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Analysis of Pollutants in Agyara Dam and its Comparative Treatment

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ABSTRACT –

Adsorption is a fast, inexpensive and universal method of water purification. The process of adsorption is far better than compared to various other methods of purifying water such as boiling, filtration, chemical treatment, flocculation, coagulation, biodegradation etc. The promotion, development and encouragement of low cost adsorbents has triggered rapid and voluminous growth of research interests in this field. Reports, studies and surveys confirm the fact that development of inexpensive adsorbents from waste materials and materials provided by the nature takes only 1-2 days. The process of removal of pollutants consumes only small fractions of time. Therefore, the process of adsorption is highly effective in terms of saving the cost and time. Generally batch and column process are common for adsorption**.**

KEYWORDS: Water, Analysis, pollutants, coagulation, Flocculation, filtration etc.

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INTRODUCTION

Water is nature's most wonderful, abundant and useful compound and it is the basis of all lives. Water is a vital natural resource, which is essential for multiplicity of purposes. Water is the only inorganic liquid that occurs naturally on earth. It is also the only chemical compound that occurs naturally in all three physical states: solid, liquid and vapour[1].

Environmental Pollution

Environmental pollution is one of the most horrible ecological crisis to which we are subjected today. Three basic amenities for living organisms are air, land or soil and water. Environmental pollution can be divided into water, air and soil and all three of these are linked[2]. Environmental pollution is the result of urban, industrial technological revolution and speedy exploitation of every bit of natural resources[3].

Water Pollution

Water obtained from different sources is associated with a large number of impurities[4]. Water gets impurities of various kinds from ground or soil with which it comes into contact[5]. Water also gets contaminated with sewage and industrial waste or effluents and different pollutants when these are allowed to flow into running water or through percolation through the ground[6,7,8].

Industrial Pollution

Industrialization has brought along with it the hazards of environmental pollution as it has the material comforts. This has gradually increased our concern about the unplanned side effects which may arise from releasing chemicals into our immediate surroundings[9,10]. These chemicals form one of the major polluting sources which are discharged by industries without any care.

So due to continuous discharge of contaminated waste water from the industries and factories of MIA region, the water quality of Hans Sarowar Dam has deteriorated at large. All the industrial effluents are discharged into this water body.

Agyara Dam [Hans Sarowar]

Agyara Dam [Hans Sarowar] which is situated at downstreams of Matsya Industrial Area, Alwar is chosen for investigations to find out the effects of various industrial effluents on it. The ill effects of

pollutants are also affecting people of nearby areas. Many villages are situated in and around this industrial area.

The water pollution of Hans Sarowar dam has resulted in the following effects: -

- Water of the Hans Sarowar Dam is polluted and is not fit for irrigation purposes.
- Due to contamination of dam's water, aquatic life is endangered. Cultivation of fish into this water is not possible due to this contamination. Dying of fish in Hans Sarowar dam due to chemical waste water discharged from the industries located at MIA, Alwar.
- Severe odour problem is also observed around the dam. Due to this problem, thousands of villagers may migrate from this area and this will also affect the social life of the common peoples.
- Due to this contaminated water, near by thousands of hectare lands become unfertile. This contaminated water is also harmful for agriculture practices.
- Due to this problem, there is severe chance of spreading of dangerous diseases. Due to contamination of dam's water, the nearby areas domestic animals and human life is also endangered.

Hence the people in this area face acute problem of deterioration of water quality. This is the reason why the author has chosen this topic as his research career and will try to treat the polluted water of Agyara Dam in nation's interest. The local people and administration are finding it tough to tackle this burning problem. Every effort is being made by the administration not only to check the dam being polluted further but also to make good of the existing reservoir.

