Preparation and properties of coatings for fertilizers solubility control

Rasa Paleckienė, Justinas Rabikauskas
Department of Physical and Inorganic Chemistry, Kaunas University of Technology,
Radvilėnų str. 19, Kaunas LT-50254, Lithuania
E-mail adress: rasa.paleckiene@ktu.lt

Introduction

One of the most popular and most common ways to control the solubility of the fertilizer is the production of coated/encapsulated fertilizers [1]. This method allows to reduce the solubility of fertilizers and increases absorption time of nutrient. The coating can be performed using various materials, but the most widely applicable and known coated fertilizers are obtained by coating with sulfur, with polymers or with layers of sulfur and polymer [2]. The rate and the mechanism of nutrient release from coated granules process depend on the nature of the coating, its thickness as well as capillary diffusion of the solvent and the solution. The most efficient technique is coating of granules with synthetic polymers, but such films usually do not decompose in the soil and causes serious environmental pollution problems because macromolecular fragments of synthetic polymer remain in the soil. Good and possible way is to produce controlled-release fertilizers (CRF) using biodegradable materials, either natural materials or biosynthetic materials from renewable raw materials [3].

The aim of is work is to explore the possibilities of application of native wheat starch coating in the production of slow-release fertilizers.

Materials and Methods

Starch is a natural polymer available in large amounts from several renewable plant sources, and it is the cheapest biopolymer and it is entirely biodegradable. Unfortunately, using starch in its native form as effective coating material is often limited due to its poor solubility, low mechanical properties and instability at high temperature and pH. Poly (vinyl alcohol) (PVA) is a water soluble, semi-crystalline, fully biodegradable and non-toxic polymer, extensively used in paper coating, textile sizing, drug release and flexible water-soluble packaging films [4].

Materials used for the preparation of composites: native wheat starch (AB „Roquette Amilina”), poly (vinyl alcohol) (TCI, $(CH_2CH)_n$, n = approx. 1700), molasses (UAB "Lietuvos cukrus") and glycerol (GLY) of analytical grade as plasticizer.

The degree of swelling and stability in different pH value and different salt solutions were evaluated [5]. Stability of the composite films was verified by instrumental (IR, STA, XRD) methods.

Conclusions

PVA films modified with wheat starch and molasses have been found to be stable to fertilizers but much more biodegradable.

A biodegradable starch / polyvinyl alcohol (PVA) blend film obtained in this study is suitable for coating the granular fertilizer has been prepared.

Results

In this work we were preparing the different formulations composite films by a solution-casting method.

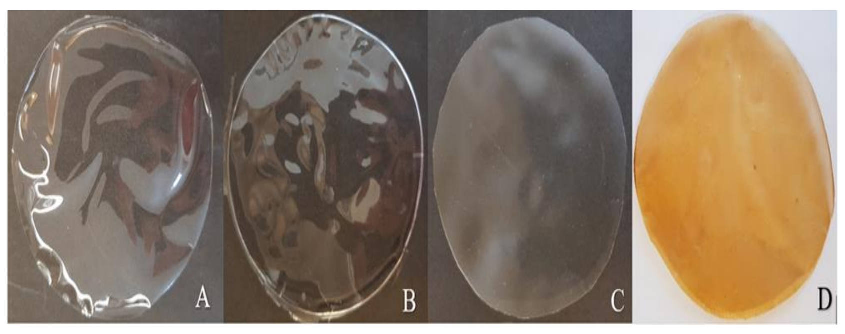

Fig. 1. PVA films prepared with different modifying additives: A – only PVA; B – PVA + glycerol; C – PVA + glycerol+ starch; D — PVA + glycerol + starch + molasses

The properties of different formulations obtained by modifying ratio of starch, glycerol and PVA were also investigated.

