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Assessment on antioxidant activity and physical characteristics of spray dried Mahkota Dewa fruit extracts

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Abstract. This paper presents the encapsulation of *Phaleria Macrocarpa Scheff. Boerl* or Mahkota Dewa extracts with maltodextrin using spray drying. The extracts of dried Mahkota Dewa fruit was obtained using subcritical water extraction process. The inlet dry air temperatures of the spray drying process was investigated at 100 °C, 125 °C, 150 °C, 175 °C and 200 °C. The spray dried powder was characterised for antioxidant activity, moisture content analysis and particle size distribution analysis. Results showed that the increased of inlet air dry temperature decreased the value of antioxidant activity, moisture content and mean diameter of the particles. The inlet air dry temperature of 200°C produced 92.19±0.18% antioxidant activity, 6.82% moisture content and 8.38 µm mean diameter particle size. Thus, can be suggested as the best inlet air temperature to encapsulate Mahkota Dewa extracts with maltodextrin using spray drying technique.

1. Introduction

The World Health Organization (WHO) defined herbal medicine as herbs, herbal materials, herbal preparations and finished herbal products that contain bioactive ingredients. Since ancient time, the herbal medicinal has been used as the first line of primary health care due to its health benefits [1]. Mahkota Dewa or *Phaleria Macrocarpa (Scheff.) Boerl* belong to *Thymelaeaceae* family is one of the famous herbal medicine. Although the plant is originated from the Island of Papua New Guinea (Irian Jaya) Indonesia, it also can be found in Malaysia. Traditionally, this herb was used as by local people that have cancer, hypertension or diabetes mellitus as herbal drink either singly or mixed with other herb [2]. Flavanoids, alkaloids, polyphenols and saponins are among the variety of bioactive compound that can be found in Mahkota Dewa fruit and leave [3-5]. Several researchers including our own work have reported the extraction of bioactive ingredients from Mahkota Dewa using subcritical water, soxhlet, and supercritical technique [6-9].

The liquid extract of the herbal product can be converted into solid form for better stability and easy handling [10, 11]. Moreover, the solid form of herbal extract has been reported to show longer shelf-life and more convenience as oral administration by consumers [11]. Several methods including spray drying can be utilized to produce solid form of herbal extracts [12-14]. The spray drying method requires high temperature to produce higher powder yield which may cause unfavorable effects to the quality of the powder produced. Since Mahkota Dewa contains several valuable bioactive compounds that sensitive to high temperature, the use of spray drying method can lead to thermal degradation issue [15]. In addition, the occurrence of agglomeration between particles and adhesion with the wall may also cause problem during spray drying process and consequently reduce the product yield and quality. These issues are presumably because of the presence of low molecular weight sugar and acids, which have low glass transition temperature. The major drawbacks are the process become inefficient and uneconomical.

It has been suggested that the use of spray drying technique with suitable carrier and appropriate operating conditions (inlet and outlet drying air temperature) can reduce the thermal degradation effect, product stickiness and wall deposition problem [16]. For instance, the viscosity and droplet size of powder will decreased when the temperature is increased [17]. Although a high temperature can cause degradation of some heat sensitive-ingredient, the use of suitable carrier is able to encapsulate and preserve the active compound by providing a coating wall to the small particles [18, 19]. Researchers have studied the effect of spray drying conditions and type of carrier material during spray drying of mla (*Emblica officinalis*) juice powder, acai (*Euterpe oleraceae Mart.*) powder and Carob Molasses [20-22] . It can be observed that, the operating conditions of the spray dryer and the carrier materials reported by those researchers are varies depending on the type of herbal medicine studied. Moreover, Phisut (2012) stated that powder properties such as moisture content, particle size, bulk density, hygroscopicity and morphology influenced by inlet temperature [23].

Therefore, it is necessary to investigate the suitable type of carrier and spray drying conditions to produce Mahkota Dewa extracts in powder form. To the best of our knowledge, literature has yet to report the production of Mahkota Dewa extract in dry solid form using spray drying technique. In this study, the liquid form of Mahkota Dewa extracts was produced in powder form using spray-drying technique with different inlet air dry temperature. Maltodextrin DE10 was used as carrier. The characteristics of the powder obtained was evaluated in terms of antioxidant activity, moisture content, and particle size distribution.

