UNIVERSITI TEKNOLOGI MARA

RAPID EXPANSION SUPERCRITICAL SOLUTION (RESS) CARBON DIOXIDE AS A GREEN TECHNOLOGY FOR GINGER RHIZOME SOLID OIL PARTICLES FORMATION

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CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 30th December 2015 to conduct the final examination of Nur Ain Binti Mohd Zainuddin on her Master of Science thesis entitled "Rapid Expansion Supercritical Solution (RESS) Carbon Dioxide As A Green Technology For Ginger Rhizome Solid Oil Particles Formation" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiners recommended that the student be awarded the relevant degree. The panel of Examiners are as follows:

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I declare that the work in this thesis/dissertation was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

Ginger (*Zingiber officinale, Rosc.*) contains high antioxidant bioactive constituents. Nowadays, ginger extract received great attention due to the increasing application of natural antioxidant in pharmaceutical products. Many studies acknowledged the high amount of natural antioxidant content in ginger as a valuable component to replace synthetic antioxidant that can be used in anticancer activity for cancer treatment. Most of the previous researchers used Supercritical Fluid Extraction (SFE) and conventional extraction technique such as steam distillation and solvent extraction method in ginger extraction. However, the conventional technique for ginger extraction required organic solvent, long extraction time, produce toxic residual and waste water that can be harmful to human and environment. SFE, solvent extraction and steam distillation for ginger extraction produced ginger extract in oil form that need to undergo conventional technique for particle formation. Recent developments in extraction technology allowed extraction of bioactive components in herb to produce solid oil particle instead of liquid oil that need to undergo further conventional techniques for particles formation. Therefore, in this study a clean extraction method that is Rapid Expansion Supercritical Solution (RESS) technology using supercritical carbon dioxide as a solvent (RESS-CO_2) was introduced for ginger powder extraction to produce solid oil particle of bioactive components. The extraction was conducted within a range of temperature (40, 45, 50, 55, 60, 65 and 70°C) and pressure (3000, 4000, 5000, 6000 and 7000psi), at a constant flowrate (24 ml/min) for 40 minutes extraction. The extract obtained was characterized using Scanning Electron Microscopy (SEM) and ImageJ Program for solid oil particle size determination and Gas chromatography Mass Spectrometry (GCMS) for component identification. The smallest solid oil particle size 2.22 μm was obtained at temperature 40°C, and pressure 5000psi. The highest extraction yield 2.41% was achieved at temperature 65°C, and pressure 6000psi. Analysis of the smallest solid oil particle using GCMS showed that the detected components were Gingerol and β-Elemene, Farnesene, Caryophyllene, Farnesol, Borneol, Thujopsene, Aromadendrene, trans-α-Bergamotene, Nerolidol, α-copaene, cis-α-copaene-8-ol, Decanal, and 2-undecanone. Experimental work for the whole range of temperature and pressure consumed more cost and time. Thus, in this study, experimental particle size data was modeled by using Artificial Neural Network (ANN) for particle size prediction. A multilayer feed-forward back-propagation ANN model was developed where two inputs variables (extraction temperature and pressure) and one output (particle size) with 35 experimental data points. An optimal ANN model consists of 1 hidden layer with 7 hidden neurons with the lowest mean square error (MSE) of 0.00031 and regression coefficient (R) of 0.99721 showed that good training and good performance agreement between ANN model predicting data and experimental data.

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