COMPARATIVE ANALYSIS OF BIOACTIVE COMPOUNDS AND ANTIOXIDANT ACTIVITY OF MALAYSIAN GINGERS AFFECTED BY DIFFERENT DRYING AND EXTRACTION METHODS

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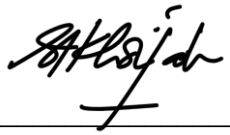

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang Al-Sultan Abdullah or any other institutions.

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ABSTRAK

Halia (*Zingiber officinale* Roscoe) telah digunakan sebagai bahan makanan, rempah ratus, tambahan dan perasa serta ubat tradisional kerana ciri uniknya seperti kepedasan, aroma, pemakanan dan aktiviti farmakologi. Halia Bentong (BG), yang ditanam di kawasan altitud tinggi di Bentong, Malaysia, mempunyai nama saintifik yang serupa dengan spesies halia biasa dan telah dipatenkan oleh kerajaan Malaysia. Halia mempunyai pelbagai kesan biologi, termasuk antioksidan, antimikrob, anti-kanser, anti-radang, dan kesan lain kerana ia kaya dengan pelbagai komponen bioaktif. Walau bagaimanapun, teknik pengeringan dan pengekstrakan mempunyai kesan yang ketara ke atas komponen bioaktif halia. Penggunaan kaedah pemprosesan suhu yang lebih tinggi boleh mengakibatkan kehilangan sebatian aromatik yang meruap, penurunan dalam aktiviti antioksidan, dan degradasi kandungan nutrien yang berguna. Oleh itu, kajian ini membentangkan kesan teknik pengeringan yang berbeza dengan pendekatan haba rendah (pengeringan katil terbendalir berputar (SFBD), pengeringan ketuhar (OD) dan pengeringan beku (FD)) terhadap kinetik pengeringan, potensi antioksidan, dan sebatian bioaktif BG. Tujuh model matematik telah digunakan pada data eksperimen untuk menentukan model pengeringan lapisan nipis terbaik untuk aplikasi pengeringan. Keputusan eksperimen menunjukkan bahawa SFBD mengurangkan jumlah masa pengeringan berbanding dengan OD dan FD, yang diterjemahkan kepada penggunaan tenaga yang rendah, kadar pengeringan yang tinggi dan keterbauran lembapan. Di samping itu, sampel BG kering daripada SFBD mempamerkan perencatan 2,2-difenil-1-picrylhydrazyl (DPPH) dan jumlah kandungan fenolik (TPC) yang lebih tinggi sedikit. Model Midilli-Kucuk menunjukkan kesesuaian terbaik untuk menerangkan tingkah laku pengeringan lapisan nipis BG untuk OD dan SFBD, manakala model Page menunjukkan kesesuaian terbaik untuk FD. Objektif kedua memberi tumpuan kepada pengoptimuman pembolehubah proses pengekstrakan dibantu ultrasonik untuk hasil sebatian fenolik yang lebih tinggi daripada BG. One-Factor-Analysis dan Central Composite Design daripada Response Surface Methodology digunakan untuk menyaring dan mengoptimumkan kesan amplitud, masa sonikasi dan kepekatan pelarut terhadap perencatan TPC dan DPPH. Keadaan optimum untuk hasil perencatan TPC dan DPPH yang lebih tinggi diperhatikan ialah amplitud 32.00%, masa sonikasi 14.94 min dan kepekatan pelarut (etanol) 82.00%. Menurut penemuan kajian, ekstrak BG boleh menjadi agen antioksidan yang berpotensi untuk industri makanan dan farmaseutikal. Oleh itu, kajian ini juga dijalankan untuk menganalisis potensi ekstrak BG yang dioptimumkan pada kepekatan berbeza (5, 10 dan 20 % v/v) yang digabungkan dalam matriks bio-nanokomposit terplastis untuk pembangunan pembungkusan filem aktif. Filem bio-nanokomposit dengan 20% BG menunjukkan peningkatan terbaik pada kekuatan tegangan, pemanjangan semasa putus, ketebalan, kelegapan, keterlarutan air dan kandungan lembapan. Ujian pelepasan antioksidan menunjukkan pembebasan berterusan antioksidan dan jumlah kandungan fenolik dalam 95% simulant makanan selama 28 hari. Kajian ini mengesahkan bahawa penggabungan ekstrak BG boleh menjadi bahan tambahan semula jadi yang menjanjikan untuk bahan pembungkusan aktif

ABSTRACT

Ginger (*Zingiber officinale* Roscoe) has been used as a food, spice, supplement and flavoring ingredient as well as traditional medicines due to its unique features like pungency, aroma, nutrition, and pharmacological activity. Bentong ginger (BG), grown in a high-altitude area of Bentong, Malaysia, has a similar scientific name to the common ginger species and been patented by the Malaysian government. Ginger has a wide range of biological effects, including antioxidant, antimicrobial, anti-cancer, anti-inflammatory, and other effects as it is rich in various bioactive constituents. However, drying and extraction techniques have a significant impact on the bioactive constituents of ginger. The use of higher temperature processing methods may result in the loss of volatile aromatic compounds, a decrease in antioxidant activity, and the degradation of useful nutrient content. Hence, this study presents the effect of different drying techniques with low thermal approach (swirling fluidized bed drying (SFBD), oven drying (OD) and freeze drying (FD)) on the drying kinetics, antioxidant potential, and bioactive compounds of BG. Seven mathematical models were applied to the experimental data to determine the best thin-layer drying models for drying applications. The experimental results showed that SFBD reduces the total drying time compared to OD and FD, which translates to a low energy consumption, high drying rate and moisture diffusivity. In addition, the dried BG sample from the SFBD exhibited a slightly higher 2,2-diphenyl-1-picrylhydrazyl (DPPH) inhibition and total phenolic content (TPC) yield. The Midilli-Kucuk model showed the best fit at explaining the thin layer drying behavior of the BG for OD and SFBD, whereas the Page model showed the best fit for FD. Second objective focuses on the optimization of ultrasonic assisted extraction process variables for a higher yield of phenolic compounds from BG. One-Factor-Analysis and Central Composite Design from Response Surface Methodology were employed to screen and optimize the effect of amplitude, sonication time and solvent concentration towards TPC and DPPH inhibition. The optimized conditions for higher yield of TPC and DPPH inhibition were observed to be amplitude of 32.00 %, sonication time of 14.94 min and solvent (ethanol) concentration of 82.00 %. According to the findings of the study, BG extracts could be a potential antioxidant agent for the food and pharmaceutical industries. Hence, this study also conducted to analyze the potential of optimized BG extracts at different concentrations (5, 10 and 20 % v/v) incorporated in plasticized bio-nanocomposite matrix for the development of active film packaging. The bio-nanocomposite film with 20% BG showed the best improvement on its tensile strength, elongation at break, thickness, opacity, water solubility and moisture content. Antioxidant release test showed continuous release of antioxidant and total phenolic content in 95 % of food simulants for 28 days. This study validated that incorporation of BG extract can be a promising natural additive for active packaging materials.

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