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Hybrid Materials Based on Chitosan as Textile Dye Adsorbents

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Introduction

Chitosan is a synthetic form of a naturally occurring cationic polysaccharide. Chitosan and its hybrid materials are utilized in a variety of industrial sectors due to their extensive range of biochemical and physical properties. The food chain is impacted by dyes and other industrial effluents, which also have the potential to cause toxicity, mutagenicity, and carcinogenesis. Textile dyes increase biochemical and chemical oxygen demand (BOD and COD), decrease photosynthesis, and affect the quality of water bodies. Dye removal must be accomplished using biobased, phyto-remediation, or physicochemical methods. There are numerous drawbacks to each of these dye degradation methods. Because it is biocompatible, biodegradable, less toxic, and good for the environment, chitosan and modified chitosan-based materials have received a lot of attention over the past few decades. However, its attractive properties depend on its ability to adsorb dye effluents and other heavy metals in a variety of ways and form links with the sulfonic groups of anionic dyes through the electrostatic force of attraction. This audit features the properties and changes of chitosan by means of (I) crosslinking; (Surfactant impregnation and graft copolymerization have been described for the creation of hybrid materials based on chitosan with improved dye sorption properties. The smart degradation of textile dyes and effluents using chitosan nanostructures, which are the subject of research, has also been the subject of discussion. Researchers can use chitosan-based composites or blends to remove a wide range of dyes and dye-based effluents thanks to this review, which sheds light on the adsorbents based on chitosan.

Description

Macromolecules like polymers are ubiquitous in nature and play a variety of roles in everyday life. There are two main types of polymers: (i) biobased (such as chitin, chitosan, silk fibroin, keratin, starch, etc.), and (ii) synthetic polymers like polyethylene terephthalate, polypropylene, and so on. Biobased polymers are environmentally friendly, economical, non-toxic, and biodegradable from them. They can be used for a variety of things, especially in conventional coatings and for targeted transport of active drug molecules for long-term release. Cellulose and chitin are important biomass resources produced by lower animals and the most abundant natural polymers on the planet. Deacetylation is the process by which chitin is used as a raw material to produce chitosan. Demineralization, deproteinization, and decolorization are the most important steps in this conversion. Chemical or biological methods (fermentation and/or enzyme-based treatment) are used to complete each of these steps. Chitosan is a naturally occurring natural polysaccharide that is bioactive, cationic, and produced when glucosamine and N-acetylglucosamine subunits are linked together via (1–4) linkages FTIR spectroscopy is the primary method used to classify chitosan based on the rate of deacetylation.

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An essential step in comprehending the potential applications of polymers, particularly in biological systems, is determining their molecular weight. The viscosity of chitosan is influenced by a number of variables, including the degree of deacetylation, molecular weight, ionization, and pH. The chitosan solution typically loses viscosity as the temperature rises. Chitosan is insoluble in water and other natural solvents yet can be broken down in specific natural acids (i.e., acidic corrosive and formic corrosive). Chitosan is used for a variety of functional biomedical and industrial biotechnological applications because of its unique physicochemical properties. Figure depicts the extraction of chitin from natural resources and its transformation into chitosan. one with a few important characteristics [1,2].

Bio- and/or nanohybrid materials based on chitosan can now be developed for potential uses in antimicrobial packaging, corrosion protection, and the removal of toxic metal ions. Chitosan has been combined with a wide variety of other polymers to accomplish this, including poly (methyl-methacrylate), polycarbonate, polyaniline, polysulfide, and polystyrene. Chitosan composites and blends can be used in a variety of technical fields, including membrane technology, biosensors, antimicrobial and biomedical materials, packaging, and the textile industry. These composites and blends have improved material properties like morphology, surface area, electrical conductivity, mechanical strength, photoluminescence, and bioactive properties. This review also discusses the potential uses of chitosan and its hybrid materials, such as composites and blends, as tools for the adsorption and degradation of toxic chemicals (dyes) and heavy metal ions from textile industrial effluents [3-5].

Conclusion

Textile dyes, along with a wide range of industrial pollutants, are linked to environmental contamination and animal deaths . As a result, the fish gills can absorb the heavy metal ions if they are released into the aquatic ecosystem, allowing them to aggregate in some tissues. As a result, they can enter human organs and cause a number of health issues via the food chain. Which can be fused to the plasma membrane and is frequently utilized in the textile industry, is able to integrate with the helical DNA structure. By acting as a significant reversible antagonist of monoamine oxidase A, an intracellular CNS enzyme, this chemical can reveal cytotoxicity. The textile industry frequently makes use of the dyes disperse red 1 and basic red 9, which have the potential to cause mutations. The effects of textile colorants, particularly those in the azo and nitro forms, can be seen over time. During anaerobic conditions, this turns into cancer-causing aromatic amines, and their degradation in water bodies causes allergic dermatitis, skin inflammation, mutagenesis, and the growth of tumors. The highly mutagenic and carcinogenic effects of dye effluents, such as chromosomal aberration in plants, humans, and aquatic animals, have been summarized in a number of studies. Other than these, environmental toxicity and inhibiting plant growth by lowering the quality of the soil have also been reported.

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