This dam is located at Alwar- Bharatpur Road at a distance of about 15 km. from Alwar City. The water of Hans Sarowar dam is spread over 20 hectare areas and depth of the Hans Sarowar dam is about 10 to 12 feet. The water colour of this dam has changed into light pink. At present , Alwar city is undergoing rapid urbanization and industrialization. MIA has many well known industries like vegetable oils, automobiles, casting units, detergents, cables, ceramics, minerals, chemicals, engineering, paper and beverages, chlorinated paraffin wax etc. The reason behind the deterioration of the water quality of this dam is the discharge of untreated or partially

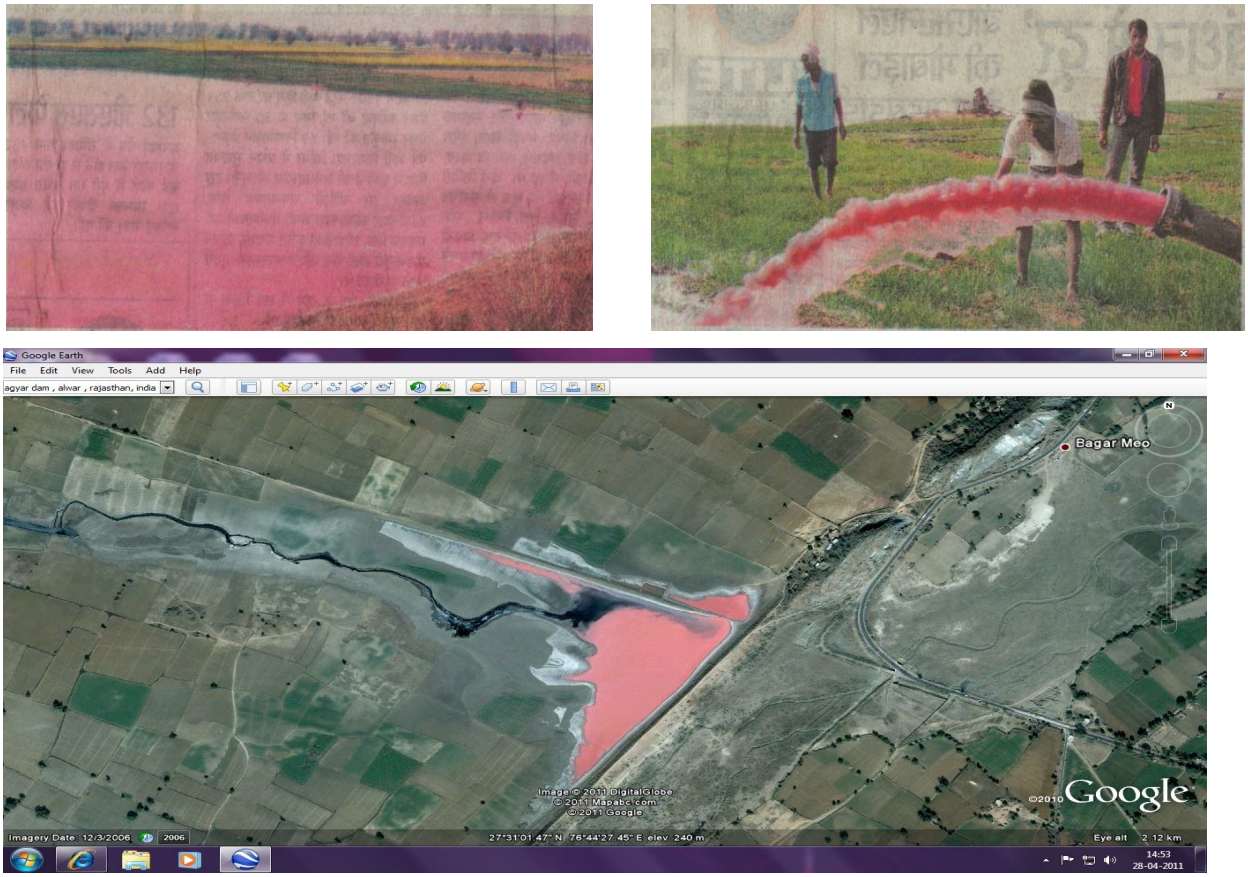


Fig - 1: Satellite Image of Agyara Dam[Hans Sarowar Dam]:-

treated waste water, that finally get accumulated into the Hans Sarowar dam over a period of time. To sort out the above problems the author will try to treat the polluted water of the Agyara dam by various adsorption medias.

