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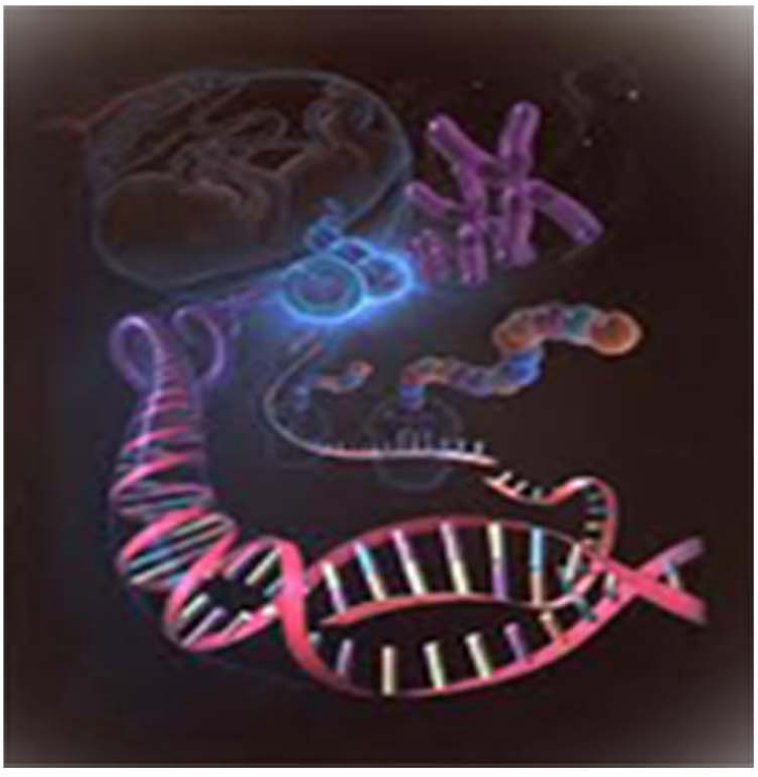

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Research Paper

CHARACTERISTICS OF STORED RAIN WATER AND ITS TREATMENT TECHNOLOGY USING MORINGA SEEDS

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The physical and chemical characteristics on water quality parameters were analyzed for the random samples collected from different locations in Ramanathapuram district of Tamilnadu. It reports that except, turbidity and iron all other parameters were found within the permissible limit, prescribed by the standard health organization. For usage it should be treated by natural coagulation method with moringa seeds. The study explain how the natural coagulant solution was prepared with moringa seeds and the required proportion it should be added with the stored water. Further, how this technology could be transferred for rural application to provide safe and potable drinking water from the stored rain water. Community model may be established near the rain water harvesting points in every village to solve the issue on drinking water problem

Keywords: Potable drinking water for rural population, Stored rain water, Treatment material, Moringa seeds, Technology for community models

INTRODUCTION

Providing safe and potable drinking water to the rural population is one of the unsolvable issue for a long while in many of the developing countries. Rain water harvesting in rural sector meet out this demand to some extent. Traditionally, the rural community use this stored water for drinking purpose, after having simple filtration by cloths. But it is not safe for human health since the stored water contains impurities and also high turbidity. So, before usage it should be treated with suitable technology and it should be accepted by the user community. Though number of treatment process are in action for water treatment but it need huge investment. As an alternate the locally available cheap material moringa seeds are used to purify the turbid water. The processes involved are all discussed in this study. Analysis on water quality parameters before and after treatment proves that the quality of treated water with Moringa seeds was found suited for drinking purpose. It leads to solve the basic problem of the rural population.

NEED FOR QUALITY ASSESSMENT

India has 16% of the world's population and 4%

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of its fresh water resources. Estimates indicate that surface and ground water availability is around 1,869 billion cubic meters (BCM). Of this, 40 percentages is not available for use due to geological and topographical reasons. Around 4,000 BCM of fresh water is available due to precipitation in the form of rain and snow, most of which returns to the seas via rivers.

92% groundwater extracted is used in the agricultural sector, 5% and 3%, respectively for industrial and domestic sector. Eighty nine per cent of surface water use is for agricultural sector and 2% and 9%, respectively are used by the industrial and domestic sector. The average availability of water remains more or less fixed according to the natural hydrological cycle but the per capita availability reduces steadily due to an increasing population.

A country is said to be water stressed when the per capita availability of water drops below 1700 cu. m/person/year. It is expected that by around 2020, India will be a 'water stressed' state with per capita availability declining to 1,600 cu m/person/year. In this situation technology on water treatment is an essential role of environmental and basic scientist of the country towards development.

SANITATION ISSUES ON POTABLE WATER

Searching of safe drinking water remains a global problem and it is expected to rise with population growth and environmental changes. Scientist in many parts of the world has made it a priority to develop practical and appropriate approaches to improve access to clean water. Water borne diseases like Cholera are a main threat in most developing countries. It is estimated that approximately 5.5 million cases of cholera are diagnosed annually. Population growth worldwide is largely responsible for the increased level of pathogens in drinking water sources. The infectious agent causing Cholera is a bacterium called Vireo Cholera, which is transmitted through water. During the summer months occurrence of Cholera vireos increases in cholera endemic areas. Methods such as boiling water (or) treating water with chlorite that are used to purify water become more difficult to apply such conditions. As a result availability of safe drinking water becomes limited. Filtering water at the time of collection and just before drinking majority of the population living in villages still depends on untreated surface water taken from the ponds for household consumption for reasons of taste and convenience, and based on the traditional belief that "quality" water in "natural", it is not chemically treated. A study on the quality of water was analyzed before treatment. This indicates that the water available in ponds of Ramanathapuram district is not advisable for drinking.

The contaminated drinking water is a threat to public health unless appropriate interventions are taken locally, regionally and globally. Such intervention methods should meet economic, social and environmental criteria are it should be low cost, socio-cultural acceptability and environmental soundness, and it should be readily accessible to the public in the rural population of the developing countries. In view of this, the field level research work has been carried out in this work.

