Guar gum, a versatile natural polymer to improve human health and water quality

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Background

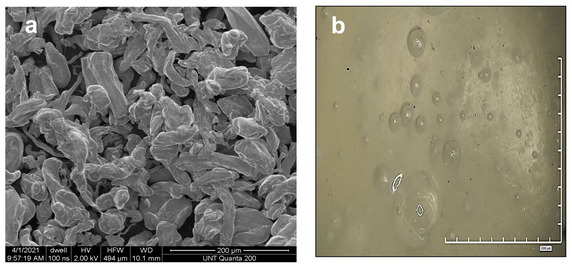
Humans are constantly exposed to hazardous chemicals present in water, air, food, and soil which can lead to a multitude of negative health impacts. Advanced materials can play a key role in preventing these impacts and biocompatible hydrogels prepared from natural polymers have gained popularity in recent years as high-performance materials for environmental contaminant remediation, drug delivery, and tissue engineering. Hydrogels possess three-dimensional network structure and can easily absorb and retain water. Guar gum (GG), a natural non-ionic, hydrophilic, abundant low-cost polysaccharide is an excellent candidate for gel fabrication. Dye-contamination in water supplies due to industrial effluents is one of the major water pollution issues and continues to be a significant public health concern given their potential toxicity to humans under acute or prolonged exposures. As a result, the development of technologies capable of removing organic contaminants especially industrial dyes like Malachite green (MG), Crystal violet (CV), Congo Red (CR) etc. has drawn the attention of numerous researchers So, it is imperative to develop ecofriendly multifunctional hydrogels which can positively impact human health by preventing exposure to environmental pollutants and making them suitable for injectable drug delivery. In our study, we report the development of cost-effective ecofriendly Guar Gum based hydrogel which displayed remarkable toxic dye removal property, self healing property and injectable property.

Objective

- Facile and Fast Synthesis of Guar Gum based hydrogel (GG)
- Evaluating the performance of newly developed hydrogel for the remediation of industrial dye -Malachite Green (MG)
- Study of Injectable property of GG hydrogel
- Study of Self Healing Property of GG hydrogel

Preparation of Guar Gum-based Hydrogel

Characterization of GG hydrogel

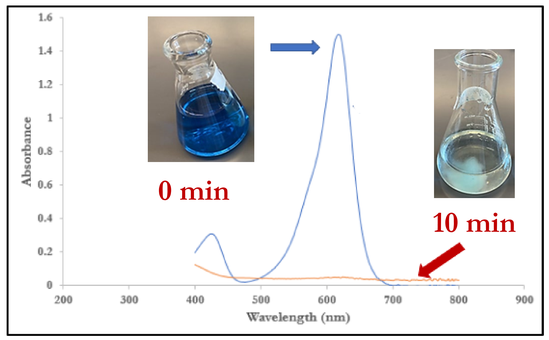


SEM Images of (a) raw GG powder (b) GG Hydrogel

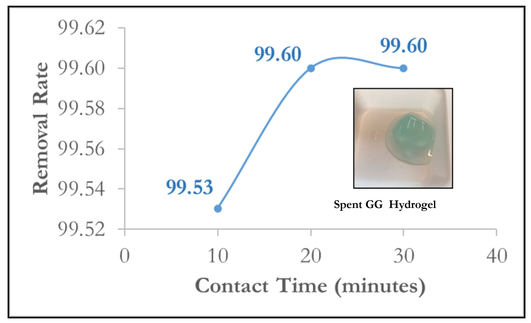
Adsorption Property of GG Hydrogel

Application:

Wastewater purification-Removal of organic dyes from waste stream

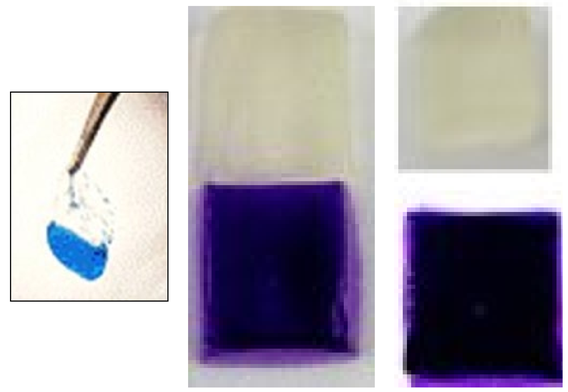


UV-VIS spectra of MG dye before and after adsorption by GG hydrogel at different time



Removal Rate of MG dye from wastewater using GG hydrogel at three different contact time

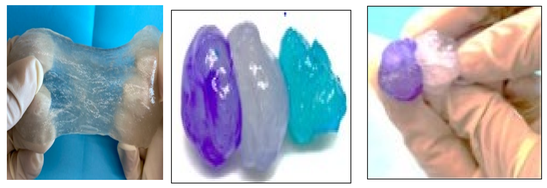
Self Healing Property of GG Hydrogel



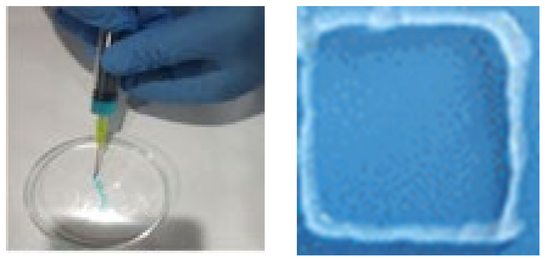
Cut and Heal Test

Application:

Flexible, wearable, and 3D-printable electronic skin and strain-sensitive sensors.



Injectable Property of GG Hydrogel



Syringe injection to produce different shapes

Application:

Drug Delivery
Tissue Engineering

Results and Conclusions

- Low-cost abundant GG derived hydrogel was prepared in 15 minutes by facile ecofriendly method using a non-toxic crosslinking agent.
- Hydrogel exhibited outstanding removal capabilities for organic dye - Malachite green (MG).
- Removal of MG dye by GG hydrogel was ~99.6 %.
- The hydrogel showed an excellent self healable property which can be applied in health monitoring.
- The GG hydrogel exhibited injectable property which can be used in drug delivery.

References

- Mandal et al. (2022). International Journal of Biological Macromolecules, 226, 368-382
- Mandal et al. (2022). Surfaces and Interfaces, 29, 101797.
- Mandal et al. (2021). Journal of Contaminant Hydrology, 243, 103869.

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