Innovations

Effectiveness of *Phyllanthus Emblica and syzygium Cuminiseed* as Coagulant for Water Purification

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Abstract : *Providing communities with enough clean water is a global issue, particularly in developing nations. The rural population relies on domestic water sources such as rivers, dams, and streams, which may harbor hazardous pollutants and diseases. Life requires water, which needs to be pure in terms of physical, chemical, and biological components in order to be portable. It was made hard by the presence of salt, and hard water is the main cause of many health issues, including kidney stones. The study investigated many physical, chemical, and biological characteristics, including but not limited to color, taste, odor, pH, acidity, alkalinity, total hardness, total dissolving solids, calcium, magnesium, chloride, and cadmium. The purpose of this study was to determine how Phyllanthus emblica seed and Syzygium cumini filtration affect turbidity and hardness reduction. The amount of calcium and magnesium in treated water samples was altered in a manner comparable to that of untreated water and alum-treated sample, and their turbidity ranged from 1.0 to 10.0 NTU. The order of Phyllanthus emblica > Syzygium cumini > alum was the most successful in removing turbidity. It was suggested that Phyllanthus emblica and Syzygium cumini seeds be used to purify water. In this study, appropriate methods were chosen to be adopted and treated in order to improve the quality, to demonstrate the effectiveness of the traditional methods our ancestors used, to learn about the health benefits of traditionally treated water, and to learn about the changes in water characteristics that occur when plant materials are added. This study finding showed that the water sample is hard.*

Key words: *Turbidity, hardness, Phyllanthus emblica ,syzygium cumini, ground water*

Introduction

The process of purifying water comprises captivating out unwanted chemicals, biological impurities, suspended solids, and gasses. Producing water suitable for certain uses is the aim. The most popular of the time, water is cleaned and disinfected previously being used for drinking, anyway there are other uses for water needs to be purified, such as pharmaceutical, chemical, and industrial uses.[1]There have been many different procedures used to purify water throughout history. Physical processes such as filtration, sedimentation, and distillation; biological processes like biologically active carbon or slow sand filters; chemical methods like flocculation and chlorination; and the use of electromagnetic radiation, such as ultraviolet light, are some of the techniques were employed. The quantity of particulate matter, such as suspended particles, parasites, bacteria, algae, viruses, fungi and other contaminants, can be decreased by purifying water. Bacteria, algae, viruses, and fungi as well as reduce the concentration of a range of dissolved and particulate matter. International or national regulations usually establish the drinking water quality criteria. Depending on the intended use of the water, these guidelines often contain minimum and maximum quantities of pollutants.

Water quality cannot be determined only by visual observation. Easy steps like boiling water or using a home activated carbon filter are insufficient to remove every potential contaminant that might be in water from an unidentified source. Before deciding what kind of treatment, if any, is required, even natural spring water that was thought to be safe for all intents and purposes in the 19th century must today be tested. Even though they are costly, chemical and microbiological analyses are the only way to get the data required to choose the best purification technique.[2]

In order to enhance drinking water quality and lower the rate of diarrheal illness, household water treatment and safe storage (HWTS) is a crucial public health intervention. This is especially true for people who depend on untreated sources of water and, in certain situations, dangerous or unstable piped water supplies. Furthermore, in the majority of catastrophes, access to safe drinking water is a top priority, and HWTS can be a useful emergency response tool. Any of a variety of technologies, tools, or techniques used to treat water at the household or point level is referred to as household water treatment applications. One of the drinkable water supplies that can be used for both home and industrial uses is ground water. In Tamil Nadu, sedimentary rocks make up the entire land area, with hard rock formations making up the remaining 73%. Bore wells, tube wells, and excavated wells are used to obtain groundwater from these rocks. There have been reports of ground water pollution in emerging nations, which poses a serious risk to the ecosystem.[3] Pure, unadulterated water is not found in the natural world. Any unfavorable alteration to the water's state caused by dangerous substance contamination is referred to as water pollution. After air pollution, it is the second most significant environmental issue. Water pollution is defined as any alteration to the physical, chemical, or biological characteristics of water that has an adverse effect on living organisms (WHO 1997, Balachandra et al 2013). Both organic and inorganic chemicals of natural origin can be found in surface water as dissolved and suspended materials. Waste, sewage, chemicals, hydrocarbons, medications, hormones, antibiotics, bacteria, viruses, fertilizers, plant-protective agents, etc., along with their cessation products, are the main roots of contaminated water in rivers and lakes.[4]

