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TREATMENT OF WATER WITH MORINGA OLEIFERA AS A COAGULANT

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ABSTRACT

The cost of treated water makes most people in rural community's to resort to readily available sources which are normally of low quality exposing them to waterborne diseases. Chemical coagulants like ammonium sulphate which used in treatment plant for purification process but the extensive use can cause problems and it is costlier and to overcome these problems it is necessary to increase the use of natural coagulants. There are different types of natural coagulants, among them one of the natural coagulant is *Moringa oleifera*. It is in this light that project is carrying out to confirm the effectiveness of powder extracted from mature dried *Moringa oleifera* seeds which is commonly available in most rural areas. Model turbid water was treated by coagulation, flocculation and sedimentation with Moringa oleifera seeds powder as a coagulant, using jar tests. The quality of water is analyzed and compared with that of the water with alum. Experiments were conducted at various dosages. To evaluate the antimicrobial activity and efficiency of a natural absorbent from Moringa oleifera seeds in treating water by physicochemical methods. Turbidity, pH, alkalinity, jar test, conductivity, chlorides and total coliform test was performed. The specific objectives is to establish the best dose of powder Moringa oleifera seeds that best removes different parameters from water and to compare between the Moringa seed powder and the selected commercial sold water treatment chemicals. M. Oleifera works as a coagulant due to the positive charge, water soluble proteins which bind with negatively charges particles allowing the formation of flocks to settle to the bottom or be removed by filtration sand and it is

accepted that treatment with Moringa oleifera seed solution will remove 90-99% of impurities in water.

KEYWORDS: Water, Moringa oleifera, natural coagulants, seed powder.

INTRODUCTION

PRESENT SCENARIO OF WATER

Water is a vital resource, but only 3% of water on our planet is fresh. Of these reserves just 10% can be exploited economically. it is estimated that 1.1 billion people lack accesses to clean drinking water and there is a water shortage in already 30 countries. Water is the most vital raw material in the 21st century. Accordingly a secure water supply is regarded as one of the important global objectives for the coming years.

Much of the ill-health which affects humanity especially in the developing countries can be traced to lack of safe and wholesome water supply. Water which is easily accessible, adequate in quantity, free from contamination, safe readily available throughout the year, there can be no state of positive health and well being without safe water. Water is not only a vital environment factor to all forms of life, but it is also a great role to play in socio-economic development of human population.

Water intended for human consumption should be both safe and wholesome. This can be defined as water that is

- Free from pathogenic agents
- Free from harmful chemical substances
- Pleasant to taste, i.e., free from odour and colour.
- Usable for domestic purposes

Water is said to be polluted or contaminated when it does not fulfil the above criteria. Water pollution is growing hazard in many developing countries.

The most widely used definition of water quality is the chemical, physical and biological characteristics of water, usually in respect to its suitability for a designated use, as we all know that water has many uses such as for recreation, drinking and fisheries, agriculture and industry. Water is severely polluted due to industries by discharging of wastes from the factories. water quality concerns can raise quickly from public complaints about odour or

taste, outbreak of water-borne illnesses or widespread death of aquatic species such as fish kills.

NEED OF WATER TREATMENT

Due to improper water treatment many people are getting diseases and mostly in India the shortage of water is more and for the ground water also we need the purification because it contains harmful chemicals.

Rural communities most often rely greatly on ground water provided that it is available in sufficient quantities, and also on surface water which may be contaminated in most cases. Most of the diseases causing death in the country are related to poor water and sanitation with malaria, diarrhoea and cholera being the most causes of mortality.

Treatment of water therefore becomes necessary to improve the quality to meet standards and avert disease outbreaks. The objective of water treatment is the removal of turbidity and other contaminants including natural organic materials and organisms. Murcott[1] identified three broad areas of water quality: physical, chemical and microbiological that can be improved by household water treatment. Physical removal technologies include ceramic and bio-sand filters, cloth filters and coagulation and flocculation technologies. Boiling, solar disinfection and chlorination are examples of technologies that improve microbial quality of water.

WATER PURIFICATION STAGES

Water purification plays a key role in ensuring access to safe drinking water. Safe drinking water positively impacts the health of the entire community. Systems are in place to ensure ongoing water quality, including water quality testing. The testing helps ensure the water treatment process results in a product that meets federal water quality guidelines. Water analysis involves looking for several kinds of contaminants, including unsafe levels of organic, inorganic, microbial and/or radioactive contaminants.

Normally there are three principal stages in water purification:-

Primary treatment- Collecting and screening including if required pumping from rivers and initial storage.

Secondary treatment- removal of fine solids and the majority of contaminants using filters, coagulation, flocculation and membranes.

Tertiary treatment- polishing, pH adjustment, carbon treatment to remove taste and smells, disinfection, and temporary storage to allow the disinfecting agent to work. Here disinfection is most important.