SUSTAINABLE WATER MANAGEMENT

Scarcity of water both in quantity and quality, poses a significant threat to the current and future well beings of the people in the country especially

for people in Rural Sector. "Sustainable Water Management" provides solution to all related issues to access the clean water for poor people in rural areas.

Science and Technology contributes to the development of new methods, tools and techniques to solve specific water quality and quantity problems. Such a contribution should meet economic conditions of Rural population, explorer on potential of environment and health risk, etc.

WATER QUALITY

"Water Quality" is used to define the physical, Chemical and Biological Characteristics by which one evaluates the acceptability of water.

Degradation of Water Quality

Water found in nature is never pure, and always contains some impurities. The impurities of water can be classified as,

- Suspended impurities
- Dissolved impurities
- Colloidal impurities

Suspended Impurities

Suspended Impurities include silt, clay, algae, fungi, organic and inorganic matters and mineral matters, etc. These impurities remain in suspension. They neither salty down nor dissolve in water. They are microscopic and make water turbid. Bacteria cause diseases while silt, clay, algae, protozoa cause turbidity, odour and colour in water. The concentration of suspended matter in water is measured by turbidity.

Dissolved Impurities

Some impurities are dissolved in water. When it moves over the surface, soil, etc., Solids, liquids and gases are dissolved in natural water. These dissolved impurities may contain organic compounds inorganic salts and gases etc.

Colloidal Impurities

It is very finely divided dispersion of particles in water. These particles are so small that these cannot be removed by ordinary filters and are not visible to the naked eye. The colloidal impurities are electrically charged and remain in continuous motion. The electric charge may be due to, the presence of absorbed irons on the surface of the particles.

Acidic and natural materials like Silica, glass and most organic material particles have negative charge, while particles of all basic materials like metallic oxides are positively charged. The electrical charges present on the colloidal particle surface are quite large in relation to the mass of the particle and therefore, repel one another. Due to this action that all the colloidal impurities are remains in motion and do not settle. All the colloidal impurities are usually associated with organic matter containing disease producing bacteria and therefore form the main source of all sorts of epidemics. These particles do not respond to chemical treatment.

ANALYSIS OF WATER

The aim of laboratory tests is, to ensure that potable water conforming the standards. The tests conducted to determine the quality of water are

- Physical tests
- Chemical tests
- Bacteriological tests

Physical tests indicate the aesthetic quality and performance of various treatment units. Chemical tests indicate the amount of chemicals present in water and the amount of pollution in it.

Bacteriological tests indicate the presence of bacteria producing pollution and whether the water is safe or not for drinking purpose.

a. Parameters of Physical Test

The physical tests which are carried out in water analysis include the following:

- Color
- Taste and Odor
- Turbidity

Color

Color in water may be due to the presence of fine particles in suspension or due to certain mineral matter in solution. Color in water is objectionable to consumers. It may stain materials .Color is measured with a tint meter.

Taste and Odor

These may result due to the presence of one or more of the following:

- Micro organisms either dead or alive.
- Dissolved gases such as carbon dioxide, oxygen, methane, hydrogen sulphide with organic matter.
- Mineral substances such as sodium chloride, iron components, carbonates and sulphates of other elements.

Turbidity

Water is said to be turbid when it contains visible material in suspension. Turbidity is measured by the resistance of water to the passage of light through it. Turbidity in water is due to the presence of suspended inorganic matter like silt, clay, etc. It is expressed in parts per million (ppm).

b. Parameters of Chemical Tests

The chemical tests carried out on water are to determine:

- Total Solids
- Hardness
- Chlorides
- Dissolved gases
- pH value or hydrogen-ion concentration
- Nitrogen and its compounds
- Metals and other chemical substances

Total Solids

The total solids in water are due to Suspended matter and Dissolved matter. These are determined separately and then added together.

Hardness

Hardness is of two kinds namely, temporary hardness and permanent hardness. Temporary hardness is due to the bicarbonates of calcium or magnesium. Permanent hardness is due to the presence of sulphates, chlorides and nitrates of calcium and magnesium. Hardness is expressed either in ppm of calcium carbonate or in terms of degrees.

Chlorides

This test is done to determine the amount of sodium chloride present in the water. Its presence indicates the possibility of contamination of water by sewage. This is due to the fact that the salt consumed in the food is excreted by the human body. In ground water, sodium chloride may be present due to the soil.

Dissolved Gases

Certain quantities of oxygen are found dissolved in surface waters which are absorbed from atmosphere. In case of surface waters, the quantity depends upon the amount and character of the unstable organic matter.

pH Value or Hydrogen-ion Concentration: This test is conducted to find the acidity or alkalinity of

a sample of water. Alkalinity in water is caused by bicarbonates or hydroxides of sodium, potassium, calcium and magnesium. Acidity is caused by mineral acids, free carbon dioxide, sulphates or iron and aluminum. When an electric charge is passed through water, it dissociates itself into positively charged and negatively charged ions. Thus, for pure water.

$H_2O = H^+ + (OH)^-$

The water breaks up into positively charged hydrogen-ions and negatively charged hydroxyl-ions.

Nitrogen and its Compounds

Nitrogen is present in water in the following common forms free ammonia, Nitrites and Nitrates. The presence of these substances in water indicates organic contamination.

Free Ammonia

Free ammonia is formed as an initial product due to decomposition of nitrogenous organic matter. The presence of ammonia indicates that the decomposition has started recently. The quantity of free ammonia is determined by boiling the sample of water.

Nitrites

Nitrites are the products obtained by oxidation of ammonia Nitrites show that the organic matter is not fully oxidized. In potable water nitrites should never be present.

