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USE OF STARCH-BORATE-UREA-LIGNIN FERTILIZER MATRIX FOR CONTROLLED RELEASE OF UREA

P.T.S.K. Dayananda* and A.D.L.C. Perera

Department of Chemistry, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka
**tashidayananda@gmail.com*

Controlled release fertilizers, by which nutrient release is synchronized with the plant uptake, are one approach to enhance crop production and mitigate environmental problems. Urea, the commonly used, hydrophilic nitrogen fertilizer, benefits from the concept of controlled release. In the present study, S-U-B-L fertilizer matrix was synthesized using starch (S), urea (U), borate (B) and lignin (L), for this purpose. Lignin was extracted by using coconut coir pith as the biomass source, under acid (A), alkaline (C) and organosolv (D) protocols. Lignin samples labeled as L_A, L_C and L_D, respectively, were selected as representative samples of each protocol, by FT-IR spectroscopic characterization. Lignin L_A and L_D had the highest and lowest yields of 31% and 2%, while L_C and L_A possessed the smallest and largest particle sizes, respectively. Lignin L_A and L_C with appreciable yields were used to prepare fertilizer films, S-U-B-L_A and S-U-B-L_C, respectively. In the urea release studies, lignin incorporated fertilizers showed a slower and gradual release rate of 70% within 5 hours, in contrast to pure urea, in which a burst release of 98% occurred within 90 minutes, and S-U-B, in which a fast release of 59% occurred within 75 minutes, with an overall release of 73% in 5 hours. S-U-B-L_C showed the highest efficiency with a 42% release, compared to S-U-B-L_A, which released 51%, within 75 minutes. Further, a lignin mass of 10% of the mass of starch was confirmed as the optimum content. In kinetic modeling, complete release profiles followed an exponential behaviour, while a linear function fitted the first 75 minutes of release. The FT-IR spectroscopic analysis confirmed the successful formation of the fertilizer. Powder X-Ray Diffraction confirmed the amorphous nature and Scanning Electron Microscopy revealed the surface morphology of fertilizer matrices.

Keywords: Coconut coir pith, Controlled release, Lignin, Nitrogen fertilizer, Urea