

Microencapsulation of Dragon Fruit (*Hylocereus polyrhizus*) Peel Extract Using Maltodextrin

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Abstract. Dragon fruit peel can be utilized as a natural dye due to betacyanin content, red-violet pigment of betalain group. Betacyanin is unstable to temperature, oxygen, and light, consequently microencapsulation technology is required to maintain its stability. This study aims to determine microencapsulation efficiency of dragon fruit peel extract with variation of encapsulation ratio and to perceive morphological characteristics of dragon fruit peel extract encapsulated. In this study, the dragon fruit peel was extracted using polar solvent pH 4 and pH 5 by maceration method. Maltodextrin is used as coating encapsulation and freeze drying is applied as microencapsulation method. The results showed that, encapsulation of dragon fruit peel extract using maltodextrin with extract ratio to suspension of 5:1, more efficient than ratio of 3:1. Morphological encapsulation of dragon fruit peel extracts resulted in matrix form with particle diameter of dragon fruit peel extract with pH 5 solvent between 0,460-0,770 μm , while particle diameter of dragon fruit peel extract with pH 4 solvent between 0,288-0,640 μm . This study has a great impact to development of microencapsulation technology on red dragon fruit peel as waste utilization which can further be utilized as a functional natural dye in food. This study would be a reference for further researchers or people who engaged in food industry.

1. Introduction

Dragon fruit is one of the tropical fruit belongs to the family Cactaceae from the genus *Hylocereus*. Its peel can be utilized as a raw material of pigment extraction due to the betalain content which presents attractive and stable colors. Dragon fruit peel contain phenolic compounds betalaine [1]. Betalain is a water-soluble pigment consisting of two stratial groups of red-violet betacyanine and betaxantin orange-yellow [2]. Betalain contained in plants is usually obtained by maceration extraction. An important extraction process is carried out to maintain the stability of sensitive pigments such as betacyanin [3]. Extraction using water is better for stabilizing pigments [4]. Betacyanin pigment is easily influenced by temperature, oxygen, light and water activity [5]. Pigment stability becomes an important consideration for optimizing utility as both antioxidant and food colorants [6]. Betalain stability can be improved through microencapsulation technology [2].

Microencapsulation is defined as the trapping process of both liquid, solid and gas particles in thin films that can provide a physical barrier between core compounds and other components whose retention is essentially influenced by chemical functionalities of solubility, polarity and volatile [7].



Microencapsulation can be used to protect sensitive food component constituents so that nutrient losses can be minimized, and the use of sensitive materials can be optimized [8]. The microencapsulation efficiency is highly depend on the composition of the encapsulated coating material [7].

Maltodextrin is the most commonly used as a coating material encapsulated in a microencapsulated process. Maltodextrin has a high solubility in water, low viscosity, a tasteless and colorless taste [6]. Freeze drying is considered as the best method in microencapsulation technology for maintaining the stability of sensitive pigments [9]. This study aims to determine microencapsulation efficiency of dragon fruit peel extract with variation of encapsulation ratio and to perceive morphological characteristics of dragon fruit peel extract encapsulated.. Microencapsulation of dragon fruit peel extract is expected to optimize the utilization of dragon fruit peel as a safe natural dye and microencapsulation products of dragon fruit peel extract can be utilized futher in food and non-food industries that have economic value.

2. Methods

2.1. Materials

The main material of this research was dragon fruit (*Hylocereus polyrhizus*) peel, which were obtained from farm in Subang, Jawa Barat. The other materials used were aquades, citric acid, maltodextrin and universal indicator.

2.2. Dragon fruit peel extraction

Dragon fruit peel extraction was performed using polar solvents with different pH (5 and 4). Extraction was done with maceration at room temperature for 14 hours [10]. Dried dragon fruit peel was destructed and blended, then was extracted in polar solvent with the ratio of the dragon fruit peel powder and polar solvent (1:20), further filtration. The filtrate was homogenized and centrifuged for 20 minutes at a rate of 4000 rpm.

