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Effect of Maltodextrin Concentrations and Drying Temperature on the Physico-chemical Characteristics and Color Measurements of Butterfly Pea Flowers *(Clitoria ternatea* L*)* Powder

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ABSTRACT

Butterfly pea flower (*Clitoria ternatea* L.) is a tropical plant that is rich in bioactive compounds, especially anthocyanins which are useful as natural dyes and antioxidant compounds. The bioactive compounds of butterfly pea flowers are unstable due to environmental influences, especially temperature, oxygen, light and acidity. In order to improve the stability of bioactive compounds, especially anthocyanin compounds in powder form, it is necessary to utilize encapsulation technology using coating materials. The aim of this research was to determine the effect of maltodextrin concentration and drying temperature on the physico-chemical characteristics and color measurements of encapsulated butterfly pea flower extract. The research method used was a factorial design prepared using a randomized block design consisting of 2 factors. Factor I (maltodextrin concentration) consisted of 3 levels, namely (10%, 20%, and 30%) while factor II (drying temperature) consisted of 3 levels (70ºC, 80ºC, and 90ºC), with 3 repetitions. The observation variables are: a) antioxidant activity, b) anthocyanin content, c) water content, d) dissolution time, e) color properties (L^*, a^*, and b^*). Based on general research results, a maltodextrin concentration of 10% and a drying temperature of 70ºC showed the best results based on antioxidant activity rate and the highest anthocyanin content (51.47% and 47.36mg/g), as well as color measurements with the lowest L^* value = 52, highest a^* value = +2.6, and highest b^* = -11.16. Except for powder solubility, a maltodextrin concentration of 30% and a drying temperature of 90ºC resulted in the fastest solubility time (16.67 seconds). For water content, all treatments were still in accordance with spice standards in Indonesia and standards issued by the USDA.

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Introduction

Butterfly pea flower (*Clitoria ternatea* L) is a plant that is rich in antioxidant compounds, especially anthocyanins. Anthocyanins are a group of flavonoid compounds which are also used as natural dyes, namely to produce the orange, red and purple colors commonly found in many flowers and fruits. Reactions that occur due to the presence of light, metal, high temperature, and high pH generally result in the destruction of anthocyanins. Provenzi et al. (2006), in Vanini et al. (2009), stated that the stability of anthocyanins was influenced by pH, temperature, oxygen and light. According to Reyes and Zevallos (2007), the color deterioration of anthocyanin pigments is caused by the change of the red flavilium cation into a colorless carbinol base and finally into colorless chalcone.

Increasing temperature will have the impact of increased anthocyanin oxidation, which will cause anthocyanin degradation. According to Jian Hie (2004), when the chalcone compound becomes unstable at high temperatures, it then degrades into a brown compound. Another possibility is that at high temperatures it will result in hydrolysis of the 3-glucose structure so that the anthocyanin changes into the unstable anthocyanidin.

Instant powder is a semi-finished food product in the form of powder or fine granules made from spices, seeds, fruits or flowers, and is usually served quickly by brewing wherein it is dissolved in cold or hot water. According to Ramadhia (2013), the advantages of instant powder are that it is practical, has extended shelf life due to the low water content, and its smaller volume makes packaging and distribution easier. The characteristics of instant powder are that it has the same color, smell, taste, and appearance

as fresh products, and has good nutritional characteristics and storage stability (Permata and Sayuti, 2016).

Making instant powder, especially from liquid materials such as anthocyanin extract, requires a coating/encapsulating material, while the process is known as encapsulation. Coating ingredients are ingredients added during the food processing process to coat flavor components, increase the total amount of solids, increase volume, speed up the drying process, and prevent damage to ingredients due to heat. In this research, maltodextrin coating material was used.

Maltodextrin is an imperfect starch hydrolysis compound, consisting of a mixture of sugars in simple form (monosaccharides and disaccharides) in small quantities, short-chain oligosaccharides in high quantities, and long-chain oligosaccharides in small quantities (Hadnađev et al., 2011). Maltodextrin is often used as a filler in encapsulation because it has good coating properties due to its ability to form emulsions and its low viscosity (Khrisnan, et al., 2005). Apart from that, maltodextrin is widely used because it is technically easy to find (Moore et al., 2005). Maltodextrin can undergo rapid dispersion, has a high solubility, can form a matrix, has a low chance of browning, can inhibit crystallization, has strong binding capacity, and has low viscosity compared to starch (Supriyadi and Sakha, 2013). Maltodextrin is a water-soluble substance and can protect the encapsulated substance from oxidation reactions (Septevani, et al., 2013). Maltodextrin can also reduce agglomeration problems during storage so that it can increase product stability (Gabas, et al., 2007). Hairunnisya (2016) reported that the differences between maltodextrin and starch included the sweeter taste of maltodextrin and faster absorption, which was because maltodextrin had a simpler polymer form. But when compared with simple sugars (dextrose, fructose and sucrose), the absorption time of maltodextrin moved more slowly. According to Yongki (2008), maltodextrin is defined as a starch hydrolysis product containing α-D-glucose units which are mostly bound through 1,4 glycosidic bonds with a DE of less than 20. Maltodextrin can be used in food because of advantages such as being able to pass through the dispersion process fast, has high solubility, can form films, has low hygroscopic properties, and can inhibit crystallization (Ekpong et al., 2016). Maltodextrin can be used in the encapsulation process to protect anthocyanin compounds and to protect compounds that are sensitive to oxidation or heat (Silitonga and Sitorus, 2014). Maltodextrin is a water-soluble material, which when used as a packaging material can protect the encapsulated active substance from oxidation reactions (Ersus and Yurdagel, 2007). The process of encapsulating the active substance with packaging material can protect the active substance from external factors and increase the stability of the active ingredient so that its functions can be maintained during storage. Maltodextrin can also reduce agglomeration problems during storage thereby increasing product stability (Gabas et al., 2007). Pratiwi (2011) stated that maltodextrin is a filler commonly used to form the body in the making of powdered drinks.

