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Application of Guar Gum based Polymers in Drug Removal from Waste Water

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Abstract: Biodegradable polymers have unique properties hence find use in different fields like medicinal, agricultural, industrial, environmental field etc. They lead to zero waste therefore known as speciality materials. Biopolymer guar gum can be extracted from the seeds of the plant *Cyamopsis tetragonoloba*. It is a biopolymer consisting of β , 1-4-linked linear mannose chain interposed with α , 1-6-linked galactose units. Guar gum consists of no. of hydroxyl functionalities which give of hydrogel character by the interaction with water molecules through hydrogen bonding. Guar gum is used in various industries for the removal of hazardous dyes. The dye removal studies were performed with respect to contact time, temperature, pH and dye feed concentration removal. This review will help the future researchers who are working on the environmental solutions based on biopolymers.

Keywords: Guar gum, grafting, dye adsorption.

I. INTRODUCTION

Naturally many polymers are present which can be taken as biopolymers such as cellulose, dextran, starch, guar gum [1]. Guar gum comes under the family of leguminous and obtained from the seed pericarp of *Cyamopsis tetragonoloba*. Generally, guar gum is also called as cluster bean [2]. Guar gum has a very well thought-out structure consists of linear chain having β , 1-4-linked linear mannose chain interposed with α , 1-6-linked galactose substituted at almost every residue point [3]. Guar gum has a broad range of application in pharmaceutical like textile, cosmetic, food industries [4]. The solubility of Guar gum is insoluble in hydrocarbon, fat, alcohol, ester and ketone [5]. It is extremely thixotropic having higher than adsorption of 1% [6]. Complete hydration logically occurs for about 30 minutes, depending on training. Maximum thickness is achieved at 25-40 °C. Thickness is not influenced by pH in pH 1.0-10.5. It is unspecified to be since because of this nature non-ionic uncharged molecules [7].

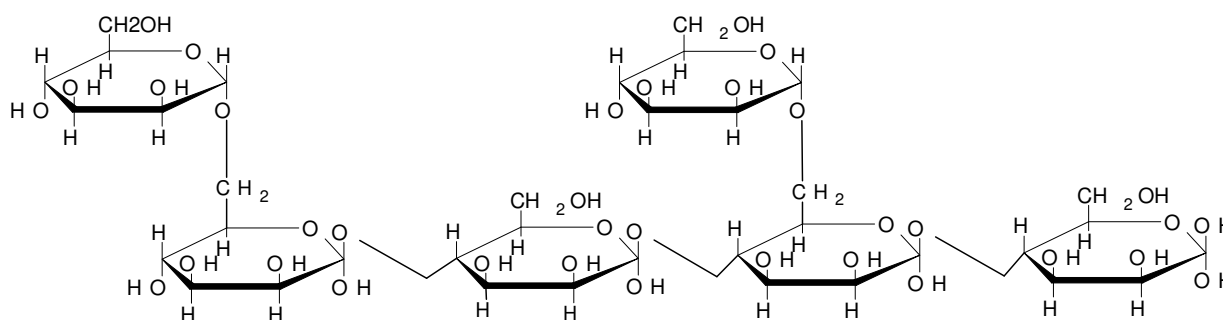


Fig 1: Structure of Guar gum

Hydration speed although maximum hydration rate is at pH 8-9, even as the minimum hydration rate is at pH >10 and pH <4. Though guar gum is non-ionic, it is not unsusceptible to salting out. Though guar gum is non-ionic, it is not unsusceptible to salting out. The dependability of guar gum solution is fine with mono-, di-, and trivalent ions with the thickness increases through increasing attentiveness of salt. Thickness decreases with growing attention of sugar. In literature serve it has proved that guar gum removed many dye like methylene blue, congo red. Now a day's modified Guar gum derivatives are used in the field of medical devices and bio-imaging also which is quite a challenging area for application [8]. Different types of guar gum derivatives were developed for the better applications as per the industrial needs with water builders, Thickness, emulsifiers, stabilizers, and charge carrier flocculent applications [9]. Biopolymers by cationic derivatives have the applications in shampooing [10]. Guar gum can be used in free form or in combined form.

II. DYE REMOVAL BY THE PURE GUARGUM:

The removal of dye by Guar gum is very helpful technique or method to remove toxicity from the water. Guar gum generally removes many dyes in which the adsorption or desorption of harmful particles in aqueous solution [11]. Many new methods or techniques are used to remove the harmful adsorption of water particles with the help of Guar gum. When Guar gum is mixed with the water having dye solution contents, guar gum make bond with the particles and make a bond with the harmful particles with makes waters polluted. There are many dyes which removal by Guar gum [12].

