PHYTO-CHEMICAL STUDIES OF *Moringa oleifera* L. SEEDS AS A SOURCE OF BIO-COAGULANT AGENT FOR WATER PURIFICATION

A dissertation work submitted to University of Kerala in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in

Botany

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MAY - 2022

CERTIFICATE

This is to certify that the dissertation entitled "Phyto-chemical studies of *Moringa oleifera* L. seeds as a source of bio-coagulant agent for water purification" submitted to University of Kerala in partial fulfillment of the requirements for the Degree of Bachelor of Science in Botany carried out by Anvarsha. S, Apsana Stephen, Anupama. S, Arundhathi. S, Aparna Lal of final year B.sc. Botany (2021-2022) students of the Department under my guidance and supervision at Bishop Moore College, Mavelikara. I further certify that this work is original, and no part of this has been submitted earlier for the award of any degree, diploma, associate ship ,fellowship of any University or Institution.

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DECLARATION

We do hereby declare that the thesis entitled "Phyto-chemical studies of *Moringa oleifera* L. seeds as a source of bio-coagulant agent for water purification" is a record of original and independent research work carried out under the guidance of Mrs. Soumya .S .R ,Assistant Professor, Department of Botany, Bishop Moore College, Mavelikara in partial fulfilment for the award of the Degree of Bachelor of Science in Botany from Kerala University. This work has not been submitted for the award of any degree, diploma, associate ship,fellowship of any University or Institution

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ACKNOWLEDGEMENT

We thank the God almighty for his blessings bestowed upon, which gave strength, confidence and health for completing this venture.

We thank Associate Professor Dr. Dinesh. R. Raj, Head of the Department, who has been encouraging and extremely supporting all through the work. It is with great pleasure that we express our esteemed sense of gratitude and sincere thanks to Mrs. Soumya .S. R ,Assistant Professor, Department of Botany for suggesting the topic and giving her invaluable guidance and constant encouragement all along the course of this work. We also thank for spending her valuable time in filling the information gaps and her sincere efforts in correcting manuscripts. We also express our sincere thanks to all teachers of our department for extending their helping hand whenever needed.

We also express our sincere gratitude to Dr. Jacob Chandy, the Principal of our college for providing necessary facilities in the laboratory.

Last but not the least, we extend heartfelt thanks to our family and classmates for their valuable help in completing this work.

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CONTENTS

LIST OF ABBREVIATIONS

BOD : Biochemical Oxygen Demand

CFU : Colony-Forming Units

DO : Dissolved Oxygen

GC-MS : Gas Chromatography Mass Spectrometry

MPN : Most Probable Number

NCBI : National Center for Biotechnology Information

NTU : Nephelometric Turbidity Unit

PPM : Parts Per Million

WHO : World Health Organization

INTRODUCTION

Water is one of the most important and abundant compounds of the ecosystem. All living organisms on the earth need water for their survival and growth. Water is a ubiquitously chemical substance vital to all known forms of life. In nature water exists in liquid, solid and gaseous states. Larger amount of water is present on the earth about three-quarters of the earth surface is covered with water occupying around 97% as seawater and 3% as fresh water. Around two-third of fresh water is icebergs and glaciers. Availability of fresh water for our daily life is only 0.8% of the total amount of water present on earth.

Water is a colorless, tasteless and odorless transparent liquid at ambient temperature. Water is a good solvent it is often called as the universal solvent. The polarity of water is an important factor in determining its solvent properties. Water dissolves most of inorganic substances and some organic substances having ionic bonds by dissociating and hydrating them. Uses of water comprise agricultural, industrial, household and environmental activities.

Drinking water is a vital resource for all aspects of human beings. Access to safe and clean drinking water is a major concern throughout the world. Ground water surface water and rainwater are often the major sources of water in a community. Ground Water is often the most appropriate source of water for drinking as long as it does not contain high mineral content. Ground water could be extracted through wells or bore holes. Surface Water requires treatment to make it safe for human consumption. Surface water is almost always contaminated by people and animals who defecate in or near the water. Rain water is pure it can be collected in large storage basin or smaller containers. However rain water collected in dirty or unclean containers have to be treated to make it safe for drinking.

Natural waters occurring in the environment are not chemically pure waters. While circulating in the environment water contacts with atmosphere, rocks and soil. Due to physical, chemical and biological processes water passing through the ground undergoes purification. Physical processes include dilution, coagulation, precipitation and adsorption. Chemical processes include degradation, oxidation and hydrolysis while biological process includes biodegradation.

Natural water contains either inorganic or organic compounds. The quantity of inorganic compounds dissolved in natural waters is differentiated. Rainwater may contain as little as a few milligrams of dissolved matter is derived from different sources such as sulphate, sulphur dioxide etc. After falling onto the land the inorganic content of the water increased. Natural waters contain organic matter including decaying matter and industrial pollutants. The naturally dissolved organic matter is transformation biological products of proteins, amino acids, fats, sugar etc.

Due to increased human population, industrialization, use of fertilizers in the agriculture and man-made activity water is highly polluted with different harmful contaminants. Therefore it is necessary that the quality of drinking water should be checked at regular time interval, because due to use of contaminated drinking water, human population suffers from varied of water borne diseases. Contaminated water is a very turbid liquid with an offensive smell in most cases. Its composition varies from large floating or suspended solids to smaller suspended solids, very small solids in colloidal form due to microbes and chemical pollutants. The quantity of organic matter present in waste water determines the strength of waste water.The different components of waste water are of primary importance as it plays a crucial role in the design of the treatment plant. Waste water generally contains biological components including pathogenic organisms mostly of fecal origin and non-biological substances such as organic and inorganic compounds. Organic components include carbohydrates, protein and fats while inorganic components includes salts and metals.

A large numbers of pollutants can impart colour, tastes and odors of water thus making them unaesthetic and even unfit for domestic consumption. The changes in oxygen, temperature and pH affect the chemical property of water often triggering chemical reactions resulting in the formation of unwanted products. The addition of organic components results in depletion of oxygen. The direct addition of nutrient through various sources enhances the algal and other biological growth which further depletes the oxygen. The decomposition of excessive organic matter results in odorous unaesthetic condition due to accumulation of several obnoxious gasses like ammonia, hydrogen sulphide and methane. The algal photosynthesis consumes carbon dioxide and increases pH of the water due to formation of carbonates which gets precipitated as calcium carbonate often co-precipitating phosphorus with it. However, pH can fall at the time of higher rate of organic matter decomposition and low photosynthetic activity which can bring back the precipitated calcium carbonate is solution from the sediments.

Producing potable water from surface water or ground water usually involves one or several treatment steps for removing unwanted substances. WHO estimates that about 85 percent of the rural population lack potable drinking water. About 80 percent of illnesses in developing countries are directly connected with contaminated drinking water. Reports also indicate that 90% of water in India is polluted. It has been estimated that 1.2 billion people do not have clean and safe drinking water. About 4 millions children die every year from water-borne diseases in India. According to a report of Indian Toxicology Research Center about 8,000 cases of cholera, 1 million cases of gastroenteritis and 7 million cases of dysentery were reported annually. Need of water treatment process is so important that we can avoid many possible water borne diseases like diarrhea, dysentery, amoebiassis, hepatitis, typhoid, Jaundice, cholera and so on. Water borne infections are responsible for more than 80% of the diseases in all over the world. Water quality is of concern to everyone. To control these diseases water needs to be purified in order to make it safe for human consumption

Water is recognized as in important aspect in transmission of many diseases It is, therefore, of great importance to remove the pathogenic organisms from drinking or polluted water. Polluted waters especially those polluted by domestic sewage and discharge from hospitals and slaughterhouses etc., are effective source of infectious diseases. Water contains great number of bacteria, many of which have important role in diseases causing. Pathogenic organisms from waste can be broadly classified as bacteria, fungi, viruses, protozoa and helminthes.

Water-borne bacterial disease (Table-1) cause a wide range of syndromes including: acute dehydrating diarrhea (cholera), prolonged febrile illness with abdominal symptoms (typhoid fever), acute bloody diarrhea (dysentery), chronic diarrhea, food poisoning, botulism and anthrax.

Table : 1. Water Borne Bacterial Diseases

Sl. No	**Disease**	**Pathogen**	**Rout of Exposure**	**Mode of transmission**
1.	Cholera	*Vibrio cholera*	Gastrointestinal	Often water borne
2.	Botulism	*Clostridium botulinum*	Gastrointestinal	Water borne
3.	Dysentery	*Shigella dysenteriae*	Gastrointestinal	Water borne
4.	Typhoid	*Salmonella typhi*	Gastrointestinal	Water borne
5.	Colon infection	*E. coli*	Gastrointestinal	Water borne

Water-borne bacterial infection accounts of diarrhea resulting in 1-2 million deaths per year. The death tends to be of infants and young children from dehydration, malnutrition and other complications of water borne bacterial infection. Contaminated river water sources and large poorly functioning municipal water distribution systems contribute to transmission of water borne bacterial disease. Chlorination can safe water handling can eliminate the risk of water borne bacterial disease. But centralized water treatment and distribution systems are expensive and take years to complete.

The need for health care is very urgent due the excessive growth urban and rural population. It clear that some of the diseases can be greatly reduced at a relatively low cost through improved housing and living conditions. To reduce the death rate from Diarrhea disease improved availability of water and sanitation services and provisions for oral-rehydration solution are needed. These deaths can be prevented. This is true for both the urban and rural areas. Since in urban areas, there is higher income for the middle income groups, it appears that the situation is better. However, the conditions of the poor for people in the urban village areas are the same as those of the rural area.

Contaminated water may have off-tastes, odors or visible particles. However, some dangerous contaminants in water are not easy to detect. Accurate water testing is needed to determine safety and quality. Turbidity in water is caused by suspended matter such as clay, silt, finely divided organic and inorganic matter, planktons, and other microscopic organisms.

Water that contains diseases causing organisms so it is necessary for water to be purified so as to be made safe for drinking. To achieve this various methods have been employed but each method has its own setbacks in terms of efficiency, cost and ecological suitability. There are several major water purification techniques some are more efficient in removing particular types of impurities. A combination of two or more technologies is better in a given situation. These Methods include; distillation, ion exchange, carbon adsorption, filtration, ultra filtration, reverse osmosis, electro deionization, ultraviolet (UV) radiation. Distillation is probably the oldest method employed in water treatment but it requires large amount of energy and water despite the fact that it removes a broad range of contaminants. It requires expert training and careful maintenance to ensure efficiency. Ion exchange is very efficient in removing organic contaminant from water. The Carbon adsorption is 99.99% efficient in removing suspended solids the pressure of a millipore membrane filters of 0.22um track down all bacterial but cannot remove inorganic as well as colloidal particles. Ultrafiltration acts as molecular sieve, effectively removed all types of particles and microbes. Reversed osmosis can effectively remove all types of contaminants to some extent (particles, pyrogens, microorganisms, colloids and dissolves inorganic) through the flow rate is limited. Electrode ionization is a technology clone from electro dialysis and ion exchange, it’s inexpensive to operate and absolutely efficient in removing inorganics but the set back is that the water requires pretreatment for water. The adsorption of UV light by the DNA and proteins in the microbial cells results in cell inactivation but the method cannot remove particles, colliods or ions.