Food drying has the aim of being a means of extending shelf life by reducing the water content to prevent the growth of spoilage microorganisms and minimize food distribution costs, because the weight and size of the food are lower (Wicaksono, 2012). Martunis (2012) stated that the drying time and temperature used couldn't be determined with certainty for each food ingredient, but depended on the type of material being dried, such as the type of powdered food ingredient using an oven with varying drying temperatures of 60ºC to 90ºC for 5 to 7 hours.

As a coating material, maltodextrin has several advantages, namely: easy to dissolve, reduces agglomeration during storage, low viscosity, easy to find, and cheaper. However, research that specifically explores the concentration of maltodextrin coating material with oven drying temperature for encapsulating butterfly pea flower extract is still too few, even if it is used for coating watermelon extract, and most of the research topics found are about the use of types of coating materials and drying methods, both individually and in combination. The aim of this research was to determine the effect of maltodextrin concentrations and drying temperature on the physico-chemical characteristics and color measurements of encapsulated butterfly pea flower extract

Materials and Methods

Sample Preparation

The butterfly pea flower samples were collected from Mulyo Santoso's Garden, Sukun District, Malang City, East Java, Indonesia. The planting location is in full sunlight with a planting medium mixed with soil, sand and manure. Fertilization uses organic fertilizer and agricultural lime which is given once every 2 weeks.The butterfly pea flowers were picked when in bloom, then while still fresh and separated from the stems, were sorted. Only those that were still intact were selected. The samples were then reduced in size by chopping them with a stainless-steel knife.

Extraction

After reducing the size of the butterfly pea flowers, the extraction process was carried out using the maceration (soaking) method. Soaking was done using boiling water as a solvent in a ratio of 1:8 (1 g butterfly pea flowers: 8 ml water). modified based on research by Yudiono (2011). The solution was stirred for 5 minutes and afterwards was filtered using filter paper, to obtain the butterfly pea flower filtrate.

Powder Production

The filtered butterfly pea flower filtrate was added with maltodextrin at levels of 10%, 20%, 30% of the filtrate. The solution was stirred again until it became homogeneous using a magnetic stirrer to ensure that the solution was evenly mixed. Then it was dried using a drying oven (three ovens available) at the temperatures of 70ºC (first oven), 80ºC (second oven), and 90ºC (third oven) with the same drying time of 7 hours. This drying process followed the research procedures of Yogaswara et al. (2017), namely the modified thin layer drying. The final stage was the flouring process using a blender, and in order to get the same size shape, sieving was carried out with a size of 60 mesh (mm add).

Determination of Antioxidant Activity (Jabbar et al. 2019)

4 ml of the sample solution was taken, then 1 ml of DPPH solution was added with a concentration of 0.2 mM, then the solution was left for 30 minutes before analysis. Afterwards, 1 ml of the solution was taken and the absorbance was measured at a wavelength of 517 nm.

$$\text{E-DPPH} = \left[\left(\frac{A0 - A1}{A_0}\right) \times 1000\right] \quad (1)$$

Here;

E-DPPH= Effect of DPPH capture (%)

A0 = absorbance of the control or without the addition of DPPH

A1 = absorbance of the sample

Determination of Anthocyanin Levels (Lee et al., 2005)

About 1g of anthocyanin powder was placed in two different test tubes and diluted. The first test tube was added with 10ml of KCl (pH 1.0) buffer solution and the second test tube was added with 10ml of CH_3CO_2Na (pH 4.5) buffer solution. Using a spectrophotometer, the absorbance values of the sample were determined at 520 nm and 700 nm wavelength. The absorbance value of the sample was calculated by using (Eq 2): (Giusti and Wrolstad, 2003)

$$\text{Absorbance (A)} = [(A_{520\,nm} - A_{700\,nm})\,pH\ 1.0 - (A_{520\,nm} - A_{700\,nm})\,pH\ 4.5] \quad (2)$$

The total anthocyanin in the sample was calculated as cyanidin-3-glucoside following (Eq. 3):

$$\text{Total Anthocyanin (mg/L)} = \frac{A\,x\,MW \times DF\,X\,10^3}{\varepsilon\,x\,l} \quad (3)$$

Here;

A = (A520nm- A700nm) pH1.0 - (A520nm- A700nm) pH4.5

MW = Molecular Weight (448.8 g/mol forcyanidin-3-glucoside)

DF = Dilution Factor

103 = Conversion from gram to milligram

ε = Molar extinction coefficient, L × mol–1 × cm–1 (26,900 L/mol/cm for cyanidin-3-glucoside)

l = Pathlength (1 cm)

Determination of Water Content (AOAC, 2005)

Before using the cup, it was first baked in the oven for 30 minutes at a temperature of 100-105ºC. Then the crucible was cooled in a desiccator to remove any water vapor and weighed (A). The sample was weighed as much as 2 g in a dry cup (B), then it was baked in an oven for 6 hours at the temperature of 100-105ºC. The sample was next cooled in a desiccator for 30 minutes and weighed (C). This stage was repeated until a constant weight was achieved. Determination of water content was calculated using the formula:

$$\text{Water content (\%)} = \frac{B-C}{B-A} \times 100\% \quad (4)$$

Here:

A: weight of empty cup (g)

B: cup weight + initial sample (g)

C: cup weight + dry sample (g)

Dissolving Time Test (Andhika, 2016)

The sample was weighed at 5 grams and dissolved in 50 ml of water, then stirred until homogeneous using a magnetic stirrer and a light, to determine whether the powder dissolved in water contained sediments or not. In this study, solubility was calculated based on the time the butterfly pea flower powder dissolved completely in seconds (s).

