The Effect of Maltodextrin Concentration and Inlet Air Temperature on Spray Dried Centella Asiatica L. Powder.

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Abstract. It is a common practice for the medicinal herbs which contain valuable bioactive compounds to be preserved by converting it into dry powder through various drying technology such as oven, freeze and spray drying. However, the number of study for the production of Centella asiatica L. (CAL) powder through spray drying process has been very limited and most of the work only focused on the chemical properties of the herbs. Therefore, the purpose of this study is to investigate the feasibility of spray dried CAL powder at different maltodextrin concentrations (0–10 %w/w) and inlet air temperatures (130–170°C). The spray dried CAL powders were analysed for the percentage of yield, outlet temperature, appearance and moisture content while the reconstituted powders were assessed for its colour and radical scavenging activity (RSA). The findings showed that the increased of maltodextrin concentration resulted in higher percentage of yield (12.60 ± 0.14 to 51.05 ± 1.68 g), decreased in the moisture content (13.58 ± 0.42 to 7.43 ± 0.99 %) and more lighter green colour of CAL powder produced, L* (20.27 ± 0.12 - 23.77 ± 0.69). Besides that, the increased in both inlet air temperature and maltodextrin concentration reduced the RSA of the spray dried powder. From the study, it can be concluded that the production of spray dried CAL powder is feasible and the addition of maltodextrin as the drying agent has provided a greater impact to the physicochemical properties of the powder.

1. Introduction

Centella asiatica L. (CAL) also known as Indian Pennyworth belongs to the family of Apiaceae and it has been used as medicinal herbs for health treatments such as skin problems, wounds or nerves and brain cells recovery [1]. The plant originates from various regions in the world such as South East Asia, China, South America and Africa [2]. It is easily found in Malaysia and able to grow like weeds throughout many places, from the ponds to the oil palm plantations [3].

According to Hashim (2011), the chemical components triterpenes and saponins contained in CAL are essential in medicinal and nutraceutical applications. The triterpenes are composed of many biological active compounds including asiatic acid, madecassic acid, asiaticosid and madecassoside. Besides that, the nutritional composition in 100 g of CAL showed the plant consists of high amount of potassium (391 mg) and calcium (171 mg) while low in protein (2.0 %), carbohydrate (6.7 %) and fat (0.2 %). The plant is also rich in vitamins for example vitamin C (48.5 mg/100 g), B1 (0.09 mg/100 g) and B2 (0.19 mg/100 g) [3].

In terms of its application, CAL is diversely utilised in food and beverages, cosmetology and pharmaceutical industries [3]. It is a common practice for the herbs to be transformed into other forms like dry powder through various drying technologies available in the industry before being used in other end-products [4]. Spray drying is the most common drying technique applied because of the
economic and flexibility reasons, and able to produce microcapsules of high quality in a simple and continuous operation with good efficiency and high powder recovery [5]. However, the study and development to produce CAL powder through spray drying process has been quite limited and most of the work only focused on the extract properties of the herbs [6] [7] [8] [9]. Only the physical characteristics of the spray dried CAL powder has been studied in past decades [10]. Thus, the purpose of this study is to investigate the feasibility of spray drying CAL powder at different maltodextrin concentrations and inlet air temperatures. It is expected for the percentage recovery of spray dried CAL powder with and without addition of maltodextrin will be difference and the increase of maltodextrin concentration and inlet air temperature would influence the physicochemical properties of the CAL powder.

2. Methodology

2.1. Sample preparation
Fresh green Centella asiatica L. (CAL) leaves were purchased from a local wet market in Seksyen 6, Shah Alam, Malaysia. The leaves were washed, plucked and kept inside a clean container. Extraction was carried out by blending 30.00±0.01 g leaves with 150.0±0.1 ml solvent (distilled water) at medium-high speed for 5 minutes using an electrical blender (Tefal, Perfect Mix BL801, France). The blended liquid was sieved and strongly pressed using a tea cloth to recover a maximum soluble solid of the leaves extract.

2.2. Spray drying process
Spray drying process to produce CAL powder was conducted using spray dryer (BUCHI, Mini Spray Dryer B-290, Switzerland) equipped with two fluid nozzles operated co-currently. Approximately 150.00±0.01 g leaves extracts were spray dried at three different inlet air temperatures (130, 150, and 170°C) and maltodextrin concentrations (0, 5 and 10 %w/w). The experiments were completed in triplicate and spray drying conditions such as feed temperature, aspirator rate, feed pump flow rate and air pump flow rate were kept constant at 25°C (room temperature), 35 m³/hr (100 %), 9 ml/min (30 %) and 11 L/min (40 mm), respectively. During the drying process, outlet temperature and time were recorded. Finally, the powders recovered were immediately weighed and kept in a sealed glass jar for further analysis.

