International Journal of Scientific Engineering and Research (IJSER)
ISSN (Online): 2347-3878
Index Copernicus Value (2015): 62.86 | Impact Factor (2015): 3.791

Use of Papaya Seed as a Natural Coagulant for Water Purification

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Abstract: ***In this study, a natural indigenous coagulant like papaya seed was suggested as a substitute for alum. It is readily available and commonly recognizable in most urban and rural communities. The powdered material is obtained from the seed of papaya was used to test coagulant rate and dose. This study mainly focused on the removal of turbidity, total dissolved solids and effect of coagulation on pH of sample etc. Turbidity and other physico-chemical characteristics of surface water sample were measured before and after the Jar test by using portable instruments. The experiments were carried out with coagulant dosage of 0.2, 0.4, 0.6, 0.8, 1.0 and 1.2 g/L in raw water sample. 89.14% turbidity removal efficiency was obtained from this study and total dissolved solids removal efficiency of papaya seed obtained from this study was 90.29% at a dosage of 0.6g/L. Papaya seed exhibited high efficiency in removing Total Suspended Solids, Alkalinity, Total Hardness, Dissolved Oxygen etc.***

Keywords: Coagulant, Papaya seed, Turbidity, Total dissolved solids

1. Introduction

Water is used for variety of purpose like drinking, washing, bathing, recreation as well as numerous other varied industrial applications. World Health Organization (WHO), report that wholesome of water means absence of suspended solids, inorganic solids and pathogens. Water covers 71% of earth surface, on earth, 96.5% of planet water is found in ocean, 1.7% in ground water, 1.7% in glaciers and icecap in Antarctica and Greenland, a small fraction in various other water bodies, and precipitation only 2.5% of earth water is fresh water and 98.8% of that water is in ice and ground water, less than 0.3% of all fresh water is in river, lakes and the atmosphere, and an even small amount of earth's fresh water contained within biological bodies and manufactured products. Safe water is essential for human and other forms of life even though it provides no calories or organic nutrients .Access to safe water is improved over last decades in almost every part of the world, but approximately one billion people still lack to safe water and over 2.5 billion lack accesses to safe sanitation. Increasing amount of discharged sewage progressing urbanization, the use of chemicals in agriculture and industry as well as anthropogenic activities all affects quality of waters. The final effect of water degradation is the limits to the use of drinking water reservoirs [2].

Water quality is of concern to everyone. Quality is the acceptability of the water for uses like drinking, cooking, bathing, and laundering. Most municipally treated water is safe and generally of good quality. Water from private or community wells can be contaminated. Contaminated water may have off-tastes, odors, or visible particles [3]. The conventional method of water purification using aluminium sulphate (alum) and calcium hypochlorite puts pressure on the nation's over-burdened financial resources since they are imported thereby making treated water very expensive in most developing countries and beyond the reach of most rural folks. Hence, they resort to the sources like dams, dug outs, streams, rivers and lakes. Water from these sources is usually turbid and contaminated with microorganisms that cause many diseases [4].

In developing countries treatment plants are expensive, the ability to pay for service minimal and skills as well as services are scare. In order to alleviate the prevailing difficulties, approaches are focused on sustainable water treatment systems that are low cost, robust and require minimal operational skill. Coagulation and flocculation helps in removal of colloidal particles, available coagulants like aluminiumsulphate and poly aluminium chloride. They are cheap, effective and easy to handle. Aluminium can be over dosed for efficient coagulation but overdose of aluminium salt increases the alum concentration and cause turbidity. Excess intake of aluminium causes Alzheimer's disease. Locally available materials can be exploited towards achieving sustainable safe portable water supply [1].

In India, people live in extreme poverty have been drinking highly turbid and microbiologically contaminated water as they lack knowledge of proper treated water, they do not afford to use high cost of treatment methods using chemical coagulants. There are few problems that cause large seasonal variations in raw water and increase its turbidity. Natural coagulants have been used for domestic purposes since traditional times in tropical rural areas. The main advantages of using natural plant based coagulants are cost effective, less production of pH and biodegradability. The naturally occurring coagulants are presumed safe for human health [1].

