PEMBUATAN BIOPLASTIK MULTIFUNGSI BERBASIS KARBOKSIMETIL SELULOSA SEBAGAI MODEL PUPUK PELEPAS-LAMBAT NPK DAN ANTI MIKROBA

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INTISARI

Pembuatan bioplastik multifungsi berbasis karboksimetil selulosa (KMS) sebagai model pupuk pelepas-lambat NPK yang bersifat anti mikroba telah dilakukan. Penelitian ini bertujuan untuk mendapatkan komposisi optimum, mempelajari pengaruh penambahan *filler* berupa zeolit (Zeo), karbon aktif (KA) dan titanium dioksida (TiO_2) terhadap sifat mekanik bioplastik, mempelajari aktivitas lepas-lambat nitrogen, fosfor dan kalium (NPK) bioplastik, dan mempelajari sifat anti mikroba bioplastik. Bioplastik dibuat dengan melakukan variasi komposisi KMS sebagai matriks komposit dan penambahan *filler* dengan variasi massa tertentu. NPK sebagai bahan utama pupuk, dibuat dari urea sebagai sumber unsur nitrogen, ammonium dihidrogen fosfat sebagai sumber unsur fosfor dan kalium klorida sebagai sumber unsur kalium. Bioplastik dengan komposisi optimum dianalisis aktivitas lepas-lambatnya dengan menentukan kinetika pelepasan pada variasi waktu 1, 3, 6, 12, 24, 48, 72, 96, 120, 144 dan 168 jam. Sifat anti mikroba dikaji terhadap bakteri patogen tanaman kentang yaitu *Ralstonia solanacerum*.

Hasil penelitian menunjukkan bahwa komposisi optimum pembuatan bioplastik KMS/NPK diperoleh pada suhu pengadukan 50 °C, KMS/NPK 0,5 g untuk variasi massa NPK, KMS/NPK/Zeo/KA 0,5 g pada variasi massa karbon aktif, dan KMS/NPK/Zeo/KA/TiO_2 0,1 g pada variasi massa TiO_2. Penambahan *filler* meningkatkan nilai kuat tarik komposit dan menurunkan persentase elongasi bioplastik komposit sejalan dengan bertambahnya massa *filler* yang digunakan. Selain itu, penambahan *filler* juga berpengaruh terhadap kadar unsur N, P dan K yang diembankan. Aktivitas lepas-lambat bioplastik mengikuti kinetika pelepasan orde kedua semu dan Higuchi. Penambahan *filler* titanium dioksida terbukti menambahkan sifat anti mikroba pada komposit bioplastik.

Kata kunci: anti mikroba, karboksimetil selusosa (KMS), kinetika pelepasan, pupuk pelepas-lambat NPK,

PREPARATION OF MULTIFUNCTIONAL BIOPLASTICS BASED ON CARBOXYMETHYL CELLULOSE AS A MODEL FOR SLOW-RELEASE NPK FERTILIZER AND ANTIMICROBIAL AGENT

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ABSTRACT

The preparation of multifunctional cellulose-based bioplastics using carboxymethyl cellulose (CMC) as a model for slow-release NPK fertilizer with antimicrobial properties has been conducted. The aim of this research is to obtain the optimum composition, study the effect of adding fillers such as zeolite (Zeo), activated carbon (KA), and titanium dioxide (TiO_2) on the mechanical properties of bioplastics, study the slow-release activity of nitrogen, phosphorus, and potassium (NPK) in bioplastics, and study the antimicrobial properties of bioplastics. Bioplastics were made by varying the composition of CMC as a composite matrix and adding fillers with certain mass variations. NPK, as the main fertilizer material, was made from urea as a source of nitrogen, ammonium dihydrogen phosphate as a source of phosphorus, and potassium chloride as a source of potassium. Bioplastics with optimum composition were analyzed for their slow-release activity by determining the release kinetics at various times: 1, 3, 6, 12, 24, 48, 72, 96, 120, 144, and 168 hours. The antimicrobial properties were studied against the potato plant pathogen bacterium, *Ralstonia solanacearum*.

The results showed that the optimum composition to produce CMC/NPK bioplastics was obtained at a stirring temperature of 50°C, with KMS/NPK 0.5 g for the NPK mass variation, KMS/NPK/Zeo/KA 0.5 g for the activated carbon mass variation, and KMS/NPK/Zeo/KA/TiO_2 0.1 g for the titanium dioxide mass variation. Adding fillers increased the tensile strength of the composite and decreased the percentage of elongation of the composite bioplastics with increasing filler mass. In addition, adding fillers also affected the amount of N, P, and K elements contained. The slow-release activity of bioplastics followed the pseudo-second-order kinetic and Higuchi release kinetics. The addition of titanium dioxide as a filler was proven to add antimicrobial properties to the bioplastic composite.

Keywords: anti-microbial, carboxymethyl cellulose (CMC), NPK slow-release fertilizer, release kinetics