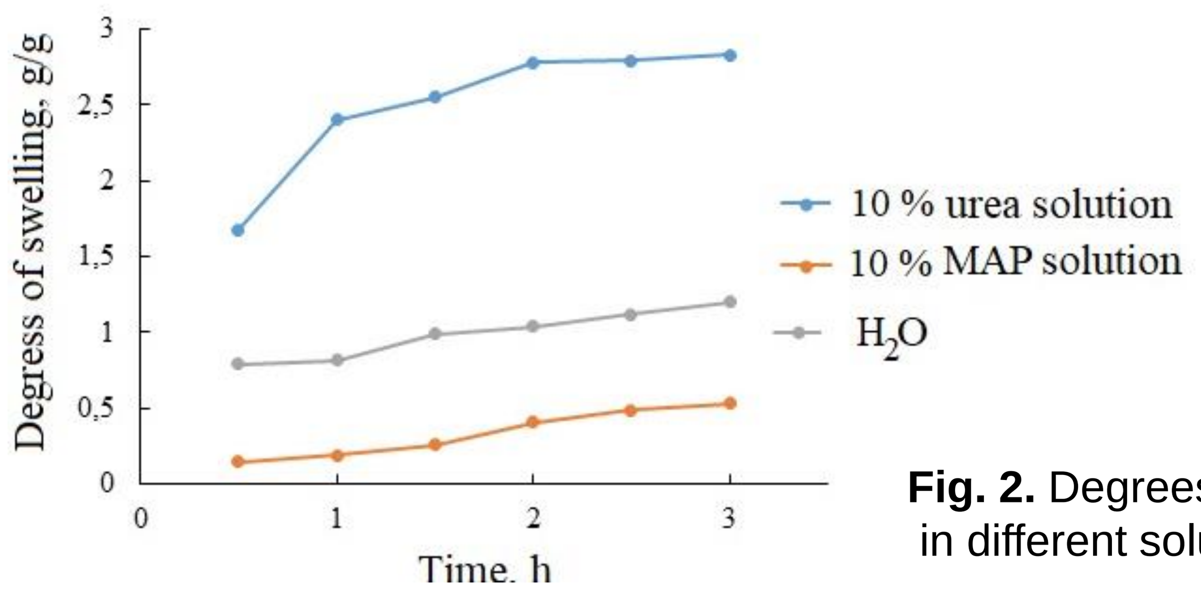

Fig. 2. Degrees of swelling of film in different solutions

The impact of the coating on urea solubility was also estimated. Films thickness directly influences the nutrient release rate. Experimentally it was found that the addition of starch to the PVA film prolongs the release time of nutrients up to 3 days.

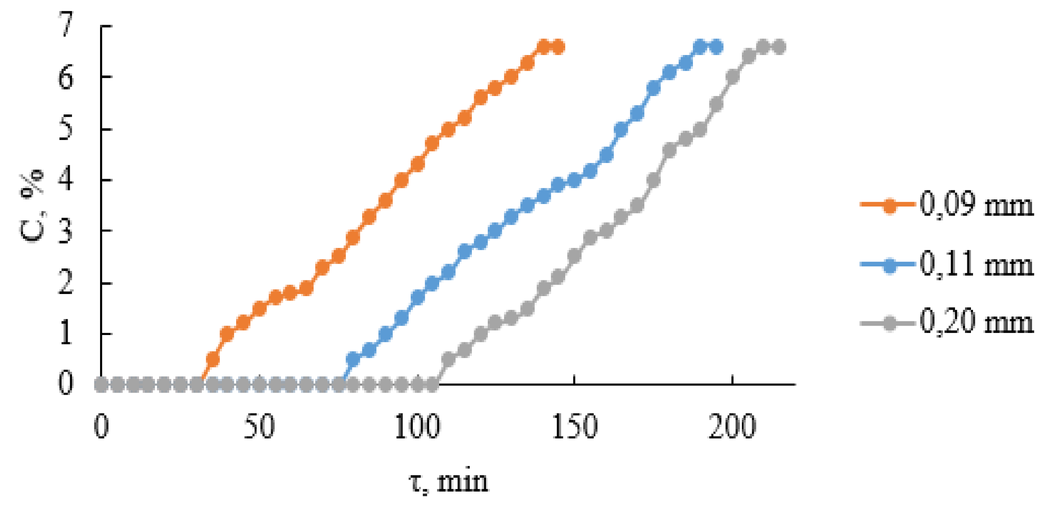

Fig. 3. Dependence of urea dissolution rate (concentration change in solution) on film thickness using composite (PVA + glycerol + starch + molasses) film coating

Stability of the composite films was verified by instrumental (IR, STA, XRD) methods. Studies of the biodegradability of composite films were performed in different soils at different moisture contents.