The water sources include lakes, rivers, streams, dugouts, and dams. These sources of water are typically murky and tainted with bacteria that can lead to a variety of illnesses, such as bilharzia and guinea worm. One of the biggest issues in developing nations is waterborne illness; each year, over a million people—two million of whom are children—die from diarrhea and approximately 1.6 million are forced to drink tainted water.[5]

The main cause of the pollution in ground water is the excessive TDS content. TDS, also recognized as parts per million (ppm), it is the total quantity of movable charged ions, including metals, salts, and minerals, dissolved in a specific volume of water. This amount is expressed in milligrams (mg) per volume of water (mg/L). The quality of water filtration systems and water purity are directly correlated with TDS. For better or worse, it has an impact on anything that utilizes, consumes, or dwells in water, whether it be organic or inorganic.[6] Organic sources of dissolved solids include leaves, silt, plankton, sewage and industrial waste, runoff from cities, road salts used in the winter on city streets, and fertilizers and pesticides used on farms and lawns. Variations in the quality of raw water over time, such as turbidity Chemicals for water treatment are imported using hard cash. High cost of chemicals used in water treatment, which accounts for 35% to 70% of ongoing costs, inadequate laboratory space to track process performances necessary to run the plants, inadequate water treatment, insufficient funds, a small revenue base, Water supply is viewed more as a social good than a financial resource. underdosing of chemicals resulting in the delivery of low-quality water, inadequate skilled labor, maintenance schedules, technology, and inadequate supply to satisfy expanding demand.[7]

Raw water with mostly in the range from 50 to 7500 NTU that has been treated with plant extracts using the Nirmali tree (Strychnous potatorum), Tamarind tree (Tamarindus indica), Guar plant (Cyamopsisp soraloides), Red Sorella plant (Hibisicus sabdariffa), Fenugreek (Trigonella foenum)[8], Barbados nut (Jatropha curcas), King Tuber Mushroom (Pleurotus tuberrregium sclerotium), Okra (Abelmoschus esculentus), Red bean (Vigna ungularis), Red maize (Zea mays), Cactus (Cactus latifera), Mesquite (Prosopis juliflora), Sugar apples (Annona squamosa), Fig (Ficus racemosa), and Lentils (Lens esculenta).[9The proper plants can clean and eliminate hazardous germs and heavy metals from water by filtering and purifying it. detrimental microorganisms, heavy metals, Insects, radioactive isotopes (green coal and porous carbon are far more effective than plants), substances, Cysts (this approach is not 100% effective because the cysts eventually travel to the plant roots with continued exposure).[10]

Phyllanthus emblica

Phyllanthus emblica, popularly known as Indian gooseberry, it's an amla tree wall-like structure that was present when the well was dug. Since this technique was employed due to its demonstrated ability to filter the water, investigations have indicated that amla tends to decrease the total dissolved solids including the concentration of inorganic salts and a few organic matters in water.[11]

Syzygium cumini

syzygium cumini is commonly known as indian black berry,javaplum,it belongs to polyembryonic species of the family myrtaceae. The common property is removing the fluoride as bioadsorbents.[12]

The goal of the current study is to compare water samples treated with Phyllanthus emblica seed, syzygium cumini, and alum before and after. The purity of the water is then analyzed using scientific methods, and the findings are published.

