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Effect of encapsulation agents on antioxidant activity and moisture content of spray dried powder from Mahkota Dewa fruit extract

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Abstract. Mahkota Dewa is rich in bioactive compounds including mangiferin, saponin and polyphenols. This work aims to investigate the encapsulation of Mahkota Dewa by spray drying using different types of encapsulation agent. A subcritical water extraction process was used to extract the bioactive compounds from dried Mahkota Dewa prior to spray drying process. The encapsulation agents used were maltodextrin (MT), arabic gum (AG) and mixture of arabic gum-maltodextrin (AG-MT). The spray drying conditions namely inlet dry air temperatures, dry air flow rate and inlet feed flowrate were 200˚C, 3.7 m/s and 485 mL/h, respectively. The spray dried powder samples were evaluated for antioxidant activity and moisture content and compared with those without encapsulation agent. A high value of antioxidant activity and low moisture content were observed for samples with encapsulation agents. Result suggested the maltodextrin produced particles with the lowest moisture content (4.84 %) and highest antioxidant activity (94.22%), thus can be recommended as the most suitable encapsulation agent in this work.

1. Introduction

Mahkota Dewa or scientifically known as *Phaleria Macrocarpa (Scheff.) Boerl* is belong to *Thymelaeaceae* family. At present, the plant also can be found in Malaysia although it was originated from Papua New Guinea Island at far east of Indonesia archipelago [1]. The plant is being consumed by Southeast Asian people an alternative complementary medicine to reduce diseases such as diabetes, cancer and hypertension [2, 3]. Green extraction techniques such as supercritical carbon dioxide and subcritical water have been reported to extract the bioactive compounds from Mahkota Dewa fruit. The works reveal the existence of bioactive compounds such as mangiferin and polyphenols in significant amount [4-6].

Encapsulation is defined as a process to create a wall surrounding particles by coating or embedded in heterogeneous or homogeneous matrix to produce particles with better properties [7]. This technique is aimed to provide protection shield to the bioactive ingredients by minimizing its exposure to environmental factors such as heat. The encapsulation using spray drying process is widely used in chemical, food and pharmaceutical industry. Medicines, juices, dairy, herbal extracts, aromas and essential oil are among the products produces by encapsulation using spray drying [8-10]. The spray drying process offer several advantages such as able to operate with large capacity of processing materials under continuous mode. As compared to the liquid extract, the product produce by spray drying has longer shelf life, better stability, easy handling and easy to consume by consumers [11, 12].

The success of the encapsulation process using spray drying is depending on the types of encapsulation agent or often known as carrier agent used for coating of the targeted bioactive compounds [13, 14]. Maltodextrin, arabic gum and starch are recently reported for encapsulation of several herbal extracts such as saffron, black Cumin, jaboticaba, and misai kucing [7, 15-17]. This is probably due to their natural behaviour, ability to prevent interaction between core material with other ingredients and low cost. The ability to retain the bioactive compounds present in the spray dried product with low moisture content is one of the important targets. This is because, spray drying process operate at high temperature to promote drying, and thus, may expose the samples to thermal degradation issue. Moisture content, on the other hand, is an important indicator related to the index of economic value, stability and quality of food products. The moisture content may influence the flow ability, storage stability and stickiness of powdered product produced [18]. Almost all the researchers who studied the spray drying of plant extracts such as lemongrass leaf [19], *phyllanthus niruri* [20] and *murraya koenigii (Linn.)* leaf [21] examined the moisture content and bioactive compounds of the product produced. Our previous work reported the, effect of inlet air temperature on the moisture content and antioxidant activity of Mahkota Dewa spray dried powder [10]. In this study, the effect of different carrier types (maltodextrin, arabic gum and mixture of maltodextrin and arabic gum) on encapsulation of Mahkota Dewa fruits liquid extracts using spray-drying technique were investigated. The quality of the powder produced were evaluated in terms of antioxidant activity and moisture content.

2. Experimental

2.1. Chemicals and materials
The dried Mahkota Dewa fruits peels were purchased from local company (Ethno Resources Sdn. Bhd, Selangor, Malaysia). Analytical grade methanol with 99.9 wt% purity and 1,1-Diphenyl-2-picrylhydrazyl (DPPH) used for analysis were obtained from Merck Sdn. Bhd. (Selangor, Malaysia). The maltodextrin with dextrose equivalent of 10, and arabic gum used as carrier agents were obtained from San Soon Seng Food Industries Sdn Bhd, Selangor, Thye Huat Chan Sdn Bhd, Penang and R&M (M) Sdn. Bhd., respectively. The deionized water used during extraction process was prepared in house using Milli-Q, Ultrapure Water Purification System (Massachusetts, USA). The chemicals and materials were used as received.

