PEMBUATAN BIOPLASTIK KOMPOSIT KARBOKSIMETIL SELULOSA/ASAM SITRAT/BENTONIT SEBAGAI MODEL PUPUK LEPAS-LAMBAT NPK, Fe, DAN Cu

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INTISARI

Pembuatan bioplastik komposit karboksimetil selulosa/asam sitrat/bentonit (KMS/AS/Ben) sebagai model pupuk lepas-lambat N, P, K, Fe, dan Cu telah diteliti. Bioplastik dibuat dengan metode *solvent casting* menggunakan pelarut air dan bioplastik dikeringkan pada suhu 30 °C selama 5 hari. Pada penelitian ini dibuat delapan variasi bioplastik, yang meliputi bioplastik KMS/AS/Ben/NPK sebagai kontrol, KMS/AS/Ben/NPK/Fe dan KMS/AS/Ben/Cu dengan variasi konsentrasi mikronutrien Fe(III) 100, 150, 200 mg/L dan Cu(II) 10, 20, 30 mg/L. Bioplastik dikarakterisasi dengan XRD, spektroskopi FTIR, uji sifat mekanik, uji *swelling*, uji stabilitas dalam air, uji biodegradibilitas. Uji lepas-lambat N dan P menggunakan spektrofotometer UV-Vis, sedangkan untuk K, Fe, dan Cu digunakan spektroskopi serapan atom.

Hasil penelitian menunjukkan bahwa penambahan asam sitrat dengan variasi konsentrasi 3–5% pada bioplastik KMS/AS/Ben/NPK, dapat menurunkan derajat *swelling* dan kelarutan bioplastik dalam air selama 168 jam, menaikkan elongasi dari 2,2% menjadi 10,80–18,96% dan menurunkan kuat tarik dari 31,24 MPa menjadi 2,49–5 MPa. Melalui uji sifat mekanik, uji biodegradibilitas dan uji lepas-lambat ditunjukkan bahwa dari delapan variasi bioplastik, KMS/AS/Ben/NPK/Fe 150 dan KMS/AS/Ben/NPK/Cu 30 memiliki hasil terbaik dan dipilih sebagai konsentrasi penyusun bioplastik dengan dua jenis mikronutrien. Bioplastik KMS/AS/Ben/NPK/Fe-Cu memiliki kuat tarik sebesar 2,46 MPa; elongasi sebesar 55,84% dan biodegradibilitas selama 7 hari sebesar 37,35%. Bioplastik ini dapat diaplikasikan sebagai pupuk lepas-lambat mikronutrien dengan persentase pelepasan Fe dan Cu selama 24 jam sebesar 9,12% dan 1,94%. Kinetika pelepasan N, P, K, Fe, dan Cu pada seluruh variasi bioplastik mengikuti kinetika orde kedua semu dengan konstanta laju pelepasan rata-rata seluruh variasi bioplastik adalah 0,017; 8,87; 2,62; 0,19; dan 0,02 mg g^{-1} jam^{-1}.

Kata kunci: asam sitrat, bioplastik, mikronutrien, pupuk lepas-lambat

PREPARATION OF CARBOXYMETHYL CELLULOSE/CITRIC ACID/BENTONITE COMPOSITE BIOPLASTICS AS A MODEL OF NPK, Fe, AND Cu SLOW-RELEASE FERTILIZER

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ABSTRACT

Preparation of carboxymethyl cellulose/citric acid/bentonite (KMS/AS/Ben) composite bioplastics as a model for N, P, K, Fe, and Cu slow-release fertilizers has been studied. Bioplastics were made by solvent casting method using water and bioplastics are dried at 30 °C for 5 days. In this study, eight variations of bioplastics were made, including KMS/AS/Ben/NPK bioplastics as controls, KMS/AS/Ben/NPK/Fe and KMS/AS/Ben/Cu with variations in the concentration of micronutrient Fe(III) 100, 150, 200 mg/L and Cu(II) 10, 20, 30 mg/L. Bioplastics were characterized by XRD, FTIR spectroscopy, mechanical properties test, swelling test, stability test in water, and biodegradability test. The slow-release test for N and P used a UV-Vis spectrophotometer, while for K, Fe, and Cu atomic absorption spectroscopy were used.

The results showed that the addition of citric acid with a concentration variation of 3–5% in KMS/AS/Ben/NPK bioplastics, could reduce the degree of swelling and solubility of bioplastics in water for 168 hours, increasing elongation from 2.2% to 10.80–18.96% and decreased tensile strength from 31.24 MPa to 2.49–5 MPa. Through mechanical properties test, biodegradability test and slow-release test, it was shown that of the eight variations of bioplastics, KMS/AS/Ben/NPK/Fe 150 and KMS/AS/Ben/NPK/Cu 30 had the best results and were chosen as the concentration of bioplastic constituents with two types of micronutrients. Bioplastic KMS/AS/Ben/NPK/Fe-Cu has a tensile strength of 2.46 MPa; elongation was 55.84% and biodegradability for 7 days was 37.35%. This bioplastic can be applied as a micronutrient slow-release fertilizer with the percentage of Fe and Cu release for 24 hours were 9.12% and 1.94%. The release kinetics of N, P, K, Fe, and Cu in all bioplastic variations followed pseudo second-order kinetics with the average release rate constant for all bioplastic variations were 0.017; 8.87; 2.62; 0.19; and 0.02 mg g^{-1} $hour^{-1}$.

Key words: bioplastic, citric acid, micronutrient, slow-release fertilizer