Production of natural colorant powder from *Clitoria ternatea* L. using tray dryer which is dehumidified by zeolite

F Mauludifia, S D Astrarini, K A Meiranti, and M Djaeni

Department of Chemical Engineering, Faculty of Engineering, Diponegoro University. Jl Prof. H. Soedarto, SH, Tembalang, Semarang, Indonesia 50275

Email: moh.djaeni@live.undip.ac.id

**Abstract.** One of food additives that are usually added to food is coloring agents. The use of synthetic colorant in food products often causes health problems [1]. Telang flowers (*Clitoria ternatea* L.), have blue color that indicates the presence of anthocyanins. Anthocyanin is a flavonoid compound that has positive health benefits. Referring to this, the flowers can potentially become natural coloring agents. This research aims to examine the effect of pH on anthocyanins, the effect of maltodextrin concentration and temperature on water content. So that the best conditions are obtained for the drying process and obtained powder that has anthocyanin content with low water content. The research was conducted in several stages, namely extraction, drying and analysis of results. The extract is varied in its pH to obtain pH with highest anthocyanin. Drying was carried out with variations in maltodextrin concentrations of 0 and 8%, and temperatures of 40, 60 and 80°C. Water content analysis for 120 minutes every 10 minutes. The results showed that at pH 2, the highest total anthocyanin was obtained. The higher the drying temperature and maltodextrin concentration that is added, the time needed to dry the extract will be faster. Lower moisture content is produced with higher maltodextrin concentration and temperature.

**Keyword:** *Clitoria ternatea* L., extract, anthocyanin, maltodextrin, drying

1. Introduction

Additives that commonly added to food are synthetic additives, for example synthetic colorant and antioxidants. However, synthetic additives are known to cause health problems [1]. Telang flowers (*Clitoria ternatea* L.) have a blue petals that indicates the presence of anthocyanins [2]. Telang flowers have higher anthocyanins compared to dragon fruit and rosella [3]. Anthocyanins are classified as natural pigments called flavonoids which are generally soluble in water. Therefore, to obtain anthocyanin pigments can be done by extraction using water solvents [1].

There was several research about anthocyanins extraction of telang flowers such as traditional extraction [4] and ultrasonic extraction [5]. The storage of anthocyanin colorant from telang flowers in liquid form has a low shelf life due to instability factors [1]. Drying process is needed to produce colorant with high stability and low water content. One methode of drying that can produce maintained nutritional quality and has high energy efficiency is drying which is dehumidified by zeolite [6]. This research aim is processing the extract telang flower to obtain anthocyanin extract in powder form. Variations in the drying process will be studied such as pH, temperature, and concentration of maltodextrin.

2. Materials and Method

2.1 Materials

Dried *Clitoria ternatea* L. petals are used in this study. Dried *Clitoria ternatea* L. petals are extracted before being dried under different temperature 40, 50, 60, 70, and 80°C. Maltodextrin is added as thickening agent. Zeolite 3A are used as adsorbent in purpose to decrease the relative humidity of air dryer.
2.2 Experimental Design

Dried *Clitoria ternatea* L. petals are extracted by aquadest as the solvent using ultrasound bath, under temperature 30˚C for 30 minutes. The ratio for the petals and aquadest is 1:4. The pH of the extract is set to 2, 7 and 10 then the anthocyanin content is being tested using spectrophotometer UV-VIS. Extract with highest anthocyanin content is dried using tray drier dehumidified by zeolite. 0% and 8% of maltodextrin is added to the extract before proceeding to the drying process. The air dryer flow is set at 3 m.s⁻¹. It is measured with an anemometer. For the first experiment, the temperature is set to 40˚C with PID controller. The drying process is carried out for 120 minutes, with weighing every 10 minutes. The process was repeated for the inlet air dryer temperature 60˚C and 80˚C.

