Int. J. Sci. R. Tech., 2025 2(4)
A Multidisciplinary peer-reviewed Journal
www.ijsrtjournal.com [ISSN: 2394-7063]

Original Article

Sustainable Wastewater Treatment Using Guar Gum Powder as A Natural Polyelectrolyte

Ezhava Shruthi*[1], Aayushi Panchal[2], Bharat Maitreya[3], Solanki Hitesh[4]

[1]*M.Sc. scholar, Department of Environmental Science, Gujarat University, Ahmedabad*
[2]*Research Scholar, Department of Environmental Science, Gujarat University, Ahmedabad*
[3]*Professor, Department of Botany, Bioinformatics, and Climate Change Impacts Management*
[4]*Professor and Head, Department of Environmental Science, Gujarat University, Ahmedabad*

ABSTRACT

Natural substitutes for synthetic polyelectrolytes are being investigated as a result of the growing need for environmentally acceptable and sustainable wastewater treatment methods. This study explores guar gum powder's potential as an environmentally friendly coagulant for wastewater treatment that is sustainable. The effectiveness of guar gum, a non-toxic and biodegradable polysaccharide, in removing suspended particles and COD from wastewater was assessed. With the right doses and pH levels, the results demonstrated that guar gum powder had coagulation effectiveness equivalent to that of manufactured polyelectrolytes. The treated wastewater complied with the regulations needed to be released into the environment. The environmental effect of wastewater treatment can be decreased by using guar gum powder as a sustainable and eco-friendly substitute for synthetic polyelectrolytes. In support of a more sustainable and ecologically friendly method of water management, this study shows the potential of guar gum powder as a green coagulant for sustainable wastewater treatment.

Keywords: Guar gum powder, green coagulant, Natural Polyelectrolyte, Coagulation- flocculation, Synthetic polyelectrolyte

INTRODUCTION

Natural materials like guar gum are being investigated as possible substitutes for traditional treatment techniques due to the growing need for efficient and environmentally friendly wastewater treatment solutions. Because it is inexpensive, plentiful, and non-toxic, guar gum—a biocompatible and biodegradable polysaccharide—has drawn interest for use in wastewater treatment. It is extracted from the seeds of the *Cyamopsis tetragonolobus* plant. (L. Saya et al.,2021; S. Mandal et al.,2022) Materials based on guar gum have been thoroughly investigated for their capacity to eliminate heavy metal ions and dyes from wastewater. Because of its hydroxyl group-rich structure, the polymer may be functionalized in a variety of ways, which improves its adsorption properties. Studies have demonstrated the potential of guar gum-based nanocomposites for real-time wastewater treatment applications, as well as its promise in the adsorption and photo-catalytic destruction of contaminants. (S. Mandal et al.,2022) Guar gum in a variety of forms, including hydrogels and nanocomposites, has been shown in studies to effectively separate water from oil and eliminate heavy metals like cadmium and lead from tainted water sources (Lei Dai et al.,2017; S. Mukherjee et al.,2018) Guar gum-based composites' adsorption properties and multifunctionality are further improved by the addition of other components, such as magnetic nanoparticles and activated carbon, opening up potential in intricate wastewater treatment procedures (V. Gupta et al.,2020)

MATERIALS AND METHODOLOGY:

MATERIALS:

i. Guar Gum Powder
ii. Synthetic polyelectrolyte
iii. Moringa Oleifera Seeds Powder
iv. Chick Pea Seed Powder
v. Bentonite Clay
vi. Alum

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

vii. Lime

(a) (b)

Figure 1:
(a) Reagents and wastewater (Raw ETP)
(b) Guar Gum, Moringa Oleifera Seeds, Chickpea Seeds solutions

METHODS:

- Preparation of reagents
- Wastewater treatment procedures

- **Laboratory analysis:**

i. pH:

Principle: Using a pH meter, the electromotive force (emf) of a cell that consists of an indicator electrode (an electrode that responds to hydrogen ions, like a glass electrode) submerged in the test solution and a reference electrode (typically a calomel electrode) is measured. Contact is made via a liquid junction that is a component of the reference electrode.