2.3. Powder analysis
The spray dried CAL powders produced in the experiment was analysed for the percentage of yield, appearance, outlet temperature and moisture content. As for the reconstituted powders, the samples were analysed for the radical scavenging activity (RSA) and colour.

2.3.1. Percentage of yield
The percentage of yield was expressed as a ratio between the total mass of powder recovered and the total soluble solids of CAL extract with maltodextrin as shown in (Equation 1) [11] [12].

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\text{Yield (\%) =} \frac{\text{Total spray dried powder recovered (g)}}{\text{Total soluble solids of CAL extract (g) + Maltodextrin (g)}}
\]  

2.3.2. Moisture content.
The moisture content was determined using a moisture analyzer balance (Sartorius, Infrared Moisture Analyzer MA35, Germany) based on AOAC 2000 method with a slight modifications. About 2.00±0.01 g of powder was weighed and evenly distributed on the aluminum pan. Next, the powder was dried at 105°C until constant mass was obtained. The moisture in the powder was expressed as a percentage ratio of water loss (g) and the powder sample (g) [13].
2.3.3. Radicals scavenging activity (RSA).
Determination for RSA was conducted using portable spectrophotometric (Hach, DR2700, USA), procedure described by Shekhar and Anju (2014) with a slight modification [14]. Firstly, 0.1 mM solution of 2, 2-diphenyl-1-picrylhydrazyl (DPPH) in 99 % methanol was prepared as a stock reagent. The solution was wrapped with aluminum foil to protect from sunlight and kept in a cool place. Next, 1000 µg/ml of CAL reconstituted powder (stock solution) was prepared. The powder was mixed with the solvent (99 % methanol) and stirred for 15 minutes before filtered using 11 μm filter paper. The dilution method for stock solution was carried out to produce 1 ml extract solutions at four different concentrations (250, 500, 750 and 1000 µg/ml).
Approximately 4.0±0.1 ml DPPH solution was added into each of 1.0±0.1 ml extract solutions. The mixture was shaken vigorously and left at room temperature for 30 minutes. A control solution was also prepared and evaluated. The absorbance was measured at 517 nm using spectrophotometer. The percentage of DPPH scavenging activity was calculated as in (Equation 2):

$$\text{Radical scavenging activity} (\%) = \frac{A_{\text{con}} - A_{\text{test}}}{A_{\text{con}}}$$

(Equation 2)

Where:
A<sub>con</sub>: the absorbance of the control reaction
A<sub>test</sub>: the absorbance with the presence of the sample of the extract

2.3.4. Colour
The colour of reconstituted spray dried CAL powder were measured using chromameter (Konica Minolta, CR-400 Chroma Meter, Japan) based on Caparino et al. (2012) method with some modification [15]. About 1.00±0.01 g each of the samples were reconstituted by adding 100.0±0.1 ml of solvent (distilled water). The reconstituted CAL powders were mixed at room temperature by vortexing until the powder completely dissolved. Finally, the International Commission on Illumination (CIE) parameters L, a* and b* were obtained by placing the lens of chromameter on the samples covered with transparent film or glass.

3. Results and Discussions

3.1. Effect of different maltodextrin concentrations on percentage of yield, outlet temperature and appearance of the Centella asiatica L. powder.
Table 1 shows the effect of maltodextrin concentrations (0-10 %w/w) at fixed inlet air temperature (150°C) on the percentage of yield, outlet temperature and appearance of the Centella asiatica L. (CAL) powders. The percentage of yield increased from 12.60±0.14 to 51.03±1.68 % with the increased of maltodextrin concentration. The results showed that the maltodextrin improved the yield and served the purpose as the drying agent in spray drying of CAL powder. Similar trends were reported by Bazaria and Kumar(2018), Fazaeli et al. (2012) and Quek et al. (2007) in spray drying of beetroot, black mulberry and watermelon powders, respectively [11, 16, 17].

A small amount of CAL powder was recovered (12.60±0.14 %) without the addition of the drying agent. The finding was similar with Quek et al. (2007) and Ibrahim et al. (2015) studies in watermelon and kafir lime leaves spray drying, respectively. There were hardly any powder produced without the presence of maltodextrin and the sticky particle mainly deposited on the wall chamber [17] [18]. This shows the importance of maltodextrin as a drying agent to encapsulate the active compound and improve the properties of the powder, hence, increase the spray drying recovery.

