International Journal of Biological Macromolecules 280 (2024) 135616

Contents lists available at ScienceDirect

International Journal of Biological Macromolecules

journal homepage: www.elsevier.com/locate/ijbiomac

Fabrication of carboxymethyl tamarind kernel gum-based hydrogel and its applicability in different types of soils for agronomy

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ARTICLE INFO

Keywords:
Agronomy
Biopolymer
Hydrogel

ABSTRACT

An avant-garde agricultural hydrogel - Carboxymethyl tamarind kernel gum-poly sodium acrylate-polyacrylamide hydrogel was designed by free-radical polymerization of biopolymer: carboxy-methyl tamarind kernel gum and monomers: sodium acrylate, acrylamide, using N,N′ methylene bisacrylamide as crosslinker and potassium persulphate as initiator, to explore its application as a soil conditioner. It was characterized by Fourier transform infrared spectroscopy, scanning electron microscopy, and thermogravimetric techniques. Swelling was investigated at different pH and in saline solutions. The fabricated hydrogel absorbed 189 ml/g of distilled water. Minimal 0.1 % hydrogel-amended different soils unveiled an upswing in maximum water holding capacity: Sandy soil (43%), Clay soil (31 %), Silty soil (29 %) & Loamy soil (9 %).; decrease in porosity: Sandy (29 %) > Loamy (15.2 %) > Silty (6 %) > Clay (5.9 %), increase in available water content: Clay soil (17.52 %), Silty (13.45 %), Loamy soil (9.416 %), Sandy soil (10.375 %); increase in bulk density: Clay (1.7 %), Silty (5.3 %), Loamy (10 %) and Sandy (13%) as compared to control sample. These sequels were corroborated by water retention capacity in chickpea plants. The designed hydrogel, as a soil conditioner, was commendable in all types of soils but is worth applying in sandy and loamy soils. This hydrogel richly assists as a soil conditioner and boosts plant performance in a green eco-friendly way.

1. Introduction

The global subsistent economy is directly related to the availability of food for all. The major agricultural input is water. So, higher food production stirs up the challenge of using the available water intelligently with little or no wastage. Research involving a shift to more water consumption and less water wastage during crop practices is the need of the present time. Besides resolving the agricultural water challenges, such research needs to focus on ensuring that no toxicity is introduced into the environment. To achieve the above targets in agriculture, many synthetic and hybrid hydrogels have been fabricated. As synthetic hydrogels impose a permanent waste generation, many biopolymers have been employed till date for the fabrication of hydrogels to be employed in agricultural procedures viz. carboxy-methylated tamarind kernel gum (CMTKG) [1], chitosan [2,3], starch [4], alginate [5], cellulose [6,7], guar gum [8], etc. The CMTKG-based biomatrices have been applied a little in this arena [9]. Therefore, the present research involves the synthesis of hydrogel with the major feedstock being carboxy-methylated tamarind kernel gum (CMTKG), which is apropos, as the hydrogel produced can be efficiently applied in agriculture as a soil water conditioner and is safer for the environment. The usage of natural biopolymer-CMTKG enhances the degradation capability, besides being non-toxic, easily accessible, biocompatible, and economical [10].

Biopolymers-based matrices have been employed in the agricultural field for various purposes such: as a soil conditioner [11], as a supplement of nutrients [2], micronutrients [11], and for wastewater purification to be employed as irrigation water [12] [13]. The present work implies the usage of hydrogel as a soil water conditioner.

Another area of concern demands urgent consideration to upgrade the productivity of less productive soils viz. the sandy soil and loamy soil [14] for sustainable and increased agronomical production required due to the increased global populace. These soils have a high infiltration rate due to high porosity. They are not able to retain the water, lowering the amount of available water content to the plants and hence leading to stagnant growth and diminished crop yields of the crops grown in them. The need for arable soils necessitates research in the development of innovative soil-conditioner alternatives that can serve as consistent

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https://doi.org/10.1016/j.ijbiomac.2024.135616
Received 25 February 2024; Received in revised form 9 September 2024; Accepted 12 September 2024
Available online 13 September 2024
0141-8130/