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The Effect of Different Drying Method on the Physico-Chemical Characteristics of *Senduduk* Fruit Powder (*Melastoma Malabathricum* L) and its Application as Natural Colorant in Food

Desy Cristiana[1], Rina Yenrina[2], Cesar Welya Refdi[2]

[1]*Student of Agricultural Product Technology, Andalas University. Indonesia 25163*

[2]*Lecturer Of Agricultural Product Technology Department, Faculty Of Agricultural Technology, Andalas University, Indonesia 25163.*

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CORRESPONDING AUTHOR

*E-mail: *yenrinarusdi@yahoo.co.id*

A B S T R A C T

This study aimed to determine the effect of different drying methods on the physical and chemical characteristics of senduduk fruit powder determine the best drying method in producing then applied as a natural dye to food. This study used an exploratory method with three treatments (drying method with a oven dryer, oven vacuum , and solar dryer). The result showed that the use of different drying methods resulted in different physical and chemical characteristics of the senduduk fruit powder and the best drying method in this study was using a oven vacuum with physical and chemical characteristics, that is yield of 15.57%, ºHue 45.27, long time dissolve 60.08 second, insoluble part 4.34%, water content 8,76%, drying time 8 hours, ash content 2.36%, antioxidant activity 67.44%, anthocyanin content 45.52 (mg/L), organoleptic test on cookies, ice cream and pudding products with the addition of senduduk powder as a natural colorant, namely the cookies product obtained an average value of 3.2 ("neither like nor dislike" leads to "like"), ice cream product 4 (Like) and pudding 4.4 (Like)..

1. INTRODUCTION

1.1. Research Background

Senduduk (*Melastoma malabathricum* L.) is a wild plant that generally grows in a place with sufficient sun, such as in shrubs. Senduduk is one of the plants that is often used as traditional medicine such as canker sores, diarrhea and wound healing. The senduduk plant has reddish-purple fruit and when the fruit is ripe it will burst and it will be purple in color with quite a lot of seeds [2]. The fruit contains anthocyanin which can be used as a natural coloring agent for processed food. Besides being able to be used as dyes, anthocyanins are included in flavonoid compounds that function as natural antioxidants. According to Ref. [2], senduduk has known chemical content such as flavonoids, saponins, terpenoids and tannins.

Senduduk has very useful chemical content and high added value, especially in supporting the traditional medicine, food and beverage industry. The processed products of Senduduk include tea, powder and natural colorant. According to Nayak and Uday (2015) in Ref. [3], the fruit has a shelf life that does not last long because the water content of the fruit is high, which is 56.6%. Therefore, it is necessary to process the fruit of senduduk by drying it [4].

1.2. Literature Review

According to Ref. [5], drying is a common technique in food preservation. The drying process will release water and cause an increase in the concentration of dissolved solids in the food. The result of the drying process is dry material which contain moisture content equivalent to the normal air balance moisture content or equivalent to the water activity value (aw) which is safe from microbiological, enzymatic and chemical damage. The purpose of the drying process is to reduce the water content of the material so that the material becomes more durable or has a longer shelf time. Drying will result in a decrease in nutritional value and a change in the color of the dried product, if the drying temperature is too high. According to Ref. [6], drying at a temperature of 50-60°C is good for maintaining the anthocyanin content and color of the dried food.

In this study, the drying methods used to dry the fruit are solar drying, vacuum oven drying and cabinet drying. Solar drying is a traditional drying that does not require special equipment, its operating costs are cheap and the temperature used is in the range of 35°C-45°C. Vacuum drying is drying under vacuum conditions

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and carried out at low temperatures, the temperature commonly used is 50℃. The usual temperature used in oven dryer is 60℃.

The manufacture of powdered fruit is one of the processing that can be done on the fruit of Senduduk. According to Ref. [7], fruit powder is a solid product in the form of dry fine particles. The nature of powdered food products is a very small partial size, has a low water content and has a large surface area. In this study, the fruit will be processed into semi-finished materials, namely in powder form, its utilization can be used as a natural colorant for food and beverages such as jelly candy, jam, bread, biscuits, ice cream and syrup. The fruit powder can also be used as a sprinkling on foods such as salads and puddings so that it can add flavor and appeal to the product [8].

1.3. Research Objective

This study aimed to determine the effect of different drying methods on the physical and chemical characteristics of senduduk fruit powder and determine the best drying method in producing the powder and applied as a natural dye to food.

2. MATERIALS AND METHODS

2.1. Materials and Equipments

Raw material in this study was the ripe reddish-purple fruit of the Senduduk, water, distilled water chemicals for observation. The equipment used in this study were a vacuum oven and oven dryer, 60 mesh sieve, a set of beakers, stirring rods, vortex, analytical balance, water bath, aluminum cup, porcelain dish, furnace, desiccator, blender, hunter lab and spectrophotometer.