The target of drinking water treatment is to remove colloidal material and microorganisms demand to achieve the quality drinking water. Conventional technique is mostly used for surface water treatment includes chemical coagulation followed by flocculation, sedimentation, filtration and disinfection. There are many steps in water treatment processes, one of them is water treatment processes which applying for removal of suspended particles and colloidal material in raw water.

Common artificial coagulants are aluminium sulphate, polyaluminium chlorides, ferric chloride, and synthetic polymers. All of these coagulants have in common the ability of producing charged ions when liquefied in water which can contribute to charge neutralization. Aluminium sulfate (alum) is a common coagulant generally utilized in water treatment. Alum increases concerns when introduced into the environment towards eco-toxicological impact regarding the application of artificial polymers and have many carcinogenic characteristic. Natural coagulants such as the seeds from many plants can also be used. Traditionally, surface water has been treated with the help of plants as natural coagulants for centuries in India. Coagulation is an important step in water treatment processes not only for adsorb particles but because it is also for removing the microorganisms that are often attached to the particles. The important process for removing turbidity is the coagulation. The aim today is how give other people access to uncontaminated drinking water by cost effective means, particularly the rural people who can not afford any water treatment chemicals without affecting the health. In view of the above quite a number of natural materials of plant origin have long been used by local communities in many developing countries in water treatment. Use of plants to reduce contaminants in environment known as phytoremediation. It is cost effective, efficient, novel and ecofriendly technique. Phytoremediation includes the use of plants *in situ* or *ex situ* to partially or substantially remediate selected organic and inorganic contaminants in contaminated soil, sludge, sediment, ground water, surface water and waste water.

Phytoremediation has also been called green remediation, agroremediation and vegetative remediation. Phytoremediation is a variety of processes occurring to differing degrees for different conditions, media, contaminants and plants. Phytoremediation can be used to clean up heavy metals, pesticides, solvents, explosives, crude oil, polyaromatic hydrocarbons and landfill leachates. Phytoremediation encompasses a number of different methods that can lead to contaminant degradation, removal through accumulation, dissipation and immobilization. Some of the effective coagulants (Table -2) used for water purification.

Table : 2. Natural coagulants can be used for water purification

SL. No.	Name of Plant	Family	Used plant parts
1.	*Acrorus calamus*	Araceae	Roots
2.	*Anaphalis cunefolia*	Compositae	Entire plant
3.	*Eclipta alba*	Compositae	Entire plant
4.	*Azadirachta Indica*	Meliaceae	Leaf
5.	*Moringa oleifera*	Moringaceae	Fruits, Roots, Stem
6.	*Stryctnos potatorum*	Loganiaceae	Seeds
7.	*Jatropha curcas*	Euphorbiaceae	Seeds
8.	*Cicer arietinum*	Fabaceae	Seeds

In recent years there has been considerable interest in the development of usage of natural coagulants which can be produced or extracted from plants. These plant based coagulants should be biodegradable and are presumed to be safe for human health. Natural coagulants produce readily biodegradable and less voluminous sludge. Natural coagulants have been used for domestic household for centuries in traditional water treatment in tropical rural areas. The usage of natural coagulants derived from plant based sources represents a vital development in sustainable environmental technology since it focuses on the improvement of quality of life for underdeveloped communities. Plant based coagulants act using adsorption and neutralization mechanism. Plant based coagulants contain phytochemical compounds such as lipids, proteins and secondary metabolites with carboxyl and hydroxyl groups which increase coagulation and flocculation for water purification. Phytochemical compounds can be separated. The separated compounds can be identified and quantified.

Contaminated water contains diseases causing agents such as bacteria, viruses, protozoa. Water also possesses chemical parameters (Alkalinity, Dissolve oxygen, Biochemical oxygen demand) and physical parameters (Turbidity, pH, Colour etc.) these parameters are very important to decide the drinking water quality. Various studies indicate that water quality parameters affected by various water borne bacteria. As a small part of this study regarding anticoagulant activity of some plants for water purification were evaluated.

For the purification of surface water there is a need to develop cost effective, easier and environmental friendly process. In the light of above facts present study is selected to know "**Phyto-Chemical Studies of *Moringa oleifera* L. Seeds as A Source of Bio-Coagulant Agent For Water Purification.**" In recent years there has been considerable interest in the development of usage of plant natural coagulants. These coagulants are biodegradable and are supposed to be safe for human health.

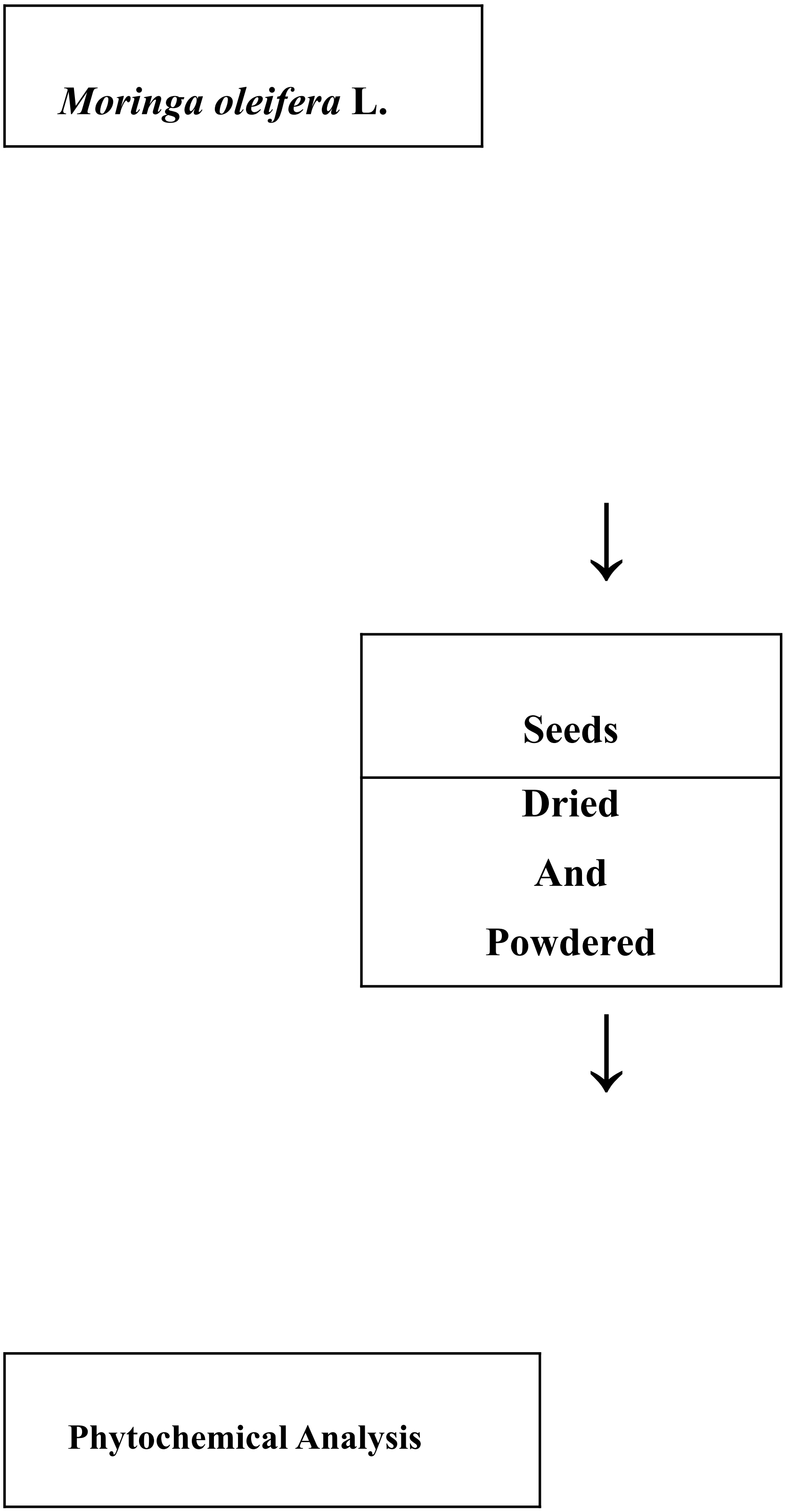
AIMS AND OBJECTIVES

The aim of this study was to find out the phyto-chemical studies of *Moringa oleifera* L. seeds as a source of bio-coagulant agent in the water purification **.** For this water sample collected from Arattupuzha ,Vallakadavu , Aranmula of Pamba river. The seeds of *Moringa oleifera* L. were collected from nearby market ,dried and then powdered. The following test were conducted and analysed their results.

- Phytochemical analysis were done using the *Moringa oleifera* L. seeds extraction using the various solvent such as acetone, chloroform and distilled water.
- Water quality analysis including physiochemical parameters such as colour, pH ,turbidity, alkalinity ,dissolved oxygen and biochemical oxygen demand.

The main objective of this study is to confirm the effectiveness of powder processed from *M. oleifera* seeds as water coagulant.

FLOW CHART OF WORK PLAN



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Water Quality Analysis

REVIEW OF LITERATURE

In India, most of the population is dependent on surface water as the only source of drinking water supply. The groundwater is believed to be comparatively much clean and free from pollution than surface water. But prolonged discharge of industrial effluents, domestic sewage and solid waste dump causes the groundwater to become polluted and created health problems (Raja *et al.*, 2002). The rapid growth of urban areas has further affected water quality due to overexploitation of resources and improper waste disposal practices. Hence, there is always a need for and concern over the protection and management of surface water and groundwater quality (Patil *et al.,*2001).

Water pollution is the contamination of water bodies including lakes, rivers, oceans and ground water. Water pollution occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds. Pollution is caused when a change in the physical, chemical or biological condition in the environment harmfully affect quality of human life including other animals life and plant (Lowel and Thompson, 1992 and Okoye 2002). Industrial, sewage, municipal wastes are been continuously added to water bodies hence affect the physiochemical quality of water making them unfit for use of livestock and other organisms (Dwivedi and Pandey, 2002).

Today water pollution is the biggest problem for human beings which deteriorate the water quality. Various human activities make water unfit for drinking and domestic purposes. The main sources of water pollution are chemical fertilizers and pesticides getting in an untreated sewage and industrial effluents into rivers and streams, running close to the cities and low lands. Garg *et al.,* (2007) reported that many dangerous diseases are caused by using polluted water by reducing the incidence of many water borne communicable diseases. The diseases associated with contaminated water cause serious public health problems in India (Tambekar, 2007).

Water pollution can come from many different sources. If pollution comes from a single source it is called point source pollution. If pollution comes from a many source it is called nonpoint source pollution (Jain *et al.,* 1998). In most of the Indian cities, the major sources contributing to the pollution problems are land disposal of solids wastes, sewage disposal on land, agriculture activities, leakage and spills of effluent carrying culverts, deep well disposal of liquid waste, urban run-off and polluted surface water refuse is dumped in low lying area.

Alagmutuhu and Rajan, (2008) indicate that one of the greatest challenges of the coming time is to provide an ample supply of safe drinking water for house hold consumption to everyone. But the quality of water resources are unevenly distributed over the earth's surface and this is deteriorating due to anthropogenic activities, so in future even countries are going to suffer from scarcity of pure water. As we dump municipal wastes and industrial waste, heavy land and salt making properties of ground water change. Therefore, it is essential to analyze the ground to study the variations in connection with quality parameters. Based on the physico-chemical parameters quality could be rated based on uses like drinking, agriculture and industrial etc.