Color Properties (Colorimeter AMTAST AMT506)

Color test measurements used the AMTAST AMT506 Colorimeter. The parameters measured include the L^* (lightness) value, which means it tended to have white, gray, and black achromatic colors; the a^* value represented the color red (+) to green (-) and the b^* value represented the color yellow (+) to blue (-). The steps of using this tool are as follows:

- Turn on the colorimeter by moving the power switch button to the 'on' position.
- Select color space L, a^*, b^* by pressing the Lab button.
- Place the tip (focus lens) of the tool on the sample target which had been placed in the plastic above
- Press the measuring button.

Measurement of the target color on the sample was completed when the indicator beeped and the target color results appeared on the display.

Results and Discussion

Antioxidant Activity

The average values of antioxidant activity of instant butterfly pea flower powder with the addition of varying levels of maltodextrin and drying temperatures are presented in Table 1.

Table 1 shows that the average value of the antioxidant activity of instant butterfly pea flower powder ranges from 6.3% to 51.47%. The highest average value of antioxidant activity is found in the treatment of adding variation in maltodextrin content of 10% and a drying temperature of 70°C, which is 51.47%. While the lowest average value of antioxidant activity is found in the treatment of adding variation in maltodextrin of 30% and a drying temperature of 90° C, which is 6.3%.

The increase of maltodextrin concentration and drying temperature can cause a decrease in the antioxidant activity of the instant butterfly pea flower powder. This is because the greater the amount of the total solids contained in the material, namely maltodextrin as a filler, the smaller the measured antioxidant activity became. Alternatively, it can also be caused by changes in antioxidant compounds as a result of the drying process using high temperatures, which causes the phenolic compounds to decompose so that their ability as antioxidants decreases (Estiasih, 2009). Heat can cause the decomposition of antioxidant compounds into other forms, resulting in a decrease in antioxidant activity, and bioactive components such as flavonoids and phenols being damaged at temperatures above 50 °C. The results of the antioxidant activity test showed that the combination of temperature and maltodextrin concentration had an effect on the stability of antioxidant compounds, where the maltodextrin concentration of 20% in various temperature

treatments appeared to be the most stable compared to other treatments. Temperature treatment causes instability of antioxidant compounds (the higher the drying temperature, the worse the impact) while maltodextrin plays a role in protecting the stability of these compounds from external factors (drying temperature), but in this study a concentration of 20% provided the best protective effect. Fathinatullabibah et al. (2014) confirmed that flavonoids were unstable at 70°C. It was further revealed that flavonoids were a class of compounds that were not heat resistant and were easily oxidized at high temperatures (Rompas et al., 2012)

Anthocyanin Levels

The average values of anthocyanin content of instant butterfly pea flower powder treated with variations in maltodextrin and drying temperatures are presented in Table 2.

Table 2 shows that the average value of the anthocyanin content of instant butterfly pea flower powder ranges from 19.02 – to 47.36 mg/g. The highest average value of anthocyanin content is found in the treatment of adding variations in maltodextrin content of 10% and a drying temperature of 70°C, which is 47.36 mg/g. While the lowest average value of anthocyanin content is in the treatment of adding variation in maltodextrin content of 30% and drying temperature of 80°C, which is 19.02 mg/g.

Increasing the concentration of maltodextrin and drying temperature can cause a decrease in anthocyanin levels in instant butterfly pea flower powder. This is because the addition of higher levels of maltodextrin will increase the solidity of the material so that the amount of anthocyanin levels decreases. Related to this, maltodextrin is a polysaccharide. With heat treatment, simpler compounds are formed, both disaccharides (sucrose) and monosaccharides (glucose). The formation of monosaccharides and disaccharides at high temperatures will cause a brown compound (melanoidin) through the Maillard reaction or caramelization. The formation of this brown color has the effect of decreasing the absorbance value so that the higher the maltodextrin the anthocyanin test results are also lower. According to (Cao et al., 2009; Rein, 2005) heating causes the degradation of sugar into furfural and 5-hydroxymethyl-furfural and reacts with anthocyanins to form brown products. This is in accordance with previous research results (Marsin et al., 2020; Hariadi et al., 2018; and Ariani, 2005). Similar results occurred in research by Padzil et al. (2018), in which increasing the concentration of maltodextrin would reduce the total monomeric anthocyanin content of purple sweet potato extract. Increasing the drying temperature causes the anthocyanin content obtained to be smaller because at high temperatures the anthocyanin degrades into ketone products. According to Dai (2010), at temperatures of more than 70°C the degradation of anthocyanins will be quite significant. Damages due to drying can occur in two stages, namely hydrolysis of the anthocyanin glycosidic bonds, resulting in unstable aglycones, and the aglycone rings open to form carbinol and chalcone groups which will cause color changes (Jian He, 2004). At the 30% maltodextrin treatment, the drying temperature was increased to 90°C, but the anthocyanin content did not differ/had no effect. This shows that the higher the concentration of the encapsulate/coating material, the stronger the protective power of the core material (anthocyanin) against heat treatment. The structure of the maltodextrin molecule is spiral-shaped so that the flavor molecules as the core ingredient will be trapped in the spiral helix structure. Thus, the addition of maltodextrin will be able to reduce the loss of chemical components during the heating process (Gustavo, et al., 1999)

Water Content

The average values of the water content of instant butterfly pea flower powder with the addition of variations in maltodextrin content and drying temperatures are presented in Table 3.