2.2. Encapsulation process
The liquid extract of Mahkota Dewa was prepared following method reported in the previous work [10]. Feed solution with 20 wt% of maltodextrin DE10 was prepared and feed into a laboratory scale spray-dryer system (Lab Plant SD06A, UK). The inlet dry air temperatures, dry air flow rate and inlet feed flowrate of the spray drying system were set at 200˚C, 3.7 m/s and 485 mL/h, respectively. A similar procedure was repeated using a feed stock solution with arabic gum and mixture of maltodextrin-arabic gum (50 wt%).

2.3. Moisture content and antioxidant activity determination
The moisture content analysis and antioxidant analysis were handled by following method reported in the previous work [10]. The moisture analysis was performed using moisture analyser (Metrohm). About one gram of sample powder was used in each analysis. The displayed moisture content in percentage value based on Karl Fischer Titration Method was recorded. The analysis was performed in triplicate.

The antioxidant activity of the sample was determined based on DPPH radical scavenging activity assay. Sample concentration and DPPH radical solution with 0.1 mg/mL and 1 mg/mL were prepared, respectively. The absorbance value of the sample was read using Tecan Infinite M200 Pro (Switzerland) microplate reader with Magellan software at 517 nm. The DPPH in methanol solution was used as a blank and the ascorbic acid was used as a standard. The percentage of antioxidant activity was calculated by using the following equation:

$$antioxidant\ activity, \% = \left[1 - \left(\frac{A_1}{A_0}\right)\right] \times 100 \quad (1)$$

where A_1 is sample absorbance and A_0 is control absorbance.

3. Result and discussion

3.1. Moisture content

Figure 1 shows the moisture content of spray dried encapsulated Mahkota Dewa extract using different encapsulation agents. Maltodextrin as the encapsulation agent recorded the lowest moisture content (4.84±0.03%). Whereas the arabic gum showed the highest moisture contents (8.29±0.19%). The moisture content of spray dried Mahkota Dewa produced without encapsulation and maltodextrin-arabic gum (M-AG) are 7.67±0.41% and 7.63±0.58%, respectively. The result is in agreement with Tran and Nguyễn, who reported that the moisture content of lemongrass leaf extract powders using arabic gum and maltodextrin are 10.9% and 7.6%, respectively. This is probably due to higher hygroscopicity in the powdered product produce using arabic gum [19, 22, 23]. The hygroscopicity of powdered product produce using arabic gum is 19.74% and are found to be higher than those produce using maltodextrin, which is 16.04% [22, 24, 25]. Tran and Nguyễn also reported that the arabic gum tends to absorb water from surrounding faster than maltodextrin during handling process. Thus, leading to the increase of moisture content in the powdered product during storage [19]. For the mixture of maltodextrin and arabic gum, the moisture content value recorded is in between the value of encapsulated by pure maltodextrin and arabic gum. This is probability due to average value of hygroscopicity, which indirectly affect the moisture content at the same process condition. Other work reported that moisture content below than 5 wt% may benefits the manufacturer since it can preserve the flavour and nutritional values of the spray dried products [26].

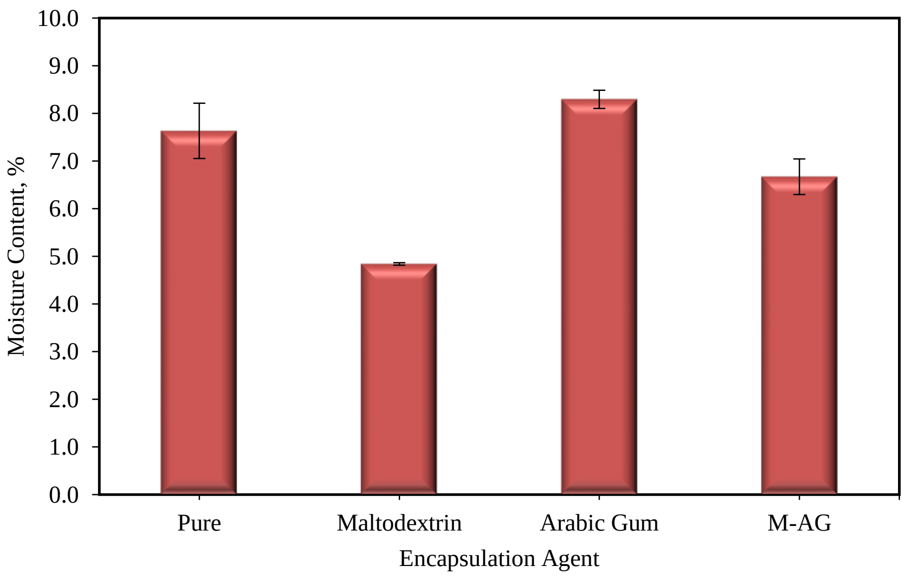

Figure 1. Moisture content of spray dried powder at different encapsulation agent. All data are the mean ± SD.