Source: APHA (2017). Standard Methods for the Examination of Water and Wastewater. 23rd ed. American Public Health Association.

ii. Chemical Oxygen Demand (COD)

Principle:
A water sample's chemical oxygen demand (COD) is a measurement of how much oxygen is needed to decompose organic materials. A powerful oxidizing agent, such potassium dichromate, is used to oxidize the organic matter in the water sample. The excess oxidizing agent is then titrated with a reducing agent, like ferrous ammonium sulfate, as part of the titration procedure for measuring COD.

Procedure:

- Collect sample of water and store it in a dark and cold place.
- Get the reagents using the APHA method to prepare the potassium dichromate, sulfuric acid, and silver sulfate reagents.
- Fill the Cod vials with the above reagents $K_2CR_2O_7$, H_2SO_4, $AgSO_4$
- Then fill the COD vial with specified volume o the water sample (2-5 ml) and keep it in the Cod digestor to heat for 2hrs.
- After 2hrs, allow the sample to cool, then dilute the sample by adding distilled water.
- Now, titrate the sample using Ferrous Ammonium Sulfate (FAS) as a titrant and Ferroin as the indicator.
- The color changes from green blue to wine red.

Calculation:

$$\frac{(V1 - V2) \times N \times 8000}{Sample\ Volume}$$

Source: (IS 3025 Part 33)

iii. Total Suspended Solids (TSS)

Principle:
The Total Suspended Solids (TSS) test quantifies the quantity of non-dissolved particle matter suspended in water. It works on the filtration principle, in which a pre-weighed filter paper is used to filter a known volume of water sample, and the mass of the particles retained on the filter is measured. The outcome is

usually expressed as the mass of suspended particles per volume of water, or mg/L.

Procedure:

- prepare the filter paper by drying it in the oven for an hr. at 103 to 105°C.
- use a Desiccator to cool the filter paper then weigh the filter paper and mark the reading as W1
- now using Vacuum Filtration equipment filter a specified volume (i.e. 50 ml) of the water sample through the pre-weighed filter paper.
- Now, dry the filter paper for 1 hr. in the hot air oven at 103 – 105°C.
- After drying cool the filter paper in desiccator and then weigh the filter paper and mark the reading as W2.

Calculation:

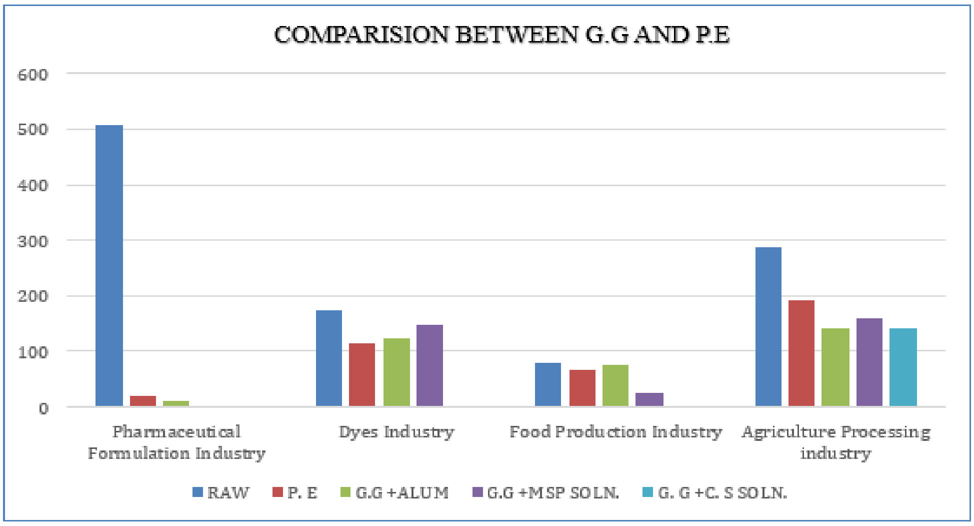
$$TSS\ (mg/l) = \frac{(W2 - W1) \times 10^6}{Sample\ Volume}$$