2.2. Experimental Design

The method used in this research is explorative method which consists of several treatments with three replications. The treatment used is the type of drying method, namely: a). Drying with the sun (Solar dryer), b). Drying oven (oven dryer), c). vacuum oven drying.

2.3. Research Implementation

2.3.1. Preparation of Senduduk Powder

Senduduk fruit is washed and reduced in size by blending until smooth and then adding enough water to help the destruction process. Then, it was blanched with steam boiling water at a temperature of 90℃ for 5 minutes. The drying process is carried out according to the treatment until the water content < 12%, The treatments area: the drying with the Solar Dryer Method [9]; Drying with Oven Dryer Method; and Drying with Vacuum Oven Method [9]. The dried fruits were then ground with a blender and sieved with a 60 mesh sieve to obtain senduduk powder.

2.3.2. The Process of Making Cookies [10]

The stages of making cookies with the addition of fruit powder are as follows: (a) Margarine, egg yolks, and powdered sugar are stirred with a mixer on speed 2 for 5 minutes; (b) add MOCAF flour, fruit powder, vanilla, salt and baking powder and stir with a mixer at speed 2 for 2 minutes; (c) After the dough is formed, let the dough rest for 10 minutes; (d) Then the printing process is carried out with a mold, and placed on a baking sheet; (e) is baked at 180 for 15-20 minutes.

2.3.3. Process of Making Ice Cream [11]

The stages of making ice cream with the addition of fruit powder are as follows: (a) sugar, egg yolks, skim milk and add 300 ml of water then mix until well blended; (b) After all the ingredients are well mixed, pasteurize the dough at a temperature of 70℃ ± 15 minutes; (c) the dough is cooled and then put into a clean container and let stand until cold, then put the senduduk fruit powder into the mixture and homogenize for 30 minutes using a mixer; (d) put the dough in the freezer until half frozen for 8 hours; (e) Then do the packaging of the dough in the ice cream cup and store it in the freezer until it freezes.

2.3.4. Pudding Making Process

The stages of making pudding with the addition of fruit powder are as follows: (a) 1 pack of agar powder, granulated sugar, salt, vanilla and fruit powder put into a saucepan then add water and stir until evenly distributed; (b) Then cook until boiling at a temperature of 100℃; (c) put it in the mold and let it rest for 15 minutes.

2.4. Observations

The observation includes physical analysis: yield, color brightness level, soluble time, and water insoluble part. chemical analysis: moisture content, ash content, antioxidant activity and anthocyanin cont. Organoleptic observations were also carried out on the application of the best-drying of senduduk powder on cookies, ice cream and pudding.

2.5. Analysis of Physical Properties

2.5.1. Yield of the powdered fruit of senduduk [12].

Yield is the percentage of the main raw material that becomes the final product. This can be expressed in decimal or percent. With the following calculations.

Yield = (weight of final product)/(weight of material) X 100%

2.5.2. Color Analysis [13]

The color analysis of the senduduk powder was carried out using the EZ Color Flex Spectrophotometer. First the equipment is calibrated, and then sample is placed under the sensor. The measurement results of the object are read on the screen, namely the value of L* as an indication of brightness (lightness) and the value of a as an indication of red (+a) green (-a) and as yellow (b+) and blue (b-), color material is measured in units L*, a*, b* which is the international standard of color measurement, adopted by the CIE (Commission International d'Ecleirage) . Brightness or lightness is between 0 and 100 while the chromatic parameters (a, b) are between 60 and 60. The CIE lab color scale is a uniform color scale, the difference between plot points in the color space can be equalized to see the planned color difference [13].

2.5.3. Dissolving Time [14])

Weigh 5 grams of the sample and then dissolve it in 100 ml of water. Then calculate the rate of dissolution of the powder using a stopwatch and note how long the sample is completely dissolved in water.

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2.5.4. Water Insoluble Parts (SNI 01-2891-1992)

Weigh 5 grams of the sample then put it into a 500 ml beaker, weigh 200 ml of water and stir until dissolved. After that, pour it into filter paper that has been dried in the oven and the weight is known. Rinse the beaker and filter paper with distilled water until a residue is obtained on the filter paper. Dry the filter paper in the oven at 105℃ for 2 hours. Cool in a desiccator and weigh.

$$\text{Water Insoluble Parts (\%)} = \left(\frac{w1-w2}{w3}\right) \text{X } 100\%$$

Information
W1 = Weight of Filter paper containing insoluble part
W2 = Weight of Blank filter paper
W3 = Weight of sample

