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TURBID FLOOD WATER TREATMENT USING TAMARIND BY PRODUCTS

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Abstract : *Water supply is a basic need required for living creatures and human beings specifically. In this world, the amount of resources available to living creatures is limited. About 75 % of world population lives in the developing countries of the world. About 1.2 billion people still lack safe drinking water and more than 6 million children die from diarrhoea in developing countries every year. However, it is untenable and unbelievable under all situations that waterborne diseases still kill on the average 25,000 people every day in developing countries while millions suffer the debilitating effects of these diseases. Safe drinking water is essential to the health and welfare of a community, and water from all sources must undergo some form of purification before consumption. Various methods are used to make water safe and attractive to the consumer. The method employed depends on the character of the raw water. One of the problems with treatment of surface water is the large seasonal variation in turbidity.*

ADVANTAGES OF PLANT- BASED NATURAL COAGULANTS

In contrast to chemical coagulants, plant-based natural coagulants are safe, eco-friendly and generally toxic free. Natural coagulants have been found to generate not only a much smaller sludge volume of up to five times lower but also with a higher nutritional sludge value. As such, sludge treatment and handling costs are lowered making it a more sustainable option. The raw plant extracts are often available locally and hence, a low cost alternative to chemical coagulants. Since natural coagulants do not consume alkalinity unlike alum, pH adjustments can be omitted and this provides extra cost savings.

LITERATURE REVIEW

Hefni Effendi et.al (2017) reviewed that tamarind seeds can be used as a natural coagulant and 4g/L tamarind seed powder could reduce turbidity of about 75%, total suspended solids about 77.14%, chemical oxygen demand about 68.18%, sulfate ion concentration about 71.42% and mercury ion concentration about 82.76%. Theyreviewed that tamarind seed powder has equal efficiency as that of the chemical coagulant like alum. **Nedunuri Phani Kumar et.al (2017)** reviewed that the maximum monolayer adsorption capacity of virgin TNFC and treated TNFC absorbents as obtained from the Langmuir adsorption isotherm was found to be 4.14 mg/g and 6.11 mg/g of fluoride. **Said S et.al (2016)** found out that plant-based coagulants are potential alternatives to chemical coagulants used in drinking water treatment. They examined the turbidity removal efficiency of Tamarindus indica fruit crude pulp extract (CPE) towards evaluating a low-cost option for drinking-water treatment. Laboratory analysis was carried out on high turbidity raw water samples (i.e. 478 NTU) using T. indica CPE of concentrations ranging from 500 to 3000 mg/L as natural coagulant, using jar tests. Results obtained showed turbidity removal efficiency of the coagulant ranging from 64 to 99%. **B.Mahesh et.al (2015)** reviewed that Tamarindus indica seeds are used for the removal of metals from waste water. Insitu analysis was carried out by varying the dosage of adsorbent, PH, temperature, and contact time. The results showed that Tamarindus indica in the powdered form act as a good absorbent with 90% efficiency. Thus, providing an economically feasible and eco-friendly technology useful for improving the quality of life for rural people

Material used-tamarind seed powder

Tamarind is a leguminous tree in the family Fabaceae indigenous to tropical Africa. The genus Tamarindus is a monotypic tax on. The tamarind tree produces pod-like fruit that contains an edible pulp used in cuisines around the world. Tamarind Kernel Powder is derived from the plant Tamarindus Indica. Tamarind is an evergreen tree. Various grades are delegated to Tamarind Seeds following which these seeds are methodically ground to powder conserving their nutritious properties, than these seeds are roasted and decorticated. Tamarind seed powder (figure 3.1) contains high protein. This protein acts as a polyelectrolyte whose utility is similar to synthetic coagulant; Tamarind seeds are relatively cheap and environmental friendly. Natural coagulants have been found to generate a very lowamount of sludge up to about less than five times than that of a chemical coagulant but, with more nutritional sludge value. As such, sludge treatment and handling cost are considerably reduced .Thus, making it a more sustainable and environment friendly option.

