ENCAPSULATION OF MAHKOTA DEWA PLANT EXTRACTS USING SPRAY DRYING TECHNIQUE

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We hereby declare that We have checked this thesis, and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has yet to be previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institution.

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ABSTRAK

Mahkota Dewa atau *Phaleria Macrocarpa (Scheff.) Boerl* tergolong didalam spesis *Thymelaeaceae* yang merupakan salah satu ubatan herba yang terkenal digunakan oleh penduduk tempatan sebagai ubat alternatif untuk diabetes mellitus, kanser dan darah tinggi. Pada masa kini, enkapsulasi menggunakan teknik pengeringan semburan untuk melindungi bahan bioaktif daripada degradasi haba semasa proses pengeluaran dan untuk meningkatkan jangka hayat. Matlamat kerja ini adalah untuk menyaring dan mengoptimumkan proses parameter yang mempengaruhi pengkapsulan ekstrak buah Mahkota Dewa menggunakan teknik pengeringan semburan. Satu Faktor Pada Satu Masa (OFAT) digunakan untuk mengkaji suhu udara kering masuk (100-200˚C), kadar aliran pam (485-2115 mL/jam), kadar aliran udara kering (3.5- 4.3 m/s) dan agen enkapsulasi (maltodekstrin, gam arab dan 50% gam maltodekstrin-arab) terhadap perencatan DPPH, kandungan kelembapan dan taburan saiz serbuk kering semburan. Kemudian, Reka bentuk Komposit Berpusatkan Muka (FCCCD) daripada kaedah permukaan tindak balas (RSM) digunakan untuk mengoptimumkan parameter. Serbuk kering semburan yang diperoleh pada keadaan optimum dicirikan lagi menggunakan penganalisis kelembapan, mastersizer, kromatografi cecair prestasi tinggi (HPLC), pengimbas elektron mikroskop (SEM), ujian fenolik Folin-Ciocalteu, ujian 2,2-diphenyl-1-picrylhydrazyl (DPPH) dan ujian aktiviti anti-diabetes (ADA). Kajian OFAT menunjukkan bahawa suhu udara kering masuk, kadar aliran pam, kadar aliran udara kering dan agen enkapsulasi mempengaruhi jumlah serbuk kering yang dihasilkan dan sifat fizikokimianya. Kandungan lembapan yang lebih rendah dan saiz serbuk yang lebih kecil dengan aktiviti antioksidan yang lebih tinggi dihasilkan pada suhu udara kering masuk yang lebih tinggi, kadar aliran pam yang lebih rendah dan kadar aliran udara kering yang lebih tinggi. Suhu udara kering masuk (200˚C), kadar aliran pam (485 mL/jam) dan kadar aliran udara kering (3.7 m/s) menunjukkan jumlah tertinggi produk serbuk kering semburan yang dihasilkan. Kandungan kelembapan, purata saiz zarah dan aktiviti antioksidan ialah 4.88%, 8.145 µm dan 91.4277 %. Enkapsulasi dengan gabungan gum arab dan maltodekstrin menunjukkan sifat fizikokimia yang lebih baik. Kandungan kelembapan, purata saiz zarah dan aktiviti antioksidan ialah 6.67%, 10.38 µm dan 91.4087%. Keadaan optimum yang diperoleh menggunakan kaedah FCCCD ialah 194.98°C suhu udara kering masuk, 447.28 mL/jam kadar aliran pam dan 3.75 m/s kadar aliran udara kering dengan 5.19% kandungan lembapan dan 92.10% aktiviti antioksidan. Pencirian mikrokapsul yang dioptimumkan menggunakan SEM menunjukkan bentuk yang tidak sekata, tiada pori terbuka pada permukaan dan kesan pengecutan yang ketara. Aktiviti antioksidan, jumlah kandungan fenolik dan hasil mangiferin ialah 92.10%, 0.65635 ± 0.0392 mg sampel GAE/mg dan 16.87 ± 2.35. Nilainya lebih tinggi daripada yang diperoleh daripada proses OFAT dan pengeringan semburan tanpa enkapsulasi. Analisis anti-diabetes mengesahkan bahawa ekstrak Buah Mahkota Dewa dan mikrokapsul yang dioptimumkan mempunyai aktiviti pemekaan insulin dengan cara yang sama seperti yang dilakukan oleh rosiglitazone, dan oleh itu, boleh menjadi bahan antidiabetik yang berpotensi. Kesimpulannya, kajian ini berjaya dilakukan untuk menyaring dan mengoptimumkan enkapsulasi ekstrak Mahkota Dewa ke dalam bentuk serbuk kering menggunakan teknik pengeringan semburan. Hasilnya memberikan keadaan yang sesuai suhu udara kering masuk, kadar aliran pam, kadar aliran udara kering dan jenis ejen enkapsulasi untuk pengeringan semburan ekstrak Mahkota Dewa.