2.6. Chemical Analysis

2.6.1. Moisture Content [15]

First, clean the aluminum cup from dirt and then dry it in the oven at 110ºC for 1 hour. After that the cup was cooled in a desiccator and weighed. After the weight of the cup is obtained, put 5 grams of senduduk powder into the aluminum cup. The aluminum cup containing the sample was placed in an oven at 110ºC. Every 1 hour heating the cup is removed from the oven and transferred to a desiccator for 10-15 minutes and then weighed. Warm up until a constant weight is obtained. Calculate the moisture content of the sample using the following formula:

$$\text{Moisture Content (\%)} = \frac{\text{W1}-(\text{W2}-W0)}{\text{W1}} \text{ x } 100\%$$

Information:
W0 = weight of empty cup (g)
W1 = sample weight (g)
W2 = weight of the cup and the powdered sample (g)

2.6.2. Ash Content [15]

5 grams of Senduduk powder was weighed and put into a pre-weighed porcelain crucible. The sample is heated until it becomes charcoal and does not emit smoke. Then it is burned in a kiln at a maximum temperature of 550℃ to become ash. Cool in a desiccator for 15 minutes and weigh as soon as it reaches room temperature.

$$\text{Ash Content (\%)} = \frac{(ash\ (g)+procelein(g)-porcelein\ (g)}{sample\ (g)} \text{ X } 100\%$$

2.6.3. Antioxidant Activity (AOAC, 1995)

Free radical scavenging ability of the extracts was tested by DPPH radical scavenging assay as described by Ref. [16, 17]. A sample of 1 gram was weighed and then added 2 ml of methanol solution containing 50 ppm DPPH. The mixture was then stirred and allowed to stand for 30 minutes in a dark room. Measurements were carried out using a spectrophotometer with absorbance readings at ƛ 517 nm.

$$\text{\% Antioxidant activity} = \left(1 - \frac{Absorbance\ Sampel}{Absorbance\ of\ Blank}\right) \text{ X } 100\%$$

2.6.4. Antocyanin [18]

Anthocyanin levels were measured by the pH difference method, namely measuring the absorbance of the solution at pH 1 and pH 4.5 measured at wavelengths of 510 nm and 700 nm, then calculated using the formula:

$$\text{A} = [(A_{510-}A_{700})_{pH\ 1} - (A_{510-}A_{700})_{pH\ 4,5}])$$

Anthocyanin concentrations were calculated as cyanidin 3 glucoside with molar extinction coefficient, in L/mol cm and molecular weight 449.2 was calculated using the following equation:

$$\text{Anthocyanin (mg } 1^{-1}\text{) ppm} = \frac{A \times BM \times DF \times 1000}{\varepsilon \times L}$$

Where:
A = $[(A_{510-}A_{700})_{pH\ 1.0} - (A_{510-}A_{700})_{pH\ 4,5}])$
MW = molecular weight (449.2) for cyanidin-3-glucoside
DF = Dilution factor
ε = 26,900 molar extinction coefficient, in L/mol cm for cyanidin-3-glucoside
L = Path-length (cm)

A sample of 10 ml was put into a test tube. Then the sample was centrifuged at 300 rpm for 15 minutes. The filtrate is separated from the precipitate. The resulting precipitate was then added with 25 ml of methanol. Then the sample was shaken for 2 hours. After that, the sample was centrifuged at 3000 rpm for 15 minutes. The filtrate is separated from the precipitate in a different place before being mixed with methanol. This is done repeatedly until the filtrate is colorless. The methanol filtrate was evaporated to dryness, then mixed with the main filtrate. Measurement of anthocyanin samples was carried out by reading a sample of 4 ml added 1 ml of sodium chloride buffer, then the absorbance was read at a wavelength of 510 nm and 700 nm at pH 1 and pH 4.5, then read the absorbance at a wavelength of 510 nm and 700 nm.

2.7. Sensory Analysis [19]

Sensory tests were carried out on taste, color, aroma and texture. The method used for this organoleptic test is hedonic test. The hedonic test has a score range of 1-5 where (1) strongly dislike; (2) dislike; (3) neither like nor dislike; (4) like and (5) like very much. Organoleptic test was carried out on panelists with a total of semi-trained panelists. The tested parameters are contained in the appendix. The organoleptic test is based on the following procedure:

a) The sample is put into a container, then the panelists are asked to observe the color, flavoor, texture, and aroma.
b) The test is carried out in a separate room between one panelist and another so that there is no contact with the panelists.
c) The panelists are given an assessment form for the level of preference for the product.
d) Panelists are asked to state their level of preference for the sample presented by giving a value in the form of numbers 1,2,3,4 and 5 in each sample column by marking (V)

