



A Review on Improving Drinking Water Quality using Organic Coagulants “Aloe Vera”

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ABSTRACT

Now a days India is developing country in the world. Water is the most important element of among the natural resources. In many developing countries, access to clean and safe water is a big critical issue. More than millions die people because of diarrhoea which is caused by polluted water. Developing countries pay cost high to import chemical for water treatment. In our country, we need to use our surface water sources therefore save our water bodies which are contaminated due to disposal of uncontrolled domestic and industrial waste water, so water treatment is a must duty to us. Coagulation is a conventional step of water purification and bio coagulants are new horizon to go green, turbidity, Ph, hardness import a great problem in water treatment. The pH of human blood is strictly maintain the lungs and kidney spare nothing to keep the pH tightly controlled since the consequences of the blood pH changes would be life threatening. The coagulation–flocculation–sedimentation process is widely used for removal of suspended solids and water turbidity reduction. The most common coagulants used to conduct this process are aluminumsulfate and ferric sulfate. In this review paper, the use of Aloe vera as a natural-based coagulant for drinking water treatment was tested. The bio-coagulant was used in two different forms: powder as well as liquid; the latter was extracted with distilled water used as a solvent.

KEYWORDS- Organic Coagulants, Aloe Vera, Coagulation, Flocculation, Sedimentation, Water Treatment

1. INTRODUCTION

1.1 General Introduction

Water is one of the essential things for human survival. In rural areas those people who were living in extreme poverty, they are drinking contaminated water because of high procurement cost of chemical coagulants and high cost of water treatment process. Usage of plant based coagulant instead of chemical coagulant is the best solution for above mentioned problems Usage of plant

based coagulants like Aloe Vera, Mung bean, Peanut seeds, Cactus, has many like low procurement cost, and biodegradable sludge production. After several months of studies and investigations we come up with the solutions for waste water treatment, our project gives a new way to treatment of waste water by plant based coagulants. Water is a vital resource, but presents a worrisome depletion in recent times. Adequate water supply for human consumption is a concern, since most

of this resource is found in oceans where the high salt content makes it unsuitable for drinking. Features such as growing population, increased economic activities and industrialization have resulted in high demand for drinking water and the subsequent misuse of this natural resource, which is severe. This hinders the treatability process and increases water treatment costs. For these reasons, coagulation-flocculation procedures associated with other processes are of great importance in order to separate contaminating component sand achieving high degrees of drinking water quality. Water is undoubtedly the most vital element among the natural resources. In many developing countries, access to clean and safe water is a crucial issue. Developing countries pay a high cost to import chemicals for water treatment. In most of the cases, these are expensive since they are required in higher dose. Many of the chemicals are also associated with human health and environmental problems. So organic coagulants can be used for water treatment as they do not causes any problems which occur due to the use of chemical coagulants.

1.2 Aloe Vera

Aloe Vera specifically refers to the *Aloe barbadensis* Miller plant. Aloe Vera is the oldest medicinal plant ever known and the most applied medicinal plant worldwide. This is a perennial tropical plant that can be cultivated in drought prone areas. In India, it is scattered in the wild, along the coast of southern India. It is a stemless or very shortstemmed succulent plant growing to 60–100 cm (24–39 in) tall, spreading by offsets. The leaves are thick and fleshy, green to grey-green, with some varieties showing white flecks on their upper and lower stem surfaces. Aloe Vera plant requires very less water for its growth as it contains 98% of water in its leaves. It contains around 75 nutrients and 200 active compounds including minerals, amino acids, enzymes and vitamins.



[Fig.1.1 Aloe Vera Plants]

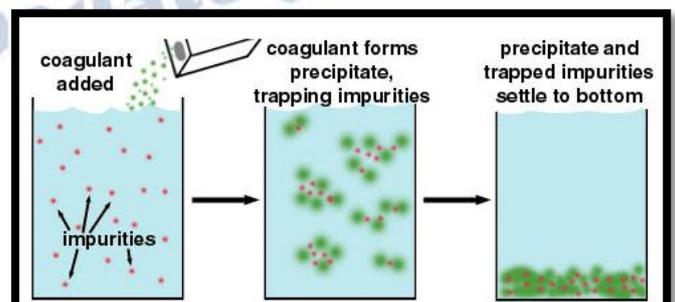
1.3 Scope & Objective

This study opens new perspectives of research on the development of natural coagulants to treat surface water, groundwater, wastewater, and industrial water, as well as on extraction processes to obtain liquid coagulants from Aloe vera, and finally on the solvent recovery procedure after extracting process. However, further investigations in pilot and full-scale plants are necessary in addition to a cost-benefit analysis to comprehensively understand the potential of bio-coagulants in water treatment.