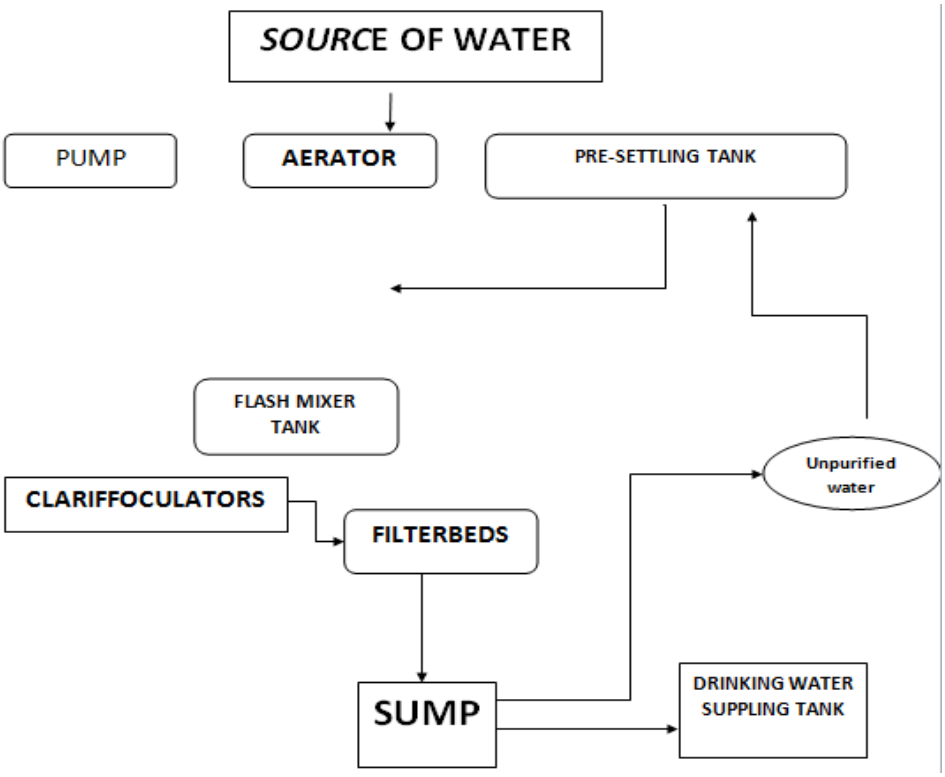


Fig. 1.1: Flow system of water treatment plant.

'WHO' GUIDELINES FOR DRINKING WATER QUALITY

The World Health Organisation (WHO) Guideline for Drinking-water Quality (GDWQ) includes the following recommended limits on naturally occurring constituents that may have direct adverse health impact:

- Arsenic 10µg/l
- Barium 10µg/l
- Boron 2400µg/l
- Chromium 50µg/l
- Fluoride 1500µg/l
- Selenium 40µg/l
- Uranium 30µg/l

Table 1.1: Drinking Water Standards as per ISI, ICMR and WHO.

DRINKING WATER STANDARDS						
	ISI		ICMR		WHO	
PARAMETERS	P	E	P	E	P	E
PHYSICAL						
Colour	10	50	5	25	5	25
Taste and odour	Unobject	-	Unobject	-	Unobject	-
Turbidity	10	25	5	25	5	25
CHEMICAL						
pH	6.5-8.5	6.5-9.2	7-8.5	6.5-9.2	7-8.5	6.5-9.2
TDS	-	-	-	-	500	1500
Total Hardness	300	600	300	600	-	-
Calcium	75	200	75	200	75	200
Magnesium	30	100	50	150	50	150
Copper	0.05	1.5	1.0	3.0	1.0	1.5
Iron	0.3	1.0	-.3	1.0	0.3	1.0
Manganese	0.1	0.5	0.1	0.5	0.1	0.5
Chlorides	250	1000	250	1000	200	600
Sulphates	150	400	200	400	200	400
Nitrates	45	-	20	50	-	100
Fluorides	0.6-1.2	-	1.0	2.0	0.5	1.0-1.5
Phenolic Substances	0.001	0.002	0.001	0.002	0.001	0.002
TOXIC						
Arsenic	0.05	-	-	0.2	-	0.2
Cadmium	0.05	-	-	0.05	-	0.05
Cyanide	0.05	-	-	0.01	-	0.05
Lead	0.1	-	-	0.1	-	0.1
Selenium	0.01	-	-	0.05	-	0.01
Zinc	5	10	-	-	-	-
Mercury	0.01	-	-	-	-	-

P= PERMISSIBBLE LIMITS

E=EXCESSIVE LIMITS

NOTE-ALL UNITS ARE MG/L EXCEPT PH

CHEMICAL COAGULANTS

Lime

This is usually not considered as an effective coagulant because it does not produce flocs like salts of iron and aluminium. It reacts with phosphorous and bicarbonate compounds in water to adjust pH causing precipitation of calcium carbonate and magnesium hydroxides.[2]

Activated Silica

The nature of interaction with suspended solids is somehow analoguos to that of polyelectrolytes but differs by lacking the long flexible chains and is therefore denser. They are usually referred to as weighting agents that promote settling of flocs. Dosages are about

20-60% of alum dose used for coagulation. They have been used with or without alum to achieve clarification in lime water-softening plants.[2]

Alum

Alum ($Al_2(SO_4)_2.14H_2O$) is available commercially in industrialized countries in lumps, ground or liquid form. It is a basic product of the reaction between sulphuric acid and a mineral despite such as bauxite. Lump or ground alum whether purified or not contain not less than 9.0% of available water-soluble aluminium as Al or 17% as Al_2O_3.[3]

Fig. 1.2: Alum.

