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A Review: Study of Surface Water and Its Treatment Using Biocoagulants

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Abstract: ***Natural materials should be used in the coagulant-flocculation process as much as possible. According to the literature, it is worthwhile to develop and, if possible, convert natural materials into commercial. On the other hand, natural coagulants are insufficient as a primary treatment since their efficacy is being hampered by increasing restrictions. Emerging technology and in-depth research contribute to the creation of these restricted settings as well as the success of chemicals. Natural coagulants are also commonly employed as coagulant aids in conjunction with manufactured coagulants. The type of coagulants used in the treatment of waste-water coagulation, in particular the usage of natural coagulants, is the subject of this investigation. Natural materials' potential for future expansion as aids and as sustainable composite coagulants are also discussed in this analytical report.***

Keywords: Turbidity; Biocoagulants; Natural; Dosage.

I. INTRODUCTION

Surface waters play a very important role in maintaining the water resources available on the surface. Under surface water, urban lakes serve as an important source of water for people living in the surrounding area. In recent years, most of these lakes have become pollutant potholes due to industrialization, urbanization, and uncontrolled man-made activities. Changes or modifications in the physical, chemical and biological properties of water lead to the growth of phytoplankton in the water. This is the main cause of turbidity in surface water [1]. Haze, like smoke in the air, is the turbidity or turbidity of a liquid caused by a large number of individual particles that are generally invisible to the naked eye. Turbidity measurement is an essential test of water quality. Liquids can contain suspended solids composed of particles of various sizes. Some particulate matter is large and heavy enough to quickly settle to the bottom of the container when the liquid sample is left unattended, but when the sample or particles are agitated regularly, the very small particles become very slow [2]. It sinks or does not settle at all. These small solid particles cloud the liquid.

Muddy water must be clean. Aggregators such as aluminium sulphate (alum) and ferrous sulphate are commonly used. Alum is commonly used as a chemical coagulant. When alum is added to raw water, it mixes with the bicarbonate alkali present in the water to form a glutinous precipitate. These flakes attract fine particles and solids in the raw water and settle at the bottom of the tank. However, this procedure is expensive and hurts people in stores. To conquer these limitations, natural coagulants such as Moringa oleifera, Tamarindus Indica seed, Phaseolus Vulgaris, Abelmoschus esculentus, Coccinia Grandis, Zea mays, Carica papaya, and Strychnos potatorum, Rice husk, Canna Indica, Typhaceae, Adenanthara pavonine, Azadirachta indica, Banana stem and Mustard are used. These natural coagulants are superior to chemical water treatment because they are reported to be natural, edible, environmentally friendly, economical and easily available.

Comparison between Chemical and Natural coagulants

Parameters	Chemical Coagulants	Natural Coagulants
Economy	The higher cost involved in procuring chemicals and during treatment processes.	Cost-effective, since they are abundantly available.
Dosage	A larger dosage is required to bring about coagulation.	A lesser dosage is required.
Effectiveness	Extended usage leads to lesser effectiveness and leads to the addition of dissolved solids (salts) to the water.	They are more stable and do not lead to the formation of dissolved solids.

Toxicity	Highly toxic and has irritant characteristics.	Lesser toxicological risk (generally non-toxic).
Sludge	A large amount of sludge contains hazardous chemicals.	Lesser amounts of sludge which are mostly biodegradable.
Removal of heavy metals	Heavy metals like Zn, Cd, and As cannot be settled easily.	Settling of heavy metals occurs along with the coagulation process.
pH	There will be a significant change in pH due to the formation of metallic salts.	Do not alter the pH of the water being treated.

Table 1. Comparison between chemical and natural coagulants

A. Application of Natural Coagulants to Treat Wastewater

The natural coagulants used in wastewater treatments include microbial polysaccharides, starches, gelatin galactomannans, cellulose derivatives, chitosan, glues, and alginate. Coagulants that carry natural characteristics are supposed to be harmless for human health, whereas the existence of aluminium zest may provoke neurology & pathology diseases. Natural coagulants are mixed with some artificial coagulants that are consumed as a coagulant aid, their effectiveness as the key coagulant remains stays at the early stages. The process of treatment in these coagulants is composed of molecules bridging, adsorption, and charge balancing. Natural coagulants are capable of wastewater treatment following effluents discharge standards.