Table 1. Average values of antioxidant activity (%) instant butterfly pea flower powder

Maltodextrin Concentrations	Drying Temperatures		
	70°C	80°C	90°C
10%	51.47g ± 0.29	41.98f ± 0.19	36.2de ± 4.11
20%	38.42e ± 1.92	34.48d ± 0.90	30.12c ± 1.85
30%	28.75c ± 0.29	10.69b ± 1.06	6.3a ± 0.50

Note: Values followed by different letters indicate significantly different results in the Duncan test (α=5%)

Table 2. Average values of anthocyanin content (mg/g) instant butterfly pea flower powder

Maltodextrin Concentrations	Drying Temperatures		
	70°C	80°C	90°C
10%	47.36f ± 0.16	43.04e ± 1.19	29.69c ± 0.28
20%	31.61d ± 0.43	24.02b ± 2.41	23.06b ± 0.29
30%	19.89a ± 0.28	19.02a ± 0.29	20.27a ± 0.16

Note: Values followed by different letters indicate significantly different results in the Duncan test (α=5%)

Table 3. Average values of water content (%) of instant butterfly pea flower powder

Maltodextrin Concentrations	Drying Temperatures		
	70°C	80°C	90°C
10%	6.75g ± 0.17	6.14f ± 0.22	4.72c ± 0.32
20%	6.51g ± 0.13	5.17d ± 0.25	3.65b ± 0.14
30%	5.73e ± 0.16	4.36c ± 0.18	2.99a ± 0.23

Note: Values followed by different letters indicate significantly different results in the Duncan test (α=5%)

Table 4. Average values of dissolution time (s) of butterfly pea flower instant powder

Maltodextrin Concentrations	Drying Temperatures		
	70°C	80°C	90°C
10%	61g ± 3.00	54.67f ± 1.52	59.33g ± 1.52
20%	43d ± 1.00	47e ± 2.00	37.33c ± 2.51
30%	17a ± 2.00	21b ± 2.00	16.67a ± 1.52

Note: Values followed by different letters indicate significantly different results in the Duncan test (α=5%)

Table 3 shows that the average water content of instant butterfly pea flower powder ranges from 2.99% - 6.75%. The lowest average value of water content is found in the treatment of adding variations in maltodextrin content of 30% and a drying temperature of 90°C, which is 2.99%. While the highest average value of water content is in the treatment of adding variations in maltodextrin content of 10% and a drying temperature of 70° C, which is 6.75%. This is because maltodextrin generally has low hygroscopicity so that the hygroscopicity of microcapsules formed with increased maltodextrin concentration decreases, resulting in microcapsules with lower water content. At maltodextrin concentration of 10% to 20% with a drying temperature of 70°C, during the Duncan test there is no difference. This can happen if the air flow in the dryer at that time was too slow, causing the water vapor content around the dried material to became increasingly saturated as a result of the differences in vapor pressure inside and outside the ingredients (10% and 20% concentration) became small; this would have an impact on water evaporation, both treatments were no different. On the other hand, the water absorbed by maltodextrin evaporates more easily, so that the process of evaporating the powder water is easier and faster, causing the water content of the material to decrease (Arifin, 2006). The higher the drying temperature used, the higher the heat received by the powder so that the amount of evaporated water in the powder increases, and the measured water content becomes lower (Dwi, 2016). Differing collected results were reported by Ali et al. (2016), which showed that the water content of guava slices dried in a convection oven for 4.5 hours at a temperature of 80°C was 7.15%. Furthermore, the research conducted by Sarofa and Saraswati (2021) on watermelon extract enriched with butterfly pea flowers, with maltodextrin encapsulate at a temperature treatment of (40, 50, 60)°C and maltodextrin concentration of (10, 15, 20)%, drying time of 7 hours, resulted in water content of 3.15 - 4.91 %The research results showed that the water content value in instant butterfly pea flower powder was normal. This is still in accordance with the Indonesian National Standard (SNI) 01-3709-1995, which states that the maximum water content in spice powder is 12%. Meanwhile, the standard moisture content for spices according to USDA (2023) is between 4%-14%, depending on the type of spice.

Solution or Wetting Time

The average values of the dissolution time of instant butterfly pea flower powder with the addition of varying levels of maltodextrin and drying temperatures are presented in Table 4.

Table 4 shows that the average value of the longest dissolving time is found in the treatment of adding variations in maltodextrin content of 10% and a drying temperature of 70°C, which is 61 seconds. While the average value of the fastest dissolving time is found in the treatment of adding variations in maltodextrin content of 30% and drying temperature of 90°C, which is 16.67 seconds.

The interaction between variations in maltodextrin addition and drying temperatures can cause the dissolution time of instant butterfly pea flower powder to become faster. This is because maltodextrin is a carbohydrate that is classified as an oligosaccharide, which is easily soluble in water, so it can form a system that is evenly dispersed (Zhang et al., 2018). The greater the amount of maltodextrin added to the preparation, the faster the dissolving time. Cano-Chauca et al. (2005) reported that mango powder coated with maltodextrin had a solubility above 90%, indicating that maltodextrin can increase the solubility of the powder. This is due to its ability to be easily dispersed in a solution due to the presence of hydroxyl groups which tend to bind water to the granules. This is because polysaccharides, which are included as maltodextrin, have hydroxyl groups which are hydrophilic. The presence of hydroxyl groups also increases the solubility of organic compounds in water, because they can form hydrogen bonds with water molecules. According to Tako (2000), the presence of free hydroxyl groups will absorb water. Thus, the greater the number of hydroxyl groups in a polysaccharide molecule, the higher its ability to absorb water. According to Siregar (1992), in Husni et al. (2020), the time required to dissolve is around 1 (one) to 2 (two) minutes. Therefore, the quicker the dissolving time is, the better the quality of the instant butterfly pea flower powder will be.