2. COAGULATION PROCESS FOR WATER TREATMENT

2.1 General

Due to the lack of proper water treatment systems in these rural or underdeveloped communities, the best immediate option is to use simple and relatively cost-effective point-of-use (POU) technologies such as coagulation. Coagulation is an essential process in the treatment of both surface water and industrial wastewater. Its application includes removal of dissolved chemical species and turbidity from water via addition of conventional chemical-based coagulants, namely, alum ($AlCl_3$), ferric chloride ($FeCl_3$) and polyaluminum chloride (PAC). While the effectiveness of these chemicals as coagulants is well-recognized, there are, nonetheless, disadvantages associated with usage of these coagulants such as ineffectiveness in low-temperature water, relatively high procurement costs, detrimental effects on human health, production of large sludge volumes and the fact that they significantly affect pH of treated water. There is also strong evidence linking aluminum-based coagulants to the development of Alzheimer's disease in human beings. It is therefore desirable to replace these chemical coagulants with plant-based coagulants to counteract the aforementioned drawbacks.



[Fig.1.2: Coagulation Process of Water Treatment]

1.2 Merits of Plant-Based Coagulants

The main advantages of using natural plant-based coagulants as POU water treatment material are apparent; they are cost-effective, unlikely to produce treated water with extreme pH and highly biodegradable. These advantages are especially augmented if the plant from which his coagulant is extracted is indigenous to a rural community. In the age of climate change, depletion of earth's natural resources and widespread environmental degradation, application of these coagulants is a vital effort in line with the global sustainable development initiatives. Usage of plant-based coagulants for turbid water treatment dates back to over several millennia ago and thus far, environmental scientists have been able to identify several plant types for this purpose. While it is understandable that the coagulants are meant as simple domestic POU technology, there have also been numerous studies focused on their usage for treatment of industrial wastewaters. The mechanisms associated with different natural coagulants are varied as well. It is imperative for relevant take holders to fully comprehend the technicalities involved when considering the coagulants for rural, domestic or industrial water treatment. To address this, this paper provides an overview of the natural coagulant sources, processes and mechanisms involved so that environmental specialists can tailor its usage for a myriad of water contaminants. To provide a more focused discussion, natural coagulants derived from non-plant sources such as chitosan (widely produced from exoskeleton of crustaceans) and isinglass (produced from fish swim bladders) are excluded from this review. This exclusion is based on practicability, since nonplant sources are less likely to have the potential for mass production compared to plant sources. It is surprising to note that a comprehensive critical analysis of available plant-based coagulants is still non-existent given the importance of sustainable environmental technology in the 21st century and hopefully this review can provide an immediate platform for environmental scientists to intensify their research on these natural materials.

1.3 Natural Plant-Based Coagulants and Coagulation Mechanisms

Polymeric coagulants can be cationic, anionic or non-ionic, in which the former two are collectively termed as polyelectrolytes. Many studies concerning

natural coagulants referred to them as 'polyelectrolytes' even though many of these studies did not actually conduct indepth chemical characterization to determine their ionic activity . As such, this term should be used carefully, and be applied only after ionic activity is determined to be present in the coagulant.

Natural coagulants are mostly either polysaccharides or proteins. In many cases, even though polymers labelled as non-ionic are not necessarily absent of charged interactions, as there may be interactions between the polymer and a solvent within a solution environment as the polymer may contain partially charged groups including -OH along its chain. It is imperative to fully grasp the underlying coagulation mechanisms associated with these natural coagulants so that complete discussion in the following sections. The existence of background electrolytes in aqueous medium can facilitate the coagulating effect of polymeric coagulants since there is lesser electrostatic repulsion between particles. Although many plant-based coagulants have been reported, only four types are generally well known within the scientific community, namely Aloe Vera. Understanding of their usage can be realized. Aggregation of Particulates in a solution can occur via four classic coagulation mechanisms: (a) double layer compression; (b) sweep flocculation; (c) adsorption and charge neutralization; and (d) adsorption and inter particle bridging. The presence of salts [or suitable coagulants] can cause compression of the double layer which destabilizes the particulates. Sweep flocculation occurs when a coagulant encapsulates suspended particulates in a soft colloidal floc. Adsorption and charge neutralization refer to the sorption of two particulates with oppositely charged ions while inter particle bridging occurs when a coagulant provides a polymeric chain which sorbs particulates. Polymeric coagulants are generally associated with mechanisms (c) and (d) as their long-chained structures (especially polymers with high molecular weights) greatly increase the number of unoccupied adsorption sites.