Table I.Literature survey on the Removal of Dye by Guar gum

S. No	DYE	BIO POLYMER	APPLICATIONS	REF.
1	Malachite Green dye	Guar gum	Malachite Green dye adsorption starts after 24hr under time taken with maxi. 6.4 pH solution.	13
2	Crystal violet dye	Guar gum	Maximum temperature taken is 273K at pH 7.6.	14
3	Reactive blue/Congo red Dye	Guar gum	The batch experiment results showed that at pH 3 and contact time 30 min.Temperature 318K maximum dye was adsorbed.	15
4	Methylene blue	Guar gum	Hydrogel adsorb showed best results at pH 7.4, room temperature and 6 h contact time.	16
5	Methylene blue/methyl violet	Guar gum	The maximumdye adsorption occurs at 6h contact time and pH 2.9.	17
6	Methylene red	Guar gum	Nano compositeform hydrogen bonding with the solvent and showed maximum dyeadsorption at pH 7.4 and room temp.	18
7	Methylene Blue	Guar gum	Guargum based hydrogel adsorb methylene blue from waste water at pH 9.9 and 4h contact time.	19
8	Methyl red	Guar gum	Guargum give best results for adsorption at pH 7.9.	20
9	Azo dye	Guar gum	Maximum dye adsorbed by the hydrogel in 24 h contact time.	21

III. DYE REMOVAL BY MODIFIED GUAR GUM

After the modification of Guar gum the nature and the adsorption of harmful dye solution content capacity also increases [22]. Many literatures survey take part of technique to modify Guar gum using different technique [23]. Biopolymers form hydro gel by deficient amount of adsorption of dye from water which affects the purity. This removal of dye by modified Guar gum can be done on different dye solution which pollutes the water. Different dye solution takes different free radical with guar gum for the removable of dye from water [24]

Table II. Literature Survey on Removal of DYE by Modified FORM OF GUAR GUM

S. No	Dye	Backbone	Modified technique	Application	Ref.
1	Anionic dye (RB,CR)	Guar gum	Graft co-polymerization	Hydrogels give maximum adsorption at 4hr, pH 10.	25
2	Malachite green	Guar gum	Block co-polymerization technique	Maximum dye adsorption occurs within 24h time and 7.7 pH.	26
3	Crystal violet dye	Guar gum	Blockco-polymerization technique	Highest adsorption took place at 6h contact time.	27
4	Violet dye	Guar gum	Alternate co-polymerization Technique	Maximum adsorption was reported in 6h time and room temp.	28
5	Congo Red, Reactive blue dye	Guar gum	Graft co-polymerization technique	Optimum adsorption was reported in 24h and pH 9.4.	29
6	Cationic Dye	Guar gum	Block co-polymerization technique	Maximum adsorption of dye occurs at 9.0 pH and 7 h contact time.	30
7	Voilet Dye	Guar gum	Graft co-polymerization technique	Hydro gel gives maximum adsorption in 24h and 35° C temperature.	31

IV. REMOVAL OF DYE BY GRAFT CO-POLYMERS OF GUAR GUM:

Graft co-polymers of guar gum have been synthesized by using different solution using polymerization techniques. Graft co-polymerization technique can done using different variation [32]. Modification by grafting onto guar gum can be done using different variation different monomer, pH, Temperature [33]. With the help of Graft co-polymers Dye adsorption by guar gum can done easily and give finite result with less time taken. The hydro gel formation of Guar gum gives maximum formation of the sample when dye is generally adsorbed [34]. Mainly grafting techniques is the best and easiest way to get good result by using grafting onto guar gum [35].

Table III. Literature survey on Removal OFDYE Bygraft Copolymers of GUAR GUM:

Sr. No	Dye	Backbone	Monomer	Application	Ref.
1	Methylene blue	Guar gum	AM/PA M	Maximum adsorption of dye with 7.0 pH dye solution with 24hr time taken.	36
2	Congo red Dye	Guar gum	HEMA	Dye adsorption value gives its finest result with time 4hr and pH 6.4 solutions.	37
3	Methylene blue	Guar gum	AA	Dye adsorption value gives its finest result with time 6hr with pH 2.	38
4	Reactive blue, Congo red	Guar gum	AA	The dye adsorption value gives its maxi. Adsorption with 4.48 pH solution or temp.318K, 40min.	39
5	Congo red	Guar gum	Poly-AA	The dye adsorption value gives its maxi. Adsorption with 7 pH solution or temp. 30 min.	40

The removal of Bismarck brown dye by graft co-polymers Guar gum is a novel work. This dye is helpful for removal of toxicity from the water by hydrogel formation of Guar gum using grafting technique.