2.3. Measurement of total betacyanin dragon fruit peel extracts

Total betacyanin content measurements were analyzed using spectrophotometer by measuring its absorbance at λ 538 nm, with fp 10 [11]. Betacyanin concentration was calculated using the following formula [12].

$$\text{Betacyanin concentration (mg/100L)} = \frac{A \times DF \times MW \times 1000}{\epsilon \times l}$$

A = Absorbance (λ 538 nm)

DF = Dilution factor

MW = Molecular weight of betacyanin (550 g/mol)

ϵ = Molar extinction coefficients (60,000 L/mol cm)

l = Path length of cuvette (1,0 cm)

2.4. Preparation of dragon fruit peel extracts

Coatings for microencapsulated processes were made from maltodextrin [6]. Coating was made by dissolving maltodextrin using aquades until the suspension was obtained with concentration of 50%, then heated at 50°C for 15 minutes while stirring using hot plate magnetic stirrer. The maltodextrin suspension then was added with dragon fruit peel extract with the extract ratio : suspension as follows 1: 3 and 1: 5.

2.5. Microencapsulation of dragon fruit peel extracts

The microencapsulation process was carried out using a freeze dryer [5]. After completion, the drying powder is weighed and stored in a desiccator at room temperature, then calculated rendement.

2.6. Morphological analysis of encapsulate structure

The encapsulated structure of the drying result was measured and using Scanning Electron Microscope (SEM). SEM is a type of electron microscope that produces images of a sample by scanning the surface with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the sample's surface topography and composition.

2.7. Measurement of surface betacyanin encapsulate

Measurement of surface betacyanin content was analyzed using spectrophotometer by measuring its absorbance at λ 538 nm, with fp 10.

2.8. Efficiency of Encapsulation (EE)

Efficiency of encapsulation (EE) is the ratio of betacyanin encapsulation with total betalain content. The rate of betacyanin encapsulation is the difference from the total betalain content with the surface betacyanin content of the capsule [2]. Efficiency of encapsulation was calculated using the following formula:

$$EE (\%) = \frac{\text{Total betacyanin concentration} - \text{surface betacyanin concentration}}{\text{Total betacyanin concentration}} \times 100$$

3. Results and discussion

3.1. Extraction of dragon fruit peel

Result of dragon fruit peel extraction using polar solvent pH 4 and pH 5 with maceration method is presented in Table 1.

Table 1. Result of Dragon Fruit Peel Extraction

Solvent	Colour Extract	Result			
		Absorbance		Betacyanin Concentration (mg/L)	Δ Betacyanin Concentration (mg/L)
pH 5	Merah	Simplo	0,795	72,875	75,95
		Duplo	0,862	79,017	
pH 4	Merah	Simplo	0,664	60,867	63,07
		Duplo	0,712	65,267	

Measurement of betacyanin concentration aims to measure how much betacyanin content in dragon fruit peel extract. Based on the result of betacyanin concentration test on dragon fruit peel extract as presented in Table 1, showed that the best betacyanin concentration was on the treatment of dragon fruit peel extract by using solvent pH 5 that is 75.95 mg/L. This is consistent with other study [13] which explained that betacyanin has a high level of stability at pH 5. While the concentration of betacyanin contained in dragon fruit peel extract using a pH 4 solvent is 63.07 mg/L. High concentration of betacyanin dragon fruit peel extract using pH 5 solvents are caused by a pH 5 solvent which has a polarity level close to betacyanin polarity thus increasing the ability to dissolve betacyanin and the extraction process occurs to the maximum. The polarity of a substance is determined by the difference in electronegativity between the constituent elements and the bonds in the molecule. This is in accordance with other study [14], betacyanin that is in dragon fruit peel extract is polar.

3.2. Microencapsulation of dragon fruit peel extract

Microencapsulation is the process of coating the core particles of a solid, liquid, or gas with a special coating material that can form the core particles having the desired physical and chemical properties [15]. This microencapsulation generates powder (10 to 5000 μm). Size of encapsulat varies and depends on the method of microencapsulation used. The advantages of freeze drying method are the product structure does not shrink, allowing rapid rehydration, high flavor retention because drying takes place at low temperatures [16].

