Life Science Informatics Publications

Research Journal of Life Sciences, Bioinformatics, Pharmaceutical and Chemical Sciences

Journal Home page http://www.rjlbpcs.com/

RJLBPCS

ISSN 2454-6348

Original Research Article **DOI: 10.26479/2020.0604.02**

NATURAL PLANT SEEDS AS AN ALTERNATIVE COAGULANT IN THE TREATMENT OF MINING EFFLUENT

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ABSTRACT: This study was conducted to identify low – cost plant materials as coagulants for effluent treatment. Five profusely grown plant seeds were selected as bio – coagulants such as *Annona squamosa, Ziziphus mauritaima, Cicer arietinum, Pisum sativum* and *Citrillus lanatus* respectively. Among the tested seeds *Pisum sativum* (green pea) showed the highest removal of pH, EC, TDS, Chloride, Phosphate, Turbidity, Sulphate and Nitrate respectively. *Pisum sativum* was found to be the best seed to purify the contaminated water.

Keywords: *Annona squamosa,* Coagulants, Effluent, Phosphate.

Article History: Received: May 25, 2020; Revised: June 20, 2020; Accepted: July 02, 2020.

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1. INTRODUCTION

Water contamination is caused by the presence of undesirable as well as hazardous materials and pathogens beyond certain limits which is due to anthropogenic activities like discharge of sewage, effluence and wastes from domestic and industrial establishments, particulate matter, metals and their compounds due to mining, metallurgy, fertilizer and pesticide runoffs from agricultural activities [1]. Discharging of effluent wastewater without treating not only pollute surface water it may also show effect on ground water pollution and soil pollution. So the effluent must be treated in a proper way to meet discharge level requirements. Modern wastewater treatment process is aiming at incorporating cost effective, natural, economical and simple. In conventional water treatment, coagulation is achieved using chemical coagulants such as ferric chloride, aluminium

sulphate, poly aluminium chloride etc. [2] while the effectiveness of coagulants is well recognized, nonetheless, their application in water treatment is becoming unsuitable owing to high procurement cost, detrimental effects on human health, production of large sludge volumes. Flocculation is the aggregation of particles in suspension into visible flocs that sediment under gravity [3, 4]. Coagulants are useful in disabling or decreasing electrostatic barriers in order to allow closer contact between individual particles [5]. Natural coagulants are biodegradable and safe for human health; majority of this coagulant is coming from plant based coagulants such as cactus, cereals, shrubs, fungus, spice, nuts, nirmali seeds (Strychnos potatorum), Moringa oleifera and tannin [6]. Currently, natural coagulant is made up of fruit wastes that have surprisingly become a great help in the treatment of water [7]. It is also made from abundance material and toxic free. Material in the sample of water react with a coagulant floc will form and clump together [8]. Many of the developing countries have turned to use this plant as a viable coagulant in water and wastewater treatment on a small scale [9]. Hence the utilization of locally available natural coagulant was related to be cost effective, convenient and environment friendly for wastewater treatment in this study.

Objectives:

1. To characterize the collected mining effluent sample.
2. To use the natural as an alternative to chemical coagulant.
3. To determine the suitability of natural coagulant such as *Annona squamosa*, *Ziziphus mauritiama, Cicer arietinum, Citrullus lanatus* and *Pisum sativum* seeds for effluent treatment.

2. MATERIALS AND METHODS

The effluent samples was collected from barite mining area of Mangampeta in Kodur mandal of Kadapa district, Andhra Pradesh (Lat. 14^{o} 01 N'; Long. 79^{o} 19' E).

Preparation of coagulants: The fully matured or ripened fruits of *Annona squamosa, Ziziphus mauritaima, Cicer arietinum, Citrillus lanatus* and *Pisum sativum* were harvested from its trees and pods and edible parts of fruits were removed in order to obtain the seeds. The seeds were allowed to air dry for 2 days at room temperature and again allowed to dry at 80^{o}C for 3 hours in hot air oven. The dried seeds were cooled at room temperature and were crushed and ground using motor and pestle and it was sieved through 15 mm.

Fig. 1 *Annona squamosa*

Fig. 2 *Ziziphus mauritiana*

Fig. 3 *Cicer arietium*

Fig. 4 *Citrullus lanatus*

Fig. 5 *Pisum sativum*

Coagulation test

Coagulation tests were conducted using jar flocculator (Fig. 6). About 500 mg of the coagulant were mixed in 200 ml of effluent sample. The speed and duration of the jar floc test used were rapid mixing for 2 mins at 100rpm and again for 30 mins at 100 rpm for slow mixing followed by sedimentation for 30 minutes. After sedimentation the effluent samples were filtered through What man's filter paper and were analyzed for the parameters such as pH, EC, TDS, hardness, chloride, alkalinity, phosphate, sulphate, turbidity and nitrate respectively.