II. LITERATURE REVIEW

Sk. Rakibul Islam, SM Samin Ishraq, Prottoy Kumar Sarker, Shadman Kaiser [2017] For experiments on the application of moringa seeds to coagulate suspended solids, they selected water from the Briganga River in Sadargat, Dhaka as a sample. From this study, they concluded that the use of moringa seeds as a coagulant significantly reduced the turbidity of the sample. Moringa seeds can be used where alum is not an excellent alternative. In colour testing, alum was more effective, but with aesthetically pleasing seed powders, the colour reduction was found to be very effective. When Moringa seed is applied as a coagulant and later filtered, better results are observed as the turbidity of the sample is reduced to 1.96 NTU (optimal dose) and the colour is reduced to 29 PtCo units. This is certainly satisfying. Therefore, the use of Moringa Oleifera seeds as biocoagulants can make a significant difference in water purification systems in both developing and developing countries.

Reena Abraham1, Harsha P2 [2019] Two separate experiments are performed in this task. One is tamarind seed powder as a coagulant and the second is papaya seed powder as a coagulant. Coagulation and aggregation were performed using a jar tester to study the effect of coagulant dose on coagulation and the effect of agitation and sedimentation time on coagulation. Before and after solidification, various parameters such as turbidity, conductivity, TSS, pH, BOD and COD were measured. From this study, we can conclude that tamarind indica seed powder was found to be more effective in reducing various parameters of kitchen drainage. Natural coagulants can also expand the ability to treat a variety of other wastewater, including fibre wastewater, tanned wastewater, and even surface water treatment. The use of locally available natural coagulants has proven to be a cost-effective, environmentally friendly and safe wastewater treatment method.

Ms. Vrushali V. Shimpi 1,Ms. PoojaR.Jondhale 2, Ms Ritu B. Gangurde3, Ms Tejal D. Jadhav4, Ms Shireen S. Kapse 5 [2018] In this study, a conventional vessel tester is used in the experiment to coagulate a water sample using MO. The results of this study propose that Moringa oleifera at a concentration of 100-150 mg / L is effective as a coagulant for the treatment of wastewater and groundwater in the industry. The optimum amount of coagulation of Moringa oleifera is also affected by the initial state of the sample to be coagulated. The higher the contamination level, the higher the optimal dose required.

Sonal Chonde and Prakash Raut [2017] The main purpose of this work was to use MO seeds as a natural adsorbent for the treatment of dairy wastewater (DIW). Moringa oleifera plant seeds contain natural polyelectrolytes that can be used as coagulants to purify turbid water. After treating the seed powder with water, the sample was analyzed for various parameters such as pH, electrical conductivity, TDS, TSS, hardness, chloride, COD, and BOD. All parameters showed a decrease with increasing seed powder dose. Therefore, the application of these economical Moringa Oleifera seeds is recommended for environmentally friendly, non-toxic and simplified wastewater treatment.

NA Zainol 1 and Nur Nasuha Mohd Fadli1[2020] In this study, the treatment of surface water using tamarind seeds as a coagulant was successfully conducted. Two extraction solutions were used to extract the active component in the tamarind seeds that can induce the performance of the coagulant itself. This scenario proved that tamarind seeds can be used to replace the commercial coagulant, alum in the water treatment industry in the future. Hence, tamarind seeds using distilled water as the solvent can be proposed as an effective natural coagulant that is safe to be used as it is safe to use without causing serious health effects to the environment. Throughout the study, the polyelectrolyte ion and polysaccharide present inside the tamarind seeds had been recognized and confirmed as one of the many factors that contributed to the efficiency of the natural tamarind seeds as the coagulant. The performances are almost as efficient as the commercial coagulants.

III. MATERIAL AND METHODOLOGY

A. *Materials*

In past research, natural, economical and easily available Coagulants were used. Biocoagulant is mainly composed of polymers of natural origin extracted from plants, algae or animals. Among these are polysaccharides and water-soluble substances that act as coagulation and or flocculation agents. Records show that in India, bio coagulants like Nirmali seeds (Strychnos potatorum) have been used for water clarification between the 14th and 15th centuries. The use of bio coagulants has gained importance once again, one of the main reasons being that they are abundantly available, easy to procure and do not alter pH and biodegradability in water. Additionally, if the natural materials are locally sourced, transportation costs are also cut down significantly. Natural coagulants are predominantly either polysaccharides or proteins. Sometimes, even though polymers are labelled non-ionic, there is not necessarily an absence of charged interactions. The presence and nature of clay particles and background electrolytes also facilitate coagulation by polymeric materials.