REVIEW OF LITERATURE

The water pollution is a matter of serious concern these days. A lot of work has been carried out by different agencies on water pollution and drinking water quality. In 1984 and 1985, The World Health Organization (WHO) published the first edition of guidelines for drinking water quality in three volumes. The development of these guidelines was organized and carried out jointly by WHO headquarters and the WHO Regional office for Europe (EURO).

- Various workers in other countries have carried out extensive studies in the related field. Anderson and Nilsson studied on enrichment of trace elements from sewage sludge fertilizers in soils and plants.

- Yesilnacar[19] et al have studied the Hydro-chemical characteristics and the effects of irrigation on groundwater quality in Harran Plain, Turkey.
- Various workers in our state Rajasthan have carried out extensive studies on water pollution. Sharma and Totawat studied the effect of municipal sewage water on the soil properties and chemical composition of vegetables grown on sandy soils of Bikaner (Rajasthan) recently.
- Mathur *et al.* studied the effects of textile dyes from Pali, Rajasthan and reported that textile industries liberate a variety of chemicals, dyes, acids and alkalis besides other toxic compounds like heavy metals in water which are known for their hazardous properties.
- Classification of water in order to assess the water quality for various purposes has been done. Piper Trilinear Diagram and US Salinity Diagram will be used to study the evaluation of the water quality and the suitability of water for domestic and irrigation purposes of water samples.

EXPERIMENTAL WORK

1. Waste water samples will be taken from different depths and points of the Agyara Dam and adjoining areas of MIA, Alwar at different time-periods.

2. Water samples will be analyzed for the characterization of toxic metals.

3. Samples will be analyzed to find out the tolerance of toxic metals in water.

4. Analysis of BOD, COD, DO, EC, pH, TDS, TH and TA etc. in water will also be the part of our study.

5. Impact of wastewater on soil, ground water and potable water may also be carried out.

6. Removal of pollutants in the water of Agyara Dam through seeds by adsorption.

7. Analysis of purified water of Agyara Dam after experimentation.

RESEARCH METHODOLOGY[2-7]

There are many parameters and standard methods for the examination of water as under-

Table No.1: - parameters and standard methods

S.No.	PARAMETERS	METHODS
1.	Colour	Human sensory
2.	Taste and odor	Human sensory
3.	Alkalinity	Titrimetric
4.	Hardness	Titrimetric
5.	Ca^{+2}	Titrimetric
6.	Mg^{+2}	Titrimetric
7.	Cl^{-}	Titrimetric
8.	TDS	Water kit
9.	DO	Winkler's Titrimetric methods
10.	COD	Dichromate reflex method
11.	Temperature	Specific Instrument (Thermometer)
12.	Turbidity	Specific Instrument (Turbidity Rod)
13.	pH	Specific Instrument (p^{H} Meter)
14.	BOD	Oxygen difference method
15.	EC	Specific Instrument Conductivity Bridge
16.	F^{-}	Ion selective electrode
17.	SO_4^{-2}	Gravimetrically
18.	CO_3^{-2}/HCO_3^{-}	Titrimetric
19.	NO_3^{-1}	Spectro-photometrically

To analyse the above samples for different parameters, the following standard methods will be used.

(1) Determination of pH:

pH of water will be determined by the measurement of electromotive force of cell comparing an indicator electrode responsive to H^+ ion immersed in the test solution and a reference electrode.

$$pH = -\log 10\ [H^+]$$

$$= \log_{10} \frac{1}{H^+}$$

(2) Determination of Electrical Conductance (EC):

EC will be determined by conductivity bridge meter based on Wheatstone bridge principle. EC signifies the total concentration of ionized constituents of water samples.

(3) Determination of Total Dissolved Solids (TDS):

TDS will be determined after evaporating a definite amount of water on a water bath at 110^0 C in a platinum crucible.

(4) Determination of Carbonate and Bicarbonate:

These ions will be determined by volumetric method. Phenolphthalein is used as indicator for carbonate and mix indicator for bicarbonate, sulphuric acid is used as titrant (carbonate is determined if pH is more than 8.3).

(5) Determination of Alkalinity

The determination has been carried out by the titration method.

Principle: - Alkalinity is directly determined by titration with 0.2 NH2SO4 using phenolphthalein and methyl orange indicators.