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3. LITERATURE REVIEW

[1] Study and Analysis of PAC AndAloevera as A Coagulant for Wastewater Treatment

Rajpure Kiran S , Mule Rakesh B , Mande Viraj V, ShindeRajaram.B [2019], This study focused on various treatment to treat the water efficiency. Among these process coagulation is the best process to remove the colloidal particles from the water. The raw water sample collected from sewage treatment plant (STP) situated in Daund area. The optimum does which is used for the treatment is obtained by the jar test, and applied the dosage of PAC of 35 mg/l , 55mg/l and 45mg/l respectively and dosages are 1ml/l , 2ml/l and 3ml/l respectively. We have determine the physical and chemical properties. PH , BOD , COD , TDS , TSS of the wastewater before and after applied the STP .

[2] USE OF ALOEVERA JUICE FOR WASTE WATER TREATMENT BY COAGULATION AND FLOCCULATION

Chinchu K Georgea ,Anitha K [2018], In this paper natural coagulant Aloe vera gel has been used as a coagulant to treat the water. Waste water sample collected from dairy plant is used. pH, dosage, COD and turbidity and the effect of variation of dosage and pH were studied on turbidity and COD. The optimal dosage of each coagulant was determined in the beginning and this dosage was further used to find optimal pH. Turbidity and COD of all samples are studying and the efficiency of all the coagulants are recording.

[3] Plant Based Coagulant For Waste Water Treatment

T.Subramani ,C.Kathirvel , H.Harris Mohamed , M.MohamedNowfis , A.Niyasdeen [2018], Water is one of the essential things for human survival. In rural areas those people who were living in extreme poverty, they are drinking contaminated water because of high procurement cost of chemical coagulants and high cost of water treatment process. Usage of plant based coagulant instead of chemical coagulant is the best solution for above mentioned problems Usage of plant based coagulants like "Mung bean, Peanut seeds, Cactus, has many like low procurement cost, and biodegradable sludge production. After several months of studies and investigations we come up with the solutions for waste water treatment, our project gives a new way to treatment of waste water by plant based coagulants.

[4] USE OF ALOE-VERA GEL AS NATURAL COAGULANT IN TREATMENT OF DRINKING WATER

Hitesh S. Patil , Sanket A. Shinde , Ganesh A. Raut , Nilesh P. Nawale , Prof. Ashish Hakke , Prof. Manoj Deosarkar [2020], Now a days India is developing country in the world. Water is the most important element of among the natural resources. In many developing countries, access to clean and safe water is a big critical issue. More than millions die people because of diarrhoea which is caused by polluted water. Developing countries pay cost high to import chemical for water treatment. In our country, we need to use our surface water sources therefore save our water bodies which are contaminated due to disposal of uncontrolled domestic and industrial waste water, so water treatment is a must duty to us. Coagulation is a conventional step of water purification and bio coagulants are new horizon to go green, turbidity, Ph, hardness import a great problem in water treatment. The pH of human blood is strictly maintain the lungs and kidney spare nothing to keep the pH tightly controlled since the consequences of the blood pH changes would be life threatening. Moringaoleifera and aloe vera where used as local locally available natural coagulant in this study to reduce turbidity, pH, hardness. Many chemicals are also associated with environmental problem and human health. So, there raised a voice to develop cost effective, easier and environmental friendly process of water clarification so, that's why natural coagulation are used such as a aloe-vera, moringaoleifera. Desirable to substitute this chemical coagulants with natural coagulant cost effective to outside the aforesaid disadvantages. So water treatment is a most used to us, aim of using all of these coagulant to make the mix proportion to treatment of the water.