Many such natural materials have been reported to have high efficiency in removing turbidity from water. this review looks only at two potential plant-based coagulants, which are locally sourced.

1) *Moringa oleifera:* Family Moringaceae within the kingdom Plantae includes a large type of trees among that Moringa oleifera and Moringa concanensis Nimmo are known as important species [19]. Moringa oleifera is often called drumstick and Nimmo is termed kattumurungai by the social group folks of Tamilnadu. Moringa oleifera is autochthonal to sub-Himalayan tracts of Asian countries, Pakistan, Bangladesh and the Islamic State of Afghanistan[20]. Whereas Nimmo is cosmopolitan in Nilgiri Mountains [21] and domestically sourced within the Veppanthattai and Kunnam taluk of Perambalur district of Tamil Nadu. In India, Nimmo may be settled in Rajasthan, Madhya Pradesh, and Gujarat [22] state and province. The plant Kattumurungai has leaves and flowers that are larger and it differs entirely from the foremost plenteous Moringa oleifera. In each species of Moringa, the bark look to exhibit a definite feature [23] and studies indicate the presence of β-sitosterol within the bark. The bark is extremely swish and extremely onerous in each Moringa oleifera and Nimmo [6]. The medicative properties of Moringa concanensis Nimmo are higher in comparison to Moringa oleifera. it's reportable that twenty forms of human ailments are also cured by the victimization of this plant with a straightforward preparation of Nimmo. However, studies show that Moringa oleifera provides zeatin, quercetin, caffeoylquinic acid and kaempferol [7]. the final properties of M. concanensis are constant as that of M. oleifera i.e., powerful tonic difference, stomachic, laxative and respiratory disorder [8]. Roots of Moringa concanensis are used as a substitute for Moringa oleifera. Moringa oleifera contains coagulator proteins that play a serious role in surface water treatment [15]. On dosing extracts of Moringa oleifera that are soluble in water, turbidness was reduced to five. 9 NTU from 100 NTU in extremely muddy water. Also, 89-96% of coliform was reduced by the victimization of this natural coagulator [9]. Historically the seeds of Moringa oleifera were utilized in the treatment of freshwater as they will lose their characteristics once collected within the agricultural space [10]. This might result in pesticides, aerial spraying, animal excrement, dust, bird excrement or alternative chemicals. Such contaminants may lead to waterborne diseases like epidemic cholera and infectious disease. Moringa oleifera seeds have used the removal of the hardness of the water and they conjointly impart useful properties to the water [24]. Therefore any studies on the role of Moringa oleifera and Moringa concanensis Nimmo as natural coagulants would be of serious importance in treating muddy water.
2) *Tamarindus Indica:* Tamarindus Indica or the Tamarind tree is a leguminous tree of the Fabaceae family [11]. Though it is indigenous to tropical Africa, it has been cultivated in India for so long that it is disputed to have originated here. A study done on the reduction of turbidity of lake water using tamarind seed powder shows a percentage reduction of turbidity of 65.82% [26]. Other studies have shown that in the treatment of effluents using tamarind powder, turbidity and COD removal of 97.78% and 43.50%have been achieved (at optimum mixing time) [12] and colour removal of 100% has been achieved [26]. It has also been stated that tamarind seeds can reduce fluoride content. These properties may be attributed to the high polyphenolic content, es-

