PEMBUATAN BIOPLASTIK KOMPOSIT BERBASIS KARBOKSIMETIL SELULOSA/TITANIUM DIOKSIDA SEBAGAI MODEL PUPUK PELEPAS-LAMBAT NPK YANG BERSIFAT ANTIBAKTERI

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INTISARI

Pembuatan bioplastik komposit berbasis karboksimetil selulosa/titanium dioksida sebagai model pupuk pelepas-lambat NPK yang bersifat antibakteri telah dilakukan dengan tujuan untuk menentukan pengaruh penambahan bentonit, karbon aktif, dan titanium dioksida terhadap sifat fisik dan kimia bioplastik, laju lepas-lambat NPK, dan pengaruh penambahan titanium dioksida terhadap sifat antibakteri bioplastik. Pembuatan bioplastik dilakukan dengan metode pengadukan selama 4 jam pada temperatur 50 ˚C, dan pengeringan di dalam oven pada temperatur 55 ˚C. Pada penelitian ini dilakukan pembuatan lima variasi bioplastik, yang meliputi bioplastik KMS/NPK, KMS/bentonit/NPK, KMS/karbon aktif/NPK, KMS/karbon aktif/bentonit/NPK, dan KMS/TiO_2/karbon aktif/bentonit/NPK. Bioplastik dikarakterisasi dengan spektroskopi FTIR dan XRD, uji sifat mekanik, uji antibakteri terhadap bakteri *Ralstonia solanacearum*, serta uji kadar NPK terserap dan lepas-lambat NPK dengan menggunakan spektrofotometer UV-Vis dan spektrometer serapan atom.

Hasil penelitian menunjukkan bahwa penambahan bentonit, karbon aktif, maupun kombinasi karbon aktif/bentonit ke dalam komposisi bioplastik menurunkan nilai kuat tarik dan elongasi bioplastik, sedangkan penambahan titanium dioksida meningkatkan nilai kuat tarik dan elongasi bioplastik. Penambahan bentonit, karbon aktif, kombinasi karbon aktif/bentonit, dan titanium dioksida juga berpengaruh terhadap penyerapan NPK dan peningkatan pelepasan lambat NPK. Kinetika pelepasan N, P, dan K dari bioplastik mengikuti model kinetika orde kedua semu, dengan rentang konstanta laju pelepasan N, P, dan K masing-masing sebesar 0,0102-0,0368; 0,0522-0,1584; dan 0,4575-1,0407 mg g^{-1} jam^{-1}. Penambahan titanium dioksida ke dalam komposisi bioplastik meningkatkan kemampuan antibakteri bioplastik terhadap bakteri *Ralstonia solanacearum*, namun masih termasuk dalam kategori kemampuan daya antibakteri yang lemah.

Kata kunci: antibakteri, bioplastik, pupuk lepas-lambat

PREPARATION OF BIOPLASTIC COMPOSITES BASED ON CARBOXYMETHYL CELLULOSE/TITANIUM DIOXIDE AS A MODEL OF NPK SLOW-RELEASE FERTILIZER WITH ANTIBACTERIAL ACTIVITY

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ABSTRACT

Preparation of bioplastic composites based on carboxymethyl cellulose/titanium dioxide as a model of NPK slow-release fertilizer with antibacterial activity has been carried out. The research aimed to determine the effect of bentonite, activated carbon, and titanium dioxide addition on the physical and chemical properties of bioplastics, the NPK slow-release rate, and the effect of titanium dioxide addition on the antibacterial properties of bioplastics. The bioplastic was made by stirring all the composition for 4 h at 50 ˚C, and drying in an oven at 55 ˚C. In this study, five variations of bioplastics were made, including CMC/NPK bioplastics, CMC/bentonite/NPK, CMC/activated carbon/NPK, CMC/activated carbon/bentonite/NPK, and CMC/TiO_2/activated carbon/bentonite/NPK. The resulted bioplastics were characterized by FTIR spectrophotometer, X-ray diffraction, mechanical properties test, antibacterial test against *Ralstonia solanacearum* bacteria, NPK content, and NPK release ability using UV-Vis spectrophotometer and atomic absorption spectrometer.

The results showed that the addition of bentonite, activated carbon, and a combination of activated carbon/bentonite to the bioplastic composition decreased the tensile strength and elongation of bioplastics, while the addition of titanium dioxide increased the tensile strength and elongation. The addition of bentonite, activated carbon, a combination of activated carbon/bentonite, and titanium dioxide also affected the NPK absorption and increased the slow-release of NPK. The release kinetics of N, P, and K from bioplastics follow a pseudo second-order kinetics model, with a range of release rate constants for N, P, and K were 0.0102-0.0368, 0.0522-0.1584, and 0.4575-1.0407 mg g^{-1} h^{-1}, respectively. The addition of titanium dioxide into bioplastic composition increased the antibacterial ability of bioplastics against *Ralstonia solanacearum* bacteria with weak antibacterial activity.

Key words: antibacterial, bioplastic, slow-release fertilizer