2. Experimental

2.1. Chemical and Materials
The dried Mahkota Dewa fruits peels were obtained from Ethno Resources Sdn. Bhd, Selangor, Malaysia. HPLC grade methanol (99.9 wt% purity) and 1,1-Diphenyl-2-picrylhydrazyl (DPPH) were purchased from Merck Sdn. Bhd. (Selangor, Malaysia). Deionized water was prepared using Milli-Q, Ultrapure Water Purification System (Massachusetts, USA) with a 0.22 mm filter available at Faculty of Chemical & Natural Resources Engineering laboratory. The maltodextrin DE10 was obtained from San Soon Seng Food Industries Sdn Bhd, Selangor, Malaysia. The chemicals were used as received.

2.2. Subcritical Water Extraction Process
The dried Mahkota Dewa was grinded to an average size of 520 μm. The 60 g/L Mahkota Dewa solution was prepared and charged into the extraction vessel. The vessel was tightly sealed and secured with nuts and bolts. The temperature and time were set at 106°C and 5 h, respectively. After that, the vessel was cooled down using cooling water supplied by Stuart recirculating cooler RE300RC (Staffordshire, UK). The extract obtained was filtered to remove residual solid and transferred into a scotch bottle for storage in -4°C refrigerator prior to spray drying process.

2.3. Spray Drying Process
The 20 wt% feed stock solution was stirred at 1500 rpm for 10 min or until maltodextrin become well dispersed. Then, the solution was pumped using a peristaltic pump into a laboratory scale spray-dryer (Lab Plant SD06A, UK). The inlet air dry temperature was set at 100°C with feed flowrate of 2115 mL/h. The sample powder obtained was collected in chamber glass bottle, and kept in refrigerator at -4°C till further analysis. The same procedures were repeated using different inlet temperatures ranging from 125°C to 200°C.

2.4. Moisture Content

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About one gram of Mahkota Dewa powder was placed on the pan of moisture analyser (Metrohm). The moisture content which displayed in percentage value based on Karl Fischer Titration Method was recorded.

2.5. Antioxidant Activity
About 1 mg of Mahkota Dewa powder was dissolved with 10 mL of deionized water. The DPPH radical solution with concentration of 1 mg/mL was prepared. The sample was diluted into several concentration and placed into microplate. Then, the mixture was kept in the dark place for 30 min. The DPPH in methanol solution was used as a blank and the ascorbic acid was referred as a standard. The absorbance value was measured at 517 nm using Tecan Infinite M200 Pro (Switzerland) microplate reader with Magellan software. The percentage of inhibition was calculated by using the following equation:

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

where A_1 is the absorbance of the sample and A_0 is the absorbance of the control.

2.6. Particle Size Distributions
The particle size distributions of the spray dried powder sample were measured using laser diffraction particle size analyser (Malvern 2000 Mastersizer, Malvern Instruments Co.). The instrument is equipped with automated Scirocco 2000 unit to control the dispersion of the sample into Mastersizer unit. The particle size distribution was measured in volume weighted mean.

3. Result and Discussion

3.1. Moisture Content
As seen in figure 1, the moisture content was decreased with the increased of inlet dry air temperature. The lowest value of moisture content of 6.82% was recorded at inlet dry air temperature of 200 °C. This finding is probably due to the faster heat transfer rate between the Mahkota Dewa feedstock solution and drying air at higher inlet dry air temperature. Phisut (2012) stated that at higher inlet dry air temperatures, powder with lower moisture content was produced due to a greater temperature gradient between the particle produce from jet nozzle and drying air and thus, resulted in higher driving force for water to evaporate [23]. Chegini and Ghobadian also reported that the increased of inlet dry air temperatures from 110 °C to 190 °C have significantly reduced the moisture content of orange juice powder [24].