Chemical coagulation with alum like any other form of coagulant is aimed at achieving the following objectives:

- Removal of turbidity, inorganic or organic
- Removal f harmful bacteria and other pathogens
- Removal of colour, taste and odour producing substances.

Alum is a relatively inexpensive coagulant if local production is possible. In most developing countries, it is imported at substantially increased cost. Treatment plants in these countries must be designed so that alum consumption may be minimised. The dosage of alum may be reduced in some instances by

1. Direct filtration of low turbidity waters
2. Pre-treating excessively turbid river waters
3. Use of coagulant aids
4. Optimum pH adjustment

The choice or selection of coagulant chemical depends upon the nature of the suspended solid to be removed, the raw water conditions, the facility design, and the cost of the amount of chemical necessary to produce the desired result.

Natural Coagulants

MORINGA OLEIFERA

The seed kernels of Moringa oleifera contain significant quantities of a series of low molecular weight, water-soluble proteins which, in solution, carry an overall positive charge (**Fig 1.2**). The proteins are considered to act similarly to synthetic, positively charged polymer coagulants. When added to raw water the proteins bind to the predominantly negatively charged particulates that make raw waters turbid (silt, clay, bacteria etc.). Under proper agitation these bound particulates then grow in size to form the flocs, which may be left to settle by gravity or be removed by filtration.[5,6] Moringa oleifera powder has been reported to have the capability of reducing low and high turbidity values in surface water.[7-14] Moringa oleifera was used as a natural coagulant in a full-scale treatment trial at the water treatment works in Malawi. Turbidity values as high as 270–380 NTU were reduced to around 04 NTU, which are within the WHO (2006) guideline value with the addition of the powder.[4]

Fig. 1.3: Moringa Oleifera seeds.

