PENGARUH PENAMBAHAN NANOPARTIKEL SENG OKSIDA DAN KITOSAN TERHADAP SIFAT KUAT TARIK, KETAHANAN AIR, DAN BIODEGRADASI BIOPLASTIK BERBAHAN TEPUNG RUMPUT LAUT *EUCHEUMA COTTONII* DAN GLISEROL

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ABSTRAK

Penelitian ini dilatarbelakangi oleh meningkatnya kebutuhan plastik yang sulit terdegradasi, sehingga diperlukan solusi alternatif mengganti plastik konvensional menggunakan bioplastik yang *biodegradable*. Namun demikian, bioplastik umumnya bersifat kaku, rapuh, dan memiliki ketahanan air yang rendah. Oleh karena itu, diperlukan zat tambahan sebagai agen *crosslinking*, *plasticizer*, dan pengawet seperti nanopartikel ZnO dan kitosan. Penelitian ini bertujuan untuk mengevaluasi pengaruh penambahan nanopartikel ZnO dan kitosan terhadap kuat tarik, ketahanan air, dan biodegradasi bioplastik berbasis tepung rumput laut *Eucheuma cottonii* dan gliserol. Nanopartikel ZnO disintesis melalui metode *green synthesis* dan dikarakterisasi menggunakan XRD dan FTIR. Selanjutnya, bioplastik dibuat dengan variasi konsentrasi penambahan ZnO dan kitosan, dan diuji sifat kuat tarik, ketahanan air, dan biodegradasinya, serta dianalisis lebih lanjut menggunakan FTIR dan SEM-EDS. Hasil menunjukkan bahwa penambahan nanopartikel ZnO secara signifikan (*p-value* = 0,001 < α = 0,05) meningkatkan kuat tarik dan ketahanan air, tetapi menurunkan laju biodegradasi. Hal ini diduga akibat ikatan ionik yang kuat antara ion Zn^{2+} dan gugus sulfat ($-OSO_3^-$), sehingga mempersulit mikroorganisme dalam memutus ikatan tersebut. Sebaliknya, penambahan kitosan menurunkan kuat tarik dan sedikit meningkatkan ketahanan air (*p-value* = 0,001 < α = 0,05), karena kitosan bersifat hidrofilik cenderung mudah mengikat air, meningkatkan kelembaban, dan mendukung aktivitas mikroorganisme dalam proses degradasi. Secara keseluruhan, kombinasi penambahan nanopartikel ZnO dan kitosan menunjukkan interaksi signifikan (*p-value* = 0,001 < α = 0,05). Variasi terbaik diperoleh pada bioplastik E, dengan kuat tarik mencapai 14,41 MPa dan terdegradasi sempurna dalam waktu kurang dari 60 hari sesuai standar SNI. Meskipun demikian, nilai ketahanan airnya (93,17%) masih di bawah standar minimum (≥99%) dan morfologinya belum merata. Oleh karena itu, disarankan untuk menambahkan agen hidrofobik dan menerapkan metode pencampuran yang lebih efektif pada penelitian selanjutnya.

Kata-kata kunci: bioplastik, *Eucheuma cottonii*, nanopartikel, kitosan, kuat tarik, ketahanan air, biodegradasi.

EFFECT OF ZINC OXIDE NANOPARTICLES AND CHITOSAN ADDITION ON THE TENSILE STRENGTH, WATER RESISTANCE, AND BIODEGRADABILITY OF BIOPLASTIC BASED ON *EUCHEUMA COTTONII* SEAWEED FLOUR AND GLYCEROL

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ABSTRACT

This study was motivated by the increasing demand for non-degradable plastics, highlighting the need for alternative, biodegradable bioplastics. However, bioplastics are typically brittle, rigid, and have poor water resistance. Therefore, additives such as ZnO nanoparticles and chitosan are required to act as crosslinking agents, plasticizers, and preservatives. This research aims to evaluate the effect of adding ZnO nanoparticles and chitosan on the tensile strength, water resistance, and biodegradability of bioplastics based on Eucheuma cottonii seaweed flour and glycerol. ZnO nanoparticles were synthesized using a green synthesis method and characterized by XRD and FTIR. Bioplastics were then produced with varying concentrations of ZnO and chitosan, followed by tensile strength, water resistance, and biodegradability tests, and further analyzed using FTIR and SEM-EDS. The results showed that ZnO nanoparticle addition significantly (p-value = 0.001 < α = 0.05) enhanced tensile strength and water resistance but reduced the biodegradation rate. This is presumably due to strong ionic bonds between Zn^{2+} ions and sulfate groups ($-OSO_3^-$), which hinder microbial breakdown. Conversely, chitosan addition reduced tensile strength and slightly improved water resistance (p-value = 0.001 < α = 0.05), as its hydrophilic nature promotes water absorption, increases humidity, and supports microbial activity in degradation. Overall, the combination of ZnO nanoparticles and chitosan showed a significant interaction (p-value = 0.001 < α = 0.05). The best formulation was bioplastic E, with a tensile strength of 14.41 MPa and complete degradation within less than 60 days, meeting SNI standards. However, its water resistance (93.17%) remains below the minimum standard (≥99%), and the surface morphology is still uneven. Therefore, the addition of hydrophobic agents and the use of more effective mixing methods are recommended for future research.

Keywords: bioplastic, Eucheuma cottonii, nanoparticles, chitosan, tensile strength, water resistance, biodegradation.