Materials and Methods

A neighborhood close to Ambattur Industrial Estate was chosen to gather a groundwater sample. Water drawn from a 120-foot bore well, pH, EC, TDS, Ca (H), Mg (H), TH, sulfate, Cl, Zn, Cr, Fe, and fluoride have all been measured in the sample. Alum, java plum seeds, and amla seeds are the ingredients used to cure raw water. The sample as a whole was handled by keeping it for the designated amount of time. Titration has been used to measure the physical and chemical characteristics of effluent water, including pH, EC, hardness by visual spectrophotometer (Total dissolved solids, fluoride, calcium, magnesium and cadmium).

Sample preparation

Phyllanthus emblica

The water sample was kept in a 100ml plastic bottle and *Phyllanthus emblica*(Amla) seeds were engrossed in it and set aside for 7 days, the seeds were crushed and then immersed to obtain the best results and the sample was given for testing. It has been said that this has the tendency to decrease the salt content by half.

***syzygium cumini* (Javaplum)**

The water sample was kept in a 100ml plastic bottle and *syzygium cumini* (javaplum) was wrapped up in it and kept back for 7 days, the seeds were crushed and then immersed to get the best outcomes and the sample was given for analysis. It has been said that this has the tendency to decrease the salt content by half.

Mixed sample preparation

Two different plant materials and their respective properties they are mixed with water for treating water, in this type we have tried all the combinations of materials and to test the treated water for its overall efficiency. *Phyllanthus emblica* seed and *syzygium cumini* were immersing these substances in the sample of water. In this method the overall color has changed abruptly including its taste, smell and transparency.

Alum

In this method the water sample was kept in a 100ml plastic bottle and alum was deep in it and kept for 7 days, the seeds were crushed and the immersed to obtain the best results and the sample was given for testing. It has been said that this has the tendency to diminish the salt content by half.

Procedures for analyzing physic-chemical properties of impure water and water treated with plant materials[13]

1) Turbidity- The standards and the turbidimeter encompassing the range of interest were measured using turbidimeter, if the device has previously been standard-calibrated. Turbidity units: this process will verify the calibration correctness and the sample's turbidity is less than 40 units shake it to distribute the solids and watch for air bubbles then using the calibration curve or the instrument scale to measure the turbidity of the sample after pouring it into the turbidimeter tube. If the sample's turbidity readings are higher than 40 units, diluted with turbidity-free water to put the values within the acceptable range and then, take readings on the diluted sample. From the turbidity of the diluted sample and the dilution factor, calculate the turbidity of the original sample.

2) Chloride Test-

A fraction of the sample, or 100 ml, was diluted to that amount. Add 3 milliliters of the aluminum hydroxide suspension, stirred, let it settle, and then filtered the sample if it is very colored. If any of the following are present: sulphide, sulfite, or thiosulfate; add 1 milliliter of hydrogen peroxide and mix for one minute. The sample was titrated directly in the pH range of 7 to 1O, and if it was outside of the range, sodium hydroxide or sulfuric acid was used to bring the pH down to 7–10. Pour in I.0 ml of the indicator solution for potassium chromate,titrated to a pinkish yellow end point using a normal silver nitrate solution. By using the titration method, standardize the silver nitrate solution and determine the reagent blank value. [14]

$$\text{Chloride in mg/L} = \frac{(V_1 - V_2)\ X N X 35.46 X 1000}{V}$$

$$= \frac{(V_1 - V_2)\ X 500}{V} = \text{........ mg/L}$$

3) Total Hardness test-

After the representative water sample was gathered, it was tested. Weighing EDTA precisely and dissolving it in distilled water produced a standard EDTA solution (0.01 M). To keep the pH of the EDTA solution constant during the titration, add a buffer solution (pH 10). Measure the water sample's volume and pipette it into a titration flask. A few drops of a suitable indicator solution, like

Calmagite or Eriochrome Black T, should be added. Using the regular EDTA solution, titrate the water sample until a color shift takes place. The titration's endpoint is shown by the color shift. Take note of how much EDTA solution was used. Calculate the total hardness of water using the following formula: Total Hardness (mg/L as CaCO3) = (Volume of EDTA solution used × Normality of EDTA solution × 50,000) / Volume of water sample (mL). Blank titrations was made with distilled water and ensure the result is negligible. Repeated the titration for accuracy, if necessary. The total hardness of water was reported in mg/L as CaCO3.[15]