pecially tannins. Tannins have been proven to be a better alternative to chemical coagulants, and their effectiveness is attributed to their structure as well as the degree of tannin modification. It is known that phenolic groups can readily deprotonate to produce phenoxide which is stabilised via resonance. This is said to enhance the effect of coagulation, and since tannins consist of a large number of phenolic groups, they naturally have better coagulation capacity. Though the tamarind seed has been extensively studied, the husk is always discarded. But it's currently noted that the husk too contains similar constituents because the seed might itself be used as a natural coagulant. From a study on the constituents of tamarind seed husk, 39% of the composition was elucidated to be polymeric tannins and such tannins also made up 77% of total polyphenolic compounds [14]. Additionally, tamarind seed husks are also known to contain polysaccharides such as xyloglucans, simple phenols such as epicatechin and 3,4-dihydroxy phenylacetate and also other polyphenols like procyanidin B2 [27]. Since all the above-mentioned compounds have a high number of –OH groups, and because the husk has radical scavenging activity, it can contribute to high coagulation capabilities. Further studies on the application of the husk to treat effluents by coagulation are required. This process will also be highly cost-efficient, as Tamarindus Indica is widely distributed throughout India (India is the world's leading producer with a production of 300,000 tonnes annually), especially in South India [13].

B. *Methodology used in Past Research*

1) *Natural Coagulant Preparation:* Natural coagulants were soaked in water for an hour to remove the adhering pulp and washed well with tap water. Further, the seeds were properly dried in the sunlight for 2 days. The seeds are first crushed in the mortar and pestle to remove the outer cover as much as possible and then cotyledons were powdered finely and sieved under 150 microns and were used for the test [5].
2) *Collection of Samples:* Precautions were taken to prevent any vertical disturbance during the collection. The water samples were collected in sterilized bottles. For a collection of water following method is adopted. Samples were collected from the water bodies. For this purpose, the pre-sterilized bottle was tied at one end of a long bamboo pole and collected the sample after displaying surface water that might contain organic floating over it. After filling, the bottle the cap was placed tightly, and the name, address, sample number, identification mark etc, were provided on the bottle. Various methods were used for the Physico-chemical analysis of the surface water [5].
3) *Preservation of Samples:* The samples collected were preserved at the optimum temperature of about 40 Fahrenheit (About 4 degrees Celsius). This refrigeration will maintain biochemical oxygen demand [4].
4) *Analysis:* Water from selected sites was collected and analysed for various physical parameters viz. clarity, odour, colour, pH, turbidity, alkalinity, dissolved oxygen and biochemical oxygen demand. Study to know about the palatability of water the standard quality and was compared to the table approved by the Bureau of Indian Standard for drinking water.
5) *Jar Test:* To perform jar test 1g each of plant powder dissolved in separate 100ml of distilled water as stock solutions. 200ml of raw sample water was measured and introduced into beakers labelled 1-7. With a calibrated pipette, each stock solution dosages of solutions were added onto the water samples in the beakers as rapidly as possible. Mix contents for 2 minutes at a speed of 100rpm, followed by slow mixing for 8mins at 25 pm. Observe the beakers and evaluated them for specific dosages and flock quality. Turned off the jar test mixer and the flocks were allowed to settle in the beakers for 30mins and observe the flocks settling characteristics.

IV. CONCLUSION

Plants surveyed in this review have remarkable properties and they could be adopted in effluent treatment. Although commercial coagulants are used on a large scale for this purpose they have several limitations and often result in destabilization of the treated water such as a change in conductivity and pH. The amount of sludge produced by conventional coagulants is very high and therefore sludge handling becomes a dreary process. Natural coagulants forms heavier flocs that settle quickly and the sludge volume is comparatively low and less toxic. The sludge produced is biodegradable and it can be used in agriculture as organic manure or as a nutrient supplement for the growth of perennials. Therefore, the overall amount of waste that is generated is highly minimized. Natural coagulants are economical as they do not alter the conductivity of the treated water and thereby protect the operating channel against corrosion. The advantages stated above and the high coagulation efficiency of natural coagulants signifies their importance as alternatives to chemical coagulants. As a result of this considerable attention has been directed toward the removal of turbidity in water treatment. Vegetables, cortex fruits and legumes have been extensively analysed for their application in water clarification. However, the potential of many abundantly available plants and trees is still untapped and in-depth knowledge of these plant materials as active coagulants might improve the prospect of commercialization of natural coagulants.

Biocoagulants such as Moringa Oliefera Seed and Tamarind Seed are very effective in treating seawater. Although some results were not very promising, the use of these biocoagulants improves the water quality of the lake and makes it available to people around the lake for daily activities.

Biocoagulants like Moringa Oliefera function effectively when the initial turbidity of the water sample is high. The study also found that MOP was relatively effective when the initial turbidity of the sample was high.