3. RESULT AND DISCUSSION

3.1. Physical Properties

Yield is a percentage of the ratio of the initial weight of the material to the final weight of the dry product material. The purpose of calculating the yield in this study is to find out how much the ratio of the ingredients, namely the undried senduduk fruit to the dried senduduk fruit that has been mashed into powder. The yield of senduduk powder with different drying methods is with an average value between 15.57-16.36% (Table 1). The highest yield was found in the drying treatment using the Sun dryer method. and the lowest yield was found in the drying treatment using a vacuum oven. According to Ref. [20], the

higher the temperature and the longer the drying time of a material. the more water that evaporates from the material. Thus the weight of the material is reduced and produces a low yield. Can be seen in the table. Drying method using oven dryer and vacuum oven has a lower yield than the solar dryer, this is because the drying temperature of the vacuum oven (50℃) and oven dryer (50℃) is higher than solar drying, causing more compounds in the material to be lost when carried out. drying using a vacuum oven and cabinet dryer [14]. Solar dryer has the highest yield because the temperature used is low even though the drying time used is longer this is because the temperature affects the decrease in water content. The higher the drying temperature, the faster the heat transfer and evaporation of water from the food. And the lowest yield was obtained from vacuum oven drying. This is presumably due to the longer drying time in a vacuum oven compared to an oven dryer. the temperature used in the vacuum oven and cabinet dryer is the same, namely 50℃ but the yield of the vacuum oven is lower due to the working principle of the vacuum oven itself, namely the decrease in air pressure in the oven dryer in a vacuum state resulting in lower water content and resulting lower yield [14].

Table 1. Physical Properties of Senduduk Powder

Treatment	Yield (%) ± SD	The value of *ºHue* ± SD	Water Dissolving Time (second) ± SD	Insoluble Part (%) ± SD	Drying Time (h)
Solar Dryer	16.36 ± 0.38	89.85 ± 0.17 *(Yellow Red)*	60.95 ± 0.20	4.72 ± 1.14	72 h
Oven Dryer	15.84 ± 0.42	54.50 ± 0.14 *(Yellow Red)*	60.54 ± 0.21	3.91 ± 0.94	15 h
Oven Vacuum	15.57 ± 0.36	45.27 ± 1.24 *(Red)*	60.08 ± 0.24	4.34 ± 0.56	8 h

The drying process causes the water content during the processing to decrease, resulting in a decrease in yield. The decrease in the yield of senduduk powder is thought to occur due to a decrease in several chemical components in the product so that it will affect the overall yield. One of the components that have decreased is the water content. The higher the drying temperature, the faster the heat transfer and evaporation of water from the food. The moisture content of senduduk powder decreased with increasing drying temperature causing low final product yield [21].

Color analysis is one of the important attributes for a product. The color analysis of the centipede powder was measured using the Hunter Lab Color Flex EZ based on the parameters L. a* and b*. The L* notation in the Hunter system shows the brightness level of a product where a value of 0 indicates a tendency for black or very dark colors, while a value of 100 indicates a tendency for light or white colors. a* notation indicates the chromatic value of red (positive) and green (negative). b* notation indicates yellow (positive) and blue (negative) chromatic values. Then calculated the value of Hue to determine the overall color value. The values of Hue are grouped as follows (Mclellan. Lind. and Kime (1995) in Ref. [22].

ºHue 18-54 : red
ºHue 198-234 : blue green
ºHue 54-90 : yellow red
ºHue 234-270 : blue
ºHue 90-126 : yellow purple
ºHue 270-306 : Blue Purple
ºHue 126-162 : yellow green
ºHue 306-342 : purple
ºHue 162-198 : green
ºHue 342-18 : red purple

The results of color analysis of senduduk powder based on the degree of Hue ranged from 45.27 to 89.85 (Table 1). The color of the powder produced is Red and Yellow Red because the fruit contains anthocyanins. The type of anthocyanin that is found in the fruit is .Delphinidine. Delphinidine with a high concentration will give a red color. while at low concentrations it will give a blue color. From the table above. It is clear .that the longer the drying time and the higher the temperature. the higher the Hue value of the senduduk powder. It can be seen in the color table that the highest Hue value is found in the Solar Dryer method. the Hue value is 89.85 (Yellow red) and the lowest Hue value is found in the vacuum oven method ºHue 45.27 (Red). this is because in the sun dryer method the drying time is longer. The duration and temperature used are not constant. causing color changes in the sun dryer method [23]..

The drying using the solar dryer. the color of the powder produced is yellow red. This shows that UV light affects the stability of the dye so that the longer the irradiation time the color will fade. Anthocyanins contained in red dyes can absorb UV light. Radiant energy causes phytochemical reactions in the visible spectrum that can damage structures. According to Jenie [24], irradiation time with 24 hours of sunlight causes pigment degradation to reach 56%. Sunlight contains ultraviolet waves that have high energy. so that when irradiating phytochemical compounds will cause the formation of free radicals which lead to unstable pigments. The balance between the anthocyanin structures is strongly influenced by light.