Nitrates

Nitrates in water are the end product of decomposition of the organic matter. This shows that the organic matter is fully oxidized and is not harmful any more. For potable water nitrates should not exceed 45 mg/L.

Fluorides

Fluorides are normally considered to be beneficial in water if present in small concentration up to 1 ppm. Such water improved dental health and prevents the formation of dental caries.

Excessive fluorides in drinking water may cause mottling of teeth or dental fluorosis, which results in discoloration of enamel, chipping of teeth in children in severe cases. With levels exceeding 1.0 mg/L, bone fluorosis or crippling effects are observed. The presence of fluorides and iodides are determined by adding colouring agents and comparing with standard colouring solutions.

Metals and other Chemical Substances

Iron present in water above a certain limit imparts taste to the water. It stains clothes, plumbing, fixtures, floors. The quantity of iron in potable water should not exceed 0.3 ppm. Manganese causes organic growth. It blocks pipes and discolors clothes. This should not exceed 0.05 ppm. The amounts of iron, manganese and other metals in water are determined by adding colouring agents to the sample of water and comparing with solutions of known amounts of the metals.

c. Microbial Tests

Water may contain bacteria. Bacteria are very small organisms which can be seen only under a microscope. Some bacteria are harmful and are called pathogenic bacteria. Some others are harmless and are called non-pathogenic bacteria.

Pathogenic bacteria cause typhoid, cholera, dysenteries, etc. Hence, public water-supply should be treated to remove them if they are present. But it is very difficult to isolate pathogenic bacteria in the laboratory.

STORED RAIN WATER AND ITS CHARACTERISTICS

Reservoirs, Ponds and Ooranis are centralized

water resource system for rain water harvesting in rural areas. The rainwater as it passes through the atmosphere gets dissolved Oxygen, Carbon dioxide, other gases and floating dust. When it reaches ground, it absorbs particles of silt and mud. While it flows towards a stream it passes through decaying vegetable matter and gets organic acids. Due to this, the dissolving action of water is increased and several salts get dissolved into it. In General the quality of the harvested rainwater be less than ideal, it nevertheless is less bad compared to most other sources of drinking water and the harvested Rain water can have all types of Chemical, Physical and Microbiological contaminants. These contaminants can come from the air which rain drops traverse before hitting the surface and the intercepting surface on the earth.

Contamination in Stored Water

Rain water collected in some agricultural areas may be subject to contamination by pesticides or other chemicals. Aerial spraying provides a greater potential for contamination. It is possible that significant amounts of animal feces will contaminate the catchment. Thus the risk of transmitting pathogens that are responsible for major water borne diseases such as Cholera, typhoid, Shigellosis and Salmonellas to the rain water tank is minimal. However the catchments area can be contaminated with bird and small animal feces, dust and leaves.

The most common salts are the carbonates, sulphates, chlorides and nitrates of calcium, magnesium, sodium and potassium. These impart alkalinity, hardness and salinity to water. In addition to these, the water also contains salts of iron, manganese, copper, zinc and aluminum.

WATER TREATMENT

Water treatment is the process of removing undesirable chemicals, materials and biological contamination from the raw water. The drinking water is treated to remove the pathogenic micro organisms, unpleasant tastes and odours, colour, turbidity, hardness, etc. The objectives of treatment of water are,

- To remove color, objectionable taste and odor.
- To remove dissolved gases, Dissolved and suspended impurities and harmful minerals.
- Suspended and Dissolved organic impurities.
- To remove harmful bacteria.

Degree of treatment depends on the type of impurities carried by water, which are further dependent on the source.

Water Treatment Process

The water treatment process involves screening, coagulation, sedimentation, filtration and disinfection. These are the main components involved in treatment process.

Flocculation and Coagulation

Flocculation and coagulation is a process, which clarifies the water. Clarifying means removing of turbidity or color, so that the water is clean.

Clarification is done by causing a precipitate to form in the water which can be removed using simple physical methods. Initially the precipitate forms as very small particles, but as the water is gently stirred, these particles stick together to form bigger particles, this process is called flocculation.

Many of the small particles that were originally present in the raw water absorb on to the surface of these small precipitate particles and so get

incorporated in to the larger particles that coagulation produces. In this way the coagulated precipitate takes most of the suspended matter out of the water and is then filtered off.

Sedimentation

Sedimentation is the process of separation of suspended solids from water by gravity. Plain sedimentation normally remove upto 60% of suspended matter and 75% of bacteria. Proper inlet and outlet, large detention period, higher temp and right pH value are a requisite for efficient sedimentation.

Filtration

After separating most floc, the water is filtered as the final step to remove the remaining suspended particles and unsettled floc.

Solar Disinfection

The process of killing harmful bacteria from water and making it safe to the consumers is disinfection. Disinfection is accomplished both by filtering out harmful microbes and also by adding disinfectant chemicals in the last step in purifying drinking water. Water is disinfected to kill any pathogens which pass through the filters. UV Radiation is very effective at in activating crusts, as long as the water has a low level of color so the UV can pass through without being absorbed. Disinfection is the primary goal, since aesthetic considerations such as taste, odor, appearance and trace chemical contamination do not affect the short term safety of drinking water.

CHEMICAL COAGULATION

Several chemical coagulants have been used in conventional water treatment processes like Aluminum Sulphate (Alum), Poly Aluminum Chloride ('PAC'), Poly Aluminum Silica Sulphate (PASS) and Ferric Chloride for portable water production. Which includes inorganic, synthetic organic polymer and naturally occurring coagulants. Generally, alum the aluminum sulphate, an inorganic coagulant and its synthetic polymeric derivatives are widely used in water treatment. However, there is a fear that aluminum may induce Alzheimer's disease and strong carcinogenic properties.