Color Profile

Brightness Color Value (L)*

The average brightness (*L**) of instant butterfly pea flower powder treated with variations in maltodextrin content and drying temperature can be seen in Table 5.

Table 5 shows that the highest average level of brightness in instant butterfly pea flower powder treated with a maltodextrin content of 30% and a drying temperature of 90°C is 69.63 so that the quality of instant butterfly pea flower powder produced has a very strong level of brightness. The lowest level of brightness in instant butterfly pea flower powder with the addition of 10% maltodextrin content and a drying temperature of 70°C is 52, so that the quality of instant butterfly pea flower powder produced has a very low brightness level.

Based on the average values, the brightness level of instant butterfly pea flower powder tends to increase with increasing variations in maltodextrin content and drying temperatures. This is because maltodextrin has the characteristics of a white powder, so the brightness coordinate value *L** is influenced by the addition of

maltodextrin levels as an powder producing during the drying process. According to Wibawanto (2014), the higher the level of maltodextrin added, the higher the brightness coordinate (L^*) produced. So, the lower the maltodextrin content is added, the lower the brightness coordinate (L^*) obtained will be. Apart from that, maltodextrin is also able to form a layer around the color pigment, so the resulting powder will tend to be brighter. Meanwhile, for the drying temperature, the higher the temperature used, the more damage and loss of pigment in the material may occur (Oktaviana, 2012). So the brightness level value of instant butterfly pea flower powder increases and it becomes brighter. Another thing is that the L^* value is related to the pigment of the material, so the greater the pigment content is, the higher the absorption value and the lower the total reflectance will be, which can result in a lower L^* value. For the treatment of maltodextrin with the concentration of (20 and 30) % and drying temperature of (70 and 80) ˚C there was no statistical difference. This shows that at high maltodextrin concentrations of (20 and 30) %, it is still effective in preventing damage to the core material (anthocyanin pigment), especially up to the drying temperature of 80°C

In this study, the L^* results are related to the anthocyanin pigment content as shown in Table 2. That is, a high anthocyanin content produces powders with lower L^* values. Garcia-Estevez et al. (2017) reported that a low L^* value indicated a higher anthocyanin content, while an increase in the L^* value indicated a decrease in anthocyanin content.

Red/Green Color Value (a*)

The average red color (a^*) of instant butterfly pea flower powder treated with variations in maltodextrin content and drying temperature are presented in Table 6.

Table 6 shows that the average level of redness (a^*) is highest in instant butterfly pea flower powder treated with 10% maltodextrin content and drying temperatures of 70°C, which is at +2.6 so that the quality of the instant butterfly pea flower powder produced has a very strong level of redness. This is because more anthocyanin extract is added at a lower drying temperature. The higher the concentration of maltodextrin, the paler the product tends to be. As the color becomes less attractive, the panelists would find it more unlikeable (Sarofa and Saraswati, 2021). According to Lestari et al. (2019), maltodextrin has a white base color. When it is added to the extract it will increase the brightness of the product and so will reduce the a^* value and vice versa. On the other hand, in the anthocyanin concentration treatments of 20% and 30% with various drying treatments, the color tends to be green (negative sign). In this treatment, the maltodextrin content was 30% and the drying temperature was -3.23, so the quality of the instant butterfly pea flower powder produced has the lowest level of redness. The higher the concentration of maltodextrin, the impact will be greater on reducing the absorbance in the color test, because the wavelength changes or decreases so that the green color is absorbed more than the red color.

Based on the average values, the redness level of instant butterfly pea flower powder tends to increase and decrease with the high and low variations in maltodextrin content and drying temperature. This is because the value of the level of redness is used as an indicator of the color produced by a reddish or greenish sample. If the redness (a^*) is increasingly positive (+a), then it indicates that the powder produced is increasingly leaning towards red. If the reddish value is increasingly negative ($-a^*$), it indicates that the color of the powder is increasingly leaning towards green (Ernawati, 2010). Meanwhile, the level of redness is also influenced by the higher drying temperature treatment which can cause a decrease in the level of redness in instant butterfly pea flower powder. According to Nurhasanah (2015), in general, high drying temperatures can increase the loss of and damage to pigments in the material, and because anthocyanins are very sensitive to heat processes, the purple color of instant butterfly pea flower powder will fade due to degradation and polymerization. The treatment of adding variations in maltodextrin content and drying temperature had a real influence on the redness level of butterfly pea flower powder.

Yellow/Blue Color Value (b*)

The b^* notation of the chromatic color with mixed blue and yellow shows a $+b^*$ (positive) value from 0 to +70 for yellow, and a $-b^*$ (negative) value from 0 to -70 for blue.. The average sizes of the yellowish color (b^*) of instant butterfly pea flower powder treated with variations in maltodextrin content and drying temperatures are presented in Table 7.