Martinus (2012) in Ref. [14] states that too long drying time causes the color of the surface of the material to darken so that it reduces the brightness of the color of the material. high temperatures and too long drying time cause changes in the color of the material and decrease the quality of the material. In this study. the difference in the mean value of Hue on senduduk powder was seen from different types of drying methods. and the best was found in drying using the vacuum oven method. This is presumably due to drying time and temperature. Drying using a vacuum oven is faster and the temperature used is stable.

Based on the Table 1, the results of the water dissolving time in of senduduk powder ranged from 60.58 to 60.95 seconds. The drying method using a vacuum oven showed the fastest dissolution time with a duration of 60.08 seconds and the longest dissolution time by drying using the Solar Dryer method. which was 60.95 seconds. From the results it can be seen that the use of drying method using a vacuum oven has a faster dissolution time.

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This is because the method using a vacuum oven has a low water content making it easier to dissolve in water. According to Hatasura (2004) in Ref. [22], the water content of the product is high. the time it takes to completely dissolve in water will also be longer.

Solubility can be influenced by the length of dissolving time. namely the longer the dissolving time. the less weight of the material left in the filter paper so that more dissolved material. The occurrence of differences in the dissolution time of the senduduk powder due to differences in the drying method, thus affecting the components or compounds contained in the senduduk powder. Tests for the ease of dissolving centipede powder are needed to find out how quickly or how long the senduduk powder dissolves in water.

Solubility is the maximum quantity of a solute that can dissolve in a certain solvent to form a homogeneous solution. In this study. after measuring the dissolving time. the water insoluble part was measured. namely the residue or residue contained in the filter paper. Based on the Table 1, it can be seen that the value of the insoluble part of senduduk powder using different drying methods produces different substances that are insoluble in water. The water-insoluble senduduk powder is about 3.9-4.72%. Where the highest value is the Sun Dryer drying method which is around 4.72%. while the use of an oven dryer produces the lowest percentage of insoluble senduduk powder. which is 3.91%.

The use of different drying methods on senduduk powder affects the solubility of the powder in water. Solubility of substances in water is very diverse. There are substances that are easily soluble and there are also substances that are difficult to dissolve. as well as senduduk powder in its solubility. Sentosa powder is a flavonoid compound that has a function as a natural antioxidant and is generally soluble in water [23]. The low part of the insoluble part in the powder is due to the fact that it contains low levels of minerals and carbohydrates. allowing it to dissolve more quickly in water. The relationship between drying method and powder solubility can be seen from the changes in the compounds contained in the powder due to the drying process. According to Ref. [14]. the imperfect drying method causes the water content to be too high because the higher the water content of the product. the more difficult it is to dissolve the product. In the solar dryer drying method. the highest insoluble part was 4.79% this could be due to the unstable temperature and long drying time when compared to the oven dryer and vacuum oven methods and also in the sun dryer method the drying room used was quite wide so it could allow foreign matter or dust to enter the powder thereby affecting the insoluble part of the powder.

The solubility of anthocyanins soluble in polar solvents such as methanol. acetone. or chloroform, and most commonly can be dissolved in water [25]. The presence of senduduk fruit compounds that are soluble in polar and non-polar compounds. resulting in a lower percentage of insoluble parts (Table 1). According to Nabil (2005) in Ref. [14], the water content of the product is related to solubility. The higher the water content of the product. the more difficult it is to dissolve the product in water. because the product forms larger granules. So that in this study. when viewed from the solubility properties of the powder. the best method to use is the oven dryer method.

3.2. Chemical Analysis

Moisture content is a way to measure the amount of water contained in a food ingredient. Moisture content can affect the freshness and shelf life of foodstuffs. High water content causes bacteria. molds. and yeasts to breed so that foodstuffs undergo changes [26]. Based on the research that has been carried out. the results of the analysis of the determination of the moisture content of senduduk powder with different drying methods can be seen in Table 2.

Table 2. Chemical Properties of Senduduk Powder

Treatment	Moisture Content (%)	Ash Content % ± SD	Antioxidant (%) ± SD	Anthocyanin (mg/L) ± SD
Sun Dryer	10.77 ± 2.21	2.71 ± 0.30	51.07 ± 10.50	22.53 ± 5.90
oven Dryer	9.76 ± 0.95	2.43 ± 0.42	44.05 ± 0.24	34.22 ± 5.90
Oven Vacuum	8.76 ± 0.95	2.36 ± 0.36	67.44 ± 1.01	45.52 ± 8.82

Based on the results of the analysis of the moisture content of the senduduk powder from various drying methods. the water content value of the senduduk powder is between 9.76 – 10.77%. As shown in Table 2. The lowest moisture content in senduduk powder is found in the drying method using a vacuum oven with an average value of 9.1% and the highest moisture content in the sun dryer drying method with an average value of 10.77%.