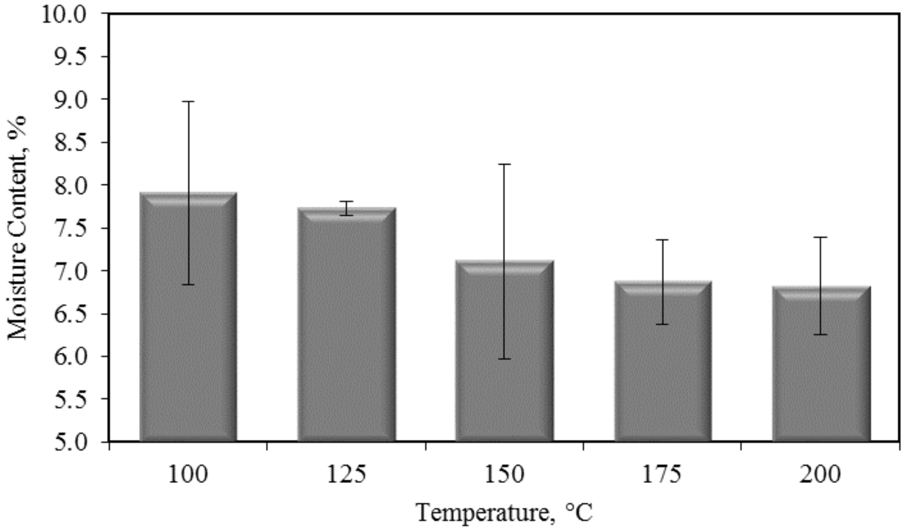

Figure 1. Moisture content of spray dried powder at different inlet dry air temperatures with 0.67 average standard deviation.

3.2. Antioxidant Activity

In figure 2, the antioxidant activity in spray dried powder shows a decreasing pattern when the inlet dry air temperature increased at constant feed flow rate and dry air flow rate of 2115 mL/h and 4.1 m/s, respectively. The antioxidant activity was recorded at 92.93±0.15% when the inlet dry air temperature was at 100 °C. As the inlet dry air temperature increased to 200 °C, the antioxidant activity was slightly decreased to 92.19±0.18%. The result in agreement with those report by Suhag and Nanda who reported that antioxidant activity and total phenolic content reduced with the increased of inlet air dry temperature [25]. The decreased of the antioxidant activity at higher temperature is probably due to the change of the phenolic compound chemical structure to other form [26].

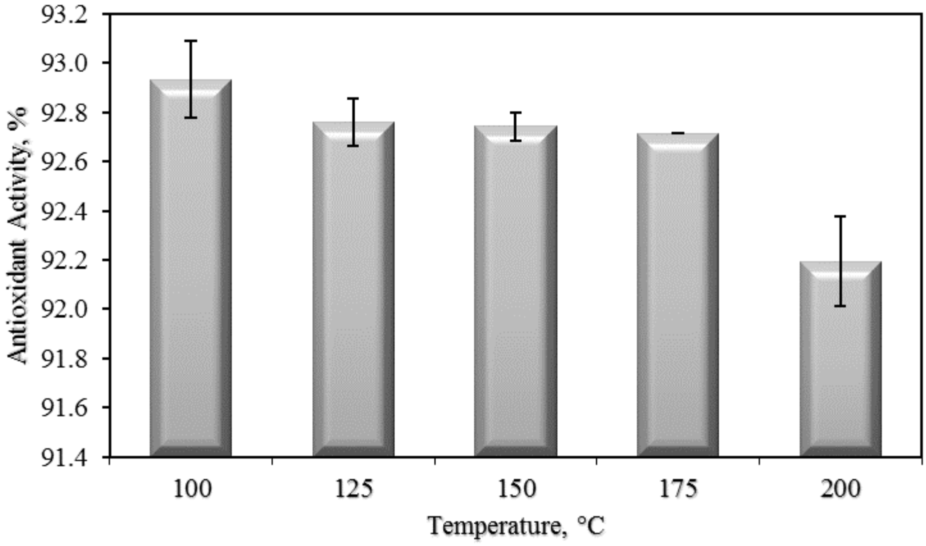

Figure 2. Antioxidant activity on spray dried powder at different inlet dry air temperature with 0.0986 average standard deviation.