2.3 Anthocyanin Content Analysis

1 ml extract is diluted to 10 ml using pH 1 buffer solution. Another 1 ml of extract is diluted to 10 ml using pH 4.5 buffer solution. Anthocyanin content is analyzed using spectrophotometer UV-VIS, by equation 1 and 2 [5].

\[
A = (A_{520nm} - A_{700nm})_{pH1,0} - (A_{520nm} - A_{700nm})_{pH4,5} \quad (1)
\]

\[
\text{Anthocyanin content} = \frac{A \times MW \times DF \times 1000}{\varepsilon \times 1} \quad (2)
\]

Where A is absorbance, MW is molecular weight of anthocyanin, DF is dilution factor, and \(\varepsilon\) is molar absorptivity of anthocyanin.

2.4 Moisture Content

To calculate moisture content of the extract, equation 3 is used.

\[
X_n = \frac{W_n - \text{dry base mass}}{W_n} \times 100\% \quad (3)
\]

Where \(X\) is moisture content at n-minute and \(W\) is weight of the extract at n-minute.

3. Results and Discussion

3.1 pH Effect on Anthocyanin

From Figure 1, it can be seen that different pH will make variation in the color of extract. pH 2 makes the extract turn red, pH 7 gives blue color, and pH 10 turns the extract to blackish green. This phenomenon can happen because the higher the pH, the wavelength will shift. Spectral changes occur due to changes in the structure of the anthocyanin from the form of flavilium cation to the form of chalcone. At low pH, anthocyanins are in the form of flavilium cations which are the most stable form (pH 1-2). At pH > 3, the red color of flavilium cation is then turned into carbinol pseudobase or quinonoidal blue in line. Then at pH > 9 will turn into chalcone which is pale colored [7]. From Figure 2, it is shown that the lower the pH, the anthocyanin concentration will be higher. At pH 2 the concentration of anthocyanin is 85.54 mg/L; at pH 7 is 68.97 mg/L and at pH 10 is 57.528 mg/L.

![pH 2, pH 7, pH 10](image)

Figure 1. Changes in color under different pH
The pH treatment can affect anthocyanin content, where at the high the pH the anthocyanin content will decrease. This phenomenon can occur because in an increasingly acidic state it will make anthocyanin pigments in the form of flavylum cation or colored oxonium and absorbance measurements will show an increase in the number of anthocyanins and cause vacuole cell walls broken so that more anthocyanins are extracted [8].

3.2 Temperature Effect on Drying Process

The drying process is carried out at temperatures of 40, 50, 60, 70 and 80 °C, the results can be seen in Figures 3 and 4. From Figure 3, it can be seen that the higher the drying temperature, the time needed to dry the extract will be faster. For the highest temperature, which is at temperature 80°C, it only takes 120 minutes for the extract to be dried and reach its constant weight. Meanwhile for lower temperatures, which are 40, 50, 60, and 70°C, it takes longer to dry the extract. This phenomenon can happen because an increase in operational temperature will increase the amount of heat given to food material which results in an increasing evaporation rate. Since the evaporation rate increases, moisture content of the sample will decrease as well as the time needed to dry the sample [9].
While in Figure 4, it can be seen that the higher the temperature, the lower the drying rate and the drying time will be faster. The higher the temperature of the dryer cause the lower the relative humidity of the air. Low relative humidity will increase the driving force of the drying process [10]. The lower relative humidity of the drying air, the water content of the material will be lower, because the water content in the material will be in equilibrium with relative humidity. The higher the temperature, the more water in the material will be released more easily, due to the greater energy given by the drying air to release water molecules that are bound in the material as the temperature rises [11].

3.3 Temperature Effect on Anthocyanin Content
The dried extract was extracted at pH 2 because it had the highest anthocyanin content of 85.54 mg/L. Telang flower was extracted with an ultrasonic bath and then the pH is set to 2. The extract before drying at pH 2 had an anthocyanin level of 85.54 mg/L. Drying extract is carried out at 40, 50, 60, 70 and 80°C using tray dryer. From the results of the determination of anthocyanin compounds with a UV-Vis spectrophotometer, anthocyanin content after drying were obtained as shown in Table 1.