Reaction

$$Ca(OH_2) + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$$

$$2\ CaCO_3 + H_2SO_4 \rightarrow Ca(HCO_3)_2 + CaSO_4$$

$$Ca(HCO_3)_2 + H_2SO_4 \rightarrow CaSO_4 + 2CO_2 + 2H_2O$$

(6) Determination of Chloride :

Chloride will be determined by Mohr's method using silver nitrate as titrant and potassium chromate as indicator , a slight excess of silver ion forms red chromate (Ag_2CrO_4) Ksp= 9×10^{-12} at the end point.

Principle:- Silver nitrates react with chloride ions to form silver chloride. The completion of reaction is indicated by the red colour produced by the reaction of silver nitrate with potassium chromate solution which is added as an indication.

Cl^- + $AgNO_3$ → AgCl ↓ (White ppt.) + NO_3^- K_2CrO_4 + $2AgNO_3$ → Ag_2CrO_4(Red ppt.) + $2KNO_3$ if pH > 8.3 - $Ag(OH)_2$ is precipitated

If pH < 7 - Cr_2O_7 is precipitated

(7) Determination of Sulphate:

Sulphate will be determined gravimetrically as barium sulphate or under strong acid conditions barium chloride solution is added in such a manner as to form barium sulphate, suspension is measured by a Nephlometer or transmission spectrophotometer at λ = 420 nm.

Ba^{2+} + SO_4^{2-} ⟶ $BaSO_4$ (white ppt.)

(8) Determination of Hardness:

Hardness of water will be determined by complexometery using EDTA as titrant.

Metal + Indicator ⟶ Metal-Indicator (Complex)

Metal -Indicator + EDTA ⟶ Metal- EDTA (Complex) + Indicator

Reaction

Total hardness:-

Eriochrome Black-T+[Ca^{+2}+Mg^{+2}] $\xrightarrow[\pm 10]{Buffer}$ EBT-[Ca+Mg]chelate.

(EBT)

EBT-[Ca+Mg]chelate+EDTA ⟶ EDTA-[Ca+Mg] Chelate+EBT

Stable complex. Blue

(9) Determination of Nitrate:

Nitrate ions are estimated usually by phenoldisulphonic acid colourimetric method. Standard Series Method is carried out for quantitative comparison of colours.

Nitrate absorbs at λ = 220 nm and the nitrate calibration curve follows Beer's law up to 11mg/l nitrate as nitrogen.

Reactions

$C_6H_5OH + 2H_2SO_4 \rightarrow$ $C_6H_3(OH)(SO_3H)_2 + 2H_2O$

Phenoldisulphonic acid (PDS)

$C_6H_3(OH)(SO_3H)_2 + HNO_3 \rightarrow$ $C_6H_3(OH)(SO_3H)_2NO_2 + H_2O$

Colourless compounds

$C_6H_3(OH)(SO_3H)_2NO_2 + 3KOH$ $C_6H_3O(SO_3K)_2NO_2K$

A yellow coloured salt

(10) Determination of Fluoride:

Fluoride ions are estimated usually by colourimetric methods.

Principle:-Fluoride decolourizes alizarin complex and the decolourization is proportional to fluoride concentration.

Reaction -

$F^- + H^+ \xrightarrow[Heat]{\Delta} HF\uparrow$ Acid distillation (HF is held in distillate)

Zr^{4+} - alizarin lack + $6F^- \xrightarrow{H+}$ Alizarin + $[ZrF_6]^{2-}$

(Reddish colour) yellow

Decrease in red colour intensity is proportional to the concentration of fluoride ions.

(10) Determination of Biological Oxygen Demand (BOD):

The method consists seeded dilutions added to sample and DO (Dissolved Oxygen) content is determined immediately and after incubation at specific temperature.

(11) Determination of Chemical Oxygen Demand (COD):

A sample refluxed in strongly acidic solution with known excess of oxidizing reagent ($K_2Cr_2O_7$) after digestion the remaining unreduced potassium dichromate $K_2Cr_2O_7$ is titrated

with ferrous ammonium sulphate. The amount of potassium dichromate consumed is determined and amount of oxidisable organic matter is calculated in terms of oxygen equivalent.