ABSTRACT

Mahkota Dewa or *Phaleria Macrocarpa (Scheff.) Boerl* belongs to the *Thymelaeaceae* family and is one of the famous herbal medicines used by local people as a complementary alternative medicine for diabetes mellitus, cancer and hypertension. Currently, encapsulation using a spray drying technique protects the bioactive ingredient from thermal degradation during production and improves the shelf life. This work aims to screen and optimise the process parameters affecting the encapsulation of Mahkota Dewa fruit extracts using the spray-drying technique. One-Factor-At-A-Time (OFAT) was used to investigate the inlet air-dry temperatures (100-200˚C), feed flow rates (485-2115 mL/hr), air-dry flow rates (3.5-4.3 m/s) and encapsulation agents (maltodextrin, arabic gum and 50% maltodextrin-arabic gum) on the DPPH inhibition, moisture content and particle size distribution of spray dried powder. Then, Faced-Centred-Composite Design (FCCCD) from response surface methodology (RSM) were employed to optimise the parameters. The spray dried powder obtained at optimised conditions was further characterised using a moisture analyser, mastersizer, high performance liquid chromatography (HPLC), scanning electron microscopy (SEM), phenolic Folin-Ciocalteu assay, 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay and anti-diabetic activity (ADA) analysis. OFAT study showed that the inlet air-dry temperature, feed pump flow rate, air-dry flow rate and encapsulation agent affected the amount of dried powder produced and its physicochemical properties. Lower moisture content and smaller powder particle size with higher antioxidant activity were produced at higher inlet air-dry temperature, lower feed pump flow rate and higher air-dry flow rate. The inlet air-dry temperature (200˚C), feed pump flow rate (485 mL/hr) and air-dry flow rate (3.7 m/s) show the highest amount of spray dried powder product produced. The moisture content, mean particle size and antioxidant activity were 4.88%, 8.145 μm and 91.4277 %, respectively. The encapsulation with the combination of arabic gum and maltodextrin showed a better physicochemical property. The moisture content, mean particle size and antioxidant activity were 6.67%, 10.38 μm and 91.4087%, respectively. The optimised conditions obtained using the FCCCD method were 194.98°C inlet air-dry temperature, 447.28 mL/hr feed flow rate and 3.75 air-dry flow rate with 5.19% moisture content and 92.10% antioxidant activity. The characterisations of optimised microcapsules using SEM showed irregular shape, no open pores on the surface and significant shrinking effect. The antioxidant activities, total phenolic content and mangiferin yield were 92.10%, 0.65635 ± 0.0392 mg GAE/mg sample and 16.87 ± 2.35, respectively. The values are higher than those obtained from the OFAT and spray drying process without encapsulation. The anti-diabetic analysis confirms that Mahkota Dewa Fruit extract and optimised microcapsules exert insulin sensitising activity in the same manner as rosiglitazone does and therefore, can become a potential antidiabetic substances. In conclusion, this work successfully screened and optimised the encapsulation of Mahkota Dewa extracts into dried powder form using the spray drying technique. The outcome provides the suitable inlet air temperature, feed pump flow rate, dry air flow rate and type of carrier for spray drying of Mahkota Dewa extract.

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