4) Total Dissolved solids-

After being cleaned and heated to 180°C for an hour, the evaporating dish was cooled in the desiccator, weighed, and kept there until it was needed. Partially filter the sample by passing it through any available filter. A sample volume was selected with residue levels between 25 and 250 mg, ideally between 100 and 200 mg. The values of a particular conductance were used to estimate this volume. The filtered material was added to the sample dish in consecutive aliquots until a detectable residue was obtained. This volume should be pipetted into a weighted evaporating dish that is set on a steam heater. A drying oven will be used for the evaporation process. The sample should not boil or spatter; instead, the temperature should be decreased to about 98°C. After complete evaporation of water from the residue and then transferred the dish to an oven at 103-105°C or 179·181°C and dry to constant mass, that is, till the difference In the consecutive weighing's is less than 0'5 mg. Dried for a long duration (usually 1 to 2 hours) is done to eliminate necessity of checking for constant mass. The time for drying to constant mass with a given type of sample and the number of samples of nearly same type were to be analyzed has to determined by trial.[16]

Calculation:-

$$\text{TDS, mg/L} = \frac{Wt.of\ Dry\ solids\ (gram)}{Volume\ of\ Sample,mL} X1{,}000{,}000$$

Magnesium Test:-

In order to be examined in a sterile container, a representative sample of the water was obtained. Make sure there are no impurities inside the container that could affect the outcome. Eriochrome Black T, also known as calmagite, is a popular magnesium indicator solution. A magnesium complexing agent solution, such as EDTA (ethylenediaminetetraacetic acid), was created. To the water sample, add a few drops of the magnesium indicator solution. When magnesium ions are present, the indicator will turn a different hue. Titrate the sample gradually with the EDTA solution until it permanently changes color. The shift in color signifies that the EDTA and magnesium ions have interacted completely. Keep track of how much EDTA solution was used during the titration. Using the volume of EDTA solution and the known concentration, determine the magnesium concentration of the EDTA solution was calculated. Performed the blank titrations with distilled water to ensure the accuracy of the procedure. Run duplicates or triplicates to ensure the reproducibility of results. The magnesium concentration in the water sample was reported in appropriate units (e.g., mg/L or ppm).[17]

Measurement of Fluoride

Treated water samples (25 ml) were taken into a 50 ml of beaker separately and the powder pillow (Hach Fluoride ionic strength adjuster) was added. It was stirred to dissolve Hach Fluoride ionic strength adjuster completely by using magnetic stirrer. To this solution, the concentration of fluoride was measured by using fluoride Probes (ISEF121) connected to calibrated Hach hq40d multi parameter.[12,18]

Measurement of Cadmium:-

Using an air-acetylene flame and a cadmium lamp, an atomic absorption spectrophotometer was used to detect the amount of cadmium present in the water sample. 21 mg of CdC12 were dissolved in 25 ml of distilled H2O in a 100 ml graduated flask to create 10 ppm of Cd2+ solution, which was then diluted to the appropriate level using distilled H2O. To calibrate the instrument, intermediate stock solutions comprising 0.002 ppm, 0.010 ppm, 0.100 ppm, and 1 ppm were generated. [19]

Measurement of Calcium:-

A Jenway PFP7 flame photometer (Serial No. 7848) was used to assess the concentration of calcium in a sample of water. 277 mg of CaCl2 were dissolved in a 1000 ml graduated flask to yield 100 ppm of Ca2+ solution, which was then diluted to the appropriate level using distilled water.To calibrate the device, intermediate stock solutions comprising 50 ppm, 10 ppm, and 1 ppm were made. [20]

Results and Discussion

Groundwater samples were collected and subsequently analyzed. The characteristics of the sample was given in (Table 1-5) after treated with Natural Herbs and Alum.