According to Nevondo and Cloete, (1991) in areas where portable water supplies are provided, the supplies are unreliable and insufficient; forcing residence to reverse to traditional contaminated water sources. It is therefore imperative to monitor the physicochemical and microbial quality of water supply in rural areas in other to highlight the quality of water supply and to provide the impetus for sustained government intervention.

According to a recent United Nations Children Federation (UNICEF) report, about 800 million people in Asia and Africa are living without access to safe drinking water. Consequently, this has caused many people to suffer from various diseases (Tanwir *et al.,* 2003). The quality of drinking water is of vital concern to mankind, since it is directly associated with human life. Fecal pollution of drinking water causes water-borne diseases, which wiped out entire population of cities (Farah *et al.,* 2002).

According to World Health Organization (WHO), (2003) drinking water supplies have a long history of being infected by a wide spectrum of microbes. Therefore, the primary goal of water quality management from health perspective is to ensure that consumers are not exposed to pathogens that cause disease. Protection of water source and treatment of water supplies have greatly reduced the incidence of these diseases in developed countries. Hasan, *et al.,* (2010) reported that the quality of the water consumed by our local population is critical in controlling infectious diseases and other health problems.

According to WHO, (2003) reported that the biological contamination in drinking water is a major problem of public health in developing world. WHO estimates that about 1.1 billion people globally drink unsafe water and the vast majority of diarrheal diseases in the world (88%) is attributable to unsafe water, sanitation and hygiene.

Various researches indicate that waste water is spoiling the entire environmental conditions. This water may have pollutants of almost all kinds from simple nutrients and organic matter (Trivedi *et al.,* 2004). Waste water is responsible for polluting the ground water level and makes the water unsuitable for drinking purpose (Singh *et al.,* 2005). Singh *et a*l., (2005) concluded that the quality of various water sources in and around of Khagaul town showed the water pollution. The water pollution causes irreparable damage to the pollution, soil, plants and animals (Trivedi, 1990 and Chandrasekhar, 1997).

Heavy metal pollution in soil and aquatic bodies is a serious environmental problem threatening not only the aquatic ecosystems but also human health through contamination of drinking water. Unlike organic pollutants heavy metals are not degraded so requires removal for decontamination. In view of the above it is very important to remove the heavy metals from the contaminated sites. According to Chermisinoff *et al.*, (2002) safe drinking water should generally be free from heavy metals, turbidity, organic compounds and pathogens. Turbidity may contain these compounds and also shields pathogens from chemical or thermal damage. It is also important to remove turbidity for the aesthetic values of the drinking water. Organic substances in water might originate from industrial and agricultural operations, which contribute with compounds such as chloroform, gasoline, pesticides and herbicides. Finally, protozoa, bacteria and viruses are all pathogens that can cause diseases.

According to WHO, (2008) among the coagulating agents used in water treatment, ferric sulphate or alum is most widely used salts. The salts acts as coagulants by neutralizing the charges of colloidal particles adsorb or trap them and facilitate the agglomeration of particles during slow mixing provided in flocculation

Studies conducted by Stumm and Morgan, (1996) that conventional treatment of water often includes coagulation, flocculation, sedimentation, filtration and disinfection. Coagulation is the destabilization of particles, which means a changed state in the dispersion of colloidal particles. The stability of colloids is dependent of their surface charge. Polymers can affect the particle interaction by forming bridges between them or by sterically stabilizing them.

The cleanup technology involves a variety of techniques ranging from simple biological process to advanced engineering technologies. The use of clean up technologies without producing other harmful waste products is required as best option (Rajkumar *et al.*, 2008).

Phytoremediation that is using vegetation to remove, detoxify or stabilize persistent pollutant is an accepted tool for cleaning of polluted soil and water. Phytoremediation includes group of technologies that use plants for remediating soils, sludge, sediments and water contaminated with organic and inorganic contaminants. Plants are unique equipped with remarkable metabolic and adsorption capabilities. Phytoremediation is an alternative technology that can be used in place of mechanical conventional technologies that require high capital inputs and labor. (Ali *et al*., 2004, Anderson *et al*., 1994).

Studies conducted by Lombi *et al.,* (2002), Cheng *et al.,* (2002), *Bhargava et al.*, (2008) conclude that attempts for developing cost-effective treatment approach always revolved around using the different types of treatment technologies. Techniques related to treatment cannot avoid chemical, mechanical and energy requirements except this they also generate a new category of pollutants. Using plants to purify soil and water has always fascinated researchers also trying for the same. Consequently many natural systems were developed such as oxidation ponds, lagoons, and constructed wetland etc. that use the ability of different plant species for the degrading or uptake of the pollutants. Use of the plants for such purpose is termed as phytoremediation.

Phytoremediation is divided into different areas such as phytoextraction, rhizofiltration, phytostabiilzation, phytodegradation, rhizodegradation and phytovolatilization. Phytoextraction also called by the name of phytoaccumulation refers to the uptake and translocation of metal contaminants in the soil by plant roots into the aerial parts of plants (Eaphan *et al*., 2005). There are two basic strategies of phytoextraction as chelate assisted phytoextraction, which may also be termed as induced phytoextraction and the other is long term known as continuous phytoextraction. Although chelate assisted phytoextraction has become more developed and also being implemented commercially.

The plant kingdom presents a wealth of chemical compounds of pharmaceutical nature. This has been resulted in the utilization of medicinal plants as flavours, odours, dyes, preservatives and a number of traditional and folklore medicines. Phytochemical derived from plants are not of recent origin, rather they have been provided by the Asia countries, India and China. In China, the medicinal record was as old as 5000-4000 B.C. In India the oldest record of the medicinal plants comes from ‘Rigveda’ (4500-1600 B.C.), the ‘Atherveda’ (4000-1600 B.C.) which provides a remarkable knowledge about Indian medicinal plants.

The importance of natural medicines can be indicated by the fact that one of the most "lifesaving drugs" (antibiotics) can only be obtained by plants. It was reported that use of phytodrugs has increased in the recent years, although synthetic compounds and microbial agents have a major contribution to the pharmaceutical industries, 25% of the prescribed drugs are of plant origin.

Most of the plants producing the valuable medicinal compounds are grown wildly in nature and some of them are cultivated. India's large quantity forest has provided a prominent position in export of medicinal plants and crude drugs. Such plants have often collected from the naturally occurring flora has created a gap in their balance over the earth.

From the time immemorial the medicinal importance of plant products is well known to human beings. Antimicrobials are defined as those secondary metabolites though not belonging to a specific class, which are capable of inhibiting the growth of other microorganisms. Several plants have been screened for their various biological activities such as antibacterial, antifungal, antiviral, insecticidal properties. Skinner, (1995) has screened a number of vascular plants for their antimicrobial activity.

According to Yin, (2010) several plant-based coagulants have been studied scientifically some of them are listed as seeds of *Strychnos potatorum* has been used to clarify turbid surface waters for over 4000 years. *Moringa oleifera* has coagulant properties related to dimeric cationic proteins.

Clijsters *et al*., (1985) reported that macrophytes based wastewater treatment systems have several potential advantages as compared to conventional treatment systems with the low operating costs. They are more flexible and less susceptible to shock, loading and have genetically homogeneous population which is small in size with abundance and rapid growth. Such treatment systems can often be established at the same site where the waste water is disposed.

According to Gray *et al.,* (2000) in case of developing countries like India, such macrophyte based technology may be extremely advantageous where a plenty of waste land requires the reclamation, so that it can be used for agriculture.

G. Vijayaraghavan *et al.,* (2011) reported that frequently studied plant-based coagulants include Nirmali seeds (*Strychnos potatorum*), *Moringa oleifera*, Tannin and *Cactu*s represents important progress in sustainable environmental technology as they are renewable resources and their application is directly related to the improvement of quality of life for underdeveloped communities.

According to (Doppalapudi sandeep *et al.,* 2012) *Cicer arietinum* which is generally consumed as a seed food is a good source of protein. Phytochemical analysis indicates the presence of flavonoids, phenols and saponins in both the methanolic and ethanolic extracts. An extra presence of the tannins in methanolic extract may contribute somewhat major anti-edematous activity when compared to that of the ethanolic extract. There by the findings concluded that *Cicer arietinum* seeds exhibit an anti-inflammatory activity and further studies were suggested to isolate the active principles responsible for the activity.

Md. Asrafuzzaman *et al.,* (2011) reported that using some locally available natural coagulants for example *Moringa oleifera, Cicer arietinum, Dolichos lablab*, significant improvement in removing turbidity and total coliforms from synthetic raw water was found. Maximum turbidity reduction was found for highly turbid waters. After dosing, water-soluble extract of *Moringa oleifera, Cicer arietinum*, and *Dolichos lablab* reduced turbidity to 5.9, 3.9, and 11.1 NTU, respectively, from 100 NTU and 5, 3.3, and 9.5 NTU, respectively after dosing and filtration. It was also found that these natural coagulants reduced about 89–96% of total coliforms. Among the natural coagulants used in this study for turbidity reduction*, Cicer arietinum* was found most effective. It reduced up to 95.89% turbidity from the raw turbid water.

G. Muthuraman *et al.,* (2013) studied coagulation-flocculation followed by sedimentation and filtration is the most commonly used water treatment process in which turbidity or particles removal is strongly dependent on proper coagulant dosage, effect of pH ,effect of time, jar test and settling column tests. The maximum turbidity removal efficiency obtained for *Moringa oleifera* at 12hrs retention time in the settling column, for 100 NTU, 250 NTU, 500 NTU initial turbidity removal efficiency are as 95.93%, 95.10% and 99% respectively. Turbidity values were very similar although the dose of aluminum sulphate which was required to achieve this was greater than that of the *Moringa* oleifera and other coagulant.

Studies conducted by Mangale S. M *et al.,* (2012) confirm the effectiveness of seed powder extracted from mature-dried *Moringa oleifera* seeds which are commonly available in most rural communities. Various doses of *Moringa* seed powder 50, 100 and 150 mg/l were taken and checked for the efficiency dose on raw water. After treatment of seed powder with water samples were analyzed for different parameter like pH,Turbidity, TDS, TS, Hardness, Chlorides,Alkalinity, Acidity, MPN and SPC. All parameters were reduced with increasing dose of 50, 100 and 150 mg/l seed powder respectively (except alkalinity and pH). *Moringa oleifera* seeds acts as a natural coagulant, flocculent, absorbent for the treatment of drinking water. It reduces the total hardness, turbidity, acidity, alkalinity, chloride after the treatment. It also acts as a natural antimicrobial active against the micro-organisms which is present in the drinking water and decrease the number of bacteria. MPN test reading was reduced after treatment of higher dose at 150 mg/l of *Moringa* seed powder.

N. Packialakshmi *et al.,* (2014) reported that the efficiencies of powdered seeds of *Strychnos potatorum* natural water treatment agents alternative to the use of synthetic chemicals. The optimum dosages and turbidities were observed to the alum and *Strychnos potatorum*. Seed extract is effective as a prime coagulant compared with alum. it produces water with slightly higher residual turbidity and residual color,but the residual turbidity and residual color are within the WHO drinking water guideline values for turbidity (5NTU) and color (15 TCU). The effectiveness of *Strychnos potatoram* in the removal of turbidity, total hardness, pH, and total dissolved solids (TDS) has been investigated.

