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# Soy Protein Isolate and Poly(lactide acid) Biodegradable Blends for Controlled Release of NPK Fertilizer

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**Abstract** – Biodegradable blends based on soy protein isolate (SPI) and poly(lactic acid) (PLA) for controlled release of NPK fertilizers were prepared using a Haake high shear mixer. Using this straightforward strategy, the release rate of NPK from such environmentally-friendly materials could be slowed down 8 times as compared to pure NPK, thus allowing the reduction of fertilizer needed, and consequently chemical pollution. Release rates could be modulated by adjusting blend porosity trough the SPI and PLA ratio. SPI forms a ordered matrix in which PLA domains are homogenous dispersed, as revealed by SEM images.

One of the most promissory strategies to reduce losses and pollution due to excessive use of fertilizers is to develop slow controlled released systems [1]. Within this framework, the present study describes the production of soy protein isolate (SPI) and poly(lactic acid) (PLA) blends containing NPK fertilizers. The main advantage of working with biodegradable polymers from biomass is the preparation of environmentally friendly products.

SPI/PLA and SPI/PLA/NPK blends were obtained by mechanical mixture using a Haake high shear mixer. A pre-formulated mixture containing SPI, PLA, and plasticizers (water and triacetine - TA) was processed during 5 min at 165 ºC and screw speed of 90 rpm. In the case of SPI/PLA/NPK blends, the NPK fertilizer, which is a mixture of inorganic salts containing N, P, and K, was introduced into the mixer after PLA melting. Using this approach, blends containing different amounts of biopolymers (SPI/PLA (w/w) – 60/40, 70/30, and 80/20) and plasticizer (5 to 20%) were obtained.

NPK release rates were firstly investigated in water using dynamic conductivity measurements. The experiments were performed under continuously stirring during 180 h in a Becker containing 100 mL of Mili-Q water and 1.6 ± 0.2 g of the sample. The release of NPK from biopolymer blends produced an important increase in conductivity due to the presence of NPK salts in solution. However, in this case it takes 8 times longer to reach the same conductivity values of pure NPK (Figure 1(a)), corroborating the slow controlled release. The release rate could be modulated by adjusting the PLA amount in blends (Figure 1(b)). According to Tomaszewska and Jarosiewicz [2], the release rate is a function of the blends morphology, and can be controlled by blend porosity. Indeed, scanning electron microscopy (SEM) images (Figure 2) showed the formation of an ordered SPI matrix in which PLA domains are homogeneously dispersed. After etching with a selective solvent such as $CHCl_3$ (selective for PLA), porous corresponding to PLA domains were observed, whose diameter was larger for SPI/PLA - 80/20 blends (Figure 2(b)) than for SPI/PLA - 60/40 (Figure 2(a)) blends.

The herein developed approach an attractive tool for environment friendly, low coast, preparation of biodegradable materials with tunable controlled release of active molecules.

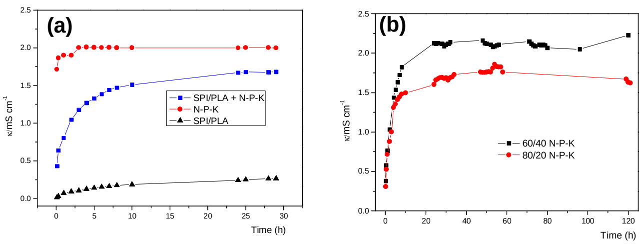


**Figure 1:** Solution conductivity during NPK release in water: **a)** SPI/PLA blends, SPI/PLA blends containing NPK, and pure NPK; **b)** SPI/PLA blends 60/40, and 80/20 with NPK.

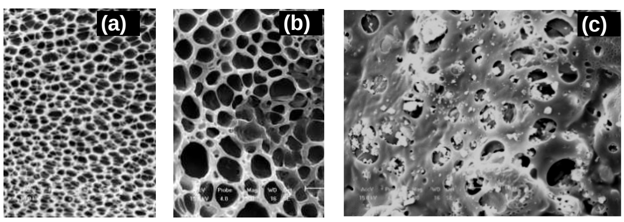


**Figure 2:** SEM micrographs of SPI/PLA blends **a)** 60/40, **b)** 80/20, and **c)** 60/40+NPK after chemical etching with $CHCl_3$ to remove PLA. Samples were fractured in transverse directions. Magnification 1000x.

**References**

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[2] M.Tomaszewska and A. Jarosiewicz. J. Agric. Food Chem. 50 (2002) 4634-4639.