The using of a vacuum oven, the lowest moisture content was 9.76%. this is because vacuum drying lowers the boiling point of water in partial pressure. which causes water evaporation at temperatures below 100°C. Applying a vacuum pressure below 1 atm in the drying chamber will increase the difference vapor pressure on the surface of the material with its environment so that the mass transfer rate of water vapor will also increase. Thus the vacuum pressure can increase the drying rate. the drying rate will decrease along with the decrease in water content during drying. The amount of bound water decreases over time. During the period the drying rate decreases. the heat energy obtained by the material is used to evaporate the remaining free water which is a small amount. In the drying method using a sun dryer. the water content value is still high. namely 10.77%. this is due to changing weather conditions that cause the temperature and drying process to be untenable and also the condition of the room used is wide enough so that the humidity (RH) high enough. Air humidity is a factor that shows changes in air quality during the drying process and the water vapor content contained in the air around the drying container [12]..

It can be seen that the longest drying time is in the Sun dryer treatment. which is 72 hours. and the fastest drying time is found in the drying treatment with a vacuum oven. which is 8 hours (Table 2). The drying process is basically the evaporation of environmental water due to the difference in water vapor pressure between the environment and the material being dried. where the higher the pressure difference between the material and the drying air. the faster the evaporation process [5].

The drying time in the sun dryer method is caused by unstable weather conditions which cause the drying process temperature to be untenable. The drying process is by placing the blanched senduduk fruit and then crushing it with a blender and adding water to assist the crushing process. After that. it is placed on a baking sheet lined with aluminum foil and then placed in the drying room for 72 hours to obtain a moisture content of <12% senduduk powder.

In the drying treatment with an oven dryer. the material is dried by placing the material on an aluminum pan and put in an oven dryer with a drying time of 15 hours to achieve a moisture content of <12%. fairly low water content. The drying mechanism in the cabinet dryer is that the heat transfer process occurs because the temperature of the material is lower than the temperature of the air flowing around it. The heat provided will increase the temperature of the material which causes the water vapor pressure in the material to be higher than the water vapor pressure of the air. resulting in the transfer of water vapor from the material to the air which is mass transfer.

In drying using a vacuum oven. the time required to obtain a moisture content of <12% is different. namely for 8 hours. The drying method using a vacuum oven is faster because in principle it reduces the pressure in a vacuum oven by 150 mmHg so that the drying time becomes shorter. namely 8 hours compared to the sun dryer and oven dryer methods. Vacuum oven drying takes place at low pressures below 1 atm. which lowers the boiling point of water and the temperature difference between the heating medium and the material is greater. This results in higher drying rates and more efficient use of heat [9].

In this case. the lowest moisture content and the fastest drying time were obtained using the vacuum oven drying method. This can be seen from the working principle of a vacuum oven. namely the use of vacuum air conditions under a pressure of 1 atm. According to the researcher. it is more efficient to measure the moisture content and drying time of senduduk powder using the vacuum oven method. because it is in accordance with the principle of use and the condition is more stable.

Ash content is the content of inorganic materials resulting from combustion in a food ingredient. Most of the food ingredients. which is about 96% consists of organic matter and water. the rest is inorganic material in the form of minerals called ash [13]. In this study. the gravimetric method was used with the working principle of ash in foodstuffs determined by weighing the remaining minerals as a result of burning organic matter at a temperature of about 550°C. Based on the research that has been done. the results of the analysis of the determination of the ash content of the centipede powder with different drying methods can be seen in Table 2.

Based on the research that has been done. the ash content of senduduk powder with the use of different drying methods. the ash content of senduduk powder is obtained with an average value ranging from 2.43-2.71%. The highest ash content was found in the treatment using Sun Dryer drying with an average value ranging from 2.71%. and the lowest ash content was found in the treatment using a vacuum oven drying with an average value of 2.36%.

The results obtained in table 8. the highest ash content was obtained from drying treatment with the sun dryer method. This is because the sun dryer method is easier to contact with free air because of the large space so that the minerals contained in the air enter into the dried powder. Ref. [14] states that there is no difference in ash content during drying because the determination of ash content is closely related to the mineral content contained in a material. the purity and cleanliness of the resulting material. The higher the ash content. the less clean the powder is in its processing. In this case. the difference in ash content obtained is not only due to differences in the level of moisture content obtained. but also due to the different drying system methods. as well as the level of cleanliness of the material and environmental influences.