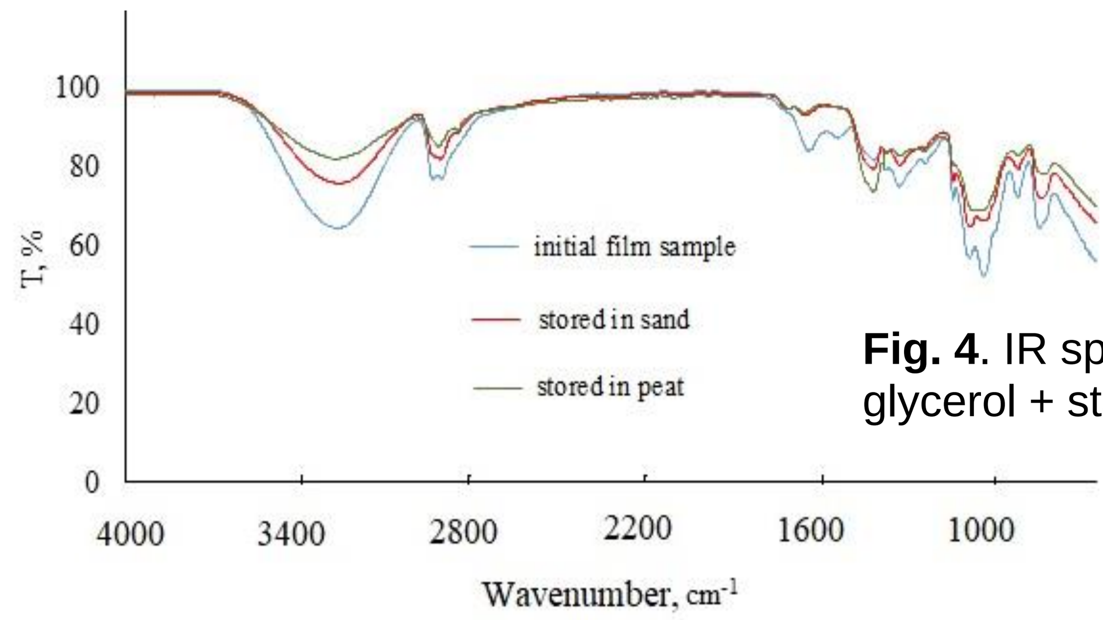

Fig. 4. IR spectra of composite (PVA + glycerol + starch + molasses) film

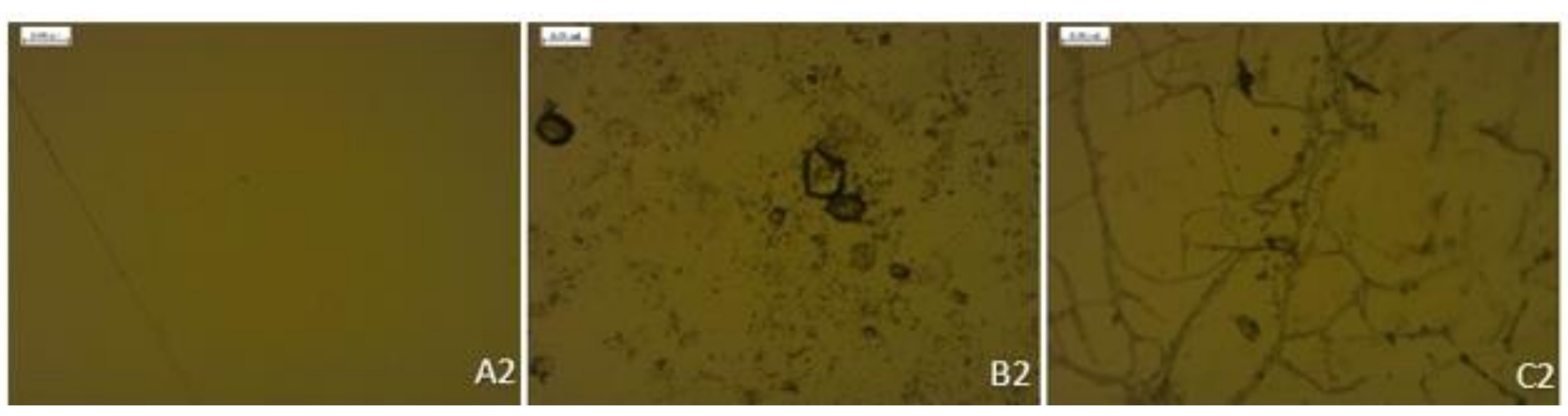

Fig. 5. Photos from optical microscope: initial composite (PVA + glycerol + starch + molasses) film (A2); sample stored in sand (B2), stored in peat (C2) for 32 days