In addition, the outlet temperature increased slightly from 68 to 71°C when the concentration of maltodextrin increased from 5 to 10 %w/w. The result indicate that outlet temperature is consistent and should not influence the properties of CAL powder as maltodextrin concentration increased. Finally, the recovered powders appearance were observed to become more fine, soft, non-sticky and lighter in colour as maltodextrin concentration increased. The outcome could be explain by the nature of maltodextrin itself which is white in colour with high molecular weight and bulking properties [19].
Table 1. Analysis of spray dried Centella asiatica L. powder at different maltodextrin concentrations on the percentage of yield, outlet temperature and appearance.

| Analysis         | Maltodextrin concentration (%w/w) |
|------------------|-----------------------------------|
|                  | 0       | 5         | 10         |
| Yield (%)        | 12.60±0.14 | 43.71±0.49 | 51.05±1.68 |
| Outlet temperature (°C) | 70-75       | 68-71     | 71-72     |
| Appearance       | Fine, with bright green colour   | Fine, soft, non-sticky with light green colour | Fine, soft, non-sticky with lightest green colour |

3.2. Effect of different maltodextrin concentrations on the physicochemical properties of the Centella asiatica L. powder.

Table 2 presents the effect of maltodextrin concentrations (0-10 %w/w) at fixed inlet air temperature (150°C) on the physicochemical properties of the CAL powder. The results showed that the moisture content of the powder drastically reduced from 13.58±0.42 to 7.43±0.99 % as maltodextrin concentration increased from 0 to 10 %w/w. Fazaeli (2012) suggested that increasing the concentrations of maltodextrin increased the feed solids and reduced the total moisture for evaporation process in the drying operation [16]. It is in agreement with the results reported by Jittanit et al. (2010) and Oberoi and Sogi (2015) in spray dried pineapple and watermelon, respectively [20] [21]. Based on the result, the moisture of the CAL powders were less than 10% with addition of maltodextrin. This would be sufficient to make the powder microbiologically safe to be produced and applied as food products [22].

Furthermore, the colour analysis showed that the degree of lightness (L\*) and yellowness (b\*) increased while the degree of redness (a\*) decreased with an increase in maltodextrin concentration. This indicated that the green colour of the powder becomes lighter as maltodextrin concentration increased and it could be explained by the addition of white maltodextrin powder that exhibited the masking effect. A similar observation was obtained in spray dried sweet potato powder by Grabowski et al. (2016), where increased maltodextrin concentration led to the production of lighter and less orange colour [23].

Antioxidant activity in spray dried CAL powder was measured by radical scavenging activity (RSA) which is an important property because of the inhibition of free radicals in foods and other biological systems [24]. CAL is rich in antioxidant (84 %) and is comparable to Vitamin C (88 %) and grape seed extract (83 %) [3]. From the experiment, it was observed that an increased in maltodextrin concentration reduced the RSA of spray dried CAL powders from 47.47±6.44 to 33.76±5.11 %. This was due to the addition of maltodextrin which itself contains no free RSA and thus, reduced the percentage of RSA in CAL powder. The same trends were also reported by Caliskan and Dirim (2013) and Mishra et al.(2014) in sumac and amla powder, respectively [23] [24].

Table 2. Analysis of spray dried Centella asiatica L. powder at different maltodextrin concentrations on the physicochemical properties.

| Analysis | Maltodextrin concentration (%w/w) |
|----------|-----------------------------------|
|          | 0       | 5         | 10         |
| Moisture content (%) | 13.58±0.42 | 8.44±0.20 | 7.43±0.99 |
| RSA (%)  | 47.47±6.44 | 41.96±4.38 | 33.76±5.11 |
| L*      | 20.27±0.21 | 23.00±0.40 | 23.77±0.69 |
| a*      | -1.05±0.18 | -2.52±0.22 | -2.37±0.19 |
| b*      | 3.53±0.15 | 6.03±0.53 | 6.64±0.41 |
3.3. Effect of different inlet temperatures on percentage of yield, outlet temperature and appearance of the Centella asiatica L. powder.