Preparation of tamarind seed powder

The coagulant which is used is tamarindus indica seed for treatment of surface water such as river water. Locally available dry Tamarindus indica seeds were obtained from the village Ayyamparambu situated in Kunnamkulam. The seeds were dried in sunlight and kept in room temperature. Then the seeds were oven dried and grounded to fine powder using a mortar and then kitchen blender to make it of approximate size of 0.005mm to make soluble in water of active ingredients of the seeds. Figure 1.shows the tamarindus indica seed and figure 2 shows tamarind seed powder.

Fig.1 Tamarind seeds

Fig.2 Tamarind seed powder

DATE SEED POWDER

Date seeds are the by-product of date stoning, either for the production of pitted dates or for the manufacture of date paste. The date seed is a hard coated seed, usually oblong, ventrally grooved, with a small embryo. Date pits weigh 0.5 g to 4 g and represent 6 to 20% of the fruit weight depending on maturity, variety and grade. Date palm is a principal fruit grown in many regions of the world. It is abundant, locally available and effective material that could be used as an adsorbent for the removal of different pollutants from aqueous solution. Date seed powder is traditionally used for animal feed. They can also be used asa source of oil (which has antioxidant properties valuable in cosmetics), as a coffee substitute, as a raw material for activated carbon or as an adsorbent for dye-containing waters. It is an excellent natural coagulant in powdered form. Date palm seeds are more effective in treating polluted water than traditional means, such as active carbon, one of the most commonly used methods to eliminate particles and toxins from water. It act as an adsorbent in the removal of unwanted materials such as acid and basic dyes, heavy metals, and phenolic compounds.

Fig.3 Date seeds

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Fig.4 Date seed powder

TAMARIND FRUIT COVER POWDER (TNFC)

Tamarind fruit cover (figure 3.5) is brittle, easily cracked shell of ripe tamarind pod that separates out from the fruit. This is available in plenty as a waste by product of tamarind pulp industry. Tamarind fruit covers (TNFC) were obtained from the ripe tamarind fruit. They are easily broken, brown in color; these are collected locally from the village Ayyamparambu situated in Kunnamkulam. Tamarind fruit cover can be used for water treatment in two ways. Either in virgin form or in acid treated form.

Fig.5 Tamarind fruit and its shell

Fig.6 Tamarind fruit cover powder

Preparation of TNFC

Locally collected tamarind fruit cover shells are washed with distilled water for discoloration and dried in an oven at 100 ^{0}C for half an hour. The dried biomass was powdered and sieved to get produced uniform sized powders. Half of the virgin biomass was pretreated with 1M HCl in order to examine the possible increase in adsorption capacity of TNFC. Fluoride adsorption investigations were made on TNFC (virgin) as well as TNFC (treated). The pre- treatment of TNFC is carried out to increase the metal uptake efficiency. The virgin TNFC was soaked in 1 M HCl for 24 hrs and kept on the water bath (70°C) for half an hr. It is cooled and is neutralized with 50 ml of 1N NaOH. Finally it was washed with distilled water several times and dried in an oven at 80^{o}C for 6 hrs and cooled at room temperature in desiccators.

CERAMIC FILTER

A ceramic water filter (figure 3.7) is a simple, bucket-shaped 25cm diameter and 30 cm deep clay vessel that is made from a mix (by weight) of local terra-cotta clay and sawdust or other combustibles, such as rice husks. The filters are formed by using a press. The simplest press utilizes a hand-operated hydraulic truck jack and two-piece aluminum/metal mould (Figure 3.8). Filters are fired to about 860 deg. C. and the milled, screened combustible material burns out, leaving porous clay walls. The filters are tested to make sure they meet a standard rate of filtration and then they are coated with colloidal silver. The combination of fine pore size and the bactericidal properties of colloidal silver produce an effective filter. When in use, the fired and treated filter is placed in a five-gallon plastic or ceramic receptacle with a lid and faucet. Water passes through the clay filter element at the rate of 1.5 to 2.5 liters per hour.

Fig.7 Ceramic filter

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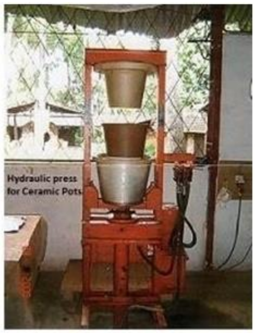

Fig.8 Hydraulic press for ceramic pots

COLLECTION OF WATER SAMPLE

The sample water used throughout the project was collected (figure 6.1) from the Puzhakal river which is located at a distance of 6.3 kilometres from IES college of engineering, Chitillapilly (figure 6.2). The raw water was stored in the plastic cans in the laboratory.

