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Development of Bio-based Carboxymethyl Cellulose/Chitosan and Its Utilization in Controlled Release Fertilizere

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INTRODUCTION & AIM

The earth's agriculture sustains humanity. Agriculture provides food and raw resources including housing, textiles, sugar, plastics, and vegetable oil. We must increase agricultural production to increase revenue and profit for this country. Productive growth requires fertilizer. Plants get nitrogen, phosphorous, and potassium from general fertilizers. Each of these three essential minerals helps plants thrive. However, fertilizer for plant growth has issues. Fertilizers dissolve quickly in soil water. Plants can't use all fertilizer nourishment. Thus, we researched controlled-release fertilizers to reduce nutrient losses by slowly releasing nutrients in line with plant needs. An environmentally friendly biopolymer made from agricultural waste encases the controlled-release fertilizer.

Due to their importance in agriculture and horticulture, slow-release and water-retention fertilizers have garnered attention recently. A new controlled release fertilizer system using carboxymethyl cellulose (CMC) and chitosan (CH) is created in this work to increase biomass consumption efficiency and reduce pollution. Bio-based CMC and CH are synthesized from sugarcane bagasse and golden apple snail shell. The generated materials are evaluated using Fourier transform infrared spectrometer (FTIR), scanning electron microscopy (SEM), and moisture absorption.

METHOD

1. Preparation of Cellulose Derived from Bagasse

Milled sugarcane bagasse was 40–50 mesh. The flask received 7% NaOH solution. Bagasse powder was slowly added to the flask at a 10:1 solvent-solid mass ratio when the liquefaction solvents reached 80°C. The mixture was liquefied by stirring at 80 °C for 120 min. Then filter and bake at 60°C for 12 h. Next, 7 g/l H_2O_2 was added to the flask (solvent: solid = 15:1). After 90 min of stirring at 80°C, the mixture was filtered and baked at 60°C for 12 h.

2. Preparation of CH Derived from Golden Apple Snail

Golden apple snail shells were washed and heated for 4 h in 4% NaOH. After drying at 60 °C for 2 h, they were boiled with 4% wt HCl for 4 h. After milling, golden apple snail shells were boiled for 4 h with 40% NaOH.

3. Preparation of CMC

NaOH (30wt%) was poured to the 10 g flask. 167 ml cellulose and isopropanol. Mixture was swirled for 90 min at 25°C. Next, 6 g. of monochloroacetic acid were put into the flask. Then, the mixture were reflux at 70°C for 3 h so as to get CMC in the final. The combination were rinsed with ethanol and dried at 70°C for 24 h.

4. Fertilizer Coating

In the first step, 1, 5, and 10% wt. CMC was applied to fertilizers. Then, the best coated fertilizers were picked for second coating. Dip coating with water and ethanol co-solvent. Second dip coating on fertilizers utilized 1%, 2%, and 3% CH in acetic acid by weight.

RESULTS & DISCUSSION

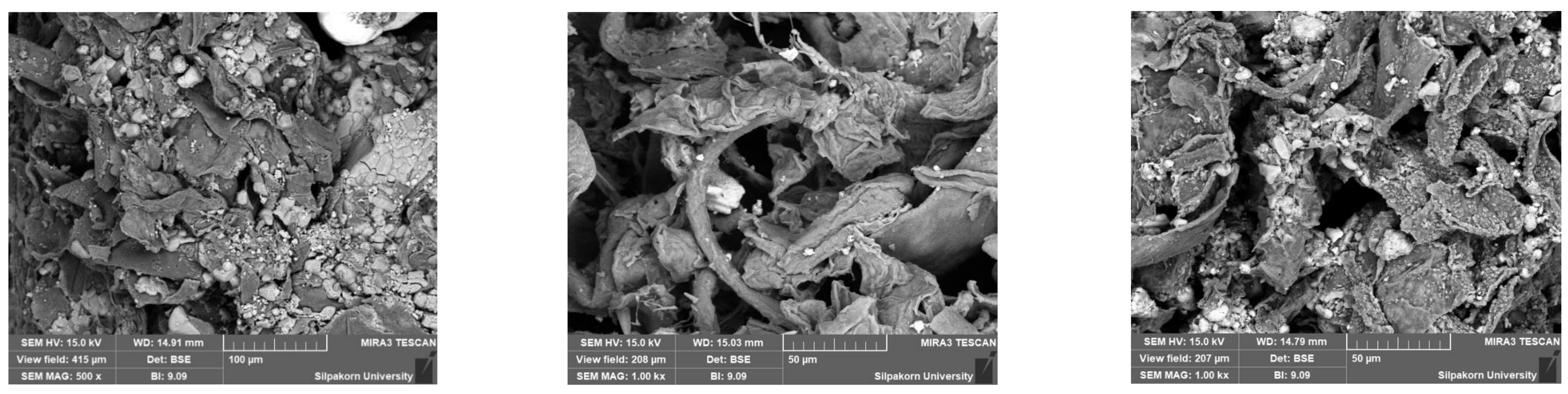

Fig. 1 SEM images of coated fertilizer with CMC at 2%, 5%, and 10% weight concentrations, captured at 500x magnification.

CONCLUSION

The behaviors of nutrient release in slow release fertilizer (SRF) are examined thoroughly. SEM images reveal that a fertilizer coated with 5 wt% CMC exhibits an effective distribution of CMC across its surface, providing a comprehensive coverage of the fertilizer. However, if the quantity is elevated, the CMC becomes aggregate, leading to a comparatively inadequate coverage of the fertilizer surface. The experimental data revealed that the fertilizer utilizing CMC and CH as coating substances exhibits advantageous slow-release characteristics. The uncoated fertilizer exhibits a water absorption value of 53.3%, while the one-coating layer fertilizer shows a value of 154.0%, and the two-coating layers fertilizer reaches 223.2%. Therefore, incorporating natural polymers can enhance the efficiency of biomass utilization, minimize nutrient loss, and optimize water use efficiency.