Problems in Chemical Coagulants

The chemical coagulation treatment faces the following difficulties,

- Reaction of alum with natural alkalinity present in water leading to reduction of pH and a low efficiency in coagulation of cold waters.
- Under-dosing of chemicals leading to production of poor quality drinking water.
- Using alum as well as other metallic salt coagulants produces large sludge volumes which are non-biodegradable.
- Potential health and environmental problems were present in the use of Chemical coagulants.
- Aluminum has been identified as a causative agent in neurological diseases such as presenile dementia.
- Ingestion of aluminum ions may induce Alzheimer's disease.
- Sludge produced are voluminous and non-biodegradable after treatment and therefore poses disposal problems leading to increase cost of treatment.

NATURAL COAGULATION

Naturally occurring coagulants are usually presumed safe for human health. Moringa seeds

contain polypeptides. It serve as an effective and low cost traditional source of natural coagulant for removing turbidity and reducing bacterial and viral contamination from drinking water. *Moringa oleifera* seeds are an effective water classification agent across a wide range of various colloidal suspensions. When is mixed with water, the crushed seed powder yields water soluble organic polymers also known as natural cationic (net positive charge) poly electrolyte.

The actual Moringa flocculants are basic Polypeptides with a molecular weight between 6 and 16 KDa, and an isoelectric pH of 10 to 11. The natural polyelectrolytes released from the crushed seed kernels function as natural flocculating agent binding suspended particles in a colloidal suspension, forming larger sedimentary particle (flocs), pathogenic micro organisms are generally attached to the solid particles and treatment employing *Moringa oleifera* seed can remove 90% to 99.99% of indicator bacterial load.

Some studies on natural coagulants have been carried out and various natural coagulants were produced or extracted from microorganisms, animals or plants. One of these alternatives is *Moringa Oleifera* seeds. The traditional use of the *Moringa Oleifera* seeds for domestic household water treatment is limited to certain rural areas. The study was carried out in Ramanthapuram district to remove the turbidity and excess iron concentration in oorani water which are used for drinking purpose in rural areas.

PREVIOUS STUDY ON NATURAL COAGULATION

Studies of literature, both primary and secondary information, correspondence with scientists, and laboratory and field research on traditional water coagulantion on different parts of Indian villages. The present paper aims at investigating how a common plant *Moringa oleifera* (drumstick) of our country could be easily cultivated for various purposes with special references to its anticoagulant properties. The use of herbal materials to reduce turbidity, or muddiness in the water and to remove the harmful biological material that can lead to illness is an age-old concept. The seeds of drumstick (*Moringa oleifera*) containing basic polypetides are an alternative and possibly cheaper water purification opportunity for rural communities in third world countries. In the tropical developing countries, the clarification of turbid waters from rivers, lakes, and wells is an old household method, and using simple equipment villagers in many countries purify water for their households with Moringa tree seeds.

Moringa oleifera is one of the most wide spread plant species that grows quickly at low altitudes in the whole tropical belt, including arid zones. It can grow on medium soils having relatively low humidity (Ndabigengesere *et al.,* 1995). *Moringa oleifera* seeds are an organic natural polymer.

Jahn (1984) has presented *Moringa oleifera* as a coagulant after her studies in the Sudan (Jahn,1984; and Jahn, 1988) when she noticed that Sudanese village women used it at home to clear the turbid Nile water. Later, many researchers have reported on the various uses of *Moringa oleifera* seeds as coagulant and coagulant aid in the last 20 years.

Moringa oleifera coagulant has been found to have high coagulation activity only for high turbidity water. The activity is low for low turbid water

(Muyibi and Evison,1995). Therefore, it is important to improve the characteristics of this plant by identifying its bioactive constituents, which has high coagulation activity.

Of the large number of plant materials that have been used over the years, the seeds from *Moringa Oleifera* have been show to be one of the most effective primary coagulants for water treatment especially in rural communities (Folkard *et al.*, 1993; Doer, 2005; and Onwuliri and Dawang, 2006).

HISTORICAL BACKGROUND

The Moringa plant is native to Northern India, where it was first described around 2000 BC as a medicinal herb. The oral traditions may go back several centuries BC, but no written documentation exists before the beginning of the first century AD. It hqas been reported that in China, attempts were taken at water clarification since the 2nd century AD and the Chinese were involved in the transfer of the technology and knowledge. It is thus believed that the Chinese have contribution to new developments.

The oldest records of a precursor of *Moringa oleifera* seeds are from ancient India (Ist century AD). European eyewitnesses reported related water clarification methods in Egypt at the end of the 16th century and while in China at the end of the 17th century. There is a striking similarity between the Indian and Egyptian methods of applying a flocculating plant material. Moringa was featured in an early chapter of Bible. The first Hindu Practice of clarifying water with plan 'coagulant' and mineral materials is mentioned in the Sushruta Samhita—the famous treatise, written by Sushruta. Interestingly, it is found that between AD 680 and 750, the famous thinker Samkara and his contemporaries such as Suresvara and Mandana Misra while giving philosophical interpretation of Vedic Scriptures in the Advaita Vedanta, mentioned the use of the seeds of *Strychnos Potatorum* for water clarification. They were obviously impressed by the remarkable ability of ground Kataka 'nuts' in the process of removing dirt from dirty water by disappearing itself in the process. In the Manu Smriti or Manu Samhita, (about AD 100-300), the use of seeds of *Strychnos Potatorum* or Kataka seeds for traditional water clarification had been mentioned as a philosophical hint, "Though the kataka tree's fruit makes water clear, water does not become limpid merely by the mention of its name".

