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Extraction and Encapsulation of Phenolic Compounds from New Zealand Macadamia Husk: A Novel Approach for Oral Delivery of its Bioactive Compounds

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Abstract

Every year tonnes of macadamia nuts are produced globally, resulting in a large production of by-products such as macadamia husk. This by-product contains high concentrations of phenolic compounds with antioxidant and health-promoting properties(1). Oral delivery of these phenolic compounds via food systems is challenging as the stability and biological activities can change when exposed to different types of environmental conditions (e.g., heat, light, oxygen, and pH)(2). Therefore, this study aimed to protect the integrity and stability of phenolic compounds from macadamia husk against such environmental conditions towards their delivery via food and related products. Different extracts of macadamia husk were prepared by conventional solvent extraction (CSE), accelerated solvent extraction (ASE), and ultrasonic probe-assisted extraction (UPAE) using water and organic solvents such as ethanol and methanol mixtures of different concentrations with water. The extracts were characterised by their total phenol content (TPC), total flavonoid content (TFC), and antioxidant properties (using the 2,2- diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity method). UPLC-HRes-MS/MS analysis was applied for screening and characterising phenolic compounds in macadamia husk extracts (MHE). Liposomes composed of soy lecithin were used to encapsulate the phenolic compounds to maintain their stability and biological activity against environmental conditions. The mean particle size, homogeneity, zeta potential, and encapsulation efficiency were used to characterise the liposome properties. 50% ethanol was the most effective solvent for maximising the TPC (47.90±0.67 mg GAE/g of dry weight and TFC (149.85±6.54 mg QE/g of DW) in extracts obtained using the three methods studied. Fifteen phenolic compounds including phenolic acids (e.g. chlorogenic acid, protocatechuic acid), flavonoids (e.g. catechin, epicatechin, epigallocatechin, gallocatechin) and other polyphenols (e.g. daidzin, myricetin 3-O- arabinoside, quercetin O-glucoside) were identified in the aqueous ethanol extract. The empty (control) liposomes had a mean diameter of 173.23±1.29 nm and exhibited a zeta potential of -80.14 mV. MHE loading significantly ($p < 0.05$) increased the liposome size (to 186.33±0.29 nm) and reduced the zeta potential values (-77.00±0.73 mV) and homogeneity of the size distribution. This study shows 50% ethanol was the most effective solvent for maximising the TPC and TFC in extracts obtained using the three different methods studied. Liposomes containing phenolic extract exhibited highly negative zeta potential values, indicating favourable stability and long-term protection of phenolic compounds. Thus, this study provides a promising approach to the extraction and encapsulation of phenolic compounds from New Zealand-grown macadamia husk for their possible incorporation into food products.

Keywords: Macadamia husk, Bioactive phytochemicals, Phenolic compounds, Liposomal encapsulation, Functional foods.

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