of waste, especially fruit skin waste, as a natural colourant that is safe for health. The types of natural colourant that are often used for colourant are betacyanin. Fruit skin waste contains a lot of natural colourant, including beetroot skin. The results showed that the appropriate extraction method was the maceration method with the results for beetroot colourant resulting in the most optimal water content, antioxidant content and colour in the dye using a single solvent in the form of Ethanol.

1. Introduction

In the culinary industry, food colouring is widely used as an additive. To produce attractive colours in food, many manufacturers use synthetic dyes. Technological advances are able to create synthetic dyes with various colour variations [1]. Synthetic dyes have several advantages compared to natural dyes, among others, easy to obtain in the market, guaranteed colour availability, variety of colour types and more practical and easier to use ([2]; [3]) and more economical [4] and cheaper [5]; [6]). The use of synthetic dyes will endanger health because synthetic dyes contain heavy metals [7]. For consumer safety, it is necessary to encourage the development of natural dyes as food additives [7]. Natural dyes can be obtained from various plants including roots, bark, leaves, flowers and fruit [2]. In 3500 BC (BC) humans have used natural dyes extracted from vegetables, fruits, flowers, and insects [8].

The types of natural dyes that are often used for dyes include carotenoids, betalains, betacyanin. The pigment found in red beets is betalain. Betalains are a class of antioxidants. Betalain pigments are very rarely used in food products compared to betacyanins and beta-carotene [9]. Beet waste contains a lot of natural dyes, such as beet skin waste. To get maximum results, both in the form of colour and nutritional content, it is necessary to have an appropriate extraction process based on the properties of the dye. The pH value for betalain is pH 4 – 6 [10]. The antioxidants of red beet are also affected by temperature and pH [10]. Extraction is the separation or taking of one component contained in a solid or liquid material using the help of a solvent based on the difference in solubility between the solvent and the solute. Separation occurs on the basis of the solubility of the components in a mixture of solvent and solute [3]. According to [4] natural dyes can be obtained by extraction from various parts of plants using water solvents at high or low temperatures. In this way the substance taken varies greatly depending on the type of source.

Previous studies on the application of natural resources as colourant have been done [11-13]. However, determination of suitable extraction method for food colourant is of important. Based on the description of the background above, this research was done to determine the most appropriate extraction method to get maximum results in the form of colour and antioxidant content in beet skin waste.

2. Research Methods

In general, this research is carried out by following the steps that have been made which are grouped into three stages of development, including: (a) Preliminary studies, (b) Determination of Methods, and (c) Experiments.

2.1. Sample Preparation

Before the sample is made simplicia, first carried out preparation. The first thing to do is to wash and drain the yam skin samples. Then the beet skin is cut into small pieces. Drying can be done in 2 ways, namely drying the skin of the beet in the sun or heating the skin of the fruit in the oven. The most effective way is to heat the beet skin in the oven. Furthermore, the simplicia obtained were tested for water content, antioxidant content and colour degree

2.2. Dye Making Process

Extracts are made by maceration, because this method is simpler and simpler. Simplicia weighed as much as 500 g, put simplicia into a glass beaker, then add solvent liquid (N1: single solvent in the form of Ethanol, N2: mixed solvent in the form of Ethanol with Aquades and N3: mixed solvent in the form of Ethanol with Citric Acid) and stir until homogeneous. The beaker glass was covered with dark plastic and allowed to be protected from light and stabilized, stirring every 4 hours for 24 hours. After that it was filtered so that the maserate was obtained. All the maserate that had been accommodated was evaporated with a rotary evaporator at a temperature of 450 C so that a thick extract was obtained from the beet skin. Furthermore, the dyes obtained were tested for water content, antioxidant content and colour degrees.

