SYNTHESIS OF CARBOXYMETHYL CELLULOSE-CHOLINE CHLORIDE-UREA-ZEOLITE BIOPLASTIC AS A MODEL FOR NITROGEN SLOW-RELEASE FERTILISER

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ABSTRACT

High mobility of urea in soil caused by denitrification and leaching is making its absorption by plants to be inefficient. This encourages efforts to prepare slow-release urea fertiliser. Research on slow-release urea fertiliser is still further developed with various products and one of them being bioplastic, which was used in this experiment. The bioplastics were synthesised by mixing zeolite suspension, urea and choline chloride (ChCl) in carboxymethyl cellulose (CMC) gel. CMC was used as the matrix, zeolite was used as the inorganic filler, and ChCl-urea was used as the plasticiser of the bioplastics. Two variations of bioplastics were made: CMC-urea-zeolite and CMC-ChCl-urea-zeolite. The amount of CMC, urea, and ChCl used were constant, which was 1 g of CMC, 0.5 g of urea, and 0.58 g of ChCl. In CMC-urea-zeolite bioplastics, zeolite weights used were 0.1, 0.5, 1, 2, 3, and 5 g. In CMC-ChCl-urea-zeolite bioplastics, zeolite weights used were 1 and 2 g because CMC-urea-zeolite 1 g and 2 g bioplastics had the highest tensile strength and amount of urea absorbed, but low strain. In this experiment, the effect of the weight variation of zeolite and the effect of ChCl addition were studied. Bioplastics were characterised by FTIR spectrometry, XRD, mechanical strength test, biodegradability test, and nitrogen release test. The amount of urea in nitrogen release test was analysed by UV-Vis spectrometry.

The bioplastics based on carboxymethyl cellulose with choline chloride, urea, and natural zeolites were successfully synthesised with CMC-ChCl-urea-zeolite 2 g bioplastic having the most optimum mechanical properties. The addition of zeolites in the bioplastics increased its tensile strength. However, the addition of zeolites greater than 0.5 g decreased its strain. Also, the addition of zeolites prolonged the time to biodegrade. The amount of urea absorbed in the bioplastics increased as the amount of zeolites increased. The best bioplastic composition was the ones with 2 g of zeolites. After being added with ChCl-urea plasticiser, the strain of the bioplastics increased by 36%. The rate constant of nitrogen slow-release for CMC-urea-zeolite and CMC-ChCl-urea-zeolite bioplastics were 0.0549 mg/h and 0.0520 mg/h respectively. The bioplastics containing zeolites had lower tensile strength but higher strain, took shorter time to biodegrade, and had higher amount of urea absorbed compared to the bioplastics containing bentonites.

Keywords: carboxymethyl cellulose, choline chloride, urea, zeolite, bioplastic, slow-release fertiliser.

SINTESIS BIOPLASTIK KARBOKSIMETIL SELULOSA-KOLIN KLORIDA-UREA-ZEOLIT SEBAGAI MODEL PUPUK NITROGEN LEPAS LAMBAT

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INTISARI

Mobilitas urea yang tinggi di dalam tanah akibat denitrifikasi dan pencucian membuat penyerapannya oleh tanaman menjadi tidak efisien. Hal ini mendorong upaya untuk membuat pupuk urea lepas lambat. Penelitian tentang pupuk urea lepas lambat masih terus dikembangkan dengan berbagai produk dan salah satunya merupakan bioplastik, yang digunakan dalam percobaan ini. Bioplastik dibuat dengan mencampurkan suspensi zeolit, urea, dan kolin klorida (ChCl) dalam gel karboksimetil selulosa (CMC). CMC digunakan sebagai matriks, zeolit digunakan sebagai *filler* anorganik, dan ChCl-urea digunakan sebagai *plasticiser*. Dua variasi bioplastik yang dibuat adalah CMC-urea-zeolit dan CMC-ChCl-urea-zeolit. Jumlah CMC, urea, dan ChCl yang digunakan konstan, yaitu 1 g CMC; 0,5 g urea; dan 0,58 g ChCl. Pada bioplastik CMC-urea-zeolit, berat zeolit yang digunakan adalah 0,1; 0,5; 1; 2; 3; dan 5 g. Pada bioplastik CMC-ChCl-urea-zeolit, berat zeolit yang digunakan adalah 1 dan 2 g karena bioplastik CMC-urea-zeolit 1 g dan 2 g memiliki kekuatan tarik dan jumlah urea terserap tertinggi, namun memiliki regangan yang rendah. Dalam percobaan ini, pengaruh variasi berat zeolit dan pengaruh penambahan ChCl dipelajari. Bioplastik dikarakterisasi dengan spektrometri FTIR, XRD, uji kekuatan mekanik, uji biodegradabilitas, dan uji pelepasan nitrogen. Jumlah urea dalam uji pelepasan nitrogen dianalisis dengan spektrometri UV-Vis.

Bioplastik berbasis karboksimetil selulosa dengan kolin klorida, urea, dan zeolit alam berhasil dibuat dengan bioplastik CMC-ChCl-urea-zeolit 2 g yang memiliki sifat mekanik paling optimal. Penambahan zeolit dalam bioplastik meningkatkan kekuatan tariknya. Akan tetapi, penambahan zeolit yang lebih besar dari 0,5 g menurunkan regangannya. Selain itu, penambahan zeolit menyebabkan bioplastik memerlukan waktu yang lebih lama untuk terurai. Jumlah urea yang diserap dalam bioplastik meningkat seiring bertambahnya zeolit. Komposisi bioplastik terbaik adalah yang menggunakan 2 g zeolit. Setelah ditambahkan *plasticiser* ChCl-urea, regangan bioplastik meningkat sebesar 36%. Konstanta laju lepas lambat nitrogen untuk bioplastik CMC-urea-zeolit dan CMC-ChCl-urea-zeolit masing-masing adalah 0,0549 mg/jam dan 0,0520 mg/jam. Bioplastik yang mengandung zeolit memiliki kekuatan tarik lebih rendah namun regangan lebih tinggi, memerlukan waktu yang lebih singkat untuk untuk terurai, dan jumlah urea terserap yang lebih tinggi dibandingkan dengan bioplastik yang mengandung bentonit.

Kata kunci: karboksimetil selulosa, kolin klorida, urea, zeolit, bioplastik, pupuk lepas lambat.