Phyllanthus emblica seed reducing the hardness of water by reducing the calcium and magnesium concentration in raw water compared with unpurified water and alum treated water. But still turbid having turbidity and the total dissolved solids concentration was close to that of the raw water and chloride and fluoride level will be increased than unpurified water. The values of Physico-chemical characteristics of water after treated with *Phyllanthus emblica* seed was shown in table.1

Table 1 Physico-chemical characteristics of water after treatment with *Phyllanthus emblica* (Amla) seeds

S.NO	PARAMETERS	METHOD	UNITS	RESULTS
1.	Turbidity	IS3025(Part10):2023	NTU	10
2.	Conductivity@25 degC	IS3025(Part 14):2013(R.2019)	µs/cm	1398
3.	TotalDissolvedSolids	IS3025 (Part16):2023	mg/l	780
4.	ChlorideasCl-	IS3025(Part 32):1988(R.2019)	mg/l	230.43
5.	FlourideasF-	IS3025(Part60): 2008(R.2019)	mg/l	0.82
6.	TotalHardnessasCaCo3	IS3025(Part21):2009(R.2019)	mg/l	201.4
7.	CalciumasCa	IS3025(Part 40):1991(R.2019)	mg/l	42.48
8.	MagnesiumasMg	IS3025(Part 46):1994(R.2019)	mg/l	23.19
9.	CadmiumasCd	IS3025(Part41)-1992(R.2019)	mg/l	0.15

Syzygium cumini is used as a coagulant of raw water and the alum has clearing the turbidity and total dissolved solids in water. But still turbid having turbidity and the total dissolved solids concentration was close to that of the raw water and chloride and fluoride level will be increased than unpurified water. The values of Physico-chemical characteristics of water after treated with *Syzygium cumini* was shown in table.2

Table 2 Physico-chemical characteristics of water after treatment with *Syzygium cumini* (Javaplum)

S.NO	PARAMETERS	METHOD	UNITS	RESULTS
1.	Turbidity	IS 3025(Part 10):2023	NTU	10
2.	Conductivity @ 25 deg C	IS 3025 (Part 14):2013 (R.2019)	µs/cm	1150
3.	Total Dissolved Solids	IS 3025 (Part 16):2023	mg/l	640
4.	Chloride as Cl-	IS 3025 (Part 32):1988 (R.2019)	mg/l	141.8
5.	Flouride as F-	IS 3025 (Part 60) : 2008 (R.2019)	mg/l	0.49
6.	Total Hardness as CaCo3	IS 3025(Part 21): 2009 (R.2019)	mg/l	212

7.	Calcium as Ca	IS 3025(Part 40):1991 (R.2019)	mg/l	50.98
8.	Magnesium as Mg	IS 3025(Part 46):1994(R.2019)	mg/l	20.61
9.	Cadmium as Cd	IS 3025 (Part 41)-1992 (R.2019)	mg/l	0.16

Raw water shows the turbidity in 10NTU,total dissolved solids in the range of 415mg/l and total hardness in 265mg/l indicates that raw water in very hard and unpurified. The other Physico-chemical characteristics of Unpurified water was shown in table.3

Table 3 Physico-chemical characteristics of Unpurified water

S.NO	PARAMETERS	METHOD	UNITS	RESULTS
1.	Turbidity	IS3025(Part10):2023	NTU	10
2.	Conductivity@25 degC	IS3025 (Part14):2013(R.2019)	µs/cm	746.2
3.	TotalDissolvedSolids	IS3025 (Part16):2023	mg/l	415
4.	Chloride asCl-	IS3025 (Part32):1988(R.2019)	mg/l	49.6
5.	Flouride asF-	IS3025 (Part 60):2008(R.2019)	mg/l	BQL(LOQ: 0.2)
6.	TotalHardnessasCaCo3	IS3025(Part21):2009(R.2019)	mg/l	265
7.	CalciumasCa	IS3025(Part40):1991(R.2019)	mg/l	72.22
8.	MagnesiumasMg	IS3025(Part46):1994(R.2019)	mg/l	20.61
9.	CadmiumasCd	IS3025 (Part41)-1992 (R.2019)	mg/l	0.16

A combined effort of Phyllanthus emblica seed and javaplum utilizing the coagulant property and turbidity reduction was shown in table.4. Treated water samples had turbidity between 1.0 NTU–10.0 NTU and the level of calcium and magnesium was changed in comparable with untreated water and sample treated with alum. The turbidity removal effectiveness was alum> *Phyllanthus emblica* >*syzygium cumini*.