V. DYE ADSORPTION STUDY

The adsorption of BB Y azo dye by guar gum and its graft copolymers was studied by the batch experiments. Different concentration of BB Y dye solution were prepared with de-ionized water at different ppm solution was scanned on Double beam UV-Vis spectrophotometer (shimadzu-1900) for λ_{max} which comes out to be $\lambda_{max} = 463nm$. The calibration curve is grafted for the various concentration solution of BB Y dye at $\lambda_{max} = 463nm$ to verify Beer's law. After specific time intervals, dye solution aliquots were withdrawn and the concentration of the remaining dye was determined at the characteristic wavelength ($\lambda_{max} = 463nm$ Bismarck brown dyes, respectively) with the help of UV spectrophotometer. Once the effect of variation of contact time was studied than at optimum contact time effect of temperature, pH and dye feed concentration were studied. Dye adsorbed (qt) and percent dye uptake (De) were calculated as:

$$Qt = \frac{C_0 - C_t}{W_d} \times V$$

$$De = \frac{C_0 - C_t}{C_0} \times 100$$

Where, C_0 = Initial dye concentrations, C_t = Dye concentrations in the solution after time's', V = Volume of the dye solution and, W_d = Weight of adsorbent taken. Using it with different behaviour of guar gum when react with different time, temperature, pH solution.

VI. CONCLUSION

From this review paper it can be concluded that guar gum could be modified to form guar gum based hydro gel using different modification technique of graft co-polymers. Graft co-polymerization technique is the easiest and best technique to modify guar gum. Guar gum is a biopolymer which helps in different fields and can easily adsorb. Guar gum can easily contact with different dye and give different adsorbed value by using dye adsorbed formula. This dye adsorbent value tells us about the different behavior of guar gum by testing it with different time, pH and temperature solutions.

REFERENCES

- [1] Gupta, A. P., & Verma, D. K. (2014). Guar gum and their derivatives: a research profile. Int. J Adv. Res, 2(1), 680-690.
- [2] Hymowitz, T. The trans-domestication concept as applied to guar. Econ. Bot. 1972, 26, 49-60.