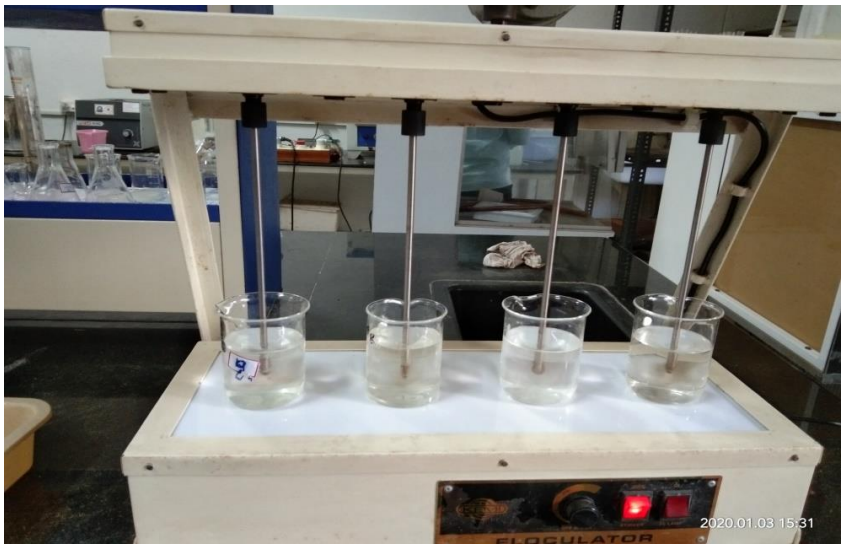

Figure 6. Jar test apparatus

The methods followed for the estimation of various physical - chemical parameters are recorded in Table 1.

Table 1. Methods followed for the estimation of Physical - Chemical Parameters [10]

S. No	Parameters	Methods
1	pH	pH meter (ELICO) L1614
2	Electrical Conductivity (µS/cm)	Conductivity meter (Hanna)
3	Total Dissolved Solids (mg/L)	TDS meter (Hanna)
4	Turbidity	Turbidity meter
5	Total Hardness (mg/L)	EDTA method
6	Total Alkalinity (mg/L)	Indicator method
7	Chloride (mg/L)	Silver nitrate method
8	Sulphate (mg/L)	Colorimetric method
9	Phosphate (mg/L)	Stannous chloride method
10	Nitrate (mg/L)	Phenol Disulphonic acid method

3. RESULTS AND DISCUSSION

In the present study, coagulation efficiency of *Annona squamosa, Ziziphus mauritaima, Cicer arietinum, Citrillus lanatus* and *Pisum sativum* was determined. pH is an important parameter which determines the suitability of water for different purpose. pH of the reaction mixtures is a key factor influencing the flocculation process [11] and the rate of pollutants elimination from an aqueous environment is mainly dependent on the pH of the effluent [12]. Raw effluent was found to be alkaline and when treated with coagulants there pH value was decreased. The removal percentage by *Ziziphus mauritiama* and *Cier arietinum* was observed to be 16.67 (Figure 7).