Kallada River is the study area which is flowing through Kollam district is one of the most important water source for domestic purpose, industrial use and water treatment plant, Punalur. Many industries are flourishing on the bank

of Kallada River. Punalur Paper Mills was one of such industry operated near the bank of this river. The effluent discharged from the industry in to river is found to alter the physicochemical factors. The quality of water is changed due to various reasons. In congested areas the water supplies get polluted mainly by domestic and industrial wastes. Population growth, rapid industrial and technological developments, urbanization, periodic drought and even legal decisions are some of the reasons for the declining of water quality. Hence it is important to treat water from Kallada River before using it for domestic purpose.

Natural coagulants have been used in rural areas as effective coagulants. The naturally occurring coagulants are presumed safe for human health. The main objective of this study is to investigate the efficiency of Carica Papaya seeds, in coagulation of turbid water. The study also focused on the determination of optimum dosage and contact time for using papaya as a natural coagulant in house hold water treatment as well as community water treatment plants. The comparative efficiency studies of alum and papaya seed for water treatment was also studied. This will show the way to improve the quality of drinking water in the rural area. This material was selected for this study because papaya seed has high protein content and some authors have considered that the active coagulating agents in plant extract are proteins.

2. Materials and Methods

2.1 Materials

Few materials were used in this study such as water and natural coagulant like Papaya seed. The detailed description of this coagulant is given below;

2.1.1 Carica Papaya

Papaya fruit contain large number of small black color seeds. The fruit as well as seeds contain large protein content and have medicinal values. Papaya seed have anti-inflammatory properties, wound healing properties, suitable for digestion, prevention of cancer and kidney disorders, provide heart health and its use increase immunity because it contains vitamin A & C. Papaya seed is a rich source of proteins. Seed work as a coagulant due to the presence of positively charged proteins which bind with negatively charged particles (silt, clay, bacteria and toxins etc), allowing the resulting flocs to settle and obtain clear water(adsorption & charge neutralization). Also papaya seed powder has ability to join with solids in water and settle to the bottom. Papain (Papaya proteinase) is the important protein present which contains 345 amino acid residues and consists of a single sequence of propeptide and mature peptide.

2.2 Methods

2.2.1 Collection of Water Sample

The raw water sample was collected from Kallada River, flowing through Punalur town, Kollam. The water was collected from the river by immersing a sterilized plastic container until it was full. The cap was inserted while it was still underway. The water was then treated using prepared coagulant.

2.2.2 Collection and Identification of Seed

Seed used in this study that is Carica papaya was collected from the market and nearby locations.

2.2.3 Preparation of Seed Powder

The fruits were sliced open using a clean knife. The seeds were washed severally with distilled water. Then seeds were dried under sunlight for a period of 7 days before crushing. The seed were made into fine powder using home grinder and powder was collected in sterile bottle with air tight cap. Then the seed powder was sieved and finer particles were then used as coagulant.

2.2.4 Water Quality Tests

Water quality tests were conducted using standard methods in APHA 1998.

3. Results and Discussion

3.1Physico-chemical parameters of raw water

The physico-chemical properties of the raw water sample used in this study are presented in table 3.1.From table it is clear that turbidity, total suspended solids, total dissolved solids and BOD value of raw water were much higher as compared to drinking water standards given by WHO and BIS. Hence need for treatment. However all other components are within the limits and safe without treatment.

3.2 Sieve Analysis Result

Table 3.2 show the readings obtained by conducting sieve test. From that value a particle size distribution curve is drawn and effective size of papaya seed powder was obtained. Figure 3.1 shows the particle size distribution curve. The effective size (D_{10}) of papaya seed powder obtained was 180μ.

