Preparation of hydrogel capsules as macro and microelements carriers

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Deficiency of macro- and microelements in the soil and plants is a global problem. The use of fertilizers improves soil fertility, but also has a destructive impact on the environment (Fig. 1). Traditional agrochemicals dissolve well in water. Plants are not able to absorb them in large amounts because they are leached into the ground water. Reducing environmental risks by adapting farming practices to the needs of the crop (appropriate dose and timing of nutrient release) is a challenge for modern agriculture (Chen *et al.*, 2018).

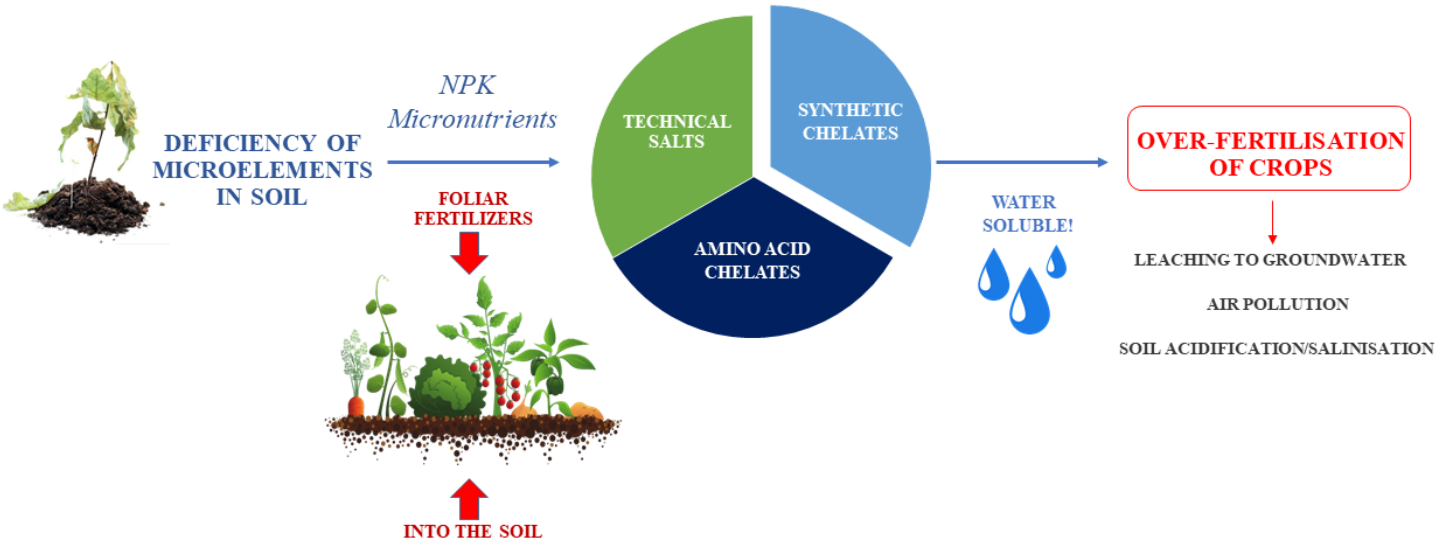

Fig. 1. The impact of traditional fertilizers on the environment.

In recent years, research has focused on increasing the efficiency of fertilizers in environmentally responsible manner. The use of biopolymer hydrogel structures as carriers of nutrients can be a potential solution for agriculture (Abobatta, 2018). Polysaccharides such as alginate or chitosan are commonly used for capsule preparation because they are cheap and biodegradable (Liew *et al.*, 2006). An additional advantage is the ability to absorb water into the hydrogel matrix, which further reduces the negative effects of hydrological drought on the crop fields.

Innovative solutions should be introduced in the agri-food sector due to the largest amounts of generated waste and the negative impact of mineral fertilizers on the ecosystem. Biowaste, especially food and crop waste, is a source of valuable nutrients and can be used as nutrient carriers materials (Skrzypczak *et al.*, 2020).

Hydrogel structures are characterized by a controlled release of substances from their matrix, which means that water and nutrients can be transferred to the soil at a rate adjusted to the needs of plants (Saruchi *et al.*, 2019). The mechanical properties of hydrogels can be improved by introducing additional substances, i.e. carboxymethyl cellulose or starch. Such biocomposites are excellent carriers of microelements due to the high availability of functional groups that are able to bind these ions. Immobilization of biomass in the polymer matrix increases the sorption capacity of the structure (Skrzypczak *et al.*, 2019).

This paper presents the production of hydrogel composites enriched in NPK and microelements. Different types of capsules (with immobilized waste biomass and variable nutrient composition) were produced using various crosslinking agents. Physicochemical properties of the structures and their sorption capacity were investigated. Considering the potential use of hydrogels in precision agriculture, the rate of nutrient release from the composites was studied.

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