According to Wilson Rwai Waweru *et al.,* (2017) the medicinal properties exhibited by various medicinal plants are driven by the phytochemicals present in the plants. Identification of the phytochemicals present in the selected plants such as Vernonia *mygdalina, Zehneria scabra, Leonotis nepetifolia, Tetradenia riparia, Aloe myrianantha*. Standard procedures for phytochemical screening were used to test for the presence of various phytochemicals. All the selected medicinal plants were found to contain tannins and flavanoids, saponnis and phenols. Alkaloids were also present in all the selected plants except *Aloe myriacantha* and *Eucalyptus* *camaldulensis*. The study concluded that medicinal plants used in Rwanda possessed various phytochemicals that aids in the medicinal properties of the studied plants.

According to Chapman and Kimstach, (1992) the pH is used to read the acid balance of a solution and it is defined as ‘the negative of the logarithm to the base 10 of the hydrogen ion concentration’. The pH scale ranges from 0 to 14 (i.e., very acidic to very alkaline), and pH 7 indicates a neutral condition. The pH of natural water stays in between 6.0 and 8.5 but could be affected by chemicals entering the waterways. This parameter can be used to evaluate the amount of effluent plume in the water body, while measuring the effects of an effluent discharge

Various researches indicate that extremely high or low pH values of fresh water make it unsuitable for most aquatic organisms. Moreover, water with low pH values become corrosive on the other hand, water with high pH values reduces the availability of phosphate, sulphate, iron and manganese (Gambrell and Patrick 1988; Jackson *et al.,* 1993; Handreck and Black, 1994). Furthermore, at high pH levels most of the dissolved carbon dioxide is converted into bicarbonate (HCO_3^-) or carbonate (CO_3^{2-}). This parameter has a direct effect on the treatability of the water. The pH value varying between 6.5 to 8.0 is required for a proper biological treatment of wastewater (Metcalf and Eddy, 1991).

According to World Health Organization (WHO) 1984 the desirable pH of drinking water is 7.0 to 8.5. The pH has no direct adverse effect on health, but at the same time alters the taste of water.

According to Chapman and Kimstach, (1992) and Liston and Maher, (1997) the Biochemical Oxygen Demand (BOD) is used to read the level of biochemically degradable organic matter or carbon loading in the water. It is usually defined by the amount of O_2 consumed by the aerobic micro-organisms present in the water sample for the purpose of oxidizing the organic matter and to convert it to a stable inorganic form. Hence, in water quality analysis this parameter is used to determine the biodegradable organic content of the waste in terms of O_2 which is required when the wastes are discharged into natural water where aerobic condition prevails.

According to Chapman and Kimstach, (1992) the BOD is usually determined through standardized laboratory procedures where the sample is incubated in the dark at a steady temperature of 20 0C for the duration of 5 days, thereby measuring the amount of O2 consumed in this process. This explains the term BOD5 (biochemical oxygen demand on five days). Unpolluted waters typically contain BOD5 values of 2 mg/l or less, while raw sewage could have a BOD5value of about 600 mg/l.

According to Odum, (1971) Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) are the significant parameter of pollution. Various researches shows that due population explosion and rapid urbanization, people dependent on water sources of unconvinced quality in the absence of better alternatives, or due to economic and technological constraint to adequate treat the available water before use (Anna and Adedipe, 1996; Calamari and Naeve, 1994).The scarcity of clean of water and pollution of fresh water has therefore led to a situation in which one - fifth of the urban dwellers in developing countries and three - quarter of their rural dwelling population do not have access to reasonably safe water supplies (Lloyd and Helmer, 1992).

Gamedze *et al.,* (2012) shows that colour, taste, smell and turbidity are the quality parameters mostly used by rural households to determine water suitability for domestic use. Most ground water sources were found to have saline water due to low ground water recharge in the area. Water quality remains a sustainable development challenge in the rural areas of Swaziland.

According to Abbasi *et al.,* (1996) and Rao *et al.,* (1985) an inverse relationship between Dissolved Oxygen (DO) and BOD and these values indicate the lowest biological activity in winter months.According to Rao, (1997) drinking water usually has a BOD of less than 1 mg/l and water is considered to be fairly pure with BOD of 3mg/l and of doubtful purity when the BOD values reach 5 mg/l.

According to Chapman and Kimstach, (1992) Dissolved Oxygen (DO) is used to measure the amount of gaseous oxygen dissolved in the water, which is crucial for all forms of aquatic life.

DO in water mainly appear by diffusion from the atmosphere and also from the photosynthesis of aquatic plants.

Coliforms are the major microbial indicator of monitoring water quality (Brenner *et al.,* 1993 and Grant, 1997). The detection of *Escherichia coli (E. coli)* provides definite evidence of fecal pollution; in practice, the detection of thermotolerant (faecal) *coliform* bacteria is an acceptable alternative (WHO, 1997).

According to the United Nations (UN) and WHO, (1996) data, more than five million people die annually from water borne diseases. Of these, about four million deaths (400 deaths/hr) are of children below age five (WHO, 1996). Most of the pollution in drinking water is caused by the uptake and distribution system, by insufficient upkeep of sewage system, by defects and breaks in the disinfection processes (Scoglio *et al.,* 1989), by human and animal fecal matter (Clark *et al.*, 1982). The fecal *coliform* and *E.coli* has been used an indicator for the potential presence of human enteric pathogen for many years, as it proliferates in the water distribution system (Moe *et al.,* 1991).

The parameters recommended by WHO, (2003) for the minimum monitoring of community supplies are those that ensure the hygienic state of water and reduce the risk of water-borne pathogens. The essential parameters of water quality are: (a) *Escherichia coli* and thermo-tolerant *coliforms* accepted as suitable substitutes, (b) chlorine residual (c) pH and (d) turbidity (WHO, 2003). The *coliform* groups of bacteria principally infect water used for domestic, industrial or other purposes (Zamaxaka *et al.,* 2004). High levels of *coliform* counts indicate a contaminated source and inadequate treatment deficiencies.

According to Watson and Cichra, (2006) organic matter also stimulates the growth of decomposers such as bacteria and fungi. Bacteria and fungi are very critical to the breakdown of the toxic component of the effluent. It has been observed that dissolved oxygen in water is required during the decaying of the organic matter, which may lead to depletion of oxygen in the water body and cause harmful substance to accumulate.

Many researchers Tona *et al*., (1998), Samy and Ignacimuthu, (2000), Palombo and Semple (2001**)**, Kumaraswamy *et al*., (2002), Govindarajan *et al*., (2006) indicated that plants are important source of potentially useful structures for the development of new chemotherapeutic agents. Plants show antiviral, antibacterial, antifungal, anthelmintic, antimolluscal and anti-inflammatory properties.

Phytochemical characterization using various solvent extracts was studied by Neha grover *et al.,* (2013) indicate that various extracts of the leaf and flower of *Woodfordia fruticosa* were screened for the presence of steroids, reducing sugars, alkaloids, saponins, tannins, flavonoids, terpenoids, anthraquinones, glycosides and ascorbic acid by standard qualitative test procedures and further this study was extended by analyzing the potent bioactive compounds in the methanolic extract of *Woodfordia fruticosa* leaves using GC-MS analysis. It was found that most of the biologically active phytochemicals were present in the methanolic extract of *Woodfordia fruticosa* leaves.

Dalen M.B. *et al.,* (2009) reported that phytochemical analysis of *Moringa oleifera* seeds indicates the presence of saponnins, flavonoids and alkaloids. Insrumental analysis showed also the presence of sodium (15.21+0.10ppm), aluminum (12.21+0.012) potassium(14.21+0.013ppm) and sulphate (1.72+0.011 ppm). Jar test trials on raw water samples displayed favorably characteristics at 60% alum to 40% *Moringa oleifera* mg/l blend with total coliform count of 30ml-1 and turbidity of 3.2NTU below the WHO maximum permissible limit of 5NTU. The results indicate that *Moringa* oleifera has a double advantage compared to commercial alum because of the presence of phytochemicals which have been reported to possess antimicrobial properties with potentials for conjunctive use with alum for water purification in rural communities.

In developing countries people do not have access to adequate sanitation facilities and the most important problem is related to the disposal of non degraded waste and waste-water (Ayaz *et al*., 2001). In case of developing countries high costs of infrastructure investment, continual replacement facilities, lack of efficient treatment technologies and financial problems become the main constraints in the path of pollutants management (Brix, 1994). Thus there is a critical need of cost-effective long-term treatment technologies to deliver public health and environmental protection in developing countries.

Hence an analysis and review of available literature reveals that biocoagulant activity of studied plant has been little explored. Review of literature indicate that there are lot of work done on effect of plant based coagulants on water quality.

MATERIALS AND METHODS

The materials and methods of present work on water purification are divided into two parts. The first part deals with seed collection of selected biocoagulant test plant *Moringa oleifera* L. and their phytochemical evaluation study. The second part deals with water quality analysis including physiochemical parameters after treatment with biocoagulant.

PART-A

For the study of phytochemical analysis the extract of *, Moringa oleifera* L. plant is analyzed for the presence of Alkaloids, Phenolics, Saponins, Quinones,Steroid and flavonoids, according to standard method Sofowora, (1982) and Kepm(1986).

Seed Collection

Riped fruits (pods) of *Moringa oleifera* L. were collected from nearby market of Kallumala, Mavelikkara .This plant were selected based on available literature, abundant availability ,medicinal and bio-coagulant properties.

Sample Treatment

For the study of phytochemical analysis,the various extract of the plant seed powder prepared according to standard methods (Sofowora, 1982).

1. Solvents used – Organic solvents such as acetone, chloroform as well as water were employed for the extraction of seed.
2. Extraction - The seeds of the *Moringa oleifera* L. collected were brought to the laboratory, washed with distilled water to remove adhering dust particles,shade dried for about 15 days under room temperature and the plant material were powdered using an electric blender. Organic solvents such as acetone , chloroform and distilled water were employed for the seed extraction under investigation.
3. Cold Extraction (Percolation) – 5 grams of the cleaned appropriate samples were transferred into clean screw cap bottles of 20 ml capacity. 10 ml of various solvent were added separately and stored overnight.Then the extract was collected and stored at 4 o C .
4. Dilution Method – Each extract was filtered using a piece of cheese cloth. 100 fold dilution was prepared by taking 1 ml extract and dissolved it in 99 ml distilled water (0.05% infusion). They were further used for phytochemical analysis.

PHYTOCHEMICAL ANALYSIS

In phytochemical evaluation solvent extracted seed powder of *Moringa oleifera* L.,
are subjected to phytochemical screening of various plant constituents.

Plants synthesize an enormous range of organic compounds that are traditionally classified as primary and secondary metabolites. Primary metabolites are compounds that have essential roles associated with photosynthesis, respiration, growth and development. These include phytosterols, lipids, nucleotides, amino acids and organic acids. Other phytochemicals which accumulate in surprisingly high concentrations in some species are referred to as secondary metabolites. These are structurally diverse and many are distributed among a very limited number of species within the plant kingdom such as alkaloids, glycosides, terpenoids, flavonoids and saponins.

