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Title:

Enhanced stability and targeted delivery of phenolic compounds from macadamia green husk via liposomal encapsulation

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Abstract: (Your abstract must use **Normal style** and must fit in this box. Your abstract should be no longer than 300 words. The box will 'expand' over 2 pages as you add text into it.)

Preparation of Your Abstract

1. The title should be as brief as possible but long enough to indicate clearly the nature of the study. Capitalise the first letter of the first word ONLY (place names excluded). No full stop at the end.
2. Abstracts should state briefly and clearly the purpose, methods, results and conclusions of the work.
Introduction: Clearly state the purpose of the abstract
Methods: Describe your selection of observations or experimental subjects clearly
Results: Present your results in a logical sequence
Discussion: Emphasize new and important aspects of the study and conclusions that are drawn from them

Introduction: Tonnes of macadamia nuts are produced globally annually, generating large amounts of by-products, particularly macadamia husk. This husk is rich in phenolic compounds with antioxidant and health-promoting properties, but its use in foods is limited by instability to heat, light, pH, oxygen, and enzymes. This study encapsulated phenolic-rich extract from macadamia green husk (MGH) into liposomes to protect integrity and improve stability for targeted food delivery.

Methods: MGH extract was incorporated into soy lecithin liposomes using high-shear mixing and high-pressure homogenisation (2000 MPa). To enhance stability, liposomes were coated with 0.4% (w/v) chitosan. Physicochemical properties (mean particle size, zeta potential (ζ-potential), encapsulation efficiency (EE), and morphology (using TEM)) were assessed. *In vitro* bioaccessibility was evaluated by measuring total phenolic content during simulated gastrointestinal digestion.

Results: Empty liposomes measured 111–136 nm, while uncoated loaded liposomes were smaller (77–78 nm). Chitosan coating increased empty vesicle size to 523 nm, indicating polymer layer formation, with coated loaded and empty liposomes showing similar diameters (501–523 nm) over two months. Empty liposomes had a ζ-potential of −62.55±1.00 mV, reduced to −43.11±3.63 mV upon extract loading; coating reversed the charge to +48.22±7.91 mV (empty) and +49.99±1.42 mV (loaded), confirming cationic polymer adsorption. TEM revealed spherical nanoliposomes consistent with dynamic light scattering. EE was higher in coated liposomes (91.15–82.59%) than uncoated (81.50–73.60%) over 28 days at 4°C. Liposomes remained stable under gastric conditions but lost membrane integrity and released phenolics in intestinal conditions.

Discussion: Phenolics in liposomes may interact with phospholipid polar headgroups via their amphiphilic nature, increasing bilayer packing density, reducing thickness, and producing smaller

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diameters than empty liposomes. Chitosan coating enhanced protection and improved intestinal-phase release compared with uncoated liposomes and free extract. Chitosan-coated liposomes are an effective delivery system for MGH phenolics, with potential applications in functional foods/beverages.