3. Results And Discussion

3.1 Results of Testing the Simplicia Content of Beet Skin Flour (Beta Vulgaris L)

In the process of making simplicia through a drying process using a cabinet dryer. Drying is the most important activity in the processing of medicinal plants because it can affect the quality of the resulting product. Drying will reduce the water content and stop the enzymatic reaction and prevent quality degradation or damage to the simplicia. Drying aims so that the sample is not easily damaged and can be stored for a long time [14]. Table 1 illustrated content of water content simplicia beet skin flour.

Table 1. Content of Water Content Simplicia Beet Skin Flour

Component	**Water Content (%)**
Beetroot Skin	10.509

Water content in beet skin flour simplicia is high. The high-water content has the potential to facilitate the extraction process. In addition, the water content can also affect the yield of antioxidants produced, because the higher the water content in the skin of the beetroot, the lower the content of phenolic compounds due to the character of phenolic compounds which have limited solubility in water. Table 2 illustrated simplicia antioxidant content of beetroot skin flour. Based on the test results showed that the antioxidant content of the beet skin simplicia showed high antioxidant activity.

Table 3 illustrated simplicia colour of beetroot skin powder. In Table 3, the colour L*a*b data obtained from the skin flour of the beet skin flour. The L colour element shows the intensity of light and dark, the a element shows a colour gradation from green to red, while the b element shows a colour gradation from blue to yellow (Figure 1).

Table 2. Simplicia Antioxidant Content of Beetroot Skin Flour

Component	**Antioxidant Activity % discolouration 2500 ppm**	**Antioxidant Activity % discolouration 5000 ppm**	**Antioxidant Activity % discolouration 10000 ppm**
Beetroot Skin	29.803	51.014	66.216

Table 3. Simplicia Colour of Beetroot Skin Powder

Component	**L**	**a**	**b**
Beetroot Skin	41.56	14.6	2.89

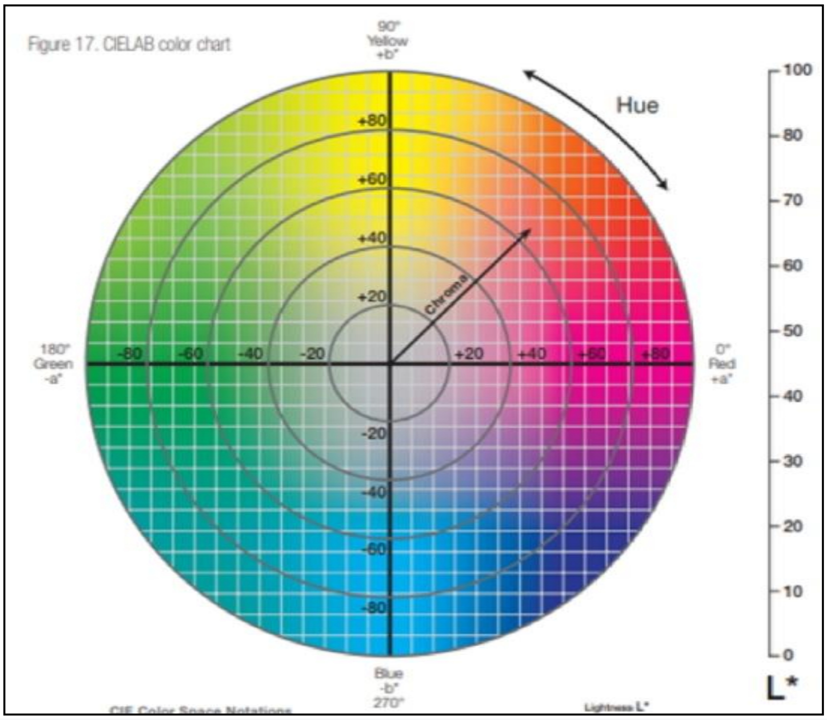

Figure 1. L*a*b Colour Space Scale

Based on the data analysis in Table 3 with reference to Figure 1. It is known that the colour of the beetroot flour ranges from reddish white to pink with slight yellowish colour interference. The colour of the beet skin flour can be categorized as a reddish white colour considering the a value is below the +20 scale. The colour of the beetroot flour tends to be reddish white, slightly darker considering the L value is below a scale of 50. The colour of the beetroot flour also has a slight yellowish white colour interference as an effect of the suspected sugar content. The colours possessed by each flour are strongly influenced by the colour pigments contained in each leather material. For beet skin is betacyanin pigment. Betacyanin colour pigments have good antioxidant capacity, where the higher the content of these compounds, which is characterized by a smaller L value (dark colour) and a greater a value, the higher the antioxidant capacity.