[5] Use of Aloe vera as an Organic Coagulant for Improving Drinking Water Quality

AbderrezzaqBenalia ,KerroumDerbal, AmelKhalfaoui [2020], All the experiments conducted in this study were performed on natural raw water with an initial turbidity of 13 NTU obtained from a drinking water treatment plant. In this work, two forms of bio-coagulants obtained from Aloe vera were used. The obtained results show that the turbidity was reduced to 6.0 NTU at pH 6 and to 1.42 NTU at pH 7.5 when AV-Powder and AV-H2O were used, respectively. It can be highlighted that the residual

turbidity from AV-H₂O addition was less than 5 NTU and fulfills the quality standards of the Algerian drinking water law [37]. Moreover, the use of natural coagulants in water treatment had no significant effect on several parameters such as pH, total hardness, total alkalinity, and salinity, whereas the concentrations of organic matter increased. This experimental study has proved that Aloe vera can be successfully used as a natural coagulant for drinking water treatment. Both AV-Powder and AV-H₂O can improve the final drinking water quality. Therefore metal-based coagulants, such as Aluminumsulfate, Ferrous sulfate, Ferric Chloride, etc., can be replaced with natural coagulants without reducing the process performance. This study opens new perspectives of research on the development of natural coagulants to treat surface water, groundwater, wastewater, and industrial water, as well as on extraction processes to obtain liquid coagulants from Aloe vera, and finally on the solvent recovery procedure after extracting process. However, further investigations in pilot and full-scale plants are necessary in addition to a cost-benefit analysis to comprehensively understand the potential of bio-coagulants in water treatment.

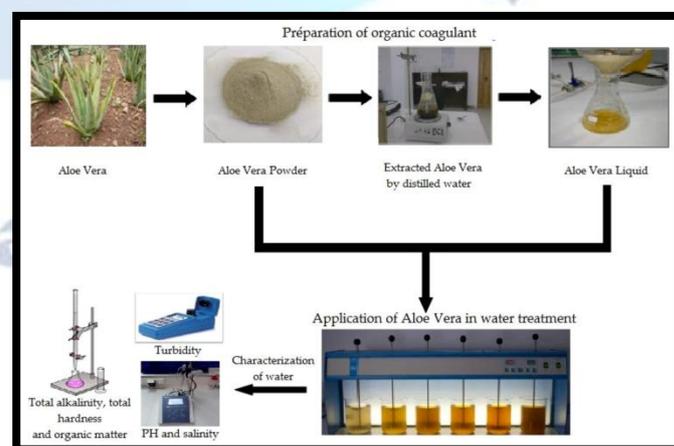
4. PROBLEMS STATEMENT

Aluminium salts are widely used as chemical coagulants in the water purification process all over the world. However, recent studies have raised doubts about the advisability of introducing aluminium into the environment, especially concerning about residuals in the treated water, large production of sludge volume and Alzheimer's disease (Diaz et al., 1999). Poly-aluminium chloride (PACl) as polymerized forms of metal coagulants has been widely used for water treatment in Europe, Japan and North America due to its reduced cost and wider availability. PACl is claimed to be more advantageous over conventional coagulants because of its higher removal of particulate and organic matters and intrinsic benefits of lower alkalinity consumption and lesser sludge production (Sinha et al., 2004).

Natural coagulants of vegetable and mineral origin were widely used in water and wastewater treatment before the advent of synthetic chemicals like aluminium and ferric salts (Ndabigengesere et al., 1998). Previous studies however, have not determined whether such natural coagulants are economically and environmentally more acceptable than chemical

coagulants. Recently there has been more interest in the subject of natural coagulants, especially to resolve the problems of water and wastewater treatment. Natural macromolecular coagulants show bright future and are considered by many researchers because of their abundant source, low price, innocuity, multifunction and biodegradation (Zhang et al., 2006). The material that has recently received a great degree of attention is the seed of *Moringaoleifera* and it has been reported by various authors (e.g. Ndabigengesere et al., 1998; Okuda et al., 2001; Heredia and Martin, 2009). Recently, natural coagulants based on mucilags like cactus and *Opuntiaficusindica* have been explored by many researchers (e.g. Young et al., 2005; Sepulveda et al., 2007; Heredia and Martin, 2009).

In India, majority of the population still lives in villages and small towns. These rural/tribal communities do not have access to public water supplies. People living in these regions obtain their water supply from unprotected sources such as open dug wells or small streams and ponds which are polluted. The treatment of water in these areas has a unique problem. Therefore, there is an urgent need for development and widespread promotion of simple treatment techniques for rural/tribal areas. The proteins in natural coagulants are considered to act similar to synthetic, positively charged polymer coagulants of non-plant origin. When added to raw water, proteins which carry a positive charge bind to the negatively charged particulates that make raw water turbid. Under proper agitation, these bound particulates grow in size due to agglomeration thereby forming flocs, which may be left to settle by gravity or be removed by Filtration.