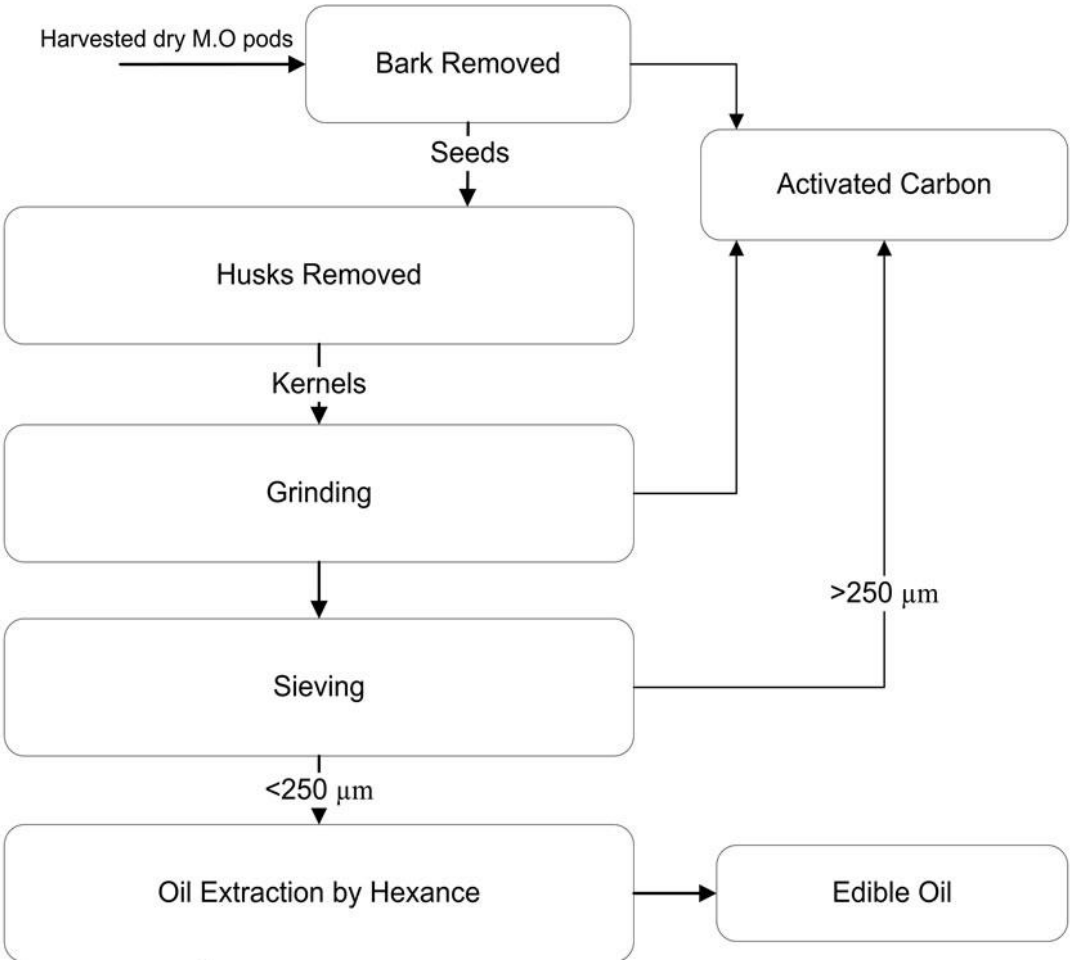


Fig. 1.4: Shows the flow chart preparation of moringa oleifera powder.

VIGNA UNGUICULATA

Vigna unguiculata (eng. "cowpea", swa. "choroko") is an annual legume plant. It is well known in Tanzania as a food crop and for animal fodder. The flowers are mostly self pollinating and give pods carrying the seeds. Vigna unguiculata can be used as a nitrogen fixing crop and for erosion control. It grows in warm and dry conditions, with temperatures above zero. The crop is preferably grown well-drained, sandy loams or soils. Vigna unguiculata is drought resistant, which makes it an important crop in many underdeveloped parts of the world. Mature green seeds are normally harvested mechanically by some type of mobile viner.[5] The active agents of Vigna unguiculata are expected to be at least two different coagulating proteins with a molecular weight of about 6 kDa.[6,7]

PEANUT SEEDS

Turbidity removal of 93.2% was obtained by using peanut seeds as coagulant[8] (**Fig 1.5**). When they used the extract of peanut using NaCl i.e. PC-NaCl by 6 mol/l NaCl solution, they achieved 92% turbidity removal with initial turbidity of 200NTU using only 20mg/l of the

extract. On the other hand the extract with distilled water resulted in only 31.5% removal of turbidity. From this they implied that the protein associations inside the peanut seeds are responsible for coagulation activity. They also found that KNO_3, KCl, NH4Cl and NaNO3 solutions were also good solvents to extract the active coagulant component for peanut seeds; leading to improvement of coagulation activity; with no much difference from NaCl solution in terms of efficiency.

Fig 1.5 Peanut Seeds.

WATER MELON SEEDS

Watermelon seeds powder was used as coagulant for treating medium turbid water with dose of 0.1g/L at pH 7, stirring time of 8 minutes and mixing speed of 100rpm which resulted in optimum removal of turbidity within the standards of WHO(**Fig 1.5).** When blended with alum, it caused unfavorable changes in the pH of the treated water. However with 20% alum as coagulant aid, the best color and turbidity removal at acceptable pH was obtained, with residual turbidity of 0.89 NTU and residual colour of 15TCU at a pH of 6.50.[9]

Fig. 1.6: Watermelon seeds.

SCOPE AND OBJECTIEVES

The objectives of the work are

1. To determine the optimum dosage of coagulants using jar test.
2. To conduct the experiments on purification of water
3. To remove colour, dissolved gasses and murkiness of water.
4. To remove objection able taste and odour from the water.
5. To kill the troublesome bacteria.
6. To make water safe for drinking and domestic purposes.

EXPERIMENTAL PROGRAM

4.0 GENERAL

From the clear cut objectives of the project work, an experiment program is planned to know the efficiency of moringa oleifera powder as a coagulant in water. The various tests are conducted on the river water to determine the efficiency of moringa oleifera seed powder. The tests include turbidity, jar test, bacteria test and chloride test. The detailed procedure of individual test is explained in the following sections.

DETERMINATION OF OPTIMUM DOSAGE OF COAGULANT USING JAR TEST

Coagulants are used in water treatment plants to remove natural suspended and colloidal matter to remove materials which do not settle in plain sedimentation and to assist in filtration. Alum [$Al_2S(SO_4)_3$. $18H_2O$] is the most widely used coagulant. When alum solution is added to water, the molecules dissociate to yield SO_4^{2-} and Al^{3+}. The +ve species combine with negatively charged colloidal to neutralise part of the charge on the colloidal particle. Thus, agglomeration takes place. Coagulation is a quite complex phenomenon and the coagulant should be distributed uniformly throughout the solution. A flash mix accomplishes this. Jar test is simple device used to determine this optimum coagulant dose required. The jar test, device consists of a number of stirrers (4 to 6) provided with paddles **(Fig 4.1)**. The paddles can be rotated with varying speed with the help of a motor and regulator. Samples will be taken in jars or beakers and varying dose of coagulant will be added simultaneously to all the jars. The paddles will be rotated at 100 rpm for 1 minute and at 40 rpm for 20 to 30 minutes, corresponding to the flash mixing and slow mixing in the flocculation of the treatment plant. After 30 minutes settling, supernatant will be taken carefully from all the jars to measure turbidity. The dose, which gives the least turbidity, is taken as the optimum coagulant dose.

