PÔSTER - RESUMO - MATERIAIS E BIOMATERIAIS

BIODEGRADABLE POLYMER FOR NUTRIENT DELIVERY DEVICES.

Rodrigo Ragazzi Dos Santos (rragazzi@usp.br)

Roselena Faez (faez@ufscar.br)

Enhanced efficiency fertilizers (EEFs) are devices designed to improve nutrient use by crops by minimizing the losses commonly associated with conventional fertilization practices. These systems regulate nutrient availability by introducing a physical barrier that limits direct contact between the fertilizer and the soil. However, most commercially available EEFs are composed of non-biodegradable materials, which can lead to long-term residue accumulation in agricultural soils. To promote more sustainable agriculture, it is essential that EEFs be made of biodegradable materials. In this context, biodegradable polymeric devices based on poly(vinyl alcohol) (PVA) and thermoplastic starch (TPS) were developed in two distinct proportions, 70:30 and 50:50 (PVA:TPS). The formulations were designed to combine the mechanical stability and processability of PVA with the renewable origin and biodegradability of TPS. The blends were incorporated with macronutrients (KNO3) by thermomechanical processing (Haake torque rheometer). Nutrient release was evaluated in aqueous media while biodegradation in soil was monitored over 100 days using Bartha-Pramer respirometry combined with structural (FTIR), morphological (SEM) and thermal (DSC) characterization before and after 100 days. In aqueous release assays, pure salts dissolved within minutes, whereas polymeric devices significantly delayed nutrient release. Devices containing KNO3, initial release after 30 min was limited to 20% (70:30) and 27% (50:50).

Soil biodegradation confirmed mineralization of the devices, CO_2 accumulation of KNO_3 devices showed a significant mineralization (213.5 mg, 41.2% for 70:30; 236.7 mg, 51.3% for 50:50). Higher TPS content enhanced biodegradation, confirming that device biodegradability can be modulated through composition. FTIR spectra showed a reduction in characteristic polymer bands after biodegradation, indicating that the biodegradation process generated a chemical structure modification. Micrographs revealed surface erosion and microbial colonization more pronounced in samples with higher TPS content. Thermal analysis indicated increased crystallinity after soil exposure, consistent with the preferential degradation of amorphous regions within the polymer matrix. Overall, the results demonstrate that biodegradable PVA/TPS matrices shaped into tablets can function as controlled-release systems while maintaining soil biodegradability. The comparison between the 70:30 and 50:50 ratios highlights the role of polymer composition in balancing release control and biodegradability, reinforcing the potential of these systems for sustainable enhanced efficiency fertilizer applications.

The authors would like to thank the National Institute of Organic Electronics (INEO) and the São Paulo Research Foundation (FAPESP - Processes 2024/14804-9 and 2024/08036-9).

Palavras-chave: enhanced efficiency fertilizer; poly(vinyl alcohol); starch.