Table 4 Physico-chemical characteristics of water after treatment with Combination of *Phyllanthus emblica* (Amla Seed)and *syzygium cumini* (Java Plum).

S. NO	PARAMETERS	METHOD	UNITS	RESULTS
1.	Turbidity	IS 3025(Part 10):2023	NTU	10
2.	Conductivity @ 25 deg C	IS 3025 (Part 14):2013 (R.2019)	µs/cm	2462
3.	Total Dissolved Solids	IS 3025 (Part 16):2023	mg/l	1380
4.	Chloride as Cl-	IS 3025 (Part 32):1988 (R.2019)	mg/l	248.15
5.	Flouride as F-	IS 3025 (Part 60) : 2008 (R.2019)	mg/l	6.895
6.	Total Hardness as CaCo3	IS 3025(Part 21): 2009 (R.2019)	mg/l	339.2
7.	Calcium as Ca	IS 3025(Part 40):1991 (R.2019)	mg/l	110.46
8.	Magnesium as Mg	IS 3025(Part 46):1994(R.2019)	mg/l	15.46
9.	Cadmium as Cd	IS 3025 (Part 41)-1992 (R.2019)	mg/l	BQL(LOQ:0.1)

The water sample treated with alum it reduce the turbidity of raw water and total dissolved solids content. They will increase the mineral content such as calcium and magnesium concentration than unpurified water but still the hardness was close to the raw water and values were shown in table.5

Table 5 Physico-chemical characteristics of water after treated with Alum

S.NO	PARAMETERS	METHOD	UNITS	RESULTS
1.	Turbidity	IS3025(Part10):2023	NTU	1
2.	Conductivity@25 deg C	IS3025(Part14):2013(R.2019)	µs/cm	36.10
3.	TotalDissolvedSolids	IS3025(Part16):2023	mg/l	20
4.	ChlorideasCl-	IS3025(Part32):1988(R.2019)	mg/l	326.40
5.	FlourideasF-	IS3025(Part60):2008(R.2019)	mg/l	6.34
6.	TotalHardnessasCaCo3	IS3025(Part21):2009(R.2019)	mg/l	413.4
7.	CalciumasCa	IS3025(Part40):1991(R.2019)	mg/l	84.97
8.	MagnesiumasMg	IS3025(Part46):1994(R.2019)	mg/l	48.96
9.	CadmiumasCd	IS3025(Part41)-1992(R.2019)	mg/l	BQL(LOQ:0.1)

Conclusion

This study concludes that alum has the ability to remove turbidity and total dissolved solids from water, *Phyllanthus emblica* seed reduces hardness, and

Syzygium cumini is an efficient coagulant of raw water. *Phyllanthus emblica* seed and javaplum, working together to reduce turbidity and employ their coagulant properties, have produced a straightforward, effective, and economical way to clean river water for usage in rural areas. The turbidity of treated water samples ranged from 1.0 to 10.0 NTU, and the levels of magnesium and calcium were altered in a manner similar to that of untreated water and alum-treated sample. All people, especially those who have osteoporosis, will receive more calcium from water that has a higher calcium content, and magnesium levels that are lower indicate the chelating qualities of java plum and amla seeds. It is a feasible approach for producing potable water because other criteria impacting the quality of drinking water were also determined to be within acceptable ranges. Since it is a point-of-use technology, it may be used anywhere and doesn't require a high level of technical support or power. A rural home with the barest necessities may complete the procedure for about 0.5 c per litre of drinkable water. The order of efficacy for removing turbidity was alum >*Phyllanthus emblica*>*Syzygium cumini*. *Syzygium cumini* and *Phyllanthus emblica* seeds were suggested for water treatment since they change the properties of water and make it healthier.

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