- [3] Robinson, G., Ross-Murphy, S. B., & Morris, E. R. (1982). Viscosity-molecular weight relationships, intrinsic chain flexibility, and dynamic solution properties of guar galactomannan. *Carbohydrate Research*, **107**(1), 17-32.
- [4] Wade, C. (1973). U.S. Patent No. 3,715,247. Washington, DC: U.S. Patent and Trademark Office.
- [5] Tripathy, S., & Das, M. K. (2013). Guar gum: present status and applications. *Journal of pharmaceutical and scientific innovation*, **2**(4), 24-28.
- [6] Ghosh, S. K.; Abdullah, F.; Mukherjee, A. Fabrication and fluorescent labeling of guar gum nanoparticles in a surfactant free aqueous environment. *Mater. Sci. Eng. C* 2015, **46**, 521-529.
- [7] Schneider, R., & Sostar-Turk, S. (2003). Good quality printing with reactive dyes using guar gum and biodegradable additives. *Dyes and Pigments*, **57**(1), 7-14.
- [8] Rana, V., Rai, P., Tiwary, A. K., Singh, R. S., Kennedy, J. F., & Knull, C. J. (2011). Modified gums: Approaches and applications in drug delivery. *Carbohydrate Polymers*, **83**(3), 1031-1047.
- [9] Tripathy, S.; Das, M. K. Guar gum: present status and applications. *J. Pharm. Sci. Innov.* 2013, **2**, 24-28.
- [10] Hössel, P.; Dieing, R.; Nörenberg, R.; Pfau, A.; Sander, R. Conditioning polymers in today's shampoo formulations - efficacy, mechanism and test methods. *Int. J. Cosmet. Sci.* 2000, **22**, 1-10.
- [11] Sharma, R., Kaith, B. S., Kalia, S., Pathania, D., Kumar, A., Sharma, N., ...& Schauer, C. (2015). Biodegradable and conducting hydrogels based on Guar gum polysaccharide for antibacterial and dye removal applications. *Journal of environmental management*, **162**, 37-45.
- [12] Makhado, E., Pandey, S., Nomngongo, P. N., & Ramontja, J. (2018). Preparation and characterization of xanthan gum-cl-poly (acrylic acid)/o-MWCNTs hydrogel nanocomposites as highly effective re-usable adsorbent for removal of methylene blue from aqueous solutions. *Journal of colloid and interface science*, **513**, 700-714.
- [13] Pathania, D., Katwal, R., Sharma, G., Naushad, M., Khan, M. R., & Ala'a, H. (2016). Novel guar gum/Al₂O₃ nanocomposite as an effective photocatalyst for the degradation of malachite green dye. *International journal of biological macromolecules*, **87**, 366-374.
- [14] Ahmad, R., & Mirza, A. (2018). Synthesis of Guar gum/bentonite a novel bionanocomposite: Isotherms, kinetics and thermodynamic studies for the removal of Pb (II) and crystal violet dye. *Journal of Molecular Liquids*, **249**, 805-814.
- [15] Pal, S., Patra, A. S., Ghorai, S., Sarkar, A. K., Mahato, V., Sarkar, S., & Singh, R. P. (2015). Efficient and rapid adsorption characteristics of templating modified guar gum and silica nanocomposite toward removal of toxic reactive blue and Congo red dyes. *Bioresource technology*, **191**, 291-299.
- [16] Gupta, V. K., Pathania, D., Singh, P., Kumar, A., & Rathore, B. S. (2014). Adsorptive removal of methylene blue by guar gum-cerium (IV) tungstate hybrid cationic exchanger. *Carbohydrate polymers*, **101**, 684-691.
- [17] Ghorai, S., Sarkar, A., Raoufi, M., Panda, A. B., Schönherr, H., & Pal, S. (2014). Enhanced removal of methylene blue and methyl violet dyes from aqueous solution using a nanocomposite of hydrolyzed polyacrylamide grafted xanthan gum and incorporated nanosilica. *ACS applied materials & interfaces*, **6**(7), 4766-4777.
- [18] Saxena, R., & Sharma, S. (2016). Adsorption and kinetic studies on the removal of methyl red from aqueous solutions using low-cost adsorbent: guar gum powder. *International Journal of Scientific Engineering Research*, **7**(3), 675-683.
- [19] Sharma, R., Kalia, S., Kaith, B. S., Pathania, D., Kumar, A., & Thakur, P. (2015). Guar-based biodegradable and conducting interpenetrating polymer network composite hydrogels for adsorptive removal of methylene blue dye. *Polymer degradation and stability*, **122**, 52-65.
- [20] Saxena, R., & Sharma, S. (2016). Adsorption and kinetic studies on the removal of methyl red from aqueous solutions using low-cost adsorbent: guar gum powder. *International Journal of Scientific Engineering Research*, **7**(3), 675-683.
- [21] Poonkuzhali, K., Sathishkumar, P., Boopathy, R., & Palvannan, T. (2011). Aqueous state laccase thermostabilization using carbohydrate polymers: Effect on toxicity assessment of azo dye. *Carbohydrate polymers*, **85**(2), 341-348.
- [22] Verma, A. K., Dash, R. R., & Bhunia, P. (2012). A review on chemical coagulation/flocculation technologies for removal of colour from textile wastewaters. *Journal of environmental management*, **93**(1), 154-168.
- [23] Abdel-Halim, E. S., & Al-Deyab, S. S. (2011). Hydrogel from crosslinked polyacrylamide/guar gum graft copolymer for sorption of hexavalent chromium ion. *Carbohydrate polymers*, **86**(3), 1306-1312.
- [24] Mittal, H., & Mishra, S. B. (2014). Gum ghatti and Fe₃O₄ magnetic nanoparticles based nanocomposites for the effective adsorption of rhodamine B. *Carbohydrate polymers*, **101**, 1255-1264.
- [25] Patra, A. S., Ghorai, S., Ghosh, S., Mandal, B., & Pal, S. (2016). Selective removal of toxic anionic dyes using a novel nanocomposite derived from cationically modified guar gum and silica nanoparticles. *Journal of hazardous materials*, **301**, 127-136.
- [26] Pathania, D., Katwal, R., Sharma, G., Naushad, M., Khan, M. R., & Ala'a, H. (2016). Novel guar gum/Al₂O₃ nanocomposite as an effective photocatalyst for the degradation of malachite green dye. *International journal of biological macromolecules*, **87**, 366-374.
- [27] Ahmad, R., & Mirza, A. (2018). Synthesis of Guar gum/bentonite a novel bionanocomposite: Isotherms, kinetics and thermodynamic studies for the removal of Pb (II) and crystal violet dye. *Journal of Molecular Liquids*, **249**, 805-814.
- [28] Shruthi, S. B., Bhat, C., Bhaskar, S. P., Preethi, G., & Sailaja, R. R. N. (2016). Microwave assisted synthesis of guar gum grafted acrylic acid/nanoclay superabsorbent composites and its use in crystal violet dye absorption. *Green and Sustainable Chemistry*, **6**(01), 11.
- [29] Pal, S., Patra, A. S., Ghorai, S., Sarkar, A. K., Mahato, V., Sarkar, S., & Singh, R. P. (2015). Efficient and rapid adsorption characteristics of templating modified guar gum and silica nanocomposite toward removal of toxic reactive blue and Congo red dyes. *Bioresource technology*, **191**, 291-299.
- [30] Patra, A. S., Ghorai, S., Sarkar, D., Das, R., Sarkar, S., & Pal, S. (2017). Anionically functionalized guar gum embedded with silica nanoparticles: an efficient nanocomposite adsorbent for rapid adsorptive removal of toxic cationic dyes and metal ions. *Bioresource technology*, **225**, 367-376.
- [31] Nagarpita, M. V., Roy, P., Shruthi, S. B., & Sailaja, R. R. N. (2017). Synthesis and swelling characteristics of chitosan and CMC grafted sodium acrylate-co-acrylamide using modified nanoclay and examining its efficacy for removal of dyes. *International journal of biological macromolecules*, **102**, 1226-1240.
- [32] Nayak, B. R., & Singh, R. P. (2001). Development of graft copolymer flocculating agents based on hydroxypropyl guar gum and acrylamide. *Journal of Applied Polymer Science*, **81**(7), 1776-1785.
- [33] Nayak, B. R., & Singh, R. P. (2001). Development of graft copolymer flocculating agents based on hydroxypropyl guar gum and acrylamide. *Journal of Applied Polymer Science*, **81**(7), 1776-1785.
- [34] Sen, G., Mishra, S., Jha, U., & Pal, S. (2010). Microwave initiated synthesis of polyacrylamide grafted guar gum (GG-g-PAM)—characterizations and application as matrix for controlled release of 5-amino salicylic acid. *International journal of biological macromolecules*, **47**(2), 164-170.