1. $2K_2Cr_2O_4 + 8\ H_2SO_4 \longrightarrow 2\ K_2SO_4 + 2\ Cr\ (SO_4)_3 + 8\ H_2O + 3\ O_2$
2. $C_6H_{12}O_6 + 6O_2 \longrightarrow 6\ CO_2 + 6H_2O$

   $Cr_2O_7 + 6Cl^- + 14\ H^+ \longrightarrow 3\ Cl_2 + 2\ Cr^{+3} + 7H_2O$
3. $Hg^+ + 2Cl^- \longrightarrow HgCl_2$

Calculation: -

COD, mg/l = $\frac{(b-a) \times N \text{ of ferrous ammonium sulphate} \times 1000 \times 8}{\text{ml sample}}$

Where, a = ml of titrant with sample

b = ml of titrant with blank

(12). Determination of Dissolved Oxygen:

DO analysis is a key test in water pollution and waste treatment process control. Two methods for DO analysis are described: Winkler or iodometric method and it's modifications & the electrometric method using membrane electrode.

Reactions:-

1. $MnSO_4 + 2\ KOH \longrightarrow Mn(OH)_2 + K_2SO_4$ (white ppt.)
2. $2\ Mn(OH)_2 + O_2 \longrightarrow 2\ MnO(OH)_2$ (Brown ppt.)
3. $MnO(OH)_2 + 2\ H_2SO_4 \longrightarrow Mn(SO_4)_2 + 3H_2O$
4. $Mn(SO_4)_2 + 2KI \longrightarrow MnSO_4 + K_2SO_4 + I_2$
5. $Na_2S_2O_3.\ 5H_2O + I_2 \longrightarrow Na_2S_4O_6 + 2\ NaI + 10\ H_2O$

Interferences: -

Iron, Nitrate and microbial mass are the chief source of interference in this method. The interference due to nitrate can be eliminated by adding sodium azide.

$2NaN3 + H2SO4 \longrightarrow 2HN3 + Na2SO4$

(Hydrazoic acid)

$HNO2 + HN_3 \longrightarrow N2O + N2 + H2O$

Calculation:-

1ml of 0.025 N $Na_2S_2O_3$ = 0.2mg of DO.