The result showed that yield of dragon fruit peel extract using pH 4 solvent was higher than yield of dragon fruit peel extracts using pH 5 solvent. This yield ranged from 41.33% to 51.67%. It was quite low due to product loss. Yield from microencapsulation of dragon fruit peel extract with pH 5 solvent showed a decrease as the ratio of maltodextrin suspension increases. On the contrary, yield from microencapsulation of dragon fruit peel extract with pH 4 solvent showed an increase as the ratio of maltodextrin suspension increases.

3.3. Efficiency of encapsulation dragon fruit peel extract

Efficiency of encapsulation indicates the number of dragon fruit peel extract coated due to encapsulation. The higher efficiency of encapsulation is directly proportional to the higher extract of dragon fruit peel coated. Efficiency of encapsulation dragon fruit peel extract is presented in Table 2.

Table 2. Efficiency of Encapsulation Dragon Fruit Peel Extract

Sample	Δ Total of Betacyanin Concentration (mg/L)	Surface of Betacyanin Concentration (mg/L)	Δ Surface of Betacyanin Concentration (mg/L)	Encapsulation Efficiency (%)
Solvent pH 5 (1 : 3)	75,95	Simplo 55,825	56,833	25,17
		Duplo 57,933		
Solvent pH 5 (1 : 5)	63,07	Simplo 29,883	30,892	59,32
		Duplo 31,992		
Solvent pH 4 (1 : 3)	63,07	Simplo 43,358	44,458	29,51
		Duplo 45,558		
Solvent pH 4 (1 : 5)	63,07	Simplo 31,533	28,783	54,36
		Duplo 26,033		

The results showed that the highest encapsulation efficiency was 59.32% on the encapsulate of dragon fruit peel extract using pH 5 solvent with extract ratio and maltodextrin 1: 5. This results indicate that there were still uncoated dragon fruit peel extract during microencapsulation process. Data in Table 2, generally indicating that the higher the surface betacyanin content, the lower encapsulation efficiency obtained. Levels of surface betacyanin are parameters that show the amount of betacyanin that was not encapsulated or attached to the surface of the capsule. The value of the surface level is very important to see how much betacyanin is completely encapsulated. Microencapsulation aims to protect the core material from damage and evaporation [17]. This indicates that unencapsulated betacyanin will be more susceptible to damage, evaporate and oxidized thereby decreasing the quality of the encapsulates.

Comparison of encapsulation efficiency obtained by encapsulation with extract ratio and maltodextrin 1:5 is higher than encapsulation with extract ratio and maltodextrin 1:3. Reduced addition of maltodextrin as encapsulant can decrease the efficiency of encapsulation of dragon fruit peel extract. This can be attributed to fewer available maltodextrin suspension ratios to keep the structural matrix like betacyanin encapsulated. The addition of maltodextrin affects the thickness of the encapsulated walls so that betacyanin is trapped more and is difficult to exit. Efficiency of encapsulation differs on the use of different molecular polymer weights. The higher the molecular

weight of polymer, the higher the encapsulation efficiency. An excessive amount of the core material will decrease the ability of the encapsulating material to coat the core material [17].

3.4. Characteristics of encapsulat morphology

The microscopic appearance of betacyanin encapsulate of dragon fruit peel extract can be seen in Figure 1.