VI. FUTURE WORK

1) Tamarind seeds powder used in this study was mainly the powder of cotyledons. But it is seen that powder with the outer covering showed better results in reducing turbidity though the colour was increased.

2) In the present study the lake water was treated with bio coagulants subsequently one after the other. Further studies can be made by mixing all the coagulants for example in the ratio of 1:2 and then using it for the treatment.

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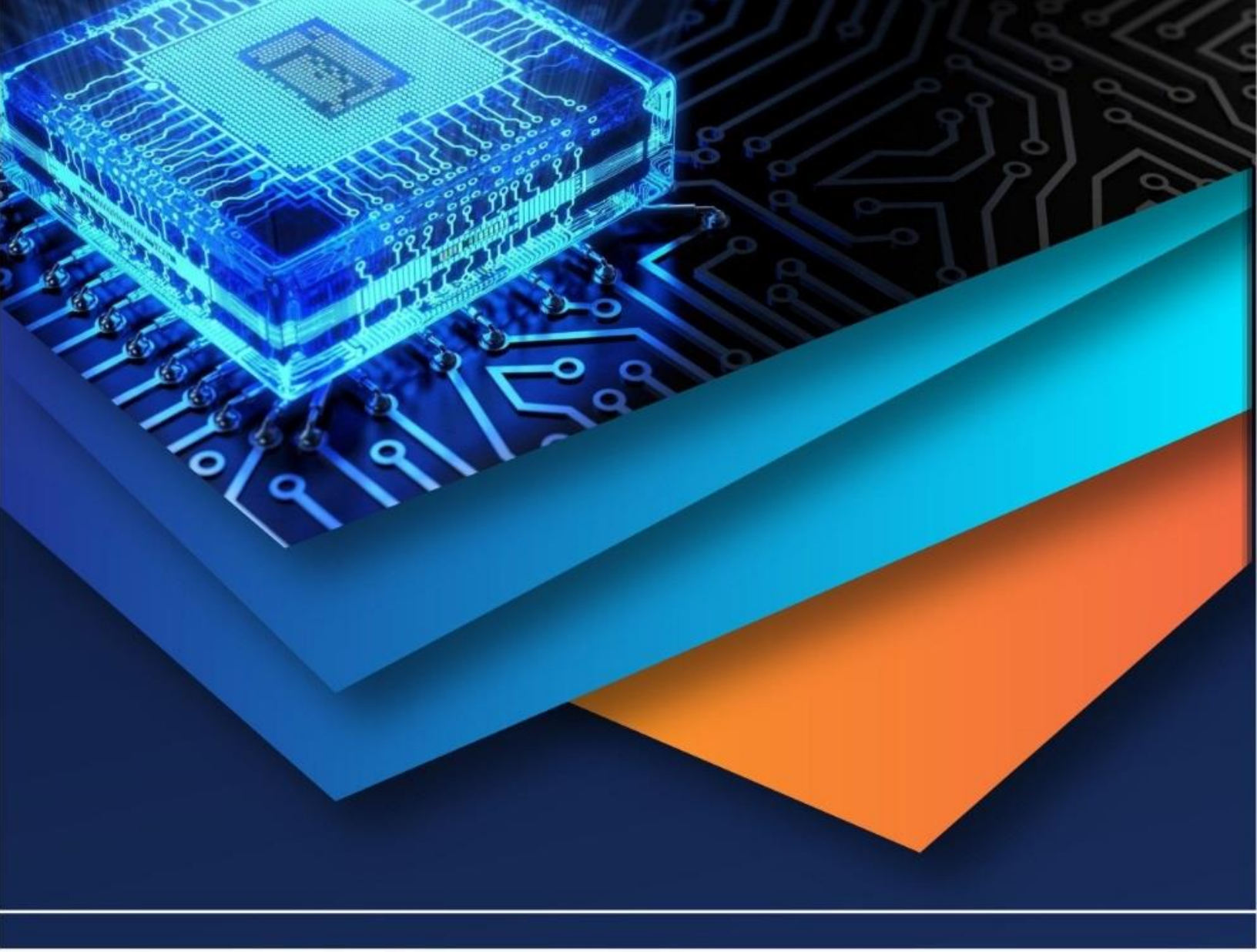

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