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DEVELOPMENT OF HYDROGEL-BASED PHOSPHATE FERTILIZER
CONTAINING LIGNIN ADDITIVE

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CONTAINING LIGNIN ADDITIVE**

MUHAMMAD KHAIRIL BIN MOHAMMAD NASER

**Final Year Project Report Submitted in
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ABSTRACT

Conventional fertilizers face issues such as nutrient leaching into the underground water. In addition to various environmental risks including surface water contamination and soil degradation, reduction in fertilizer application efficiency is another concern. To address these issues, controlled-release fertilizers (CRFs) could be a promising option. Hydrogel-based fertilizer has been developed with nutrient recovery capability, highlighting its potential to be further used as CRFs. This study focuses on the development and evaluation of cellulose-based hydrogel fertilizers incorporated with lignin as an additive for controlled phosphate release. The hydrogels were synthesized using carboxymethyl cellulose (CMC), micro fibrillated cellulose (MFC), and calcium carbonate (CaCO_3), with iron (III) chloride (FeCl_3) as the crosslinking agent. Lignin was incorporated at varying loadings (0, 1, 3, and 5 wt. %) to investigate its effect on the structural, swelling, and nutrient release properties of the hydrogel. The hydrogel beads were characterized using Fourier Transform Infrared (FTIR) spectroscopy, optical microscopy, and water uptake analysis. An increase in lignin loading from 1 to 5 wt.% has reduced both water absorption and phosphate release. Additionally, phosphate release was found to be pH-dependent, with higher release rates observed under acidic conditions (pH 4) compared to neutral conditions (pH 7). Overall, the study demonstrates that lignin-enhanced cellulose hydrogels hold significant potential as sustainable controlled-release phosphate fertilizers, offering improved nutrient retention and environmental compatibility for agricultural applications.

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