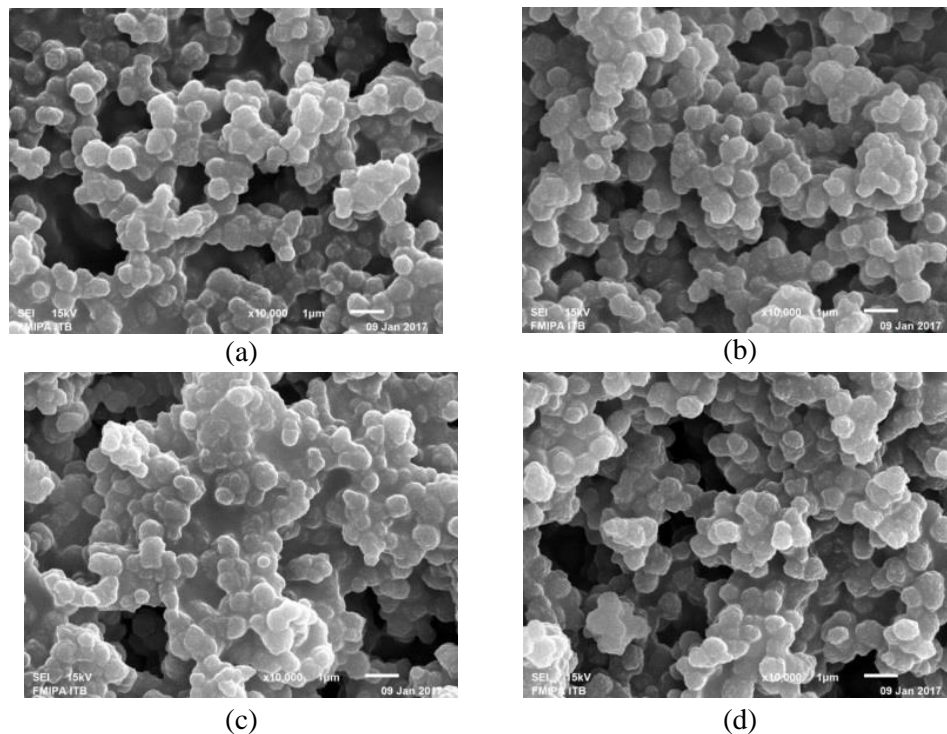


Figure 1. Scanning Electron Microscope (SEM) Scale Test Results of Dragon Fruit Extracts; (a) pH 5 Solvent (1:3) magnification 10,000 x, (b) pH 5 Solvent (1:5) magnification 10,000 x, (c) pH 4 Solvent (1:3) magnification 10,000 x, (d) pH 4 Solvent (1:5) magnification 10,000 x

The particle size of betacyanin encapsulation of dragon fruit peel extracts varied but was still in microparticle size. Figure 1.a shows that the extract of dragon fruit peel extract with solvent pH 5 and ratio of extract with coating of 1: 3 has particle diameter of 0.494-0.770 μm while the extract of dragon fruit skin peel with solvent pH 5 and ratio ratio extract with coating 1: 5 has a particle diameter of 0.460-0.611 μm which is addressed in Figure 1.b. The encapsulated diameter with 1: 3 encapsulation ratio was greater than the encapsulation with a 1: 5 encapsulation ratio, but the size was not much different. Figure 1.c shows that the extract of dragon fruit peel extract with solvent pH 4 and ratio ratio of extract with coating of 1: 3 has a particle diameter of 0.288-0.410 μm whereas the encapsulation of dragon fruit skin extract with pH4 solvent and ratio ratio extract with coating of 1: 5 has particle diameter 0.563-0.640 μm shown by Figure 1.d. The particle size variation of the dragon fruit skin encapsulation extract was caused the coated material was not uniform, so the size of the encapsulation varied but still in microparticle size. The type of encapsulation produced was a matrix type encapsulate referring to other study [7]. According to Figure 1, visible surface of the dragon fruit peel extract shaped matrix. The irregular shape of particles but visible granules that unite signifies the formation of encapsulation through an encapsulation process that contains dragon fruit peel extracts. The surface area seen in the image was estimated to encapsulate the skin dragon fruit extract. The phenomenon of dragon fruit peel extract in the form of matrix indicates the process of encapsulation works well.

4. Conclusion

The highest efficiency of encapsulation of dragon peel extract is 59,32%. The results were obtained from the encapsulation composition with solvent pH 5 ratio extract and maltodextrin 1: 5. While the lowest encapsulation efficiency of dragon fruit peel extract was 25.17%, obtained from the encapsulation composition with solvent pH 5 ratio extract and maltodextrin 1: 3. High levels of betacyanin surface dragon fruit peel extract inversely proportional to the efficiency of encapsulation obtained. Reduced ratio of maltodextrin as encapsulation can decrease the encapsulation efficiency of dragon fruit peel extract. Morphological encapsulation of dragon fruit peel extract in the form of a matrix with irregular particle shape. The dragon fruit peel extract encapsulation has almost the same particle diameter.

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