3.3 Study of coagulant dose on removal of turbidity

Turbidity of water sample is due to the presence of suspended impurities of organic and inorganic salts. It is the measure of the degree to which the water loses its transparency due to the presence of suspended particulates. Jar test experiment was conducted to measure the turbidity removal efficiency of coagulant. Different amount of coagulant doses was added to six water samples with 0.2g/L interval (Table3.3). After experiment, it was clear from figure3.2; papaya seed powder has potential to remove turbidity of raw water sample. Best result was observed at optimum dose of 0.6g/L at which 89.14% turbidity was removed from the sample

3.4 Study of coagulant dose on removal of Total dissolve solid

Total dissolved solids (TDS) were determined by gravimetric method. It was due to dissolved inorganic and organic salts. It was observed from table3.4, the amount of total dissolved solid decreases with increase of coagulant dosage, showed maximum efficiency at 0.8g/L. At this optimum dose of coagulant 91.92% TDS were removed from water sample.

3.5 Study of coagulant dose on removal of Total Hardness

Hardness is the amount of dissolved calcium and magnesium in the water. Hard water is not a health risk, but a nuisance because of mineral build up on fixtures and poor soap and / or detergent performance. It was observed from table3.5, the amount of total hardness decreases with increase of coagulant dosage, showed maximum efficiency at 0.6g/L. At this optimum dose of coagulant 91.92% Total Hardness were removed from water sample.

3.6 Study of coagulant dose on pH of water sample

There is no significant change on pH before and after experiment. Therefore it was concluded that papaya seed powder has no measurable potential to neutralize surface water sample. pH of the water sample was measured using digital pH meter.

4. Conclusion

It was evidenced from this study papaya seed powder coagulant as a real alternative to traditional inorganic metal coagulants in the removal of turbidity and total dissolved solids. The pH reading was almost similar before and after treatment. From the results obtained, Papaya seed has been found to be an efficient natural coagulant for river water treatment. From the observations taken it was also concluded that when natural coagulants were used as a coagulant aid, the dosage of alum can be reduced which can help to reduce the detrimental effects caused by chemical based coagulants. Natural coagulant is sustainable and suitable for economical way of water treatment process. Considering the fact that papaya seed can be locally produced, its use in water purification should be encouraged. This is likely to reduce the high cost of the current water treatment systems. The seed used has not giving any toxic effect. It is eco-friendly and provides cheaper method of water treatment. These seeds can be used in rural areas where no facilities are available for the water treatment; the sludge settled can be used as bio fertilizer advantage for rural villages. Papaya seed is high efficient to remove turbidity of water.

Acknowledgement

The authors will like to acknowledge UKF College of Engineering and Technology for the valuable support for the completion of present project.

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Table 3.1: Initial parameter values of Kallada River Water

Parameter	Initial Result	WHO Standard	BIS Standard
pH	7.6	6.5-8.5	6.5-8.5
Electrical conductivity(µS/cm)	130	1400 Max	2000 Max
Turbidity(NTU)	35	5Max	5Max
Alkalinity(mg/L)	98	-	200
Acidity(mg/L)	24	-	15
Total hardness(mg/L)	52	500	200
Total suspended solids(mg/L)	860	-	-
Total dissolved solids(mg/L)	1610	500	500
Dissolved oxygen(mg/L)	4.3	-	4-6
Biochemical oxygen demand(mg/L)	2.4	6	2

Table 3.2: Sieve test results

Sieve size	Weight retained	Percentage weight retained	Cumulative percentage retained	Percentage finer
600µ	70.61	24.61	24.61	75.39
300µ	82.63	28.8	53.41	46.59
212µ	90.84	31.66	85.07	14.93
150µ	29.14	10.16	95.23	4.77
75µ	11.55	0.04	95.27	4.73
Pan	2.13	0.0072	95.28	4.72