Table 5. Average value of brightness color measurement (L^*) of instant butterfly pea flower powder

Maltodextrin Concentrations	Drying Temperatures		
	70°C	80°C	90°C
10%	52a ± 0.10	55.97b ± 0.45	57.47c ± 0.45
20%	58.4c ± 1.56	58.33c ± 0.35	64.2e ± 0.36
30%	62.77d ± 0.72	63.23d ± 1.10	69.63f ± 0.32

Note: Values followed by different letters indicate significantly different results in the Duncan test (α=5%)

Table 6. Average value of red color size (a^*) of instant butterfly pea flower powder

Maltodextrin Concentrations	Drying Temperatures		
	70°C	80°C	90°C
10%	+2.6e ± 0.45	+2.57e ± 0.30	+2.37e ± 0.10
20%	-2.27cd ± 0.37	-2.37cd ± 0.5	-2.47b ± 0.35
30%	-2.31cd ± 0.15	-2.42cb± 0.10	-3.23a ± 0.41

Note: Values followed by different letters indicate significantly different results in the Duncan test (α=5%); The (-) sign indicates the color direction tends to be green, the (+) sign indicates the color direction tends to be red

Table 7. Average value of yellowish color size (*b**) of instant butterfly pea flower powder

Maltodextrin Concentrations	Drying Temperatures		
	70°C	80°C	90°C
10%	-11.16^{e} ± 1.83	-11.17^{e} ± 0.41	- 12.33^{d} ± 0.05
20%	-18.2^{c} ± 0.20	-18.37^{c} ± 0.35	- 19.57^{ba} ± 0.15
30%	-18.4^{b} ± 0.70	-19.23^{ba} ± 0.55	- 21.27^{a} ± 0.23

Note: Values followed by different letters indicate significantly different results in the Duncan test (α=5%); The (-) sign indicates the color tends to be blue, the (+) sign indicates the color tends to be yellow

Table 7 shows that in, the yellowness value test (*b**) for all treatments shows a blue color, especially with the higher maltodextrin concentration and higher drying temperature. These results show that the color value *b** has a negative correlation with the results of the analysis of anthocyanin levels High temperatures cause the release of hydroxyl groups from maltodextrin so that the condition of the dried product becomes more alkaline. In alkaline conditions the anthocyanin pigment will turn blue, therefore when the drying temperature is increased the -b (blue) value also increases . This is in accordance with the research results of Shao et al. (2011) who reported that there was a negative correlation between the color variables *b** and *L** and the total anthocyanin content. Furthermore, it is stated that a negative correlation between the color variable *b** and total anthocyanins can occur if the value of the *b** variable is negative, that is, showing the color yellow to be moving to blue.

According to Harijono et al., (2001), adding maltodextrin levels can reduce the intensity of the yellow color so that the yellowness level value decreases due to the browning effect. The addition of more and more maltodextrin in the making of instant butterfly pea flower powder causes the yellowness level to become lower; this is because maltodextrin undergoes enzymatic and non-enzymatic browning reactions in the drying process. The color of the butterfly pea flower is purple, not blue, and the purple color is a combination of reddish coordinates (*a**) and yellowish coordinates (*b**), which are in the red and blue areas.

Conclusion

In chemical tests, treatment with a maltodextrin concentration of 10% and a drying temperature of 70°C obtained the highest antioxidant activity value of 51.47%, with the highest anthocyanin content of 47.36 mg/g.

In the physical te treatment with a maltodextrin concentration of 30% and a drying temperature of 90°C produced the lowest water content of 2.99% (provided that all water content treatments still met SNI standards), the fastest dissolving time value was 16.67 seconds.

In the color profile test, treatment with a maltodextrin concentration of 10% and a drying temperature of 70°C obtained the lowest brightness measurement (*L**) of 52 ± 0.10, the highest redness measurement (*a**) of +2.6 ± 0.45, and the yellowish measurement (*b**) was relatively high at -11.16 ± 1.83 (note that for *b**all treatments point to blue).

The moisture content of all instant powder treatments when referring to instant spice powder standards, still complies with the Indonesian National Standards or the standards issued by the USDA.

The maltodextrin concentration of 10% at a drying temperature of 70°C is the recommended treatment

References

AOAC (Association of Official Analyst Chemist), (2005). Official methods of analytical of the association of official analyst chemist. AOAC, Washington, DC.

Ali, M.A., Yusof, Y.A., Chin, N.L. and Ibrahim, M.N. (2016). Effect of different drying treatments on colour quality and ascorbic acid concentration of guava fruit. *International Food Research Journal,* 23 (Suppl. 1), S155-S161.

Andhika, D. (2016). Making instant powdered drinks from various parts of the meniran plant. *Andalas Agricultural Technology Journal*, 20 (1) ISSN 1410-1920.

Ariani, N. L. (2005). Making anthocyanin powder from purple eggplant skin (Solonum molengena) using the "foam mat drying" method. study of the type and concentration of filling materials. Thesis. Department of Agricultural Product Technology, Faculty of Agricultural Technology, Brawijaya University Malang.

Arifin, H., Anggraini, N., and Rasyid, R. (2006). Standardization of ethanol extract of eugenia cumini Merr, *J. Science Tech. Far* 11(2), Andalas University.

Cahyaningrum, P.L. (2014). Comparison of antioxidant stability between ethanol extraction of 50% mangosteen peel (*Garcinia mangostana* L.) and its microparticle form using the DPPH method. Thesis. Pharmacy Study Program, Faculty of Medicine and Health Sciences Jakarta.

Cano-Chauca, M., Stringheta, P. C., Ramos, A. M., and Cal-Vidal, J. (2005). Effect of the carriers on the microstructure of mango powder obtained by spray drying and its functional characterization. *Innovate Food Science and Emerging Technologies* 6: 420-428.

Dai, J. and Mumper, R.J. (2010). Plant Phenolics: Extraction, analysis and their antioxidant and anticancer properties. *Molecules*, 15, 7313-7352. http://dx.doi.org/10.3390/molecules15107313

Dwi, E.K. (2016). The effect of temperature and drying time on the characteristics of katuk leaf herbal tea (*Sauropus Adrogynus* L. Merr). Pasundan University Food Technology Final Assignment Research.

Ekpong A, Phomkong W, Onsaard, E. (2016). The effects of maltodextrin as a drying aid and drying temperature on production of tamarind powder and consumer acceptance of the powder. *Int Food Res J.* ;23:300–8.