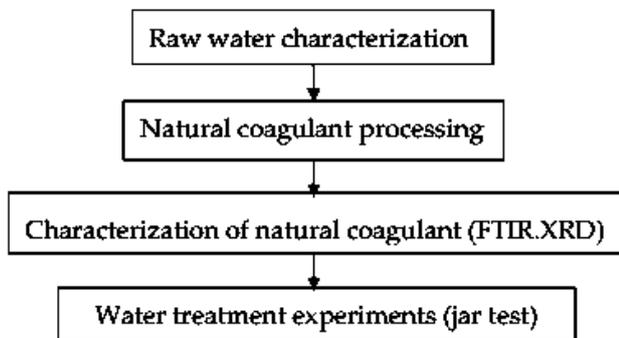


[Fig.4.1: Water Treatment Process Using Aloe Vera]

5. PROPOSED METHODOLOGY

5.1 Methodology

All coagulation experiments were carried out using sampling lake water. A conventional jar test apparatus was used in the experiments to coagulate sample of sampling lake water using coagulants.



5.2 Materials Collection (Preparation of Aloe Vera gel)

Aloe Vera leaves were collected from in campus. The leaves were washed under the tap water to remove the dirt. Thick green cover or epidermis was carefully separated from the gel part. Then the gel part was blended in mixer to form liquid and preserved in glass bottles in refrigerator. 1% dilution of aloe vera was made by using 1ml aloe vera gel in 100 ml distilled water similarly different percentage of aloe vera solutions were made.



[Fig.5.1: Preparation of Aloe vera gel aqueous solution]

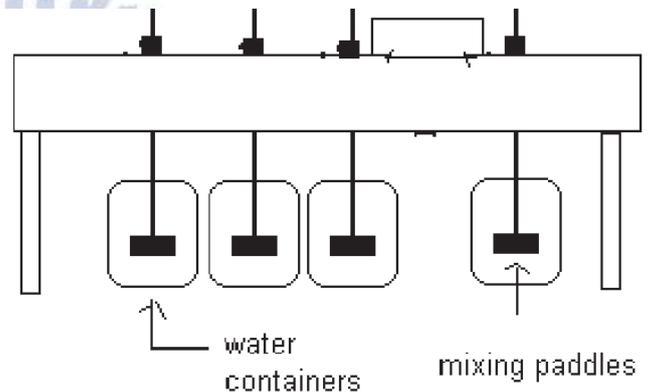
5.3 Experimental Setup (Jar test Experiments (test of coagulation-flocculation))

The coagulation-flocculation was performed according to the protocol of "Jar Test". Increasing doses of Aloe vera were introduced in 500 mL of dairy waste water. After settling time, 100 mL of the supernatant were collected in the average of 2 and 3cm from the surface using a pipette

and subjected to the same physicochemical analyzes of the dairy raw water. The removal efficiency of the analyzed parameters was determined by the formula below-

Removal parameter in percentage = $100 * (C_i - C_f) / C_i$

Where: C_i represents the concentration of the parameter in the raw water. C_f represents the concentration of the same parameter in the treated water.



[Fig.5.2: Jar Test Apparatus]

6. FUTURE SCOPE

The usage of plant based natural coagulants represents a fundamental development in sustainable environmental technology for the improvement of quality of life for communities. In an era of increasing environmental concerns, water scarcity admits the draw backs of chemical coagulants and poor sanitary facilities in most low income earning countries, the need to further develop natural coagulants as alternative environmentally favorable water purifying chemicals is exigent. The usage of bio-coagulants derived from plant based sources represents a vital development in 'grassroots' sustainable environmental technology through cost effectiveness. Design natural water purification techniques using plants extracts for bioremediation of turbid water. Application of this lowcost protocol will be recommended for simplified, point-of-use, lowrisk water treatment where rural and peri-urban people living in extreme poverty are presently drinking highly turbid and microbiologically contaminated water. The ultimate purpose of proposed research study is to come up with a compendium of plant coagulants that could be used as a technology that is cost effective and ecofriendly. It is felt that further research can be conducted by using the information described in

this review as a platform to discover other plant species which are non-toxic and can be mass produced.

7. CONCLUSION

Locally available plants based coagulants such as Aloe Vera were used for water purification. In our project paper evaluates Aloe can be used as water purifiers and it would be possible to develop an eco-friendly method of water purification. This will show the way to improve the quality of drinking water in the rural areas. We have presented natural coagulants whose availability is innate, their efficiency is also presented so that they can be considered for further study. It can be concluded that natural coagulants bring with them advantages of being, low cost, copious, native and efficient for treatment.

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Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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