Fig.9 Collection of water sample

SCREENING OF WATER SAMPLE

Screening is the first unit operation used at wastewater treatment plants (WWTPs). Screening removes objects such as rags, paper, plastics, and metals to prevent damage and clogging of downstream equipment, piping, and appurtenances. Some modern wastewater treatment plants use both coarse screens and fine screens.

Experimental setup

Jar test apparatus

Jar test is the most widely used experimental methods for coagulation-flocculation. A conventional jar test apparatus (figure 6.3) was used in the experiments to coagulate sample of turbid. Water using natural coagulant. It was carried out as a batch test, accommodating a series of six beakers together with six-spindle steel paddles. Before operating the jar test, the sample was mixed homogenously. Then, the samples ought to be measured for turbidity, for representing an initial concentration. Coagulants of varying concentrations were added in the beakers. The whole procedures in the jar test were conducted in different rotating speed.

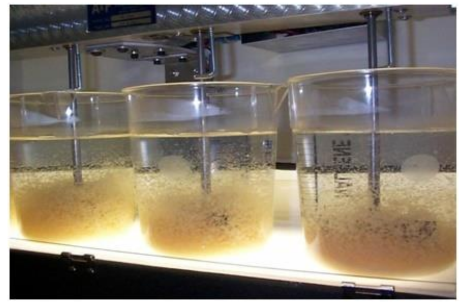

Fig.10 Conventional jar test apparatus

Turbidity measurements were conducted using digital Nephelo turbidity meter (figure 6.4).The initial turbidity value of the sample water was noted down and the turbidity values after jar test were found out. The percentage efficiency of turbidity removal was calculated by using the following equation.

Percentage efficiency of turbidity removal = ((initial turbidity – final turbidity)/ (initial turbidity)) x 100%

Fig.11 Nephelo turbidity meter

Defluoridation using TNFC

Tamarind fruit cover is brittle, easily cracked shell of ripe tamarind pod that separates out from the fruit. This is available in plenty as a waste by product of tamarind pulp industry. Tamarind fruit covers (TNFC) were obtained from the ripe tamarind fruit. They are easily broken, brown in color and these were collected locally from Thrissur. It was washed with distilled water for discoloration and dried in an oven at 100 ^{0}C for half an hour. The dried biomass was powdered and sieved to get produced uniform sized powders. Half of the virgin biomass was pretreated with 1M HCl in order to examine the possible increase in adsorption capacity of TNFC. Fluoride

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adsorption investigations were made on TNFC (virgin) as well asTNFC (treated).

CERAMIC FILTRATION

The coagulation processes are carried out in three stages using the coagulants such astamarind seed powder, date seed powder and tamarind fruit cover shell powder. Ceramic filtration has to be carried to remove the biological organisms in water such as bacteria, protozoa, and microbial cysts. Colloidal silver is sometimes added to the clay mixture before firing or applied to the fired ceramic pot. Colloidal silver is an antibacterial that helps in pathogen inactivation, as well as preventing growth of bacteria within the filter itself.

Fig.12 Ceramic pot filter

REMOVAL OF CONTAMINATION

Pathogens and suspended material are removed from water through physical processes such as mechanical trapping and adsorption. Quality control on the size of the combustible materials used in the clay mix ensures that the filter pore size is small enough to prevent contaminants from passing through the filter. Colloidal silver aids treatment by breaking down pathogens' cell membranes, causing them to die. Contaminated water is poured into the ceramic pot. The water slowly passes through the pores and is collected in the lower container. The treated water is stored in the container until needed, protecting it from recontamination. The user simply opens the tap at the base of the container when they need water. For turbidity levels greater than 50 NTU (Nephelometric Turbidity Units), the water should strained through a cloth or sedimented before using the ceramic pot filter. The filter pot should be regularly cleaned using a cloth or soft brush to remove any accumulated material. It is recommended that the filter pot be replaced every one to two years. This is, in part, to protect against fine invisible cracks which may have developed over time. Any cracks will reduce the effectiveness since water can short-circuit through the cracks without being filtered through the ceramic pores. Furthermore, flow through the filter will slow over time even with regular cleaning, as accumulated material that cannot be removed by cleaning continues to build up and block thepores.