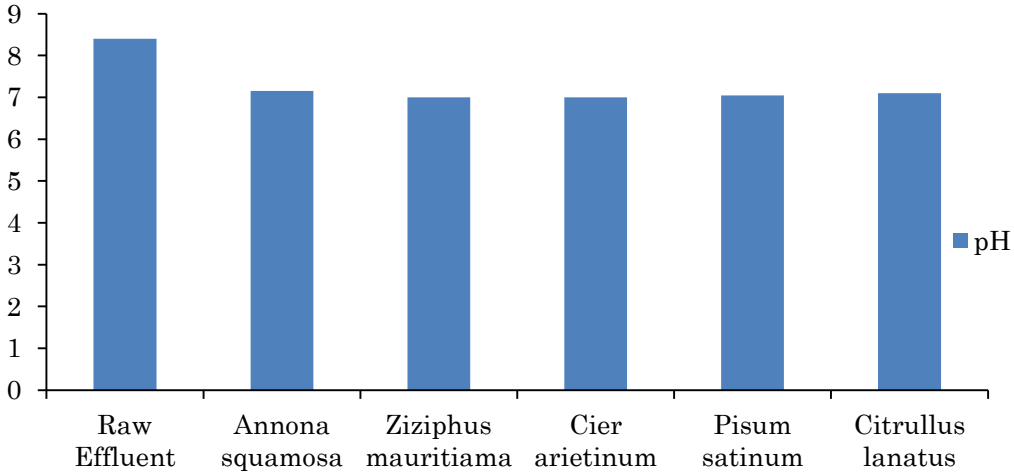

Figure 7. pH values of effluent before and after treatment

Electrical Conductivity, Total dissolved solids and Total hardness was observed high in the raw effluent whereas the coagulants treated effluent showed lower values. Among the studied, *Pisum sativum* showed much reduction in the EC and TDS values (Table 2; Fig. 8) whereas total hardness by *Annona squamosa* and *Citrullus lanatus* seed have decreased to 17.21 %. It has been observed

that the higher the solubility of a coagulant, the greater the collision of its total dissolved solid particles [13].The percentage removal of hardness for *Tamarindus indica* and *Moringa oleifera* seeds was 10% and 34% respectively [14]. Suleyman [15] reported that as a polyelectrolyte it may therefore be postulated *Moringa oleifera* removes hardness in water through adsorption and inter-particle bridging.

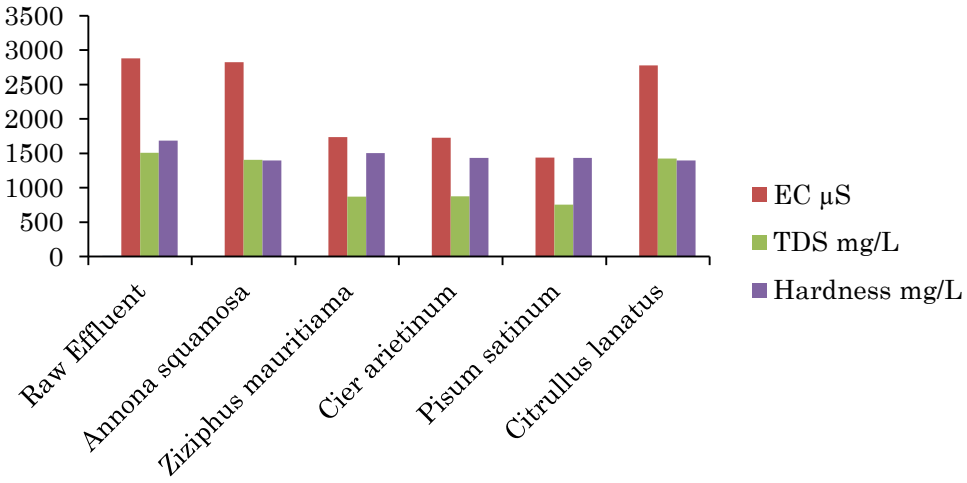

Figure 8. EC, TDS and Total hardness values of effluent before and after treatment

Alkalinity of the water source is more significant than its pH because it takes into account the principal constituents that influence the water's ability to regulate the pH of the medium. In the present investigation the alkalinity were absent in the coagulants treated effluent sample. Chloride is often associated with sodium since sodium chloride is a common constituent, the levels above 140 mg/L are considered to be toxic for plants [16]. The chloride contents indicate domestic as well as industrial pollution [17]. According to the result obtained *Pisum sativum* seed have decreased the chloride by 30.61 % followed by *Annona squamosa* and *Ziziphus mauritiama* (Table 2; Fig. 9).

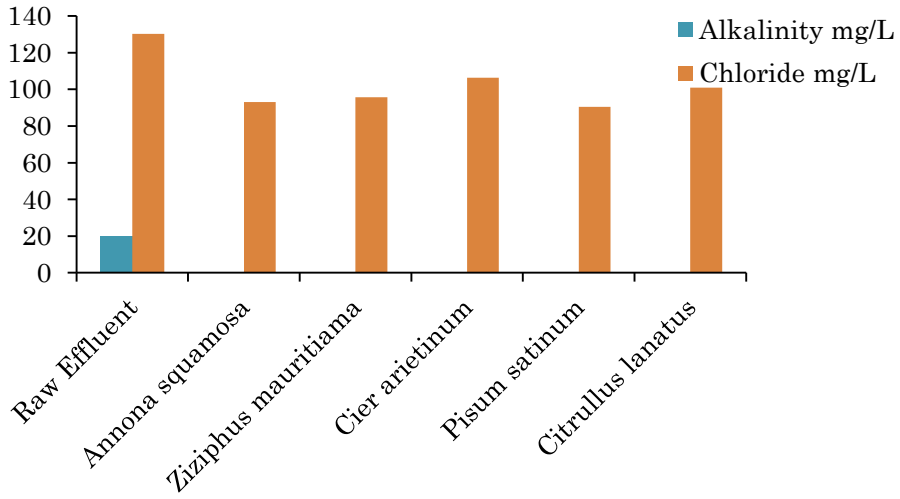

Figure 9. Alkalinity and Chloride values of effluent before and after treatment

The phosphorus and nitrates are nutrients needed for plant growth. The levels of the nutrients dropped for all the coagulants treated samples (Fig.10). *Pisum sativum* showed considerable