D.O.in mg/*l* = ml of thiosulphate x 0.2 x 1000

200

(13) Analysis / Determination of Metals and Trace metals

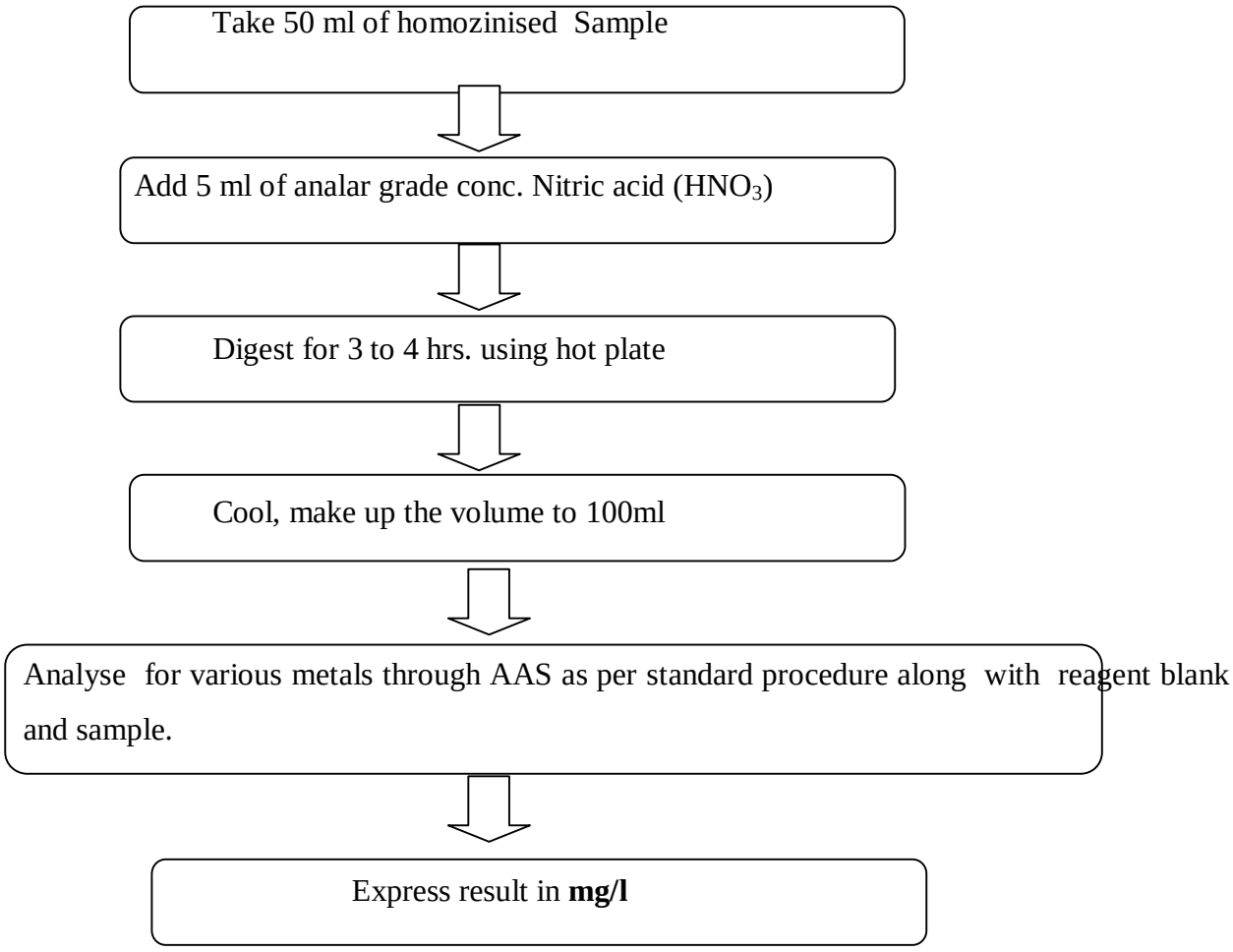
Iron

1. $Fe(OH)_2 + 3H^+ \longrightarrow 4Fe^{3+} + 3H_2O$
2. $4\ Fe^{3+} + 2\ NH_2OH \longrightarrow 4\ Fe^{3+} + N_2O + H_2O + 4H^+$

Maganese

$2\ Mn^{2+} + 5\ IO^{4-} \longrightarrow 2\ MnO^{4-} + 5\ IO^{3-} + 6H^+$

Flow Chart for Metal Analysis



Removal of Pollutants of Agyara Dam Through Adsorption by Seeds -

Adsorption is a fast, inexpensive and universal method of water purification. The process of adsorption is far better than compared to various other methods of purifying water such as boiling, filtration, chemical treatment, flocculation, coagulation, biodegradation etc. The promotion, development and encouragement of low cost adsorbents has triggered rapid and voluminous growth of research interests in this field. Reports, studies and surveys confirm the fact that development of inexpensive adsorbents from waste materials and materials provided by the nature takes only 1-2 days. The process of removal of pollutants consumes only small fractions of time. Therefore, the process of adsorption is highly effective in terms of saving the cost and time. Generally batch and column process are common for adsorption [2,3].

It has been known for some time that seeds can also be used to purify water through adsorption process. Tree seeds could provide a low cost water purification system for developing nations. In general seeds are powdered, mixed with polluted water and act as adsorbent for the removal of the pollutants present in it.

In the environment around us, seeds are present in abundance. Using a variety of seeds for the process of water purification is extremely beneficial since seeds are eco-friendly, inexpensive and easily accessible and available. The above facts created strong foundations for the author to adopt the technique of water purification through seeds in a local dam. The burning issue of the purification of water of Agyara Dam is an urgent one. The need of the hour is to contribute a bit to the ecosystem, the animals and the humans. We can use various seeds which are otherwise hazardous to the society. For example- Parthenium, Lantena Camera, Zuliflora and Moringa oleifera etc.