EXPERIMENTAL STUDIES

The experimental studies on rural water treatment dealt with the following objectives:

a. To prepare natural coagulant solution from *moringa oleifera* seeds.

b. To assess coagulation dosage for the removal of turbidity in stored rain water.

c. To study the quality assessment of stored rain water samples in rural area.

d. To study the low cost water treatment technology using natural coagulation method.

e. To compare the water quality parameters before and after treatment with the standard values.

a. Moringa oleifera – Coagulant Solution

Moringa seeds can be used as a natural coagulant for water treatment process in rural areas. The seed kernels of *Moringa Oleifera* contain significant quantities of low molecular weight water soluble proteins, which carries a positive charge. When the crushed seeds were added with raw water, the proteins produce positive

charges acting like magnets and attracting the predominantly negatively charged particles such as clay, silk, bacteria and other toxic particles in water. Flocculation process occurs when proteins bind the negative charges forming flocs through the aggregation of particles in the water. Flocs will be easily removed by settling or filtration.

To prepare coagulant solution, matured seeds were removed from the pods, and shelled seed kernels are crushed and sieved. The seed powder is mixed with a small amount of clean water to form a paste. The paste in then diluted to the required strength before using it. Dosing solutions can be prepared from 0.5 to 10% concentrations. The effect of the solution is similar to that of aluminium sulphate and calcium hypochlorite. The steps involved in the preparation of coagulation solution using *Moringa Oleifera* were explained below:

Step 1: Seed Pods are allowed to mature and dry naturally to a brown color on the tree.

Step 2: The seeds are removed from the harvested pods, and shelled.

Step 3: The seed kernels are crushed and sieved (0.8 mm mesh or similar). Traditional techniques used to produce maize flour have been found to be satisfactory.

Step 4: The finely crushed seed powder is mixed with clean water to form a paste, and is then diluted to the required strength. Dosing solutions can be prepared from 0.5 to 5% concentration (i.e., 0.5 to 5 g/L).

Step 5: Insoluble material is filtered out using either a fine mesh screen or muslin cloth.

Step 6: The solution is ready for use.

b. Dosage Calculation

The dosage calculations for water treatment were made in the environ-mental testing laboratory at Mohamed Sathak Polytechnic College campus. The results obtained from the Jar Test Method for various turbidity concentrations were given in Table 1 as below.

Table 1: Dosage Calculations for Water Treatment

Level of Turbidity in NTU	Dosage Range (mg/l)
Below 50 NTU	10 – 25
Between 50 to 150 NTU	25 - 75
Above 150 NTU	75 - 150

WATER QUALITY PARAMETER ANALYSIS ON STORED RAIN WATER

Providing drinking water for rural population in Ramanathapuram district is one of the funda-mental problem to the district adminis-tration. In most of the blocks the rain water collected at the Ooranis during the rainy season are used for drinking purpose without making any pre treatment. In some of the areas the women taking the water for drinking purpose from the Oorani, making cloth filtering for purification. In some other areas, traditional treatment on portable water was done by using Thatah seeds. The identified low cost technology on water purification using Moringa oleifera seed was tested in the study. To carry out the work, six water samples, which are used for drinking purpose in rural area from different Ooranis in Ramanatha-puram district were collected. Their water quality parameters were tested in TWAD Board water testing lab in Ramanathapuram by adopting stands testing methods. The result obtained on the samples before treatment were reported in the Table 2 for analysis.

Table 2: Analysis on Water Quality Parameter Before Treatment

Parameters	Sample – 1 Idampadal	Sample – 2 Valantharavai	Sample – 3 Ervadi	Sample – 4 Michael Pattinam	Sample – 5 Thiruppalaikudi	Sample – 6 Panchanthangi
Examination on Physical Parameters						
Appearance	Whitish	Whitish	Whitish	Brownish	Whitish	Whitish
Colour	-	-	-	-	-	-
Odour	None	None	None	None	None	None
Turbidity	150	70	120	120	80	260
Total Dissolved Solids	295	310	670	120	182	260
Electrical Conductivity	420	440	960	170	260	370
Examination On Chemical Parameters						
pH	7.7	7.4	7.8	7.0	6.8	7
Alkalinity pH	0	0	0	0	0	0
Alkalinity Total as $Caco_3$	160	165	315	40	50	120
Total Hardness as $Caco_3$	65	92	100	30	40	60
Calcium as Ca	16	21	24	8	8	16
Magnesium as Mg	6	10	10	2	5	5
Sodium as Na	70	60	160	25	35	50
Potassium as K	8	8	12	4	4	8
Iron as Fe	14	6	12	12	8	40
Manganese as Mn	0	0	0	0	0	0
Free Ammonia as NH_3	0	0	0	0	0	0
Nitrite as NO_2	0.04	0.06	0.08	0	0	0.08
Nitrate as No_3	Nil	2	3	0	0	2
Chloride as Cl	35	35	100	35	40	25
Fluoride as F	0.4	0.6	0.6	0.2	0.2	0.4
Sulphate as SO_4	10	13	15	4	0	15
Phosphate as PO_4	0	0.12	0	0	0	0.08

The water quality parameters examined before treatment were taken for analysis on comparison with the standard values given in Table 3.

WATER QUALITY STANDARDS

The water quality parameters for drinking purpose should satisfy the standard norms adopted by various organization. Depending upon the proposed uses of water certain quality criteria are established. Based on these criteria, quality standards are specified by health and other

Table 3: Drinking Water Quality Standards

	Bureau Indian Standards IS 10500-1983 (ISI)		World Health Organization (WHO)		Indian Council of Medical Research (ICMR)		Central Public Health Environmental Engineering and Research Organization (CPHEERO)	
	P	E	P	E	P	E	P	E
Turbidity	2.5	10	5	25	5	25	2.5	10
Total Dissolved Solids	-	-	500	1500	-	-	500	2000
Electrical Conductivity	-	-	1400μS/cm	-	-	-	-	-
Chemical Examination								
pH	6.5-8.5	6.5-9.2	7- 8.5	6.5-9.2	7-8.5	6.5-9.2	7- 8.5	6.5- 9.2
Alkalinity pH	-	-	-	-	-		-	-
Alkalinity Total as $CaCO_3$	200	600	200	600	50	450	200	600
Total Hardness as $CaCO_3$	300	600	100	500	300	600	200	600
Calcium as Ca	75	200	75	200	75	200	75	200
Magnesium as Mg	50	150	30	150	50	150	30	150
Sodium as Na	-	-	200	-	-	-	-	-
Iron as Fe	0.3	1	-	-	-	-	0.1	1
Manganese as Mn	0.1	0.3	-	-	-	-	0.05	0.5
Nitrite as NO_2	-	-	-	-	-	-	0.02	0.22
Nitrate as NO_3	-	-	-	-	-	-	45	100
Chloride as Cl	250	1000	200	600	250	1000	200	1000
Fluoride as F	0.5	1.5	-	-	-	-	1	1.5
Sulphate as SO_4	150	400	200	400	200	400	200	400

