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Composite fertilizers produced from the alum sludge: combining a waste with a biodegradable material for agricultural application

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Composites produced from biodegradable matrices have been highlighted as a sustainable strategy to increase the fertilization efficiency and reducing nutrient losses. Thermoplastic starch (TPS) is a common polysaccharide biopolymer widely used to develop this type of material due to its low cost and high biodegradability. Combining TPS with fertilizer formulation promotes nutrient release through the degradation and dissolution of the fertilizer. Moreover, it increases the matrix's flexibility, allowing it to be molded into various shapes, which facilitates the production of granules. Water treatment plants (WTP) produce tons of alum sludge (AS) during the water treatment process. The chemical composition of this waste makes it a promising raw material for the development of zeolite materials. In this work, we developed a composite fertilizer using TPS, urea (as a plasticizer and also as N source) and zeolite synthed from AS using alkaline medium and autoclave treatment. Alum sludge from Hortolândia - SP WTP was used as Si and Al source. Sodium silicate was added to improve cristalization process. The obtained zeolite material, sodalite (SOD-Na), underwent a cation exchange procedure to become SOD-K. This process enriches it with K⁺ ions, contributing to the nutritional value of the material. SOD-K was then used to prepare composites with the final composition of 70% solids (50g SOD-K, 40g TPS and 12g urea) and 30% desionized water. After mixing to obtain a homogeneous material, the formulation was processed in a silicone mold, dried at room temperature, and then characterized using various techniques. The fertilizer composite was evaluated for its potential to achieve controlled-release of K⁺ ions and to control nitrogen losses related to ammonia volatilization. Additionally, it was assessed for its potential to control plant pathogens through the addition of microorganisms.

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