Fig. 4.1: Jar Test.

PROCEDURE

- Take 1-litre beakers and fill them with sample up to the mark.
- Keep each beaker below each paddle and lower the paddles, such that each one is about 1cm above the bottom.
- Find the pH of the sample and adjust it to 6 to 8.5.
- Pipette 1, 2, 3, 4, 5, 6 ml of the alum solution into the test samples.
- Immediately run the paddles at 100 rpm for 1 minute.
- Reduce the speed to 30-40 rpm and run at this rate for 30 minutes.
- Stop the machine, lift out the paddles and allow to settle for 30 minutes.
- Find the residual turbidity of the supernatant using nephelometer.
- Plot a graph with alum dosage along x-axis and turbidity along y-axis.
- The dosage of alum, which represents least turbidity, gives Optimum Coagulant Dosage (O.C.D.).

Repeat steps 1-10 with higher dose of alum, if necessary.

DETERMINATION OF TURBIDITY

PRINCIPLE

Turbidity is the optical property that causes light to be scattered and absorbed, rather than transmitted. The scattering of the light as it passes through a liquid is caused by the suspended solids. The higher the turbidity, the greater is the amount of scattered light. The molecules in a very pure fluid scatter light to a certain degree, no solution will have zero turbidity.

The light beam that passes through the sample is scattered in all direction. The intensity and pattern of the scattered light is affected by many variables including the wavelength of the incident light, particle size and shape, refractive index and colour.

PROCEDURE

For best results, the measurement techniques must be followed during calibration. If formalin standards are used, mix the cuvvetes gently for about 1minute and then allow the standard to settle for 1minute before calibration.

1) Before making the calibration, assure that you are in the correct mode. To enter calibration, press cal key while in main screen. The first screen of GLP information is displayed. Press "CAL" functional key to start calibration.
2) FIRST POINT CALIBRATION: The first calibration point is displayed on the LCD. This point is used for FNU and NTU modes to check the quality of water used for dilution of water and confirm that the optical system is not dirty. In this case the value of first point is over 0.15FNU (NTU), a warning "cal point high" is displayed when the cal is saved and warning out of calibration range is displayed when measurement is under 10.0 FNU(NTU) are performed.
3) THIRD CALIBERATION POINT: Remove the second standard cuvette. Place the cuvette for third calibration point.
4) FOURTH CALIBERATION POINT: Remove the third standard cuvette. Place the cuvette for fourth calibration point. Close the lid and press "READ" functional key. The display will show the value blinking and the light: on during measurement. If the "cal" is terminated the display will briefly show "store" and the three point "cal" is saved. The instrument returns in the main screen.
5) Fill a clean, dry cuvette with 10ml of sample up to the mark, only handle the cuvette by the top.
6) Press "READ" functional key and keep it pressed to take continuous readings. The first value will appear after 10seconds and then new reading is displayed each second as long as "READ" functional key is kept pressed. When the new value is displayed, the measurement value will be briefly displayed.

DETERMINATION OF CHLORIDES

PRINCIPLE: This assay is based up on precipitation type of reaction; it is a Mohr's method of chloride estimation, where chloride sample is directly titrated with standard $AgNO_3$

solution as an indicator. Initially added $AgNO_3$ solution gives white AgCl precipitate, when equivalent amount of reactant reacts with excess drop where $AgNO_3$ forms a silver chromate precipitate having reddish brown colour, Mohr's titration is carried out at neutral PH.

$$2AgNO_3 + K_2crO_7 \longrightarrow Ag_2crO_4 + 2KNO_3$$

Reddish brown ppt

PREPARATION OF SOLUTION

Standard silver nitrate solution: Dissolve 4.791gms of silver nitrate in distilled water and make up to 1000ml.one ml of the solution is equivalent to1mg of chlorides (as Cl).

Potassium chromate solution: Dissolve 5g of potassium chromate in distilled water and make up to 100ml.

PROCEDURE

1) Take 100ml of the sample in 250ml conical flask.
2) Add 2ml potassium chromate solution as an indicator.
3) Titrate against standard $AgNO_3$ solution, until perception reddish colour is produced,
4) Note down the burette reading.

CALCULATION

$$\text{Chlorides (as Cl) mg/lit} = \frac{1000 \times V_2 \times f}{V_1} \qquad \text{Eq. 4.1}$$

V_1=Volume of sample taken

V_2= Volume of burette reading

F=1

BACTERIAL EXAMINATION OF WATER

The bacteriological examination of water is performed routinely by water utilities and many governmental agencies to ensure a safe supply of water for drinking, bathing, swimming and other domestic and industrial uses. The examination is intended to identify water sources which have been contaminated with potential disease -causing microorganisms. Such contamination generally occurs either directly by human or animal feces, or indirectly through improperly treated sewage or improperly functioning sewage treatment systems. The organisms of prime concern are the intestinal pathogens, particularly those that cause typhoid fever and bacillary dysentery.