- [35] Bajpai, U. D. N., & Rai, S. (1988). Grafting of acrylamide onto guar gum using KMnO_4 /oxalic acid redox system. *Journal of applied polymer science*, **35**(5), 1169-1182.
- [36] Pal, S., Ghorai, S., Dash, M. K., Ghosh, S., & Udayabhanu, G. (2011). Flocculation properties of polyacrylamide grafted carboxymethyl guar gum (CMG-g-PAM) synthesised by conventional and microwave assisted method. *Journal of hazardous materials*, **192**(3), 1580-1588.
- [37] Sharma, R., Kaith, B. S., Kalia, S., Pathania, D., Kumar, A., Sharma, N., ...& Schauer, C. (2015). Biodegradable and conducting hydrogels based on Guar gum polysaccharide for antibacterial and dye removal applications. *Journal of environmental management*, **162**, 37-45.
- [38] Makhado, E., Pandey, S., Nomngongo, P. N., & Ramontja, J. (2017). Fast microwave-assisted green synthesis of xanthan gum grafted acrylic acid for enhanced methylene blue dye removal from aqueous solution. *Carbohydrate polymers*, **176**, 315-326.
- [39] Pal, S., Patra, A. S., Ghorai, S., Sarkar, A. K., Mahato, V., Sarkar, S., & Singh, R. P. (2015). Efficient and rapid adsorption characteristics of templating modified guar gum and silica nanocomposite toward removal of toxic reactive blue and Congo red dyes. *Bioresource technology*, **191**, 291-299.
- [40] Patra, A. S., Ghorai, S., Sarkar, D., Das, R., Sarkar, S., & Pal, S. (2017). Anionically functionalized guar gum embedded with silica nanoparticles: an efficient nanocomposite adsorbent for rapid adsorptive removal of toxic cationic dyes and metal ions. *Bioresource technology*, **225**, 367-376.



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