3.2. Antioxidant Activity

Figure 2 illustrates the antioxidant activity of spray dried powder of Mahkota Dewa extract produced using different encapsulation agents. The highest antioxidant activity in spray dried Mahkota Dewa extract powder was obtained using maltodextrin as an encapsulation agent (94.22±1.2%), following with arabic gum (93.99±2.07%) and mixture of maltodextrin-arabic gum (91.41±2.3%). The values obtained are relatively high as compared with powdered Mahkota Dewa obtained without encapsulation agent (70.26±0.07%). It can be seen that 24.05% of improvement in terms of antioxidant activity was obtained after the encapsulation process. This result is in agreement with Tonon and Brabet, who studied the production of acai powder using different encapsulation agents [22]. Their work reported that, the powder encapsulated by maltodextrin and arabic gum contain high antioxidant activity at the same experimental condition. Based on solubility concept, encapsulation agent with high solubility value able to produce powder with high antioxidant activity. The solubility of maltodextrin and arabic gum are 94.44% and 94.78% respectively. This solubility value explains the similar value of antioxidant analysis in both powdered product produce by using maltodextrin and arabic gum. But, for mixture of maltodextrin and arabic gum (M-AG) the value of antioxidant activity decrease probability due to forming crust layer during encapsulation process which can affect the dissolution of sample. Other study also shows a positive effect of encapsulation method, for instance 35.7% of antioxidant activity of spent coffee ground can be preserved from the extract [27].

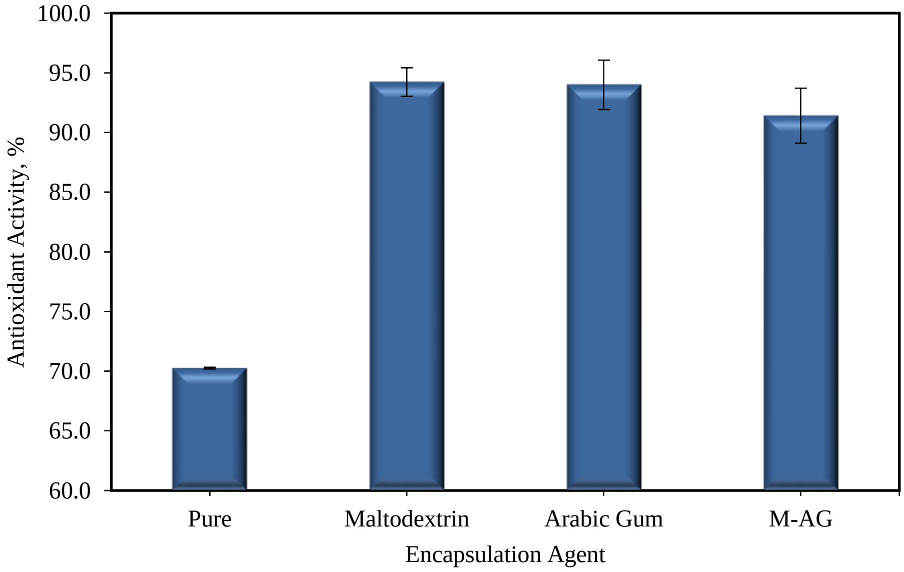

Figure 2. Antioxidant activity of spray dried powder at different encapsulation agent. All data are the mean ± SD.

4. Conclusion

In general, the spray dried Mahkota Dewa extracts encapsulated with different carrier agents was successfully produced. The results showed that the carrier agent significantly affect the moisture content and antioxidant activity. The powder produced using maltodextrin as encapsulation agent shows the lowest moisture content and highest antioxidant activity, whereas arabic gum showed the highest amount of moisture content but with slightly low antioxidant activity. Thus, maltodextrin can be recommended as carrier agent for encapsulation of Mahkota Dewa extract using spray drying. However, considering the nature of maltodexrin, which is high in sugar content, mixture of maltodextrin-arabic gum can be explored as encapsulation agent for Mahkota Dewa spray drying process. Further works also can be done to optimize the spray drying conditions to achieve better yields and product characteristics.

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