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**Fabrikasi Granul Bifasik Kalsium Magnesium Fosfat Berbasis Duri Landak Laut Dengan Coating Perak
Fosfat untuk Rekayasa Jaringan Tulang**
Khalifatus Sakdiyah, Prof. Dr. Eng. Yusril Yusuf, S.Si., M.Si., M.Eng.
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

INTISARI

FABRIKASI GRANUL BIFASIK KALSIUM MAGNESIUM FOSFAT BERBASIS DURI LANDAK LAUT DENGAN COATING PERAK FOSFAT UNTUK REKAYASA JARINGAN TULANG

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Naskah ini melaporkan keberhasilan fabrikasi, modifikasi permukaan, serta karakterisasi granul *biphasic calcium magnesium phosphate* (BCMP) berbasis duri landak laut Diadema setosum. Penelitian ini dilatarbelakangi oleh kebutuhan *biomaterial bone graft* yang tidak hanya memiliki sifat osteokonduktif dan biodegradabel, tetapi juga mampu menghambat pertumbuhan bakteri penyebab infeksi pada regenerasi tulang alveolar. Penelitian ini bertujuan memfabrikasi granul BCMP melalui metode disolusi-presipitasi secara hidrotermal, memodifikasi permukaannya menggunakan Ag_3PO_4 melalui metode *dip coating*, serta mengevaluasi pengaruhnya terhadap karakteristik fisikokimia, biodegradasi, aktivitas antibakteri, dan sitokompatibilitas *in vitro*. Granul BCMP difabrikasi melalui fosfatisasi hidrotermal menggunakan larutan 1 M $(NH_4)_2HPO_4$ pada suhu 200°C selama 10 hari, kemudian dimodifikasi menggunakan larutan $AgNO_3$ berkonsentrasi 10 mmol/L dan 15 mmol/L. Karakterisasi dilakukan menggunakan XRD, FTIR, SEM-EDS *mapping*, *Surface Area Analyzer* (SAA), dan biodegradasi sedangkan pengujian biologis meliputi aktivitas antibakteri terhadap *Staphylococcus aureus* dan *Porphyromonas gingivalis*, serta uji viabilitas dan proliferasi sel preosteoblas MC3T3-E1. Hasil penelitian menunjukkan bahwa granul BCMP berhasil terbentuk sebagai biomaterial bifasik yang terdiri dari fase karbonat apatit (CO_3Ap) dan *β-tricalcium phosphate* (β-TCP) yang mempertahankan struktur stereom dan kandungan Mg alami duri landak laut. Modifikasi menggunakan Ag menghasilkan pembentukan fase Ag_3PO_4 yang meningkatkan aktivitas antibakteri, menurunkan laju biodegradasi, serta tetap mempertahankan viabilitas sel >70% sesuai ISO 10993-5 dan mendukung proliferasi sel.

Kata kunci: granul, bifasik, kabnonat apatit, duri landak laut, antibakteri.

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ABSTRACT

FABRICATION OF BIPHASIC CALCIUM MAGNESIUM PHOSPHATE GRANULES FROM SEA URCHIN SPINES WITH SILVER PHOSPHATE COATING FOR BONE TISSUE ENGINEERING

By

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This study reports the successful fabrication, surface modification, and characterization of biphasic calcium magnesium phosphate (BCMP) granules from the sea urchin spine (*Diadema setosum*). The study was motivated by the need for bone graft biomaterials that possess not only osteoconductive and biodegradable properties but also antibacterial activity to prevent infection during alveolar bone regeneration. The objective of this study was to fabricate BCMP granules using a hydrothermal dissolution-precipitation method, modify their surfaces with silver phosphate (Ag_3PO_4) via dip coating, and evaluate the effects of this surface modification on the physicochemical properties, biodegradation behavior, antibacterial activity, and in vitro cytocompatibility of the granules. BCMP granules were synthesized through hydrothermal phosphatization using 1 M $(NH_4)_2HPO_4$ solution at 200 °C for 10 days and subsequently surface-modified with $AgNO_3$ solutions at concentrations of 10 mmol/L and 15 mmol/L. Physicochemical characterization was performed using XRD, FTIR, SEM-EDS mapping, surface area analysis (SAA), and biodegradation testing. Biological performance was evaluated through antibacterial assays against *Staphylococcus aureus* and *Porphyromonas gingivalis*, as well as cell viability and proliferation assays using MC3T3-E1 preosteoblast cells. The results demonstrated that BCMP granules were successfully fabricated as a biphasic biomaterial composed of carbonate apatite (CO_3Ap) and β-tricalcium phosphate (β-TCP), while preserving the natural stereom architecture and magnesium content of the sea urchin spine. Surface modification with Ag_3PO_4 resulted in the formation of a silver phosphate phase that enhanced antibacterial activity and reduced the biodegradation rate without compromising cytocompatibility. All samples exhibited cell viability >70%, meeting the ISO 10993-5 standard for non-cytotoxic biomaterials, and supported MC3T3-E1 cell proliferation.

Keywords: granules, biphasic, carbonate apatite, sea urchin spines, antibacterial.