Table 1. Anthocyanin Content After Drying Process

| No | Temperature (°C) | Anthocyanin Content (mg/L) |
|----|-----------------|---------------------------|
| 1.  | 40              | 82.13                     |
| 2.  | 50              | 79.12                     |
| 3.  | 60              | 75.22                     |
| 4.  | 70              | 69.99                     |
| 5.  | 80              | 65.12                     |

Anthocyanin is a class of flavonoid compounds, where these compounds have the potential as antioxidants. Based on Table 1, it can be seen that the increase in temperature causes the smaller anthocyanin content that obtained. This is because at high temperatures anthocyanin degrades into ketone products. Anthocyanin degradation is quite significant at temperatures over 70°C [12]. Degradation that caused by heating can occur in two stages, first hydrolysis of anthocyanin glycosidic bonds to produce unstable aglycones, then aglycone rings that open form carbinol and chalcone groups which cause discoloration [7].
3.4 Maltodextrin Concentration Effect on Drying Process

From the Table 2, it can be seen that by adding 8% maltodextrin, the time needed to dry the extract will be faster. Time to make the extract reach its constant weight will be faster as well. It is different when 0% maltodextrin is added, where the time needed to dry the extract is much longer. This phenomenon can happen because by adding maltodextrin, desorption of water vapor increases. Additional concentrations of maltodextrin resulted in an increase in feed solids and a reduction in total moisture for evaporation [13].

Table 2. Maltodextrin concentration effect on drying process

| Sample | Maltodextrin (%w/v) | Temperature (°C) | Drying Time (minute) | Moisture Content (%) |
|--------|---------------------|------------------|-----------------------|----------------------|
| 1      | 0                   | 40               | 230                   | 33.6                 |
| 2      | 0                   | 50               | 190                   | 32.3                 |
| 3      | 0                   | 60               | 170                   | 33.4                 |
| 4      | 0                   | 70               | 160                   | 32.8                 |
| 5      | 0                   | 80               | 140                   | 32.0                 |
| 6      | 8                   | 40               | 200                   | 23.3                 |
| 7      | 8                   | 50               | 170                   | 22.9                 |
| 8      | 8                   | 60               | 150                   | 22.6                 |
| 9      | 8                   | 70               | 140                   | 22.8                 |
| 10     | 8                   | 80               | 120                   | 22.4                 |

4. Conclusions

The results showed that different pH will make variation in the color of extract. pH 2 makes the extract turn red, pH 7 gives blue color, and pH 10 turns the extract to blackish green. At pH 2, the highest total anthocyanin was obtained. The higher the drying temperature and maltodextrin concentration that is added, the time needed to dry the extract will be faster. Lower moisture content is produced with higher maltodextrin concentration and temperature.

References

[1] Ernawati Santy, Haryadi Y and Adawiyah D R 2010 Food Science and Technology 1856
[2] Suebkhampet A and Sothibhandhu P 2011 Suranaree Journal of Science Technology 19 15-19
[3] Suppadit N, Sunthorn P, Poongsuk P. 2011 African Journal of Biotechnology 10 19109-19118
[4] Zussiva Ana, Bertha Karina L., C Sri Budiayati 2012 Jurnal Teknologi Kimia dan Industri Vol 1 No 1
[5] Kusrimi E, Dewi Tristantini, Ni`matul Izza 2017 Jurnal Jamu Indonesia 2
[6] Djaeni M, M Ikhwan Shofarudin, Tri Nugroho 2012 Jurnal Teknologi Kimia dan Industri 1 150-156
[7] Brouillard R 1982 Chemical structure of anthocyanins Anthocyanins as Food Colours ed In P. Markakis (New York: Academic Press) p 26-28
[8] Fennema, Owen 2008 Food Chemistry 4th edition Marcell Dekker, Inc New York.
[9] Abasi S, Mousavi S M, Mohebi M and Kiani S 2009 Iranian Journal of Chemical Engineering 6 57-70
[10] Djaeni M and Dessy Agustina Sari 2015 Procedia Environmental Sciences 23 2-10
[11] Suherman, Aprilina Purbasari and Margaretha Praba Aulia 2012 Prosiding SNST 3 45-50
[12] Dai, J. and R. J. Mumper 2010 Plant phenolics: extraction, analysis and their antioxidant and anticancer properties Molecules 15.
[13] El-Hamzy E M A and El-Kholany E A 2014 Journal of Applied Sciences Research 10 72-86