Since human faecal pathogens vary in kind (viruses, bacteria, protozoa) and in number, it would be impossible to test each water sample for each pathogen. Instead, it is much easier to test for the presence of non-pathogenic intestinal organisms such as E. coli. E. coli is a normal inhabitant of the intestinal tract and is not normally found in fresh water. Therefore, if it is detected in water, it can be assumed that there has been faecal contamination of the water.

In order to determine whether water has been contaminated by faecal material, a series of tests are used to demonstrate the presence or absence of coli forms. The coli form group is comprised of Gram-negative, nonspore- forming, aerobic to facultative anaerobic rods, which ferment lactose to acid and gas. Two organisms in this group include E. coli and Enterobacter aero genes; however, the only true faecal coli form is E. coli, which is found only in faecal material from warm-blooded animals. The presence of this organism in a water supply is evidence of recent faecal contamination and is sufficient to order the water supply closed until tests no longer detect E. coli.

In this exercise, you will be testing water samples for the presence of coli forms. There will be three principal tests: the **presumptive**, **confirmed** and **completed** tests.

STANDARD WATER ANALYSIS

The Presumptive Test

In the presumptive test, a series of lactose broth tubes are inoculated with measured amounts of the water sample to be tested. The series of tubes may consist of three or four groups of three, five or more tubes. The more tubes utilized, the more sensitive the test. Gas production in any one of the tubes is presumptive evidence of the presence of coli forms. The most probable number (MPN) of coli forms in 100 ml of the water sample can be estimated by the number of positive tubes (see MPN Table).

The confirmed Test

If any of the tubes inoculated with the water sample produce gas, the water is presumed to be unsafe. However, it is possible that the formation of gas may not be due to the presence of coli forms. In order to confirm the presence of coli forms, it is necessary to inoculate EMB (eosin methylene blue) agar plates from a positive presumptive tube. The methylene blue in EMB agar inhibits Gram-positive organisms and allows the Gram-negative coli forms to grow. Coli forms produce colonies with dark centres. E. coli and E. aero genes can be

distinguished from one another by the size and colour of the colonies. *E. coli* colonies are small and have a green metallic sheen, whereas E. aero genes forms large pinkish colonies.

If only E. coli or if both E. coli and E. aero genes appear on the EMB plate, the test is considered positive. If only E. aero genes appears on the EMB plate, the test is considered negative. The reasons for these interpretations are that, as previously stated, E. coli is an indicator of faecal contamination, since it is not normally found in water or soil, whereas E. aero genes is widely distributed in nature outside of the intestinal tract.

The Completed Test

The completed test is made using the organisms which grew on the **confirmed** test media. These organisms are used to inoculate a nutrient agar slant and a tube of lactose broth. After 24 hours at 37°C, the lactose broth is checked for the production of gas, and a Gram stain is made from organisms on the nutrient agar slant. If the organism is a Gram-negative, nonspore-forming rod and produces gas in the lactose tube, then it is positive that coli forms are present in the water sample.

FIRST PERIOD

Material

1. Nine tubes of double-strength lactose broth.
2. 10, 1.0 and 0.1 ml pipets.
3. Water samples.

Procedure: (work in groups of four)

Presumptive Test

1. Take a water sample (dilute as instructed in some cases) and inoculate three tubes of lactose broth with 10 ml, three tubes with 1.0 ml and three tubes with 0.1 ml.
2. Incubate all tubes at 37^{o}C for **24 hours**.

SECOND PERIOD

Material

1. EMB agar plates.

Procedure

Presumptive Test

1. Observe the number of tubes at each dilution that show gas production in 24 hrs. Record

results.

2. Reincubate for an additional **24 hours** at 37°C.

Confirmed Test

1. Inoculate an EMB plate with material from a tube containing gas.
2. Invert and incubate the plate at 37°C for **24 hours**.

THIRD PERIOD

Material

1. Lactose broth tubes
2. Nutrient agar slants

Procedure

Presumptive Test

1. Observe the number of tubes at each dilution that show gas. Record results and determine the most probable number index.

Confirmed Test

1. Observe EMB agar plates. A positive confirmed test is indicated by small colonies with dark centers and a green metallic sheen (*E. coli*). Record results.

Completed Test

1. Inoculate a lactose broth tube and a nutrient agar slant with organisms from the EMB plate.
2. Incubate the broth tube and agar slant at 37°C for **24 hours**.