Source: (APHA Method 2540 D)

RESULT AND DISCUSSION:

4.1 Comparative Study on The Flocculation Efficiency of Guar Gum Powder To Reduce Suspended Solids

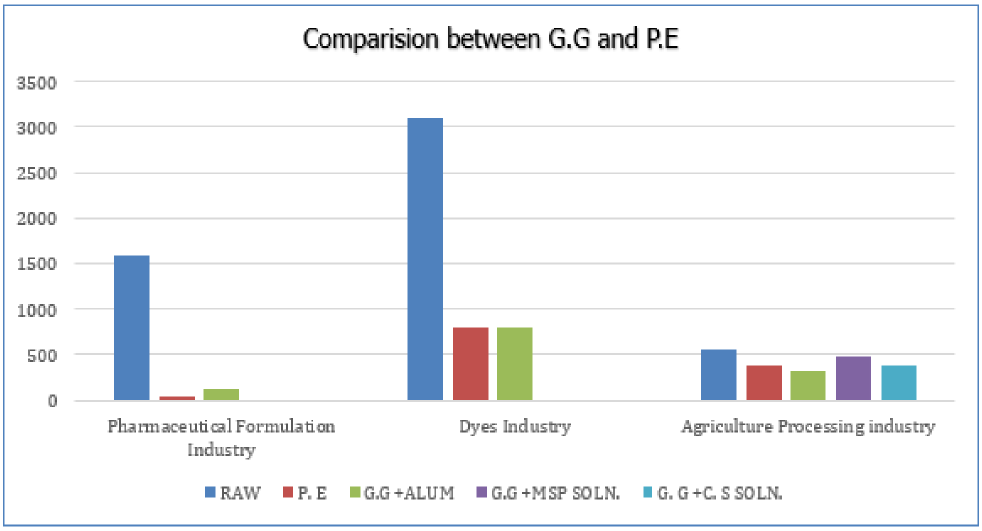
Sr. No.	SAMPLE	Volume (Ml)	Result				
			RAW	P. E	G.G +ALUM	G.G +MSP SOLN.	G. G +C. S SOLN.
1.	Pharmaceutical Formulation Industry	50	506.8	18.4	10.8	-	-
2.	Dyes Industry	50	174.2	115.6	123.8	147.4	-
3.	Food Production Industry	50	80	67	75.4	24.6	-
4.	Agriculture Processing industry	50	288.2	192.6	141	159.8	141.2



The above graph shows that guar gum has the potential to be a used as a natural flocculant in lowering suspended particles in a variety of sectors. Guar Gum and Alum together produced the greatest reduction, especially in the pharmaceutical formulation sector (from 506.8 to 10.8) and the agricultural processing sector (from 288.2 to 141). In contrast to synthetic polyelectrolytes, the combination of Guar Gum and Moringa Seed Powder (MSP) was the most successful in the food manufacturing sector, lowering solids from 80 to 24.6. In the dye business, guar gum by itself performed mediocrely, and adding MSP had a lower impact than other treatments. Guar gum has high flocculation effectiveness overall, particularly when paired with environmentally friendly coagulants, making it a biodegradable and sustainable substitute for synthetic alternatives.

4.1 Comparative Study on The Flocculation Efficiency of Guar Gum Powder to Reduce The Chemical Oxygen Demand (Cod)

Sr. No.	Sample	Volume (Ml)	Result				
			RAW	P. E	G.G +ALUM	G.G +MSP SOLN.	G. G +C. S SOLN.
1.	Pharmaceutical Formulation Industry	20	1580	48	115.2	-	-
2.	Dyes Industry	20	3094	796.8	787.8	-	-
3.	Agriculture Processing industry	20	563.2	378	327.6	470.4	386.4