The seed extracts using different solvents were screened for the qualitative identity of different classes of natural compounds,using the methodology of Sofowora(1982) and Kemp(1986).
The major pharmaceutically valuable phytochemical componds investigated in the present study were:

1. Alkaloids
2. Flavanoids
3. Phenols
4. Proteins
5. Saponins
6. Steroids and terpenoids
7. Tannins
8. Quinones
9. Sugars

- **Detection of alkaloids :** A few drops of dilute HCl was separately treated with 1ml each of various extracts. Then it was filtered and the filtrates were treated with 1 ml of Dragendoff's reagent. Formation of reddish orange precipitation indicated the presence of alkaloids.
- **Detection of flavonoids:** A fraction of the extract treated with 1N aqueous NaOH solution and concentrated sulphuric acid. Appearance of yellowish orange colour shows the presence of flavonoids.
- **Detection of phenols :** 1ml of the various extracts dissolved in 5 ml of alcohol was treated separately with a few drops of neutral Fecl3 solution.Any change in colour indicated the presence of phenolic compounds.

- **Detection of protein :** 5 ml each of various extracts were dissolved in 5 ml of water separately and were subjected to the following tests.

  Biuret test : 1 ml each of the various extracts was warmed gently with 10% NaOH solution and a drop of diluted CuSO4 solution. Formation of reddish violet colour indicated the presence of proteins.
- **Detection of saponins:** In a test tube add about 5ml of extract and add a drop of sodium bicarbonate. Shake mixture vigorously and kept for 3minutes. The formation of a honey comb like froth showed the presence of saponins.

- **Detection of tannins:** To 5ml of extract solution, 1ml of lead acetate solution was added. Flocculent brown precipitate indicates the presence of tannins.
- **Detection of quinones:** 1 ml of the various extracts was separately treated with alcoholic KOH solution. Quinones give colorations ranging from red to blue.

- **Detection of steroids and terpenoids:** A small amount of sample dissolved in 2ml of chloroform taken in a dry test tube. Add equal volume of concentrated sulphuric acid and shake gently. The presence of steroids and terpenoids indicated by the upper layer of chloroform turning red and lower layer showing yellow green fluorescence.
- **Detection of sugars :** 5 ml each of thevarious extracts was dissolved separately in distilled water filtered and then subjected to the following test.

  Fehling's test : A small portion of various filtrates were treated with 1 ml of Fehling's solution 1 and 2and then heated gently. Change in colour indicated the presence of sugars.

PART-B

For the present study, physic-chemical and bacteriological characters of water parameters of sample water were observed. For the analysis of various physico-chemical parameters were determined by following methods devised by APHA, (1976); Adoni, (1985); Trivedy and Goel, (1984) and Gupta, (2006).

Collection of Water Samples

Water samples were collected from Arattupuzha, Vallakadavu, Aranmula of Pamba river during the month March 2022. Precautions were taken to prevent any vertical disturbance during the collection. The collected water samples were stored in a clean bottle for analysis. Various methods were used for physico-chemical analysis of the surface water. The tests for BOD and DO were conducted on the same day of collection. The pH was determined using the pH meter. The oxygen content was measured by Wrinkler's method. All the other parameters were found using APHA(2012).

WATER QUALITY ANALYSIS

Water from selected sites of rivers was collected and analyzed for various physical parameters viz. clearity, odour, colour, pH, turbidity, alkalinity, dissolved oxygen and biochemical oxygen demand. Study to know about palatability of water the standard quality and was compared to the table approved by Bureau of Indian Standard for drinking water.

Jar Test

To perform jar test 1g each of plant powder dissolved in separate 100ml of distilled water as stock solutions. 200ml of raw sample water were measured and introduced into beakers labeled 1-7. With a calibrated pipette, each stock solution dosages of solutions were added onto the water samples in the beakers as rapidly as possible. Mix contents for 2 minute at a speed of 100rpm, followed by slow mixing for 8mins at 25 rpm. Observe the beakers and evaluated for specific dosages and flock quality. Turned off the jar test mixer and the flocks allowed to settle in the beakers for 30mins and observe flocks settling characteristics.

pH determination

The term pH refers to the measure of hydrogen ion concentration in a solution and defined as the negative log of H+ ions concentration in water and wastewater. The values of pH 0 to a little less than 7 are termed as acidic and the values of pH a little above 7 to 14 are termed as basic.

The pH of water sample was measured by pH meter. Before using the pH meter it is necessary to eliminate the error. The meter was earlier calibrated against the
known buffer solutions of 7.0 pH and 9.2 pH.

Turbidity of water

Turbidity is the technical term referring to the cloudiness of a solution and it is a qualitative characteristic which is imparted by solid particles obstructing the transmittance of light through a water sample. Turbidity often indicates the presence of dispersed and suspended solids like clay, organic matter, silt, algae and other microorganisms. Turbidity of water sample was measured by century made CTD 401 digital turbidity meter usind Nephelometry-US EPA method.

Method

Take clean sample cell and add turbidity free distilled water up to the horizontal mark. Wipe gently with soft tissue. Place sample cell in the turbidity meter such that the vertical mark in the sample cell should coincide with the mark in the turbidity meter and cover the sample cell. Now adjust the reading to zero using the set zero knob. Prepare a standard 10 NTU, 100 NTU solutions by diluting the standard 4000 NTU solution. Add standard solutions to the sample cells up to the horizontal mark, wipe gently with soft tissue. Place it in the turbidity meter and cover the sample cell. Now check reading 10 NTU, 100 NTU. If the instrument is not showing 10 NTU, 100 NTU, using the calibration knob adjust the reading. Fill sample water in sample cell and check turbidity of sample.

Total alkalinity determination

Alkalinity was determined titrimetrically with (0.02 N) sulphuric acid, using the phenolphthalein and methyl orange as indictor. Carbonate and bicarbonate were calculated by the method as given by Adoni, (1985) and APHA, (1976).

Method

Rinse the burette with 0.02N Sulphuric acid and discard the solution. Fill the burette with 0.02N sulphuric acid and adjust it to zero. Using a measuring cylinder exactly measure 100 ml of sample and pour it into a 250 ml of conical flask. Add few drops of phenolphthalein indicator to the contents of conical flask. The colour of the solution will turn to pink. This colour change is due to alkalinity of hydroxyl ions in the water sample. Titrate it against 0.02N sulphuric acid till the pink color disappears. This indicates that all the hydroxyl ions are removed from the water sample. Note down the titter value (V1). The value of titration is 0.5ml .This value is used in calculating the phenolphthalein alkalinity. To the same solution in the conical flask add few drops of mixed indicator. The colour of the solution turns to blue. This colour change is due to CO3 -2& HCO3- ions in water sample. Continue the titration from the point where stopped for the phenolphthalein alkalinity. Titrate till the solution becomes red. The entire volume (V2) of sulphuric acid is noted down and it is accountable in calculating the total alkalinity.

Calculation

$$\text{Total Alkalinity} = \frac{\text{Volume of } H_2SO_4 \text{ X Normality X 50X 1000}}{\text{Volume of sample taken}}$$

Normality of Sulphuric Acid = 0.02 N

Volume of Sample = 50 mL

Biological Oxygen Demand (BOD) determination

The biochemical oxygen demand determination is a chemical procedure for determining the amount of dissolved oxygen needed by aerobic organisms in a water body to break the organic materials present in the given water sample at certain temperature over specific period of time. BOD of water or polluted water is the amount of oxygen required for the biological decomposition of dissolved organic matter to occur under standard condition at a standardized time and temperature.

All reagents needed for measuring of dissolved oxygen were also used in BOD estimation by APHA standard method 5210B, (1976). Three oxygen bottles were filled with the water sample to be analyzed. To the first bottle, Winkler's reagents was added immediately just after the sample collection. The rest two bottles were sealed immediately without letting the air bubble go in and were kept in the incubator at 20 o C for five days (BOD5). At the end of fifth days, the amount of dissolved oxygen was measured in each of the bottles. In the polluted samples, the dissolved oxygen was completely used up after five days incubation period, or 70 % of the initial oxygen is consumed, it was necessary to aerate and dilute the water sample.

Calculation

Let DO = DO in the sample bottle on 0th day.
D1 = DO in the sample bottle on 5th day

C0 = DO in the blank bottle on 0th day
C1 = DO in the blank bottle on 5th day.
C0 – C1 = DO depletion in the dilution water alone.
D0 – D1 = DO depletion in sample + dilution water.

(D0 – D1) – (C0 – C1) = DO depletion due to microbes.

BOD mg/l = (D0 – D1) – (C0 – C1) mg x Decimal fraction of sample used.

If the sample is seeded, find out BOD of seed in the above manner and apply correction, as per demonstration

This study was conducted in order to test the bio-coagulant activity of medicinally important plant *Moringa oleifera* L. seeds were selected after phytochemical screening. Good quality *Moringa oleifera* seeds are taken and removed its wings and coat from their seeds.Fine powder was prepared by using mortar and pestle and this powder was directly used as coagulant.Water samples were collected from Arattupuzha, Vallakadavu,Aranmula of Pamba river for the study purpose.

Water is treated by adding of *Moringa Oleifera* Seed powder directly.The water quality parameters were checked before and after treatment of *M.Oleifera*. Doses of seed powder were selected as 50, 100 and 150mg/ litre for treatment.

The coagulant was mixed with the water samples and kept on the mechanical shaker for 45min at 110 -120 rpm. The settling time was 1-2 hours (depending on the water turbidity of different samples).After sedimentation, supernatant water is separated and the same is taken for test. The water quality parameters were checked before and after the treatment and the efficiency dose of *Moringa oleifera* seed powder was determined.

Scientific name : *Moringa oleifera*

Figure 1: *Moringa oleifera* tree [12]

Systematic Position

Kingdom	:	Plantae
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Family	:	Moringaceae
Genus	:	*Moringa*
Species	:	*oleifera*

Description

Moringa oleifera belongs to family Moringaceae is a nontoxic tropical multipurpose tree that is commonly known as the miracle tree found throughout India. Common name of *Moringa oleifera* is drumstick tree, horseradish tree and senjana. The Moringa tree is considered one of the world's most useful trees,as almost every part of the Moringa tree can be used for food or has some beneficial properties.It is used as forage for livestock and used as a micronutrient powder to treat various ailments. The fruit of the tree is quite popular as a vegetable in Asia and African countries. In India and other parts of the country the fruit called drumstick. The Moringa trees have been used to combat malnutrition especially among infants and nursing mothers.This plant leaves are very good nutrient supplement for malnutrition and also used as an antibiotic.

Parts used – Seeds

Traditional Medicinal Use

Among many other properties, *M. oleifera* seeds contain a coagulant protein that can be used either in drinking water clarification or wastewater treatment. It is said to be one of the most effective natural. It has an impressive range of medicinal uses with high nutritional value. Different parts of this plant contain a profile of important minerals, and are a good source of antioxidants, protein vitamins, beta-carotene, amino acids and various phenolics compounds. It also shows antibacterial and antifungal activity.