reduction after the introduction of coagulants, where as Ndabigengesere and Narasiah (1998) [18] reported that nutrient was not successfully removed by Moringa extracts. Adamu (2014) [19] suggested that layer compression and adsorption as well as neutralization of charged particle by other charged particle results in cleaving, settling and formation of precipitates during coagulation. Removal percentage of turbidity and sulphate by *Pisum sativum* is 74.36 and 91.67. A survey conducted by *Dolichos lablab* as a natural coagulant for the turbidity reduction [20] and the limitation in turbidity removal by Moringa confirmed that it is less effective in treating water with low levels of turbidity [21]. The nutrient content of the treated effluent when reused should not form an algal blooms which may occur if the values of N and P are high [22].

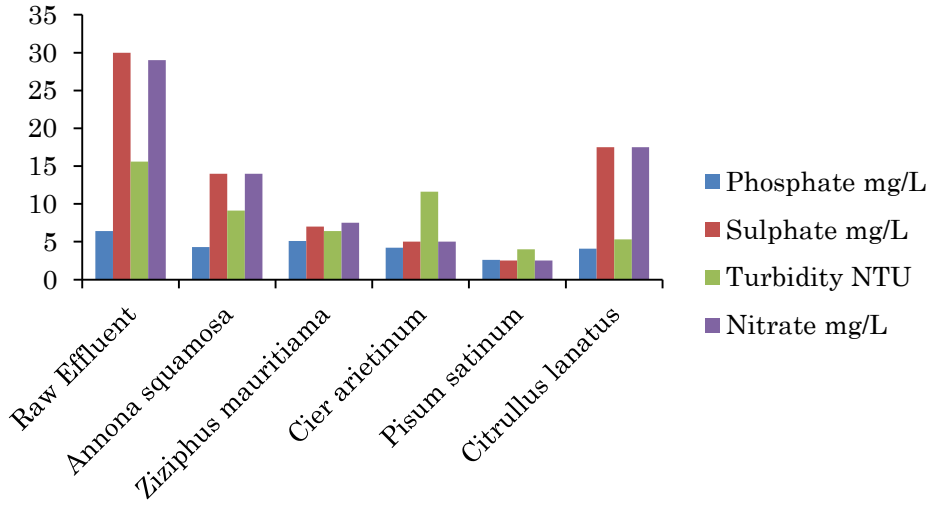

Figure 10. Phosphate, Sulphate, Turbidity and Nitrate values of effluent before and after treatment

Table 2. Physical and chemical characteristics of raw and treated effluent

Parameters	Raw Effluent	Treated Effluent				
		Annona squamosa	*Ziziphus mauritiama*	*Cicer arietinum*	*Pisum sativum*	*Citrullus Lanatus*
pH	8.4	7.15	7.0	7.0	7.05	7.10
EC µS	2882	2823	1737	1727	1437	2776
TDS mg/L	1510	1406	872	876	755	1426
Hardness mg/L	1685	1395	1502	1432	1435	1395
Alkalinity mg/L	20	0	0	0	0	0
Chloride mg/L	130.27	93.05	95.71	106.35	90.39	101.03
Phosphate mg/L	6.4	4.3	5.1	4.2	2.6	4.1
Sulphate mg/L	30	14	7.0	5.0	2.5	17.5
Turbidity NTU	15.6	9.1	6.4	11.6	4.0	5.3
Nitrate mg/L	29	14	7.5	5.0	2.5	17.5

4. CONCLUSION

All the coagulants tested reduced all the tested parameters considerably. The *Pisum sativum* could be best to decrease the pH, EC, TDS, Chloride, Phosphate, Sulphate, Turbidity and nitrate respectively. *Pisum sativum* recorded the highest removal of turbidity and sulphate of 74.36 % and 91.67 %. It can be concluded that the usage of plant seed – based coagulants for the effluent treatment represents a vital role in sustainable environmental technology.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

HUMAN AND ANIMAL RIGHTS

No Animals/Humans were used for studies that are base of this research.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

The authors confirm that the data supporting the findings of this research are available within the article.

FUNDING

None

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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