GREEN CHEMISTRY EXPERIMENTS: DEMONSTRATING THE ABILITY OF A GREEN BIODEGRADABLE POLYMER TO SERVE AS AN EFFECTIVE ENCAPSULATING AGENT FOR AGRICULTURALLY ACTIVE MATERIALS FOUND IN FERTILIZERS

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Laboratory activities have a distinctive and central role in the science curriculum and science educators have concluded that many benefits arise from engaging students in science laboratory experiments. The educational experiments designed in our laboratory aim to introduce significant concepts related to “Green Chemistry” and the twelve “Green” principles in particular.

This work is centered around the preparation of a biodegradable polymer which could be used as a support for the gradual release of active nutrients to the soil.

Agrochemicals, such as fertilizers, used in conventional agriculture are notorious environmental polluters, particularly of the groundwater. Using biodegradable polymers we can achieve controlled release of fertilizers avoiding extensive leaching through the soil.

Poly(ε-caprolactone) (PCL) is an especially suited substance for encapsulating active agents because it is a green biodegradable polymer available at low cost.

PCL can be prepared by ring opening polymerization of ε-caprolactone using catalysts such as stannous octanoate. In our case ring opening polymerization was affected by microwave irradiation of the monomer (2min) in the absence of solvent and precipitation of the resulting product with ethanol.

In order to demonstrate the ability of PCL to control the release of active agents found in fertilizers such as potassium chlorides or ammonium nitrates, we prepared a system of cellulose and polycaprolactone. In particular we impregnated a piece of filter paper (cellulose) with a solution of potassium chloride or ammonium nitrate. Then after drying, we polymerized ε-caprolactone on the surface of the paper. Coated and non coated papers were immersed in distilled water and the concentrations of the released salts were determined using simple standard analytical techniques.

We concluded that the release of potassium chloride and ammonium nitrate could be controlled by a cellulose and polycaprolactone system.

In summary, the title experiment besides being “Green” by virtue of its use of non toxic reagents and microwaves, demonstrates effectively Green Chemistry principles such as the those referring to prevention of waste, use of catalysts, increased energy efficiency and to the design of the biodegradable chemicals to name the most relevant.