Table 3 presents the effect of inlet air temperatures (130-170°C) at a constant maltodextrin concentration (5 %w/w) on the percentage of yield, outlet temperature and appearance of the CAL powder. The result showed that the increased of inlet air temperature have low impact towards the powder recovery. The highest percentage of yield obtained was at 150°C inlet air temperature (43.71±0.49 g) and it was slightly reduced as the temperature increased to 170°C. According to Phisut (2012), the decreased of percentage of yield was due to the melting of the powder and wall cohesion, thus, the powder recovered during the drying process decreased [26]. This is in accordance with the finding in fruit juice spray drying by Chegini et al. (2008) [27]. Moreover, the outlet temperature increased from 59 to 80°C when the inlet air temperature increased due to more heat was supplied during the spray drying operation. Thus, the properties of final product would be affected by changes of outlet temperature. Besides that, the recovered powders produced at all inlet air temperature were fine, soft, non-sticky and have a light green colour appearance. Thus, the result showed that the inlet air temperature not affected recovery and appearance of the spray dried CAL powder.

| Analysis          | Inlet air temperature (°C) |
|-------------------|----------------------------|
|                   | 130           | 150           | 170           |
| Yield (%)         | 40.76±0.72    | 43.71±0.49    | 41.91±1.27    |
| Outlet temperature (°C) | 59-65       | 68-71         | 80-83         |
| Appearance        | Fine, soft, non-sticky with light green colour | Fine, soft, non-sticky with light green colour | Fine, soft, non-sticky with light green colour |

3.4. Effect of different inlet air temperatures on the physicochemical properties of the Centella asiatica L. powder.

Table 4 presents the effect of inlet air temperatures (130-170°C) at fixed maltodextrin concentration (5 %w/w) on the physicochemical properties of the CAL powder. The result showed that an increased in inlet air temperatures have a small effect towards the moisture content of the powder. The moisture content of CAL powders obtained were slightly increased from 8.43±0.21 to 8.84±0.13 % as inlet air temperature increased from 130 to 170°C. Similar result was reported for spray dried pandan powder, where there was no significant effect of inlet air temperatures on moisture content of the powder [28]. On the other hand, study by Quek et al. (2007) and Suzihaque et al. (2015) in spray dried fruit powders observed the decreased in moisture of the powders as the inlet air temperature increased, due to the increased in rate of water evaporation [17] [28]. Hence, the finding showed that the inlet air temperature heavily influence the fruit compare to the leave powders. Moreover, it was shown that the colour of reconstituted CAL powders did not significantly change as inlet air temperature increased. The degree of lightness (L*) was slightly varied from 22.43±0.26 to 23.00±0.40 as the temperature increased from 130°C to 170°C. Similarly, the value of redness, a* and yellowness b* from -2.52±0.22 to -2.69±0.12 and from 6.03±0.53 to 5.51±0.44, respectively.

In addition, inlet air temperature resulted in a significant effect on free radical scavenging activity (RSA) of CAL powder. An increase of inlet air temperature reduced RSA from 46.09±3.02 to 34.50±12.96 %. The outcome of low free radical scavenging activity due to the exposure of high temperature which would affect the structure of phenolics causing it to break or synthesis into other forms [25]. The similar results was obtained in spray drying of sumac extract [24].
Table 4. Analysis of spray dried Centella asiatica L. powder at different inlet air temperatures on the physicochemical properties.

| Analysis        | Inlet air temperature (°C) |
|-----------------|----------------------------|
|                 | 130           | 150           | 170           |
| Moisture content (%) | 8.43±0.21    | 8.44±0.20    | 8.84±0.13    |
| RSA (%)         | 46.09±3.02   | 41.96±4.38   | 34.50±12.96  |
| L*             | 22.43±0.26   | 23.00±0.40   | 22.63±0.33   |
| Colour a*       | -2.66±0.17   | -2.52±0.22   | -2.69±0.12   |
| Colour b*       | 5.51±0.44    | 6.03±0.53    | 5.77±0.53    |

4. Conclusions
This study demonstrated the feasibility of spray dried Centella asiatica L. (CAL) powder with and without the addition of maltodextrin at different inlet air temperatures. Overall, CAL powder able to be produced with and without maltodextrin and the increased of maltodextrin concentration give a greater impact to the production and properties of the CAL powder compared to the inlet air temperature. The increased in the concentration of maltodextrin added to the CAL extract significantly increased the percentage of yield and reduced the moisture content, radical scavenging activity (RSA) and the green colour of the reconstituted powder. From the study, the most suitable maltodextrin concentration and inlet air temperature can be operated to produce spray dried CAL powder were at 5 %w/w and 130°C, respectively. This result would provide an opportunity for the food, pharmaceutical and cosmetology industries to utilized spray drying technique in the production of CAL powder.

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