Antioxidants are compounds that donate electrons (electron donors) or reductants that are able to counteract or reduce the negative effects of oxidants in the body. Analysis of antioxidant activity in senduduk powder was carried out using the DPPH (1.1-diphenyl-2-picrylhydradzy) method. DPPH is a stable radical containing dark purple organic nitrogen with a strong absorbance at a wavelength of 517nm. The results of antioxidant analysis on senduduk powder with different drying methods can be seen in Table 2.

From the research conducted. it can be seen that the results of the analysis of antioxidant activity in senduduk powder ranged from 44.05 to 67.44% (Table 2). The highest antioxidant activity was found in the drying method using a vacuum oven. namely 67.44% and the lowest was found in the drying method using a Sun Dryer. namely 44.05%.

The use of different drying methods on senduduk powder has an effect on antioxidant activity. Drying method using oven dryer resulted in lower antioxidant activity. This is because the temperature of the oven dryer is higher than that of the sun dryer. The solar drying temperature tends to be less constant and generally lower than the oven dryer temperature. This is what causes senduduk powder with oven dryer drying to have low antioxidant levels compared to other drying processes and as a result of the drying process it causes damage to the active substances contained in a food ingredient. Higher temperatures cause foodstuffs to lose more antioxidant activity. different from a vacuum oven. even though it uses the same temperature as an oven dryer. but the condition of the vacuum oven is more stable and there is also a vacuum in it so that it gets the highest antioxidant activity. because according to its antioxidant properties it is easily damaged by use due to heating (Putra and lelana.. 2014 in Ref. [14].

High antioxidant activity indicates a stronger ability of the sample to reduce free radicals. According to Lima et al.. 2011 in Ref. [27], antioxidant activity can be caused by the presence of a large number of anthocyanin pigments. so that the lower the anthocyanin content. the lower the value of antioxidant activity. Therefore. if various processing processes of senduduk powder can reduce the anthocyanin content. then the processing process can reduce the value of antioxidant activity. The antioxidant activity of anthocyanins is related to the amount of free hydroxyl around the pyrone ring. where the more hydroxyl. the greater the antioxidant activity (Miguel. 2011 in Ref. [27].

The antioxidant activity of senduduk powder can decrease due to temperature treatment and drying time. the highest antioxidant activity is obtained at the lowest temperature with the shortest drying time. This statement is in accordance with the present study. where the antioxidant activity of senduduk powder can decrease or increase due to different drying methods. temperature. time and drying time. The handling of raw materials also has a major effect on the antioxidant activity of the ingredients (Zubia et al.. 2007 in Ref. [14]).

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From the research carried out. it can be seen in Table 2, the results of the analysis of the levels of anthocyanin in senduduk powder ranged from 22.53-45.52 mg/L. where the highest anthocyanin levels were found in the drying method using a vacuum oven. which was 45.52 mg/L. while The lowest anthocyanin content was found in the drying method using a Sun Dryer. which was 22.53 mg/L. The low levels of anthocyanins are due to the influence of temperature. light and time used for drying. The rate of anthocyanin degradationtends to increase during the storage process accompanied by an increase in temperature. Thermal degradation causes loss of color in anthocyanins which eventually results in browning.

The low levels of anthocyanins in the drying method using the Sun Dryer because the drying method uses direct sunlight. According to Ref. [21], light is known to accelerate degradation. Anthocyanin degradation due to light is detrimental because it can change products containing anthocyanins. Increasing temperature and light intensity can reduce anthocyanin levels and antioxidant abilities. However. when compared with the effect of temperature. light has a stronger effect on decreasing anthocyanin levels and its ability to neutralize free radicals [27]. Heat treatment causes anthocyanins to be easily degraded. In addition. it can also cause changes in the balance of the four types of anthocyanins and the formation of colorless chalcones.

3.3. Sensory Analysis

The sensory test was carried out using a scoring test with the criteria that the higher the number. the better the quality. According to Ref. [28], in the scoring test the panelists were asked to rate the appearance of the sample based on the intensity of the attribute or trait being assessed. In the organoleptic test. the best drying method was used based on the results of physical and chemical analysis. namely the Vacuum Oven drying method. Aspects assessed on cookies. ice cream and pudding products include the panelists' preference for color. aroma. texture and taste. Sensory testing was carried out on semi-trained panelists with a total of 15 panelists who were students. where the panelists were asked to rate how much they liked the product. Sensory analysis results can be seen in Table 3.

Color is an important organoleptic parameter because it is the first sensory property that the panelists see. Attractive color is a very important component in determining the quality or degree of acceptance of a food product [29]. The color of the product can be caused by several factors such as raw materials. processing and chemical factors. The results of organoleptic analysis of Cookies. ice cream. pudding flavors with the addition of senduduk powder (Table 3).