RESULT AND DISCUSSION

WATER QUALITY STANDARDS

Table 1 contains the water quality standards of turbidity, pH, chlorides, dissolved oxygen, sulphate, alkalinity, biological oxygen demand, dissolved oxygen and also initial water characteristics.

Table 1 Water quality standards

Sl.No	PARAMETER	DESIRABLE LIMIT	PERMISSIBLE LIMIT	INITIAL WATER CHARACTERISTICS
1	Turbidity (NTU)	5	10	18.4
2	pH	6.5-8.5	No relaxation	9.5
3	Chlorides (as Cl in mg/l)	250	1000	75
4	Sulphate (mg/l)	200	400	24
5	Dissolved solids(mg/l)	500	2000	155
6	Alkalinity(mg/l)	200	600	183
7	BOD(mg/l)	-	<20	28
8	DO(mg/l)	-	>5	4

OPTIMUM DOSAGE AND TURBIDITY REMOVAL

It may be observed from Table 7.2 that, at a residual turbidity of 0.84 NTU the optimum dose of coagulant was 150mg/l by using tamarind seed powder. The respective coagulant dosage levels with corresponding residual turbidity values were clearly shown in the form of graph in Figure 7.1. It was noticed that turbidity values are gradually decreasing from coagulant dosage level of 50mg/l to 150mg/l and gradually increasing from dosage level of 200mg/l to 250mg/l. The minimum residual turbidity was obtained when coagulant dosage was 150mg/l and it is considered as the optimum coagulant dosage.

Sl.No	COAGULANT DOSAGE (mg/l)	RESIDUAL TURBIDITY (NTU)
1	50	1.98
2	100	1.55
3	150	0.84
4	200	1
5	250	1.4

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Table 2 Turbidity removal using tamarind seed powder

TURBIDITY REMOVAL WITH VARYING pH WITH CONSTANT DOSAGE

At a constant coagulant dosage of 150mg/l, the optimum pH was determined at a pH of 8.0 and the turbidity removal was 95.44% as shown in Table 7.3. It was found that the percentage of turbidity removal was gradually increased from pH 2 to 8 and the % of turbidity removal was gradually declined from pH 10.

Table 3 Turbidity removal at optimum dosage

Sl.No	pH	TURBIDITY REMOVAL IN %
1	2	89.11
2	4	91.27
3	6	92.44
4	8	95.44
5	10	94.77

CHARACTERISTICS OF WATER SAMPLE AFTER TREATMENT

The characteristics of water sample after treatment are as shown in table 7.8. The characteristics of water sample were observed after a series of water treatment processes such as turbidity removal using tamarind seed powder, defluoridation using tamarind fruit cover powder and ceramic filtration. Several parameters were tested for checking the quality of water before and after treatment. The parameters are turbidity in NTU, pH, chlorides in mg/l, sulphates in mg/l, dissolved oxygen in mg/l, biological oxygen demand in mg/l, alkalinity in mg/l, fluoride content in mg/l, coli form bacteria per 100ml of water sample, total hardness of water , dissolved solids in mg/l and electrical conductivity in us/cm.

CONCLUSIONS OF THE STUDY

In this study, an attempt has been made to evaluate the efficiency of locally available natural coagulant, tamarind seed powder for reduction of turbidity in the quality improvement of surface water. The chief conclusions are as follows,

- The efficiency of tamarind fruit cover powder as an adsorbent for fluoride ions is evaluated in defluoridation of surface water and results showed more than 90% efficiency.
- The final stage of filtration using a porous ceramic pot assures 99% safe water for drinking which is free from bacterial content.
- All the stages of water treatment are easy to operate and there is no need of any special maintenance.
- The turbidity removal efficiency of tamarind seed powder is 95.33% at 150mg/l optimum coagulant dosage.
- At optimum pH of 8, the turbidity removal efficiency was obtained as 95.44%.
- The turbidity removal efficiency was observed by varying the mixing time and it was obtained that as the mixing time increases residual turbidity decreases.

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