Table 3.3: Coagulant dosage Vs Turbidity

Sl. No	Volume of sample (ml)	Coagulant dose g/L	Initial Turbidity (NTU)	Final turbidity (NTU)	% removal
1	1000	0.2	35	6.8	80.57
2	1000	0.4	35	5.1	85.42
3	1000	0.6	35	4.4	87.42
4	1000	0.8	35	6.6	81.14
5	1000	1.0	35	6.9	80.28
6	1000	1.2	35	7.2	79.42

Table 3.4: Coagulant dosage Vs Total Dissolved Solids

Sl. No	Volume of sample (ml)	Coagulant dose g/L	Initial TDS (mg/L)	Final TDS (mg/L)	% removal
1	1000	0.2	1610	340	78.88
2	1000	0.4	1610	290	81.99
3	1000	0.6	1610	146	90.93
4	1000	0.8	1610	130	91.92
5	1000	1.0	1610	148	90.8
6	1000	1.2	1610	158	90.18

Table 3.5: Coagulant dosage Vs Total Hardness

Sl. No	Volume of sample (ml)	Coagulant dose g/L	Initial Hardness (mg/L)	Final hardness (mg/L)	% removal
1	1000	0.2	52	21	59.61
2	1000	0.4	52	21.3	59.04
3	1000	0.6	52	15.3	70.58
4	1000	0.8	52	18	65.38
5	1000	1.0	52	21	59.61
6	1000	1.2	52	23	55.77

Table 3.6: Coagulant dosage Vs pH

Sl. No	Volume of sample (ml)	Coagulant dose g/L	pH of sample
1	1000	0.2	7.6
2	1000	0.4	7.8
3	1000	0.6	7.6
4	1000	0.8	7.7
5	1000	1.0	7.6
6	1000	1.2	7.9

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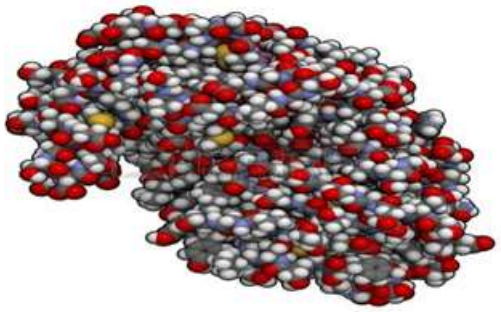