regulating agencies to ensure that the water quality in a resource is suitable for the proposed use. Drinking water requires the highest standards of purity, where as water of relatively lower quality is acceptable for other purposes like agriculture, Industry, etc., The agencies playing an important role in specifying the norms for various effluents are,

Indian Standards Institution (ISI)

Worlds Health Organization (WHO)

Indian Council of Medical Research (ICMR)

Central Public Health Environmental Engineering and Research Organisation followed in TWAD Board,

The water quality stands as per the above organization are given Table 3.

FINDINGS ON WATER QUALITY PARAMETER FOR TREATMENT

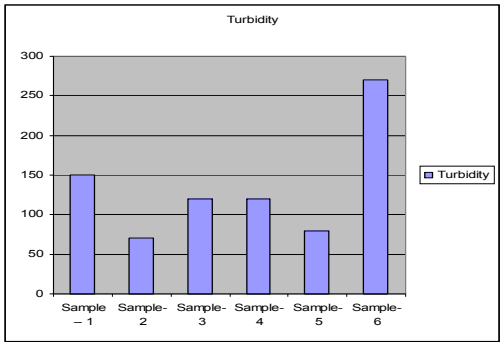
The results on water quality parameters for the selected samples after examination were discussed in the following section.

a. Analysis on Physical Parameters

Turbidity

The presences of turbidity in six different samples before treatment were given in Figure 1 for analysis.

Figure 1: Turbidity Levels Before Treatment



The turbidity is an important parameter responsible for aesthetic acceptance of water. It is caused by presence of suspended substances like clay, silt finally divided organic and inorganic matter, soluble colored organic compound and other microscopic substances. For portability the value of turbidity is in between 2.5-10 NTU. The results on the bar chart shows that in all six cases the turbidity is not suitable for portability. It should be treated by an appropriate technology for drinking purpose.

Total Dissolved Solids and Electrical Conductivity

The presence of total dissolved solids and electrical conductivity in the selected six samples before treatment were reported in Figure 2 and Figure 3, respectively for analysis.

From the above bar Charts 2 and 3 it was observed that in all the six samples the total dissolved solids and electrical conductivity were found within the desirable limit. Hence, treatment should be made to minimize the turbidity level only by adopting the low cost Technology.

Figure 2: Total Dissolved Solids Before Treatment

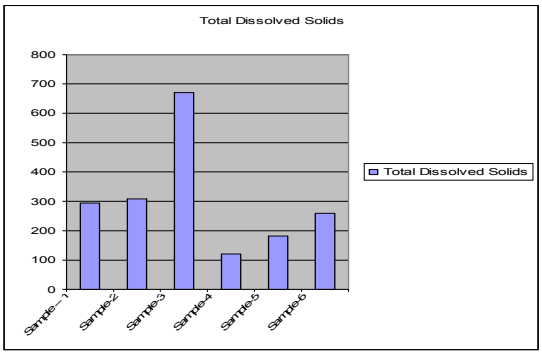
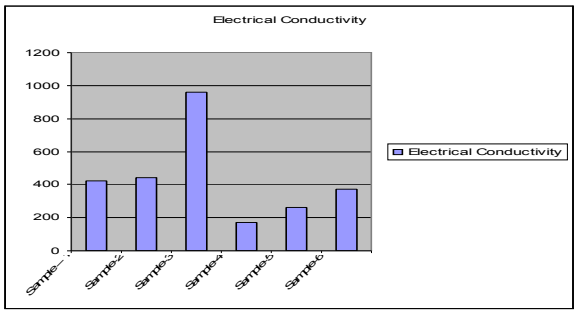


