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Abstract

Composite Materials Based on Chitosan for Slow Release of Nitrogen–Phosphorus–Potassium Fertilizers in Agriculture †

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1. Introduction

The global food system is under increasing pressure. Therefore, the agriculture sector will be challenged to provide food security for a growing world population without harming the environment. Modern technology will also be required in agro-ecosystems to ensure sufficient food production and reduce the harmful environmental effects brought by using chemical fertilizers and the incorrect disposal or recycling of agricultural waste [1,2]. Numerous studies in the literature have focused on the development of controlled-release biofertilizers and the use of crop residues as a cover and carrier. Nitrogen (N), phosphorus (P), and potassium (K) are essential nutrients for plant growth. However, the application of these nutrients in the form of chemical fertilizers affects crops and soil [3,4]. Thus, a controlled release of nutrients is needed. As a result of this societal and environmental necessity, new composite materials with high nutrient content were developed in this study.

2. Materials and Methods

For the preparation of innovative composite materials (cryogels) with nutrient content, commercial chitosan (CC) and liquid digestate (obtained from anaerobic digestion of organic waste) were used. Other reagents included the following: acetic acid, which was used in mixture with water, for chitosan dissolution; crosslinking agent. Two series of samples were prepared, some based on chitosan being considered as reference samples. In the case of the second series, there were also nutrient-containing cryogels.

3. Results

In order to highlight the preparation of the aimed materials, several characterization techniques were needed (FTIR, SD, SEM). The FTIR spectra confirmed the incorporation of the liquid digestate into the polymer matrix by the appearance of the characteristic bands for the materials. The swelling degrees were able to determine the ideal time for the samples (with and without a liquid digestate) to resist in water. Following this study, the cryogels will be further tested on UV-Vis for the controlled release of fertilizers.

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4. Conclusions

In conclusion, new composite materials based on chitosan and liquid digestate were developed. These materials show great properties in terms of their structure, morphology, and swelling capacity, making them potential candidates for future agricultural applications as controlled release systems for NPK.

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