Process:-

Seeds are cheaply available. Water will require different amounts of seeds powder to purify it, depending on the impurities present. We will remove the seeds from the plants and shell them, leaving a whitish kernel. Now we will crush the seed kernels to a fine powder and will sieve them. And than will add the powder (approximately 2 gm) to one cup of clean water and will pour into a bottle and shake for 5 minutes. Now we will filter the mixture through a clean cloth into a bucket of dirty water that is to be treated.

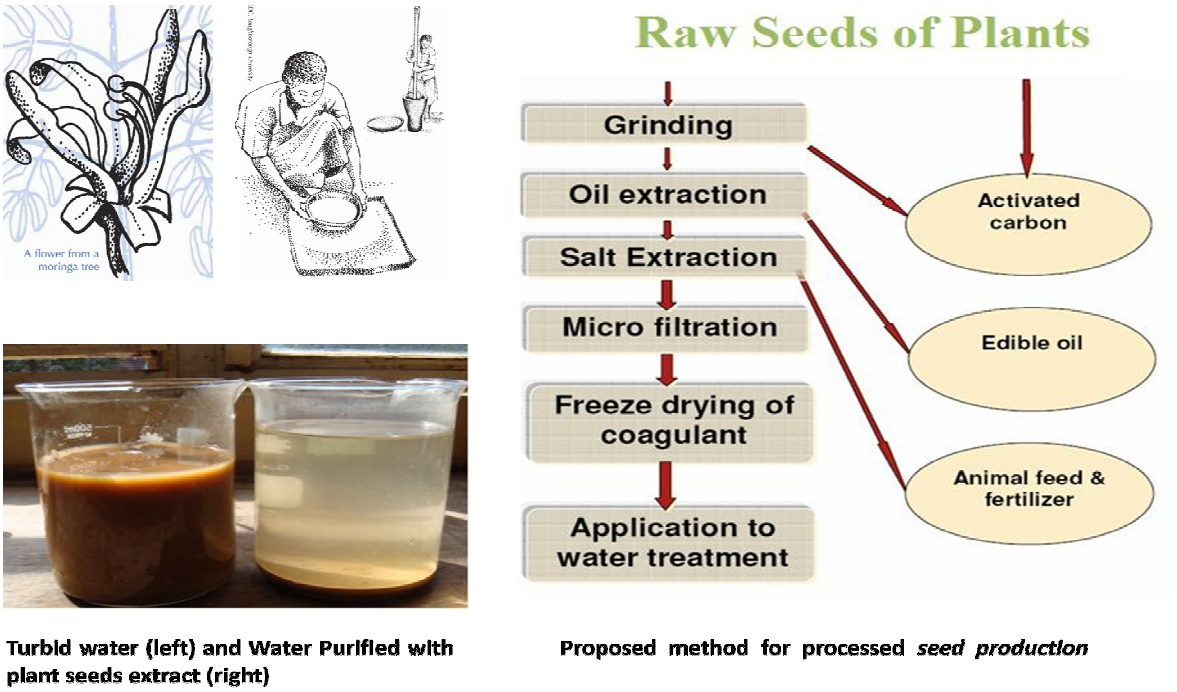


Fig. 1: Proposed method for processed seed production

Stir the water quickly for 2 minutes and slowly for 10-15 minutes. During the slow mixing, the fine particles and bacteria will begin to clump together and sink and settle to the bottom of the bucket. Cover the bucket and leave it undisturbed until the water becomes clear and the impurities have sunk to the bottom. This may take up to an hour. The clean water may be siphoned or poured off the top of the bucket or filtered through a clean cloth. The process removes at least 90 % of the bacteria and other impurities that cause turbidity[5].

This process actually involves hydration of seed followed by chemisorption. Chemisorption is a non reversible process in which diffusion occurs first followed by bond formations (chemical reactions). Hence it is very suitable for the removal of pollutants from water bodies.

Indian Alien Species which can be used as adsorption medias:-

(a) Parthenium
(b) Lantena camera.
(c) Zuliflora.

} Seeds can be used of these species ,which are otherwise hazardous to society

(d) Moringa oleifera seeds.
(e) Tamarind Seeds- Nontoxic and biodegradable.

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