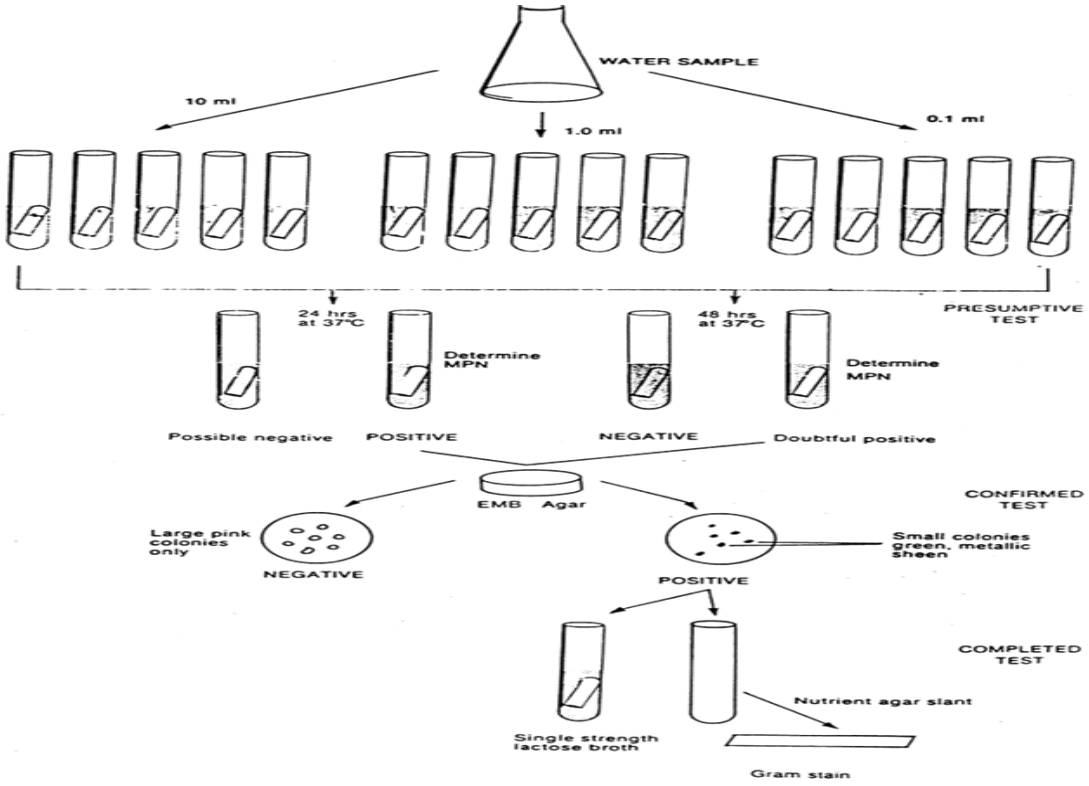
FOURTH PERIOD

Procedure

Completed Test

1. Check for gas production in the lactose broth tube.
2. Make a Gram stain from the organisms on the nutrient agar slant.
3. Record result

PROCESS OF BACTERIA TEST



MPN (MOST PROBABLE NUMBER) CHART

MPN DETERMINATION FROM MULTIPLE TUBE TEST

NUMBER OF TUBES GIVING POSITIVE REACTION OUT OF			MPN Index per 100 ml.	95 PERCENT CONFIDENCE LIMITS	
3 of 10 ml. each	3 of 1 ml. each	3 of 0.1 ml. each		Lower	Upper
0	0	1	3	<0.5	9
0	1	0	3	<0.5	13
1	0	0	4	<0.5	20
1	0	1	7	1	21
1	1	0	7	1	23
1	1	1	11	3	36
1	2	0	11	3	36
2	0	0	9	1	36
2	0	1	14	3	37
2	1	0	15	3	44
2	1	1	20	7	89
2	2	0	21	4	47
2	2	1	28	10	150
3	0	0	23	4	120
3	0	1	39	7	130
3	0	2	64	15	380
3	1	0	43	7	210
3	1	1	75	14	230
3	1	2	120	30	380
3	2	0	93	15	380
3	2	1	150	30	440
3	2	2	210	35	470
3	3	0	240	36	1,300
3	3	1	460	71	2,400
3	3	2	1,100	150	4,800

Gram Staining

This was used to distinguish two groups of bacteria namely gram negative and gram positive. A loop full of the culture under study was transferred onto the surface of clean glass slides

and heat fixed. The slides were flooded with crystal violet solution for up to one minute and wash gently in tap water and drain against a paper towel. After draining the smeared slides were again flooded with Gram iodine solution, and allowed to act as a mordant for one minute. This was also washed under running tap water and drained. Stained slides were flooded with 95% alcohol for 10 seconds and washed off with water. The slides was drained afterwards, flooded again with safranin solution and allowed to counter stain for 20 – 30 seconds. The safranin-flooded slides were washed with tap water, drained and blotted with filter paper. The slides were then examined under the microscope using the oil immersion lens to characterise the isolated organisms.