Figure 3: Electrical Conductivity Before Treatment



b. Study on Chemical Parameters

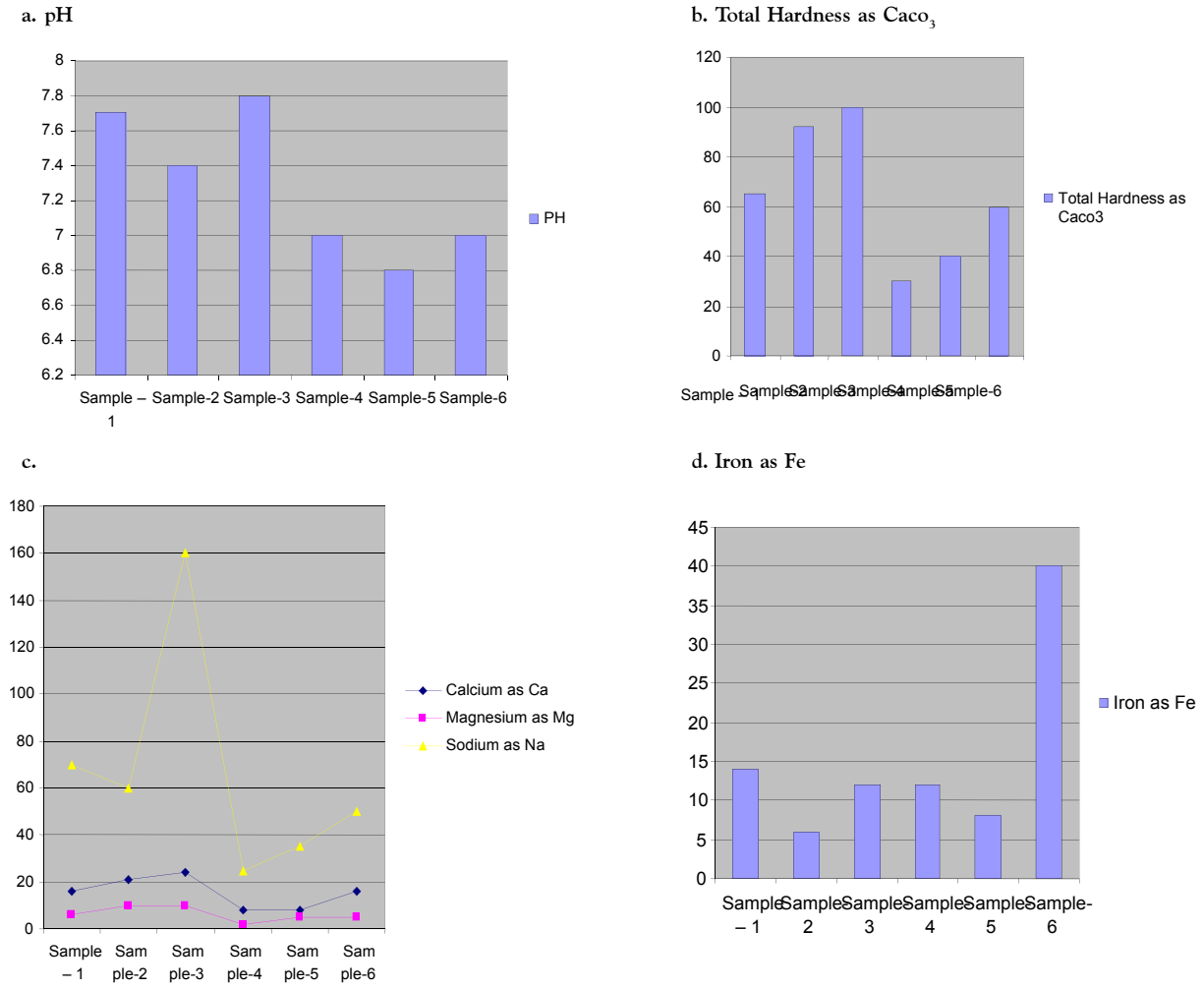
The report on chemical parameters for the tested six samples were given in Figure 4 to analyze the water quality parameters of pH, total Hardness, calcium, magnesium, sodium and iron.

On comparing with the standard values the observations on the bar chart shows that except Iron all other chemical parameters were found within the permissible limit of the standard values. The excess iron present in the water should be reduced by adopting suitable technology.

WATER TREATMENT WITH *MORINGA OLEIFERA*

The results obtained on water quality parameters before treatment shows that there is a need for treatment on turbidity and excess iron

Figure 4: pH, Total Hardness, Chemical Content and Iron



concentration present in the selected six samples. This was done by adding moringa oleifera coagulant solution in proper ratio mentioned in the dosage tabulation with the untreated water sample. The high level turbid content water sample before treatment and the reduced turbid level after treatment with coagulant mix in a test is as shown in Figure 5.

Sludge the deposited at the bottom by flocculation removed. After treatment with coagulant mix, the turbidity removed water samples were taken for examination at the testing laboratory in TWAD, Ramanathapuram. The result obtained on the water quality parameters after treatment were given in Table 4 for analysis.

RESULT AND DISCUSSION

After treatment with moringa oleifera the results on water quality parameters of turbidity and iron concentration were compared with the values of the same parameter before treatment. The level of turbidity and the variation of iron concentration

Figure 5a: Turbid Water for Treatment

Figure 5b: After Treatment - Turbidity Removed

Figure 5c: Sludge Deposit

Figure 5d: Coagulant Mix with Turbid Water

in the selected samples before and after treatment were given in Figure 6.

Chart 6a was observed that the turbidity level varies from 150 NTU to 8 NTU in sample 1. Similarly the variation levels were differed from 70 to 6, 120 to 10, 170 to 6, 80 to 8 and 260 to 10 NTUs for all other respective samples. After treatment the turbidity levels were found within the

Table 4: Results on Water Quality Parameters After Treatment

Physical Examination	Sample – 1 Idampadal	Sample – 2 Valantharavai	Sample – 3 Ervadi	Sample – 4 Michael Pattinam	Sample – 5 Thiruppalaikudi	Sample – 6 Panchanthangi
Appearance	Slty Whitish	Slty Whitish	Slty Whitish	Slty Whitish	Slty Whitish	Slty Whitish
Colour	-	-	-	-	-	-
Odour	None	None	None	None	None	None
Turbidity	8	6	10	6	8	10
Total Dissolved Solids	320	320	685	250	245	245
Electrical Conductivity	460	460	950	360	350	350
Chemical Examination						
PH	7.2	7.6	8.1	6.9	7.3	7.1
Alkalinity PH	0	0	0	0	0	0
Alkalinity Total as $CaCO_3$	150	160	280	140	170	110
Total Hardness as $CaCO_3$	70	72	100	80	90	40
Calcium as Ca	16	16	24	16	20	8
Magnesium as Mg	8	8	10	10	10	5
Sodium as Na	65	65	170	45	30	65
Potassium as K	6	6	12	4	4	6
Iron as Fe	0.8	0.6	1	0.6	0.8	1
Manganese as Mn	0	0	0	0	0	0
Free Ammonia as NH_3	0	0	0	0	0	0
Nitrite as NO_2	0.04	0.06	0.06	0	0	0.06
Nitrate as NO_3	Nil	2	3	2	0	2
Chloride as Cl	35	40	170	25	30	30
Fluoride as F	0.4	0.6	0.8	0.4	0.4	0.4
Sulphate as SO_4	5	13	18	13	13	15
Phosphate as PO_4	0	0.12	0	0	0	0.08

permissible limit and it is suitable for drinking purpose.