Figure 2. Beet Skin Dye Solution

3.2 Test Results for Beetroot Skin Dye Content

Figure 3. Beetroot Skin Colour

Table 4. Content of Beetroot Skin Dye

No	Code	Water Content (%)
1	B1	66.040
2	B2	73.216
3	B3	29.681

Information :
B1 : Beet Skin Colour with a single Solvent in the form of Ethanol
B2 : Beet Skin Colour with mixed solvent in the form of Ethanol with Aquades
B3 : Beet Skin Colour with mixed solvent in the form of Ethanol with Citric Acid

Table 4 shows the lowest water content in the beet skin dye sample with a mixed solvent in the form of ethanol and citric acid. This is because citric acid also has the ability to reduce the degree of acidity (pH). In addition, citric acid can be found easily in the market and has a low price. based on research results [15], this is because the added citric acid causes a diffusion process or the displacement of solid or gas particles from a more concentrated to a less concentrated [16].

Table 5. Antioxidant Content of Beetroot Skin Colour

No	Code	Antioxidant Activity % discolouration 2500 ppm	Antioxidant Activity % discolouration 5000 ppm	Antioxidant Activity % discolouration 10000 ppm
1	B1	25.612	43.039	74.052
2	B2	14.102	15.967	22.475
3	B3	21.562	31.239	47.104

Based on Table 5 above, it shows that the beet skin dye using ethanol resulted in the highest antioxidant activity compared to other samples. This is because the more acidic conditions will cause more betacyanin pigments to be in the form of coloured flavilium or oxonium cations and absorbance measurements will show an increasing number of betacyanins. Besides, the more acidic conditions cause more vacuole cell walls to break so that more betacyanin pigments are extracted [17]. Water and citric acid solvents are suitable for the extraction of betacyanin pigments because these pigments have water-soluble properties and are stable under acidic conditions [18]. Based on the results of the study, it can be seen that the best solvent treatment in the extraction of betacyanin on beetroot skin is the use of ethanol. This is presumably due to the combination of ethanol as a solvent which gives a polarity level that is close to the polarity of betacyanin in the beetroot skin, thereby increasing the ability to dissolve betacyanin and maximum extraction can occur. Vogel [19] stated that this high dissolving power is related to the polarity of the solvent and the polarity of the compound extracted.

Table 6. Degrees of Beetroot Skin Dye Colour

No	Code	L	a	b
1	B1	32.39	9.38	6.126
2	B2	26.99	2.18	0.74
3	B3	24.72	1.34	- 0.17

Based on Table 6 about the colour test results of beet skin-based food colouring, which was extracted using pure alcohol, diluted alcohol and a mixture of citric acid alcohol. It is known that: with alcohol solvent, a better level of colour density is obtained because there is a purification factor for the extraction of pink dye. It is characterized by a darker/concentrated L value. But the extraction process is also not satisfactory (not 100% able to take pink dye, indicated by a decreased value of a while the value of b increases. In the extraction of beetroot dye with diluted alcohol and alcohol mixed with citric acid, the results are worse considering the pink colour is getting lower (reddish white colour is obtained) with the lower a value and the lower b value. Only the L value is getting thicker but it is suspected that it does not come from the red pigment desired in this study.

4. Conclusion

The conclusion of the study is that the appropriate extraction method was the maceration method with the results for beetroot colourant resulting in the most optimal water content, antioxidant content and colour in the dye using a single solvent in the form of Ethanol.

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