According to the graph Guar Gum (G.G.) is a natural coagulant that effectively lowers Chemical Oxygen Demand (COD) in a variety of industrial effluents. Although it was less successful than synthetic polyelectrolytes (P.E.), guar gum and alum dramatically decreased COD in the pharmaceutical formulation business from 1580 to 115.2. Guar Gum with Alum decreased COD from 3094 to 787.8 in the dyes sector, demonstrating performance equivalent to P.E. and proving its dependability in handling high-strength effluents. The G.G. + Alum combination outperformed P.E. (378) and other natural coagulant blends such as G.G. + Moringa Seed Powder (470.4) and G.G. + Chickpea Seed Solution (386.4) in the agriculture processing business, demonstrating improved results once more (reduced COD to 327.6).

Figure: 2 Beakers Containing Sample (Raw ETP) and treated Sample with Guar Gum Solution

Figure 3: Jar Test Beakers of Treated Wastewater with Guar Gum and Different Coagulants After One Hour

CONCLUSION:

The above study demonstrates that the Guar Gum powder is an effective natural substitute for synthetic polyelectrolytes in lowering suspended solids and COD in a variety of industrial effluents. This is especially true when paired with alum. Both characteristics were significantly reduced in the pharmaceutical formulation and agricultural processing industries, demonstrating the synergy between guar gum and alum. Guar gum combined with Moringa seed powder shown exceptional efficacy in reducing suspended particles in the food production industry. Despite being marginally less effective in the dyes sector, Guar Gum nonetheless demonstrated excellent performance, particularly with Alum. Guar gum is an environmentally benign, biodegradable, and reasonably priced product that promotes sustainable wastewater treatment methods

REFERENCE

1. APHA (2017). Standard Methods for the Examination of Water and Wastewater. 23rd ed. American Public Health Association.
2. APHA (2017). Standard Methods for the Examination of Water and Wastewater. 23rd ed. American Public Health Association.
3. Dai, L., Wang, B., An, X., Zhang, L., Khan, A., & Ni, Y. (2017). Oil/water interfaces of guar gum-based biopolymer hydrogels and application to their separation. Carbohydrate polymers, 169, 9-15. https://doi.org/10.1016/j.carbpol.2017.03.096.
4. Gupta, V., Agarwal, S., Ahmad, R., Mirza, A., & Mittal, J. (2020). Sequestration of toxic congo red dye from aqueous solution using ecofriendly guar gum/ activated carbon nanocomposite. International journal of biological macromolecules. https://doi.org/10.1016/j.ijbiomac.2020.05.025.
5. IS 3025 (Part 33) (2009). Methods of Sampling and Test (Physical and Chemical) for Water and Wastewater. Part 33 Chemical Oxygen Demand (COD).
6. Mandal, S., Hwang, S., & Shi, S. (2022). Guar gum, a low-cost sustainable biopolymer, for wastewater treatment: A review. International journal of biological macromolecules, 226, 368-382. https://doi.org/10.1016/j.ijbiomac.2022.12.039.
7. Mukherjee, S., Mukhopadhyay, S., Zafri, M., Zhan, X., Hashim, M., & Gupta, B. (2018). Application of guar gum for the removal of dissolved lead from wastewater. Industrial Crops and Products, 111, 261-269. https://doi.org/10.1016/J.INDCROP.2017.10.022
8. Saya, L., Malik, V., Singh, A., Singh, S., Gambhir, G., Singh, W., Chandra, R., & Hooda, S. (2021). Guar gum-based nanocomposites: Role in water purification through efficient removal of dyes and metal ions. Carbohydrate polymers, 261, 117851. https://doi.org/10.1016/j.carbpol.2021.117851.

HOW TO CITE: Ezhava Shruthi*, Aayushi Panchal, Bharat Maitreya, Solanki Hitesh, Sustainable Wastewater Treatment Using Guar Gum Powder as A Natural Polyelectrolyte, Int. J. Sci. R. Tech., 2025, 2 (4), 518-522. https://doi.org/10.5281/zenodo.15257724