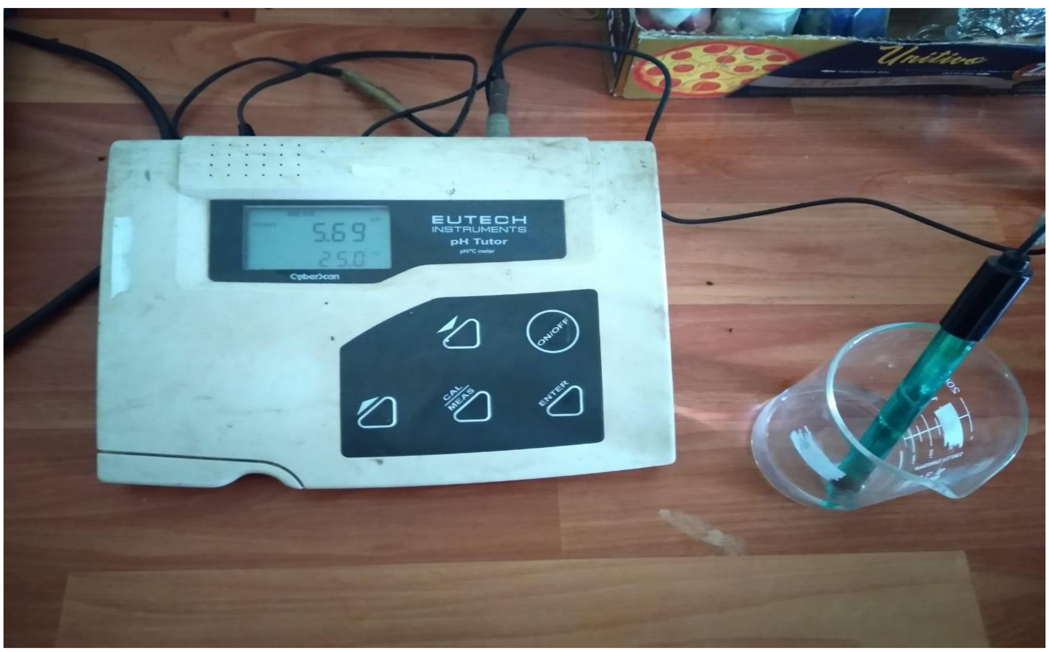
PLATE – 1

1:- *Moringa oleifera* L. Seeds and Plant

Plant Seeds Selected for Analysis of Natural Coagulant Activity

PLATE – 2

3.1:- Turbidity Meter **3.2:-Water Bath**



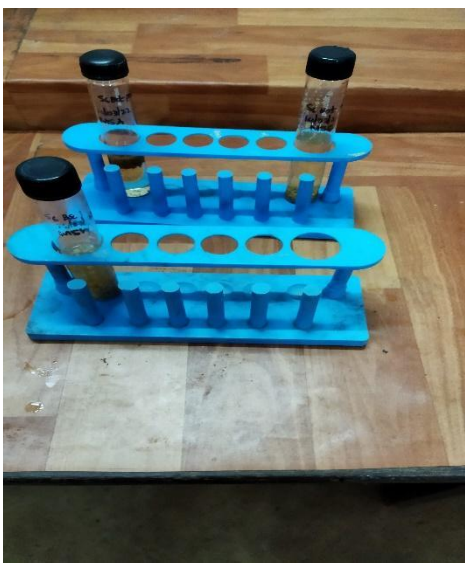
3.3:- pH Meter

Showing Some Instruments Used During Phytochemical Analysis

PLATE - 3

3.1: Treated and untreated water sample

3.2: Water Sample collected from Pampa



3.3 : Reagents used for DO

3.4 : Moringa Seed Extraction

RESULTS AND DISCUSSION

The result and discussion of present work on water purification are divided into two parts. The first part deals with phytochemical analysis of biocoagulant test plant, *Moringa oleifera* . The second part deals with water quality analysis including physiochemical parameters after treatment with biocoagulants.

PART-A

In present investigation *Moringa oleifera* plant has been selected as a biocoagulant and subjected to phytochemical screening of the plant constituents which are illustrated on figures above (PLATE- 4).

Table :1

Parameter	Solvent extract		
	Acetone	Chloroform	Water
Alkaloids	+	+	+
Flavanoids	_	_	_
Phenols	_	_	_
Proteins	+	+	+
Saponins	+	+	+
Steroids	+	_	_
Terpenoids	_	_	_
Tannins	_	_	_
Quinones	+	+	+
Sugars	+	_	+
%Phytochemical extractable	60	40	50

Preliminary Phytochemical Analysis of Solvent Extracts of Moringa Seeds

(+) = Present, (-) = Absent

Table :1 shows the phytochemical analysis done on the seed extract of *Moringa oleifera* using organic solvents such as acetone, chloroform and water.While the phytochemicals considered were alkaloid,flavonoids,phenols,proteins,saponins,steroids,terpenoids,tannins,sugars and quinones.In all the three solvents used for extraction of Moringa seed ,it was observed that alkaloid, saponins ,proteins, quinones were present while flavonoids, phenols, terpenoids, and tannins were absent. Sugars were present in both acetone and water extracts of Moringa seeds except chloroform extract. Steroids were present only in acetone extract while absent in both chloroform and water extracts. Among the ten phytochemicals examined for Moringa seed extract , acetone extract had six (60 %), chloroform had four (40 %) and water extracts had five (50%) of the phytochemicals.

PART-B

Water quality analysis

Stock solutions of biocoagulant *Moringa oleifera* was prepared through seed powder for each sample was maintained in the amount of 100 mg/l.

Physio-chemical parameters

Water samples before and after treatment was estimated in the form of colour, odor and clearity. In all samples control was very cloudy in clearity offensive in odor and dirty brown in colour. *Moringa oleifera* ,one of the selected plant as bio-coagulant which was very clear, odorless in odor and totally colourless.

Table: 2. Physicochemical Parameters before and after Treatment of Water with M.O Seed Powder

Sample	Colour		Odour	Clearity
	Before Treatment	After Treatment		
Moringa oleifera	Faint Brown	Colourless	Odourless	Very clear
Control	Faint Brown	Dirty brown	Offensive	Very cloudy

The water samples under study has faint brown colour before treatment with *Moringa oleifera* seed powder. After adding different doses of Moringa to the sample removes colour and the samples are colourless.This suggests that the *Moringa oleifera* seeds show absorbent properties. Good clarification is obtained if a small cloth bag filled with the powder seeds of Moringa is swirled round with turbid water. These above observations can show from Table: 2.

pH

Hydrogen ion concentration plays an important role in the biological processes of almost all aquatic organisms. Low pH values indicate acidic water having corrosive properties. High pH values indicate alkaline properties. pH values between 6.5 to 8.5 are considered acceptable. Two different concentrations (50 mg/l and 100 mg/liter) were estimated on the behalf of pH before and after treatment of water sample. In the sample control shows maximum pH in both concentrations (8.22, 8.22). In concentration 50 mg/l of plant sample pH of *Moringa oleifera was* 8.15. On the other hand the concentration of 100 mg/l pH was 7.95 of *Moringa oleifera* (Table-3).

Sample	**pH**		
	Before Treatment	**After Treatment**	
		50 (mg/ml)	100 (mg/ml)
Moringa oleifera	6.3	8.15	7.95
Control	7.2	8.22	8.22

Table 2 : pH of all three samples before and after treatment With M.O. seed powder

During the present study, treatment of *Moringa oleifera* seed powder was given to the collected water samples in different doses. During the analysis, it was observed that after treatment with Moringa Seed powder, pH was increased for 50mg/L and it was decreased for 100mg/L .After treatment the pH range was 8.15 to 7.95 .In the given sample the water was acidic in nature before treatment and it was converted to the basic nature after treatment.

Treatment of *Moringa oleifera* seed powder was given to water sample in different doses. It was observed that before treatment the pH was 6.3 show acidic properties. After treatment with M.O. powder, pH was increased to 8.15 at 50mg/L dose but gradually decreased to 7.95 by adding of M.O. powder at 100mg/L. After treatment the range of pH in the Sample was 8.15 to 7.95 and it is within the limit of W.H.O. Standards.

The recommended acceptable range of pH for drinking water specified byW.H.O.was 6.0 to 8.0**.** The treatments gave a pH range of 8.15 to 7.95 which falls within the reducing trends on the concentration of the dosing solutions were increased. In some doses pH increases with increasing concentrations of Moringa as coagulant. It was reported that the action of M.O. as a coagulant lies in the presence of water soluble cationic proteins in the seeds. This suggests that in water, the basic amino acids present in the protein of Moringa would accept a proton from water resulting the release of a hydroxyl group making the solution basic.

Turbidity

Turbidity refers to the cloudiness of a solution and it is a qualitative characteristic which is imparted by solid particles obstructing the transmittance of light through a water sample.
After treatment turbidity was minimum in *Moringa oleifera* (7.4 NTU) . Maximum turbidity was examined in control that was (54.0 NTU) (Table-3).

Table 3 : Turbidity of all three samples before and after treatment with M.O. Seed powder

Sample	Before Treatment	After Treatment	
		50 mg/L	100 mg/L
Moringa oleifera	14.7	7.4	7.2
Control	54	_	_

The variation of turbidity in the collected water samples after adding *Moringa oleifera* seeds are shown in the plate 5 .This turbidity of the sample may be continuous movement of water in the river. Before treatment of *Moringa oleifera*, turbidity is 14.7 NTU in water sample. In the samples it was observed that, the use of M.O. Powder Seeds, decreases the turbidity with increasing doses. In the above sample collected it was observed that the turbidity decreases with increasing doses of M.O powder at 50 mg/L (7.4 NTU)and 100 mg/L(7.2 NTU) respectively. It was found that 90-99%of turbidity in treated water was removed by using *M. oleifera* seed powder. These studies are confirmed that the seeds are highly effective in removing suspended particles from water with medium to high levels of turbidity.

Alkalinity

Comparative analysis of alkalinity of water before and after treatment with seed powder was observed in increasing order from *Moringa oleifera* to control. Maximum alkalinity was estimated (124 mg/l) for control and minimum was for water sample treated with *Moringa oleifera* (116 mg/l – Table:4)

Table : 4. Comparative Analysis of Alkalinity of Water before and after Treatment with Seed Powder Dosage range (100 mg/l)

Sample	Volume of Sample (ml)	Burette Reading (ml)		Volume of Sulphuric acid(ml)	Alkalinity(Mg/l)
		Initial	Final		
Moringa oleifera	50	10	15.8	5.8	116
Control	50	0	6.2	6.2	124

Dissolved Oxygen (DO)

Dissolved oxygen in of considerable importance in water quality investigation and its concentration in water is an indicator of ability of a water body to support a well-balanced aquatic life. DO in water is replenished through photosynthesis, dissolution from the atmosphere and addition of oxygen rich water such as through run-off.

DO of the collecter water samples were examined before and after treatment with seed powder.