Ernawati, S. (2010). Stability of natural coloring powder preparations from roselle (*Hibiscus sabdariffa* L.) produced by spray drying and tray drying methods. Faculty of Agricultural Technology, Bogor Agricultural Institute. Bogor Agricultural Institute.

Ersus, S. and Yurdagel, U. (2007). Microencapsulation of anthocyanin pigments of black carrot (*Daucus carota* L.) by spray dryer. *Journal of Food Engineering* 80: 805-812 .

Estiasih, T. (2012). Competitive adsorption of phospholipids on the surface of oil globules in caseinate-stabilized emulsion systems. *Journal of Agricultural Technology*. 13 (1) : 16-26.

Fathinatullabibah, Kawiji, and Khasanah, L. U. (2014). Stability of anthocyanins from teak leaf extract (*Tectona gramdis*) against pH and temperature treatments. *Journal of Food Technology Applications,* 3(2), 60-63

Gabas, A. L., Telis, V.R.N., Sobral, P.J.A. and Telis-Romero, J. (2007). Effect of maltodextrin and arabic gum in water vapor sorption thermodynamic properties of vacuum dried pineapple pulp powder. *Journal of Food Engineering*. 82 (2) : 246-252.

Garcia-Estevez, I., Alcalde-Eon, C., Puente, V., and Escribano-Bailon, M.N. (2017). Enological tannin effect on red wine color and pigment composition and relevance of the yeast fermentation products. *Molecules* 22(12): 2046.

Giusti, M.M. and Wrolstad, R.E. (2003). Acylated Anthocyanins from Edible Sources and Their Applications in Food Systems. *Journal of Biochem. Eng*. 14, 217–225.

Gustavo, V., Barbosa, C., Gongora, M. N. M. and Barry, G. S. (1999). Preservation of foods with pulsed electric fields". Academy Press : London

Hairunnisya, N. (2016). Making Aloevera powder (*Aloe vera* L.) using the "foam mat drying" method study: type and concentration of filling materials. Thesis. Department of Agricultural Product Technology, Faculty of Agricultural Technology, Brawijaya University Malang.

Hadnađev, M., Dokic, L., Hadnađev, T. D., Pajin, B., and Krstonosic, V. (2011). The Impact of maltodextrin-based fat mimetics on rheological and textural characteristics of edible vegetable fat. *J. Texture Stud*. 42: 404–411. Link : https://doi.org/10.1111/j.1745- 4603.2011.00302.x

Hariadi, H., Sunyoto, M., Nurhadi, B., Karuniawan, A. (2018). Comparison of phytochemical characteristics of pigment extract (Anthocyanin) sweet purple potatoes powder (*Ipomoea batatas* L) and clitoria flower (Clitoria) as natural dye powder, *Journal of Pharmacognosy and Phytochemistry*, 7(4), 3420– 3429.

Harijono, J, Kusnadi., and Mustikasari, S.A. (2001). Effect of carrageenan content and total soluble solids of young apple juice on quality aspects of jelly candy. *Journal of Agricultural Technology*, 7(2): 55-75.

Husni, P., Fadhilah, M.L., and Hasanah,U. (2020). Formulation and physical stability test of instant granules of dry powder of genjer stalks (Limnocharis flava (L.) Buchenau.) as a fiber supplement. *Farmasyifa Pharmaceutical Scientific Journal* 3 (1): 1 – 8. DOI : 10.29313/jiff.v3i1.5163.

Jabbar, A., Wahyuni, W., Malaka, M.H., and Apriliani, A. (2019). antioxidant activity of ethanol extracts of fruit, leaves, stems and rhizomes on wualae plants (Etlingera Elatior (Jack) R.M Smith): *JFG* 5, 189–197. https://doi.org/10.22487/j24428744.2019.v 5.i2.13671.

Jian Hie (2004). Absorption, excretion, and transformation of individual anthocyanins in rats. Thesis. Faculty of Graduate School of The University of Maryland.

Krishnan, A., Xu, Y., Gandour, J. and Cariani, P. (2005). Encoding of pitch in the human brainstem is sensitive to language experience. *Cognitive Brain Research*. 25 : 161–168.

Lee, J., Durst, R.W., Wrolstad, R.E. (2005). Determination of total monomeric anthocyanin pigment content of fruit juices, beverages, natural colorants, and wines by the pH differential method. Collaborative Study. *Journal of AOAC International*. 88 ,1269- 1277.

Lestari, P.D.A., Wrasiati L.P., Suwariani N.P. (2019). Characteristics of the encapsulate functional dye extract of rosella flowers (Hibiscus sabdariffa L.) in the casein-maltodextrin ratio treatment. J Agroindustry Engineering and Management. 7:509–20.

Maray, A.R.M., Mostafa, M.K., Alaa El-Din, M. A., El-Fakhrany. (2017). Effect of pretreatments and drying methods on physico-chemical, sensory characteristics and nutritional value of oyster mushroom. *J. Food Process Preserv*. 2018;42:e13352. https://doi.org/10.1111/jfpp.13352.

Marsin, A. M., Jusoh, Y. M. M., Abang, D. N., Zaidel, Z. H., Yusof, A. H. M., and Muhamad, I. I. (2020). Microwave-assisted encapsulation of blue pea flower (*Clitoria ternatea*) colourant: maltodextrin concentration, power, and time. *Chem. Eng. Trans*. 78, 199–204. doi: 10.3303/CET2078034

Martunis (2012). The Effect of temperature and drying time on the quantity and quality of granola variety potato starch. *Journal of Indonesian Agricultural Technology and Industry (JTIP Indonesia)*. 4 (3), 26 - 30.