Presence of excess amount of iron concentration is another parameter which affects the portability of water. Chart 6b was observed that after treatment the level of iron were found below one unit in all the samples. It shows the best performance on water treatment. On removal of turbidity and excess iron concentration the collected samples were found suitability for drinking purpose

Figure 6a: Variation of Turbidity Before and After Treatment

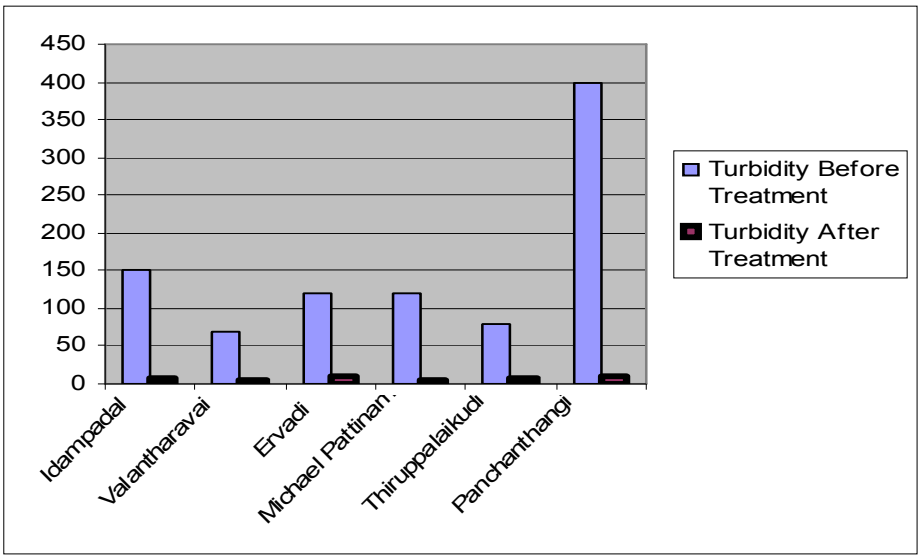
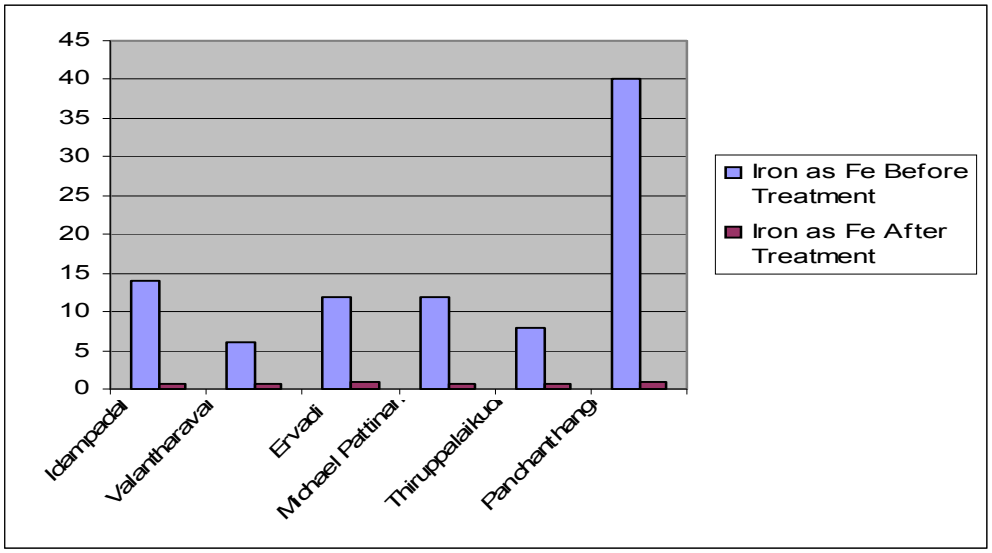


Figure 6b: Variation of Iron Concentration before and After Treatment



CONCLUSION

Providing safe drinking water to rural population is the major challenge for a district administration. It could be possible by having the water treatment technology using *Moringa oleifera* coagulant solution. The low cost water treatment using *Moringa oleifera* (drumstick) seeds in the form of water soluble extract is suspension resulting an effective clarification agent for highly turbid and untreated pathogenic water. Efficient reduction on high turbidity produces an aesthetically clear supernatant. In addition the presence of excess

iron concen-tration were also be reduced by the same technology. Applications of this low cost treatment technology at rural and urban people living in extreme poverty are leads to provide solution for drinking the highly turbid and micro biologically contaminated water.

Scope for Future Study: After treatment disinfection may be done using solar radiation if necessary. Since the ultra violet radiations from the sun kills all varieties of micro organisms due to its short wave length. Even visible light, in sufficient intensity such as sunlight can kill or injure micro organisms. Exposure to sunlight during day time may eliminate a considerable amount of harmful microorganisms in the catchments zone. But the rainfall run off to the catchments surface contributes bacteria and moderate levels of inorganic chemicals to stored rain water. The low cost technology can be extended further for community models to meet the demand of portable water in rural sector. The source which is used for this treatment technology is inexpensive and the technology involved has been appropriate and been proved one. Thus, the locally available *Moringa Oleifera* a cheapest material can be used as a natural coagulant for water treatment.

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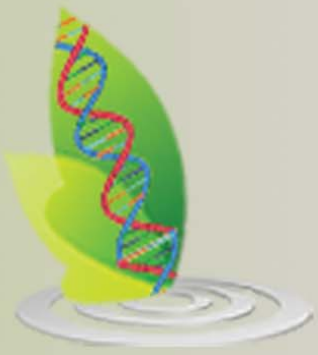

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