Tabel 3. Sensory Score of Cookies. ice cream, pudding with the addition of senduduk powder

Product	Color	Aroma	Flavor	Texture	Overall
Cookies	3.2	3.5	3.6	3.26	3.39
Ice Cream	4.0	3.4	3.7	3.2	3.575
Puding	4.4	2.8	3.5	3.13	3.457

From the table it can be seen that the average value of cookies is 3.2 (“neither like nor dislike” leads to “like”). The addition of senduduk powder to cookies produces a brownish yellow color and the resulting color is less attractive. In the panelist's level of preference test for ice cream products. a score of 4 (likes) was obtained. the addition of senresiden powder to the ice cream produces a purple color but the resulting color is not dominant and is more faded. while in the panelist's level of preference test for the color of the pudding product. it was obtained a value of 4.4 (like). the addition of senresiden powder to the pudding produces a purple color.

Aroma is the main attraction in determining the delicious taste of a food product [30]. In this case the smell is more influenced by the sense of smell. Generally. the smell that can be received by the nose and brain is a mixture of 4 kinds of smells. namely fragrant. acid. rancid and charred Based on the panelist's level of preference for the aroma of cookie products. an average value of 3.5 (“neither like nor dislike” leads to “like”). for ice cream products. the average value is 3.4 (“neither like nor dislike” leads to “like”) and for pudding products. the average value is 2.8 (dislike) (Table 3). The addition of senresiden powder to the three products did not affect the aroma produced.

Results of organoleptic analysis of Cookies flavor of ice cream. pudding with the addition of senresiden powder can be seen in Table 3. Pudding with the addition of Senduduk Powder Flavor is a determining factor for acceptance of food products. The Flavor factor has an important role in product selection. Flavor is the response of the tongue to stimuli given by food. The sense of taste is divided into four tastes. namely sweet. salty. bitter and sour. Consumers will decide to accept or reject products with these four flavors [30]. Based on the panelist's level of preference test for the taste of cookie products. an average value of 3.6 (“neither like nor dislike” leads to “like”) was obtained, for ice cream products. the average value is 3.7 (“neither like nor dislike” leads to “like”) and for pudding products. the average value is 3.5 (“neither like nor dislike” leads to “like”) [Table 3). In the addition of senduduk powder to the three products. the taste of senduduk powder is not too dominant. However, if you add too much senduduk powder, the taste you get is bitter.

The results of sensory analysis of Cookies flavor, ice cream and pudding with the addition of senduduk powder can be seen in Table 3. Texture is a sensory picture of a product structure which is part of the pressure reaction measured as mechanical forces (such as hardness. adhesiveness and cohesiveness. viscosity. elasticity and crispness). Assessment of food texture can be done using fingers. teeth and palate. Texture factor among them is palpation by hand. tender and easy to chew [31]. Based on the panelist's level of preference for the texture of cookies. the average value was 3.26 (“neither like nor dislike” leads to “like”) l). for ice cream products. the average value is 3.2 (“neither like nor dislike” leads to “like”)) and for ice cream products. the average value is 3.13 (“neither like nor dislike” leads to “like”) (Table 3).

4. CONCLUSION

Based on the results of the research that has been done. it can be concluded that: (1) The physical properties of senduduk powder from different drying methods show the average value of the analysis results. namely. the sun dryer method has a yield of 16.36%. Hue 89.85. time to dissolve in water 60.95 seconds. insoluble part 4.72%. The oven dryer method has a yield of 15.84%. Hue 54.50. water soluble time 60.54 seconds. insoluble part 3.91%. The vacuum oven method has a yield of 15.57%. Hue 45.27. dissolving time in water 60.08 seconds. insoluble part

4.34%; (2) Chemical properties of senduduk powder from various drying methods indicate the average value of the analysis results. namely the solar dryer method has a moisture content value of 10.77%. drying time 72 hours. ash content. 2.71%. antioxidant activity 51.07 %. anthocyanin analysis 22.53 (mg/L). The oven dryer method has a moisture content value of 9.76%. drying time 15 hours. ash content (2.43%). antioxidant activity (44.05%). anthocyanin analysis 34.22 (mg/L). The vacuum oven method has a moisture content value of 8.76%. drying time of 8 hours. ash content of 2.36%. antioxidant activity of 67.44%. anthocyanin analysis of 45.52 (mg/L). (3). The best drying method is the drying method with a vacuum oven. where the value of physical and chemical analysis is better than the other two drying methods (solar dryer and oven dryer). (4) Sensory test on cookies. ice cream and pudding products with the addition of senduduk powder as a natural color. namely in cookies products. the average value for color was 3.2 ("neither like nor dislike" leads to "like") , ice cream products 4 (likes) and puddings 4.4 (like). Based on the research that has been done. there are several things that can be suggested for further research. namely conducting research on the shelf life and packaging of senduduk powder.

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