DO of untreated water was (0.2 mg/l). Maximum DO was reported in *Moringa oleifera* (3.0 mg/l –Table :5)

Table : 5. Dissolve Oxygen of Water before and after Treatment with Seed Powder Dosage range (100 mg/l)

Sample	**D0**	**D1**	**DO = D0 – D1 (Mg/l)**
Moringa oleifera	7.2	4.2	3
Control(Without treatment)	4.2	4.0	0.2
Blank	9 (C0)	1.6 (C1)	7.4

Biological Oxygen Demand (BOD)

BOD of water is the amount of oxygen required for the biological decomposition of dissolved organic matter to occur under standard condition at a standardized time and temperature. Maximum BOD was estimated in control (70 mg/l). In various treated water samples show maximum BOD at *Moringa oleifera* (26 mg/l –Table : 6)

Table : 6. BOD of Water before and after Treatment with Seed Powder Dosage range (100 mg/l)

Sample	DO = D0-D1	C0-C1	Decimal fraction of sample	BOD (Mg/l)
Moringa oleifera	3.0	0.4	10	26
Control(Without treatment)	7.2	0.2	10	70

The waste generated by modern society when discarded in nature can make the water unfit for human consumption. Thus to obtain drinking water is necessary to perform a physical-chemical treatment which allow the removal of the turbidity and organisms harmful to health. Various methods are used to make water safe to the consumer. The method employed depends on the character of the raw water. For the treatment of surface water some traditional chemicals are used during the treatment of surface water at its various steps. Commonly used chemicals for various treatment units are synthetic organic and inorganic substances. In most of the cases, these are expensive since they are required in higher dose and do not shows cost effectiveness. Many of the chemicals are also associated with human health and environmental problems. The use of clean up technologies without producing other harmful waste products is required as best option using vegetation to remove, detoxify or stabilize persistent pollutant is an accepted tool for cleaning of polluted soil and water. Natural coagulants have been used for domestic household for water treatment in rural areas. Now a day some reports describe natural coagulants from plants are used for natural water purification.

The use of plant seed materials is receiving attention for their effectiveness in wastewater treatment. The technologies involved are economical, traditional and easy to implement. These observations motivate me to analyze the biocoagulant property of the plant *Moringa oleifera* was selected for further study.

Operation and maintenance of plant-based technologies operating a plant-based water clarifier system is very simple with no major machinery or specialized labor required as observed by Kebreab, (2004) and Yongabi, (2006). Some previous studies have screened a number of plants as disinfectant for water treatment, *Acrorus calamus*, *Anaphalis cunefolia*, *Arnebial nobills*, *Eclipta alba*, *Azadirachta indica*, *Moringa oleifera* (Jahn, 1981).

The seed powder of *Moringa oleifera* has been used in many african societies for water clarification for domestic use reported by Sutherland *et al.,* (1990); Lowell, (2001); Kebrea, (2004). Reports on the potentials of this plant in wastewater treatment existed by Yongabi K.A., (2004).

In earlier studies *Moringa oliefera* phytochemical screening revealed presence of flavonoids and saponins, Tannins,Alkaloids, were reported by Napolean *et al.*, (2009) and Phytochemicals in fruits and vegetables may reduce the risk of a cancer possibly due to their dietary fibers, polyphenol antioxidants and anti-inflammatory effects (Brow and Arthur, 2001).

Phytochemicals such as carbohydrates, reducing sugars, steroids and alkaloids were found to be moderate in concentration. Steroids are used in the stimulation of bone marrow and growth. It stimulation lean body mass and also play vital roles in the prevention of bone loss in elderly men (De-piccolli *et al*., 1991).

In previous studies, the natural alternative methods have been applied in water treatment, especially in the rural area (Folkard *et al*., 1993; Doer, 2005; and Onwuliri and Dawang, 2006) by using natural compounds found in plants such as Okra (Agarwal *et al*, 2001), Rice, fenugreek and psyllium as coagulant materials to remove the contaminants from drinking water.

Reports have also described the Moringa seeds powder is most effectively used to treat, purify and contaminant removal from drinking water (Olsen, 1987; Daniyan *et al.*, 2011; Prabhu *et al.*, 2011). In Sudan, dried seeds of *Moringa oleifera* have been used by women in rural areas as a natural alternative to replace the alum (aluminum sulphate) in the removal of turbidity from water (John and Dirar, 1979; Muyibi and Evison, 1994).

Rajendran *et al.*, (2013) reported that seeds of *Moringa* oleifera have shown promising result as the source of natural coagulant in the clarification of turbid water. Asrafuzzaman *et al*., (2011) studied the reduction efficiencies of *Moringa oleifera* in treatment of synthetic water and reported that this plant is most effective in reduction of turbidity.

The present study of phytochemical investigation of *Moringa oleifera seed* powder revealed the presence of alkaloids, flavanoids, phenol and steroids (Table: 1& Plate: 4, 5). it was observed that alkaloid, saponins ,proteins, quinones were present while flavonoids, phenols, terpenoids, and tannins were absent. Sugars were present in both acetone and water extracts of Moringa seeds except chloroform extract. Steroids were present only in acetone extract while absent in both chloroform and water extracts. Among the ten phytochemicals examined for Moringa seed extract , acetone extract had six (60 %), chloroform had four (40 %) and water extracts had five

(50%) of the phytochemicals. The observations made during the present study are in agreement with Nepolean *et al.,* (2009) but disagreed with the finding of saponins.

The results obtained in the present study thus suggest that the identified phytochemical compounds may be the bioactive constituents and these plants are proving to be an increasingly valuable reservoir of bioactive compounds of substantial medicinal merit. Some of these observations have helped in identifying the active principle responsible for such activities and in the developing drugs for the therapeutic use in human beings.

Knowledge on the physico-chemical characters of the water source is very important because it may influence the immediate environment of aquatic, wet lands flora and human health. WHO (1971 & 1976) standards for drinking water specify that, water intended for human consumption must be free from organisms and from concentrations of chemical substances that may be a hazard to health. In addition, supplies of drinking water should be as pleasant to drink as circumstance permit.

Results of present research work indicate that water samples physical parameters were estimated in the form of colour, odor and clearity (Table: 2). In all samples control was very cloudy in clearity offensive in odor and dirty brown in colour. Whereas *Moringa oleifera* treated water was very clear, odorless and colourless.

Colour in water may be caused by the presence of minerals such as iron and manganese or by substances of vegetable origin such as algae and weeds. Colour tests indicate the efficacy of the water treatment system. Odour and taste are associated with the presence of living microscopic organisms or decaying organic matter, industrial wastes containing ammonia, phenols, halogens, hydrocarbons.

According to WHO, (1984) the desirable pH of drinking water is 7 to 8.5, the pH has no direct adverse effect on health, but at the same time alters the taste of water. Higher pH reduces the germicidal potentiality of chlorine and induces the formation of toxic trihalomethanes (Trivedy and Goal, 1986).

Our present study results indicated that two different concentrations (50 mg/l and 100 mg/liter) were estimated on the behalf of pH before and after treatment of water sample. In all samples control shows maximum pH in both concentrations (8.22, 8.22). In concentration 50 mg/l of plant sample, pH of treated water sample with *Moringa oleifera* show maximum pH(8.15). On the other hand the concentration of plant sample 100 mg/l maximum pH was 7.95 of *Moringa oleifera.*(Table :2).This study has conclusively indicated that pH of water can be reduced considerably with the application of phytocoagulants. Our results also shows similarly with the study of Eman *et al.,* (2010) that the pH of the treated wastewater decreased from after the addition of different coagulants.

Tasneembano Kazi and Arjun Virupakshi (2013) reported that *Moringa oleifera* used as locally available natural coagulants to reduce turbidity of tannery wastewater. R.M.S. Radin Mohamed et *al.,* (2014) studied that the pH value of raw car wash waste water before treatment was in the range of 8.0 - 9.0. It was observed that after the treatment with alum, *Moringa oleifera* the pH reduced to the range between 6.5 and 7.0. The optimum value of pH depends essentially on the properties of the water treated, type of coagulant used and its concentration (Abdul Aziz et al., 2007).

Turbidity refers to the cloudiness of a solution which is imparted by solid particles obstructing the transmittance of light through a water sample. Results of our present work indicate that after treatment turbidity was minimum in *Moringa oleifera* (7.4 NTU). Maximum turbidity was examined in control that was (54.0 NTU) (Table: 3). Selected biocoagulant reduced turbidity ranged from 42.8% to 72.9% after treatment. This study has conclusively indicated that turbid water can be treated considerably with the application of phytocoagulants. It has been evident from our findings that *Moringa oleifera* was more effective as prime coagulant for turbidity removal in water purification. This act as green technology chemical over traditional chemicals of water purification.

Yasabie Abatneh *et al*., (2014) indicated that *Moringa oleifera,* reduce turbidity of water. The reduction efficiency is higher for more turbid waters. Turbidity reduction exceeding 90 % was achieved for all the three extracts on shallow well water with an initial turbidity of about 50 NTU.

The alkalinity natural or treated wastes is the capacity of some of its components to accept protons that is to be bind an equivalent amount of strong acid like hydroxyl ions and anions of weak acid (e.g. bicarbonates and carbonates). It is the therefore, a measure of the buffering capacity of the water (Train, 1978).

Our results indicated that comparative analysis of alkalinity of water before and after treatment with seed powder was observed in increasing order from *Moringa oleifera* to control. Maximum alkalinity was estimated (124 mg/l) for control and minimum was (116 mg/l) for sample *Moringa oleifera* . (Table: 4). This study has conclusively indicated that alkalinity of treated water can be reduced considerably with the application of selected phytocoagulant. It has been evident from our findings that *Moringa oleifera* was more effective plant based coagulant for alkalinity removal in water purification.

Mangale Sapana M *et al.,* (2012) stated that alkalinity during the research work was observed to be 130mg/l for ground water. At various doses of *Moringa oleifera* seed powder, it was observed that the alkalinity reduced after the treatment at 50 mg/l dose. But at higher dose of 100 and 150 mg/l of *Moringa* seed, the alkalinity was slowly increased. The alkalinity was present in the range of 95 – 100 mg/l which was within limits of WHO standards.

Dissolved oxygen present in drinking water adds taste and it is a highly fluctuating factor in water. According to European Economic Community, the permissible standard of drinking water for dissolved oxygen in 5 mg/l to 7.3 mg/l.

Results of present research indicates DO of all samples were examined before and after treatment with seed powder. DO of untreated water was (0.2 mg/l). Maximum DO was reported in *Moringa oleifera* (3.0 mg/l- Table:5) .This study has conclusively indicated that DO of treated water can be increased considerably with the application of selected phytocoagulant. It has been evident from our findings that DO levels are increased effectively by the application of *Moringa oleifera* based coagulant for water purification.

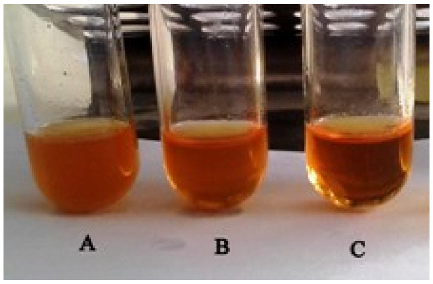
Drinking water usually has a BOD of less than 1 mg/l and water is considered to be fairly pure with BOD of 3 mg/ l and of doubtful purity when the BOD values reach 5mg/l (Rao, 1997).