3.3. Particle Size Distribution

Figure 3 shows the particle size distribution for spray dried powder at different inlet dry air temperature. A bimodal distribution which is the same to result reported by Tonon et al. (2008) is observed. According to Tonon et al. (2008), a bimodal distribution shows two distinct peaks with predominant size which is small and larger particle population. The small particles may occupy less space since it can fit into the spaces available between the larger particles. Meanwhile, larger particles population may indicate a start of the agglomeration process through formation of irreversible link bridges that lead to the production of particles with larger size. [22]. From table 1, it can be seen that when the inlet dry air temperature increased from 100 °C to 200 °C, the particles mean diameter reduced from 78.918 µm to 8.376 µm. This is possibly due to the high moisture content which shown in figure 1 that presence in the powder at low inlet dry air temperature. This phenomenon may promote agglomeration that leads to a formation of particles with larger mean diameter and particle size distribution. In term of pharmacy study by Chu et al (2012), smaller in particle size manages to a higher increase in dissolution rate through an increase in specific surface area and a decrease in thickness of the diffusion layer around each particle[27].

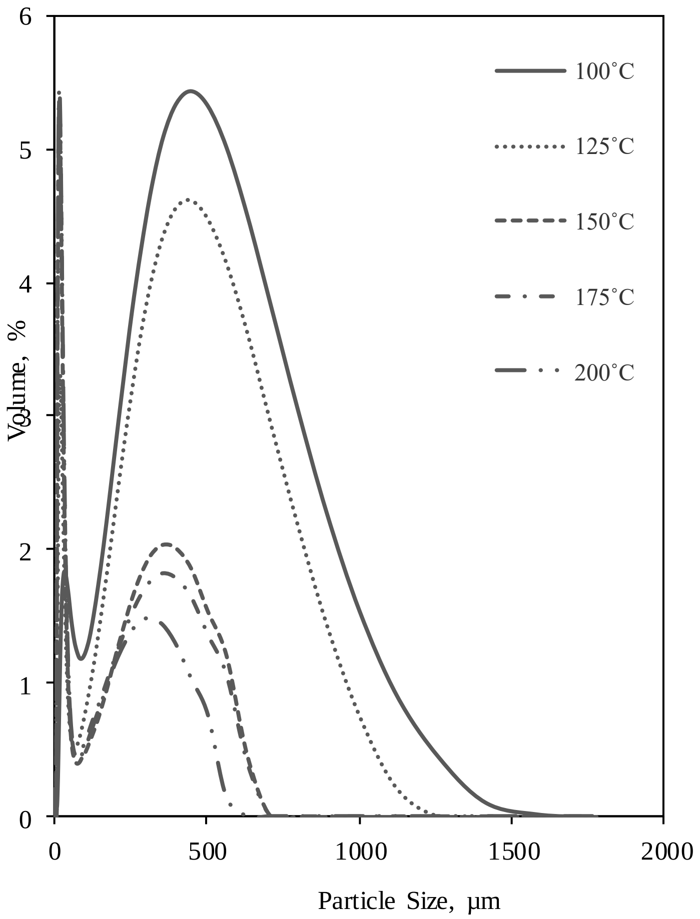

Figure 3. Particle size distributions of spray dried powder at different inlet dry air temperature.

Table 1. Physical properties of spray dried powders produced at different inlet dry air temperature.

Temperature, °C	Mean diameter, µm
100	78.918
125	34.419
150	10.472
175	10.240
200	8.376

4. Conclusion
The spray dried Mahkota Dewa extracts encapsulated with maltodextrin was successfully produced using a spray drying technique. The result shows that higher inlet dry air temperature (200°C) lead to lower moisture content (6.82%) and smaller diameter of particle (8.376 µm). However, the antioxidant activity at of 92.93±0.16%100°C was slightly reduced to 92.19±0.18% at 200°C. It can be suggested that the encapsulation of spray dried powder using maltodextrin at suitable inlet air temperature can preserved the antioxidant activity.

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