Fig 2.1: Papain structure

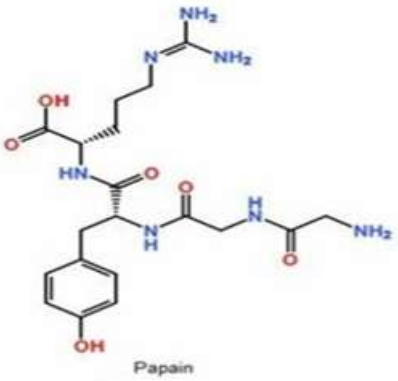

Fig 2.2: Papain skelton

Fig 2.3: Papaya plant

Fig 2.4: Raw papaya seed

Fig 2.5: Dry papaya seed

Fig 2.6: Papaya seed powder

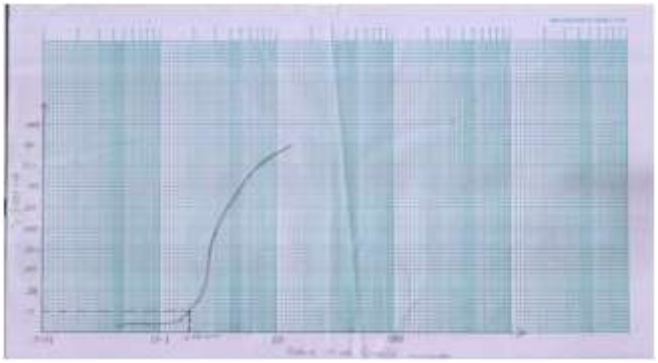

Fig 3.1: Particle size distribution curve

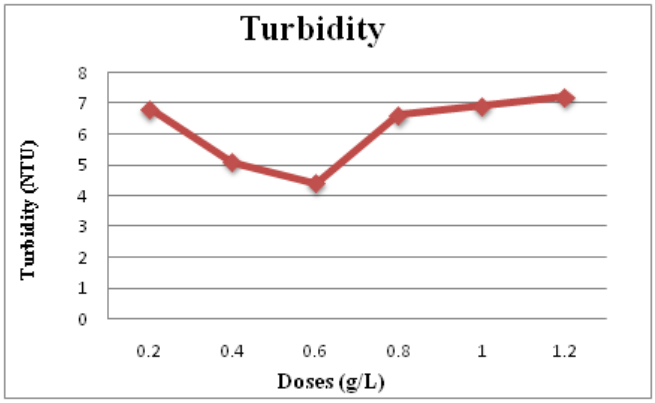

Fig 3.2: Effect of Coagulant dosage on Turbidity

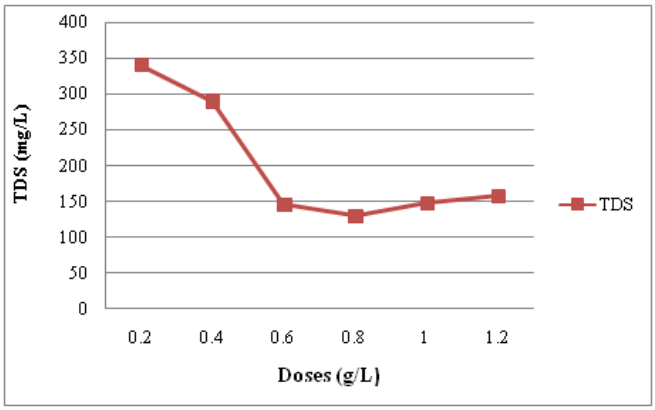

Fig 3.3: Effect of Coagulant dosage on TD

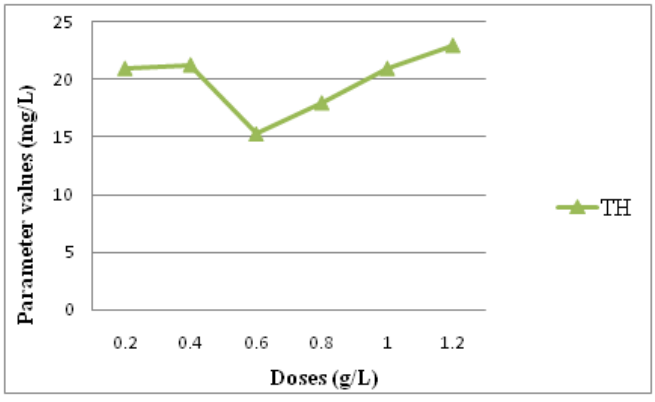

Fig 3.4: Effect of Coagulant dosage on Total Hardness

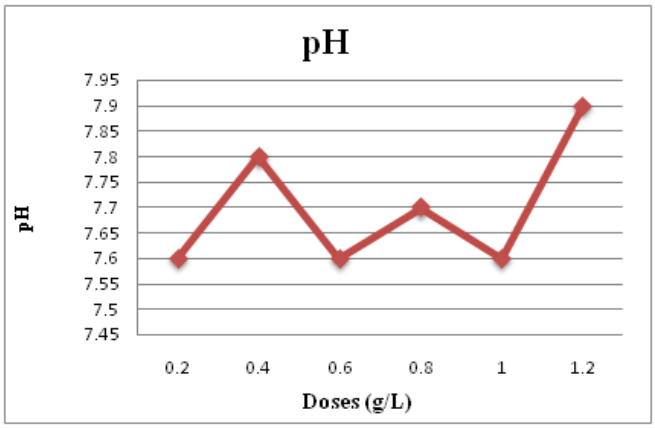

Fig 3.5: Effect of coagulant dosage on pH