Moore, G.R.P., do Canto, L.R., Amante, E.R., Soldi, V. (2005). Cassava and corn starch in maltodextrin production. *Quim Nova*. 28 (4) : 596-600.

National Standardization Agency (1995). SNI 01-3709-1995 Quality requirements for spice powders. National Standardization Agency. Jakarta.

Nurhasanah, N., Karismawati, A.S., Widyaningsih, T.D., and Nugrahini, N.I.P. (2015). Effect of antioxidant jelly drink red dragon fruit peel and rosella on SGOT and SGPT levels. *Journal of Food and Agroindustry*. 3(2), 511-522.

Oktaviana, Y. (2012). Combination of maltodextrin concentration and heating temperature on the quality of starfruit (*Averrhoa bilimbi* Linn.) Instant Powdered Drink. Thesis. Faculty of Technobiology. Atma Jaya University. Yogyakarta.

Padzil A.M., Aziz A.A., Muhamad I.I., (2018). Physicochemical properties of encapsulated purple sweet potato extract: effect of maltodextrin concentration and microwave drying power, Malaysian *Journal of Analytical Sciences*, 22(4), 612–618.

Permata, D.A and Sayuti, K. (2016). Making instant powdered drinks from various parts of the meniran plant (*Phyllanthus niruri*). *Journal of Agricultural Technology*. 20(1): 43-49.

Pratiwi, I.Y. (2011). The Effect of maltodextrin variations on the quality of cinnamon instant powder drink (*Cinnamomum burmanii* Bl.). Thesis. Atma Jaya University Yogyakarta Faculty of Technobiology Yogyakarta Biology Study Program.

Ramadhia, M., Kumalaningsih, S. and Santoso, I. (2012). Making Aloe vera (*Aloevera* L) flour using the foam mat-drying method. *J. Agricultural Technology*. 13(2): 125-137.

Reyes, L. Fernando, L. Cisneros-Zevallos (2007). Degradation kinetics and colour of anthocyanins in aqueous extractsof purple- and red-flesh potatoes (*Solanum tuberosum* L.). *J. Food Chemistry* 100, 885–894.

Rompas, R. A., Edy, H. J., and Yudistira, A. (2012). Isolation and identification of flavonoids in seagrass leaves (*Syringodium isoetifolium*), *Pharmacon*, *1*(2), 59-63. https://doi.org/10.35799/pha.1.2012.x

Sarofa, U. and Saraswati, P. (2021). Effect of maltodextrin concentration and the characteristics of watermelon (*Citrullus vulgaris* S.) albedo instant drink enriched with telang flower (*Clitorea ternatea*) Extract. *Anjoro: International Journal of Agriculture and Business*. 2(2): 50-57

Septevani, A. A., Dewi, S. and Ghozali, M. (2013). The effect of spray drying techniques in microencapsulation of asiaticoside and ginger extract. *indonesian materials science journal*. 14 (4): 248 – 252.

Shao, Y., Z. Gan, and J. Ao. (2011). Total phenolic content and antioxidant capacity of rice grains with extremely small size. *African J. Agric. Res*. 6(10): 2289–2293. do

Silitonga, P. and Sitorus, B. (2014). Encapsulation of Anthocyanin Pigments from Purple Eggplant Skin. *Journal of Equatorial Chemistry*. 3 (1) : 44-49.

Supriyadi and Sakha, A. R. (2013). Characteristics of galangal essential oil microcapsules with maltodextrin as encapsulant. *Journal of Food Technology and Industry*. 24(2): 201-208.

Tako, M. (2000). Gelatinization Characteristics of rice starch (Yukihikari). Departement of Bioscience and Biotechnology. Faculty of Agriculture. University of the Ryukyus. Japan. *J. Appl. Glycoscy*. Vol.47(2). P.187-192

Triani, L., Suhaidi, I., and Sentosa, G. (2015). The Effect of drying temperature and dextrin concentration on the quality of instant drinks for beetroot. Food Science and Technology Study Program, Faculty of Agriculture, USU Medan. 3(2).

U.S. Department of Agriculture (USDA) (2023). Commercial item description spices and spice blends. USDA purchase specifications are available at: https://www.ams.usda.gov/selling-food/product-specs.

Vanini, L.S., Hirata, T.A.M, Kwiatkowski, A., Clemente, E. (2009). Extraction andstability of anthocyanins from the Benitaka grape cultivar (*Vitis vinifera* L.). *Braz. J. Food Technol*., 12 (3): 213-219, jul./set.

Wibawanto, N.R., Ananingsih, V.K., and Pratiwi, R. (2014). Production of natural red beet (beta vulgaris l.) coloring powder using the oven drying method. Proceedings of the national science and technology seminar. Wahid Hasyim University Faculty of Engineering. DOI: http://dx.doi.org/10.36499/psnst.v1i1.972

Wicaksono, W. (2012). Modification of anchovy drying machine using a rotary system. Final project at the Faculty of Engineering, Diponegoro University, Semarang.

Yogaswara, I.B., Wartini, N.M., and Wrasiati, L.P. (2017). Encapsulate characteristics of pandan fruit coloring extract in gelatin and maltodextrin encapsulant treatment. faculty of agricultural technology, Unud. J*ournal of Agro-Industrial Engineering and Management,* Issn: 2503-488x, 5 (4), 31-40.

Yongki, L.K. (2008). Maltodekstrin. www.yongkikastanyaluthana.wordpress.com. Diakses 10 Desember 2023).

Zhang, X., Wang, X., Wang, M., Cao, J., Xiao, J. and Wang, Q. (2019). Effects of different pre-treatments on flavonoids and antioxidant activity of *Dryopteris erythrosora* leaves. *PloS one*, 14(1), e0200174.https://doi.org/10.1371/journal.pone.0200174.

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