DETERMINATION OF TOTAL DISSOLVED SOLIDS

PROCEDURE

To determine or measure the TDS of a sample using the direct reading mode

1) Press MODE and then TDS to select TDS measure mode
2) Select the direct reading mode(see TDS set up selection)
3) Then note down the reading of sample.

RESULTS AND DISCUSSIONS

GENERAL

The present chapter explains the results and discussions of various tests conducted on raw water sample and treated water.

JAR TEST & TURBIDITY

- Jar test was used to determine the optimum dosage of coagulant to treated raw water. The coagulants studied in the present work are alum (general coagulant) and moringa oleifera(natural coagulant).
- The dosage of alum is considered as 0.5,1.0,1.5,2.0,2.5,3.0% of 200ml of water and dosage of moringa oleifera seeds powder 0.05,0.10,0.15,0.20,0.25,0.30% of 200ml of water.
- The water added with coagulant is stirred at 30-40rpm and the test was conducted for 30minutes. After that, the water from the top was collected in another beaker and using turbidity meter for each sample, the turbidity was measured. The turbidity values are presented in Table 5.1.

Table 5.1: Turbidity Results.

S.NO	SAMPLE	DOSAGE OF COAGULANT	TURBIDITY (NTU)
1.	ALUM	0.5 1.0 1.5 2.0 2.5 3.0	0.74 1.19 1.52 0.46 2.91 3.04
2.	MORINGA OLIEFERA SEEDS POWDER	0.05 0.10 0.15 0.20 0.25 0.30	3.83 20.0 9.81 8.04 5.11 9.09

BACTERIA TEST

- Alum, moringa oleifera seeds powder and raw water for these three samples microbiological tests are conducted
- For the raw water it shows the growth of bacteria after incubating the sample for 24 hours
- For the alum and moringa oleifera treated water it shows that it does not contain any growth of any bacteria.
- For the confirmation of the organisms in the raw water, most probable number test has been conducted and the table5.2 depicts most probable number(MPN) of raw water.

Table 5.2: Most probable number of raw water.

3 of 10ml each	3 of 1ml each	3 of 0.1ml Each	MPN per 100ml	Lowest limit	Upper limit
2	2	0	21	4	47

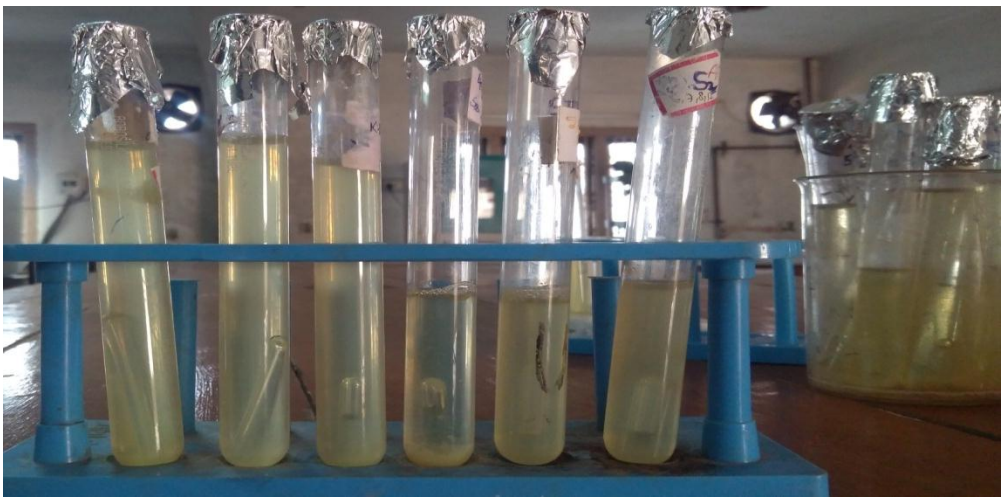


FIG. 5.1: Showing gas in the test tubes.

- For the confirmation of the organisms in alum & moringa oleifera seeds powder treated water, it does not show any gas in the test tubes it does not contain any bacteria in he test tube.
- The test tubes of raw water which contain high gas, need to be taken for refrigeration of 24hours.
- For the confirmation of E-COLI gram staining test is to be conducted.
- The test confirmed the presence of E-COLI bacteria which was identified by the presence of red/pink rod shaped organisms**(FIG 5.2).**

FIG. 5.2: E-coli bacteria.

CONCLUSION

The following conclusions can be drawn from this study:

1. The jar test identifies the optimum dosage of coagulant required to add in treatment of water. For alum, the optimum dosage obtained is 2.0% and for moringa oleifera it is 0.05%.
2. Turbidity is an important indicator of the amount of suspended sediment in water. The turbidity test on different water samples identified the optimum dosage of coagulant. The test results obtained by jar test are strengthened by this test. Lower the turbidity values indicate the high quality of water.
3. The bacteria tests on optimum dosages of coagulant confirmed the presence of bacteria in raw water and no bacteria in treated water.

This confirms that bacteria can be removed by treating water with Moringa Oleifera.

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