Results of present work indicate that maximum BOD was estimated in control (70 mg/l). In various treated water sample show maximum BOD at *Moringa oleifera* (26 mg/l-Table: 6 .Our study has conclusively indicated that BOD of treated water can be manipulated considerably with the application of selected phytocoagulant. Results indicated the use of natural coagulants derived from plants as an alternative to usage of chemical coagulants for water purification. The organic matter supported good microbial growth; the microorganism utilizes the oxygen and leads to high values of BOD, COD and low values of dissolved oxygen. Similar results were obtained by Chinedu *et al.,* (2011) and Shrivastava *et al.,* (2010).

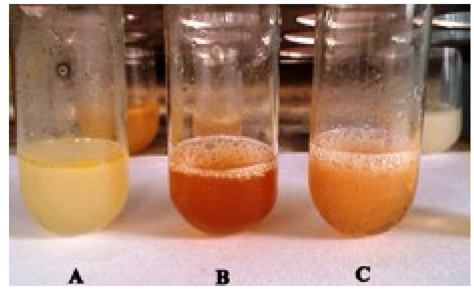
The findings of the present study further justify traditional use of plant based biocoagulant for water purification. The use of natural coagulants from plant based source represent a vital development in sustainable environmental technology as it focus mainly on the improvement of quality of life for communities. The bio coagulant process become more efficient and cost of treatment is reduced. Biocoagulants helpful in removal of turbidity, heavy metals, colour from wastewater. Hence, the present studies also justify the claimed use of the plant(*Moringa oleifera*) in the traditional water purification system. The study of qualitative phytochemical analysis of study plants seed extract revealed the presence of bioactive compounds such as terpenoids, alkaloids, flavonoids, phenols, steroids and saponins .

PLATE – 4

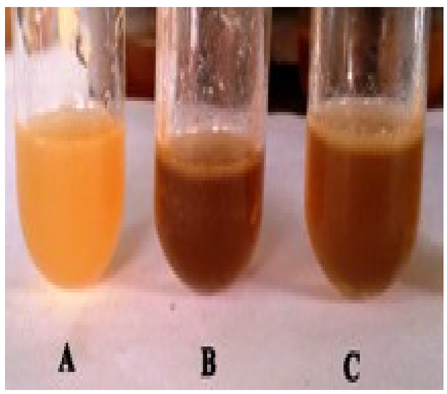
Showing Phytochemical Analysis of Acetone, Chloroform & Water Extract



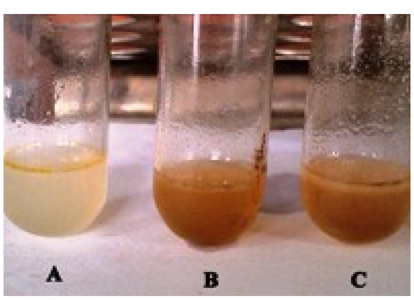
4.1:- **Alkaloids Detection**

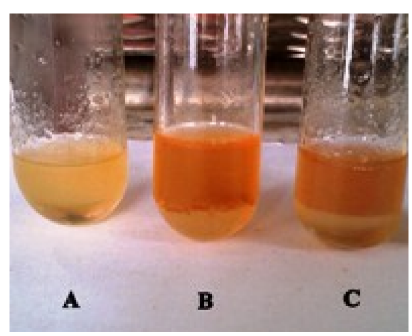


4.2:- Flavonoids Detection



4.3:- Phenol Detection



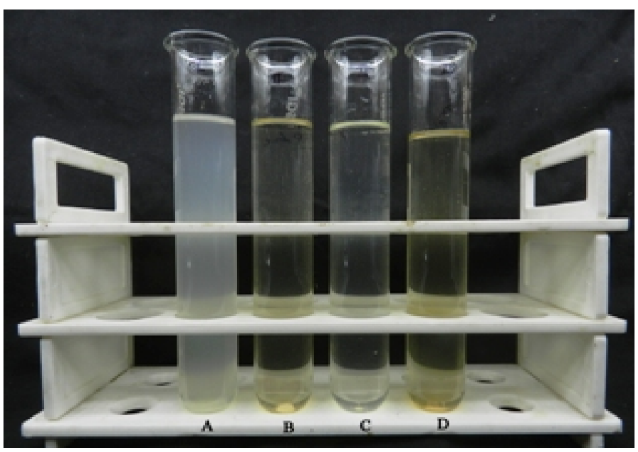


4.4:- Saponin Detection

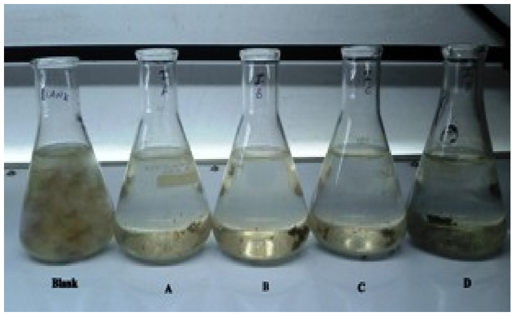
4.5:- Steroid Detection

PLATE – 5:

5.1:- Stock Solution of Plant Seed Powder



5.2:- Untreated and Treated Water Sample (Turbidity)



5.3:- Alkalinity Determination Using Titration Method

SUMMARY AND CONCLUSION

Water is the most vital element among the natural resources. In many developing countries today access to clean and safe water is a crucial issue. The surface water becomes highly polluted due to indiscriminate discharge of untreated waste from tannery, textile, municipal waste into water bodies, poor drainage system. More than six million people die because of diarrhea which is caused by polluted water. Developing countries pay a high cost to import chemicals for water treatment. Water from all sources must have some form of purification before consumption. Various methods are used to make water safe 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. For the treatment of surface water, some traditional chemicals are used during the treatment of surface water at its various steps. Commonly used chemicals for various treatment units are synthetic organic and inorganic substances. In most of the cases, these are expensive since they are required in higher dose and do not shows cost effectiveness. Many of the chemicals are also associated with human health and environmental problems so, there raised a voice to develop cost effective,easier and environmental friendly process of water clarification. In recent years there has been considerable interest in the development of usage of plant natural coagulants. These coagulants are biodegradable and are presumed to be safe for human health. In addition natural coagulants produce readily biodegradable and less voluminous sludge that amounts only 20– 30% that of alum treated counterpart. The use of clean up technologies without producing other harmful waste products is required as best option using vegetation to remove, detoxify, or stabilize persistent pollutant is an accepted tool for cleaning of polluted soil and water.

The production of drinking water from most raw water sources involves coagulant use at a coagulation or flocculation stage to remove turbidity in the form of suspended and colloidal material. Many coagulants and flocculants are widely used in conventional water treatment processes. These materials can be classified into inorganic coagulants (e.g. aluminium and ferric salts) and synthetic organic polymers (e.g. polyacryl amide derivatives and polyethylene imine). Aluminium salts are cheap and are the most widely used coagulants in water and wastewater treatment all over the world. Regarding the application of synthetic polymers, the presence of residual monomers is undesirable because of their neurotoxicity and strong carcinogenic properties.

Natural coagulants have been used for domestic household for centuries in traditional water treatment in rural areas. Now a day, some reports describe natural coagulants from plants are used for natural water purification. The use of plant seed materials is receiving attention for their effectiveness in wastewater treatment. The technologies involved are economical, traditional and easy to implement and ideal for rural areas. The process being biological in nature does not generate any non-treatable wastes. These processes are easy to operate and require little or no maintenance. For the future development of the use of plant materials for wastewater treatment, other native plants and plant materials should be investigated as coagulants for color and turbidity removal.

There is an increasing interest in the phytochemical compounds, which could be relevant to their nutritional incidence and their role in health and disease. In recent years the interest for the study of the organic compounds from plants and their activity has increased.

It has been evident from our findings that the usage of plant based natural coagulants represents a fundamental development in sustainable environmental technology for the improvement of quality of life for communities. In an era of increasing environmental concerns, water scarcity admits the draw backs of chemical coagulants and poor sanitary facilities in most low income earning countries, the need to further develop natural coagulants as alternative environmentally favorable water purifying chemicals is exigent. The usage of bio-coagulants derived from plant based sources represents a vital development in 'grassroots' sustainable environmental technology through cost effectiveness.

Design natural water purification techniques using plants extracts for bioremediation of turbid water. Application of this lowcost protocol will be recommended for simplified, point-of-use, lowrisk water treatment where rural and peri-urban people living in extreme poverty are presently drinking highly turbid and microbiologically contaminated water. The ultimate purpose of proposed research study is to come up with a compendium of plant coagulants that could be used as a technology that is cost effective and ecofriendly. It is felt that further research can be conducted by using the information described in this review as a platform to discover other plant species which are non-toxic and can be mass produced.

The decisive purpose of proposed research study is to come up with a compendium of plant coagulants that could be used as a technology that is cost effective and ecofriendly. It is felt that further research can be conducted by using the information described in this review as a platform to discover other plant species which are nontoxic and can be mass produced. However, detailed studies are necessary to completely delineate the appropriate mechanisms like co- precipitation, co-flocculation, and self-agglomeration involved in the turbidity removal by various natural coagulants used, so that it can be applied on a large scale treatment basis. The results of these findings will lead to the development of household water treatment methods and a transfer of scientific knowledge to the rural people who are using natural coagulants. This work and our finding may have small start.

The results obtained show that the powder from seeds of *M. oleifera* contains some coagulating properties and acts as a flocculent, absorbent for the treatment of drinking water at loading doses of 50mg/L and 100mg/L It reduces the total turbidity after treatment. This lends support to earlier findings of the use of powder processed from Moringa seeds as a coagulant in water purification system. Considering the fact that Moringa coagulum can be locallyproduced, its use in water purification should be encouraged. This is likely to reduce the highcost of the current water treatment systems.The seeds of *M.Oleifera* exhibited the fastest turbidity and colour removal potential.These studies have also confirmed that the seeds are highly effective in removing suspended particles from water with medium to high levels of turbidity. *M.Oleifera* seed is not giving any toxic effect. It is eco-friendly method of purification of water and consequently it is being recommended for large scale water treatment use in the rural industrially developed area where no facilities are available the treatment of drinking water.

APPENDIX

Appendix : I Drinking Water Standard Parameters

	Standards	Recommended Agency	Unit Weight
P^H	6.5 - 8.5	ICMR / BIS	0.2190
Total Alkalinity	120	ICMR	0.0155
Total Hardness	300	ICMR / BIS	0.0062
T.D.S.	500	ICR / BIS	0.0037
Calcium	75	ICMR / BIS	0.025
Magnesium	30	ICMR / BIS	0.062
Chloride	250	ICMR	0.0074
Nitrate	45	ICMR / BIS	0.0413
Sulphate	150	ICMR / BIS	0.0124
D.O.	5.0	ICMR / BIS	0..723
B.O.D.	5.0	ICMR	0.3723

All values in mg/L except pH

Appendix : II WHO Standards for Drinking water

S.No.	Parameter	WHO Standards
1.	Colour	acceptable
2.	Odour	unobjectionable
3.	Taste	agreeable
4.	Turbidity	5 NTU
5.	pH	7-8.5
6.	Electrical conductivity	1000 µmhos/cm
7.	Total Dissolved Solids	500
8.	Chloride	250
9.	Alkalinity	120
10.	Hardness	300
11.	Sulphate	200
12.	Nitrate	45
13.	Fluoride	1
14.	Dissolved Oxygen	5
15.	BOD	3

All values except Turbidity, pH and Electric Conductivity are expressed in mg/L

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