

A Study on the Assessment of Water Quality Treated With Selected Plant Species

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ABSTRACT: Water is indispensable for human health and well being. In developing countries, large sections of the population dependent on raw water for drinking purposes, polluted by chemicals, agricultural runoff and human and animal feces. Plants have ability to purify waste water. This work was aimed at examining natural plant extract to purify drinking water and waste water. The plant species selected for the study showed significant reduction of turbidity especially with *Zea mays*, *Ziziphus jujuba*, *Jatropha curcas*, *Manihot esculanta Crantz*. The quality of water was also assessed by examining the physico-chemical parameter using pulverized powder of plant parts reveal, *Zea mays*, *Cicer arietinum*, *Manihot esculanta Crantz* possess properties to reduce the harmful physical and chemical components in water. Purity of water in terms of microbial load was also assessed showed significant reduction in the number of colonies after treatment with *Carica papaya*, *Manihot esculanta Crantz*. In this study powders of dried leaves of *Zea mays*, powders of root of *Manihot esculanta Crantz*, seeds of *Ziziphus jujube*, showed clarification property which can be used for water treatment. Seeds of *Phyllanthus emblica* showed significant reduction of coliform count and *Zea mays*, *Manihot esculanta Crantz* powder also showed significant reduction of coliform count when compared to the standard after treatment. The standard test result examined for five plant species include pH, TDS, BOD, and total coliform per 100ml showed significant reduction in all parameters after treatment. The study reveals that seeds and leaf extracts were also more effective in clearing and in sedimentation of suspended organic and inorganic matter present in water sample.

KEYWORDS: Coagulants, Water, TDS, BOD, *Zea mays*, *Cicer arietinum*.

I. INTRODUCTION

Water is the basis of life on earth and it is most important for human survival. WHO estimates that about 85% of the rural population facing lack of potable drinking water. In developing countries 15 million infants die every year due to contaminated drinking water, poor hygiene and malnutrition. A developing country are directly connected with contaminated drinking water (WHO)¹⁰. Ground water, surface water and rain water are the major sources of water availability in a community. Potable water, which is safe for drinking must be free of pathogenic organisms, toxic substances and an excess of minerals and organic pollutants. It must be colourless, tasteless and odourless in order to be attractive to consumers. World population increasing year to year and reaching 7 billion in 2012 whereas an access of getting pure water remains a problem especially for people who live in developing countries. The severity is much observed in rural dwellers who is their source of drinking is surface water which is not purified and this results for transmission of waterborne diseases (Hudson, et.al.1981).⁷ Number of chemical coagulants and disinfectants used for waste water and number of waterborne pathogens are growing resistant to Chlorine- Alum and lime treatment, Chlorine or Halogen compounds used in disinfecting water has been tagged a precursor for cancer, as it forms tetra halomethane compounds and lead to hormone mimics. Beside aluminum sulphate is generating dementia in young and elderly, there is a need to probe into indigenous knowledge in waste water purification. There is a lot of indigenous knowledge and plants that has remained unexploited due to lack of adequate science and technology. Historically, there is evidence to suggest that communities in the developing world have used plant based materials as a strategy for purifying drinking water (H. Aylin et al., 2012)⁴. Recently a number of effective coagulants have been identified of plant origin treatment. Seeds of *Moringa oleifera* & *Strychnos potatorum* shown to be effective primary coagulants for water treatment in

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rural communities. In coagulation and disinfection, numbers of active compounds have been isolated from various parts of plant species. The active coagulating component can be extracted from the plant parts and used in pure or semi-pure form, thus decreasing the total amount of organic material added to the treatment process which may resulting in the possibility for undesired and increased microbial activity (Gebremichael et al., 2005)¹. Plant extract also have ability to reduce the inorganic pollutants such as metals, present in waste water. In many regions there is a lack of surface water and severe water contamination is to be found shallow groundwater resources are often of insufficient quality and over-exploited. It has been found that also the new kinds of polluting agents, especially organic compounds, can be minimized or removed by natural purification processes in the subsurface. This work suggests the use of these plants for water purification, which are an economical and eco-friendly approach.

II. RELATED WORK

World population increasing year to year and reaching 7 billion in 2012 whereas an access of getting pure water remains a problem especially for people who live in developing countries. The severity is much observed in rural dwellers who is their source of drinking water is surface (raw) water which is not purified and this results for transmission of waterborne diseases. To reduce such like problems and the strong push to meet the drinking water needs of the developing world have led to the recent growing interest in using plant based natural coagulants and is infactants and plant species showed promising result in coagulating and disinfecting raw water.

The widely studied plant is *Moringa oleifera* which used as primary coagulant and coagulant aid. Other plant species also showed a very good result in coagulating turbid water however few reports are available in disinfecting capability of plant species therefore studies should focus in disinfecting ability of natural products (Chidanand Patil.,2015)¹³. Beyond their advantages over Alum, natural coagulants have also limitation. For instance they increase organic load in the water which tend restablization to occur. In addition water treated with natural coagulants (e.g. *Moringa*) was reported only used for 24 hours and inefficiency of treating low turbid water is another problem. To avoid the above stated problems researchers are investigating the active component rather than relying on crude extraction and protein was reported to be the major active component used in coagulation. (Megersa *et al.*, 2014.)⁵ In general, other plants should be studied in order to tackle the problem of quality water especially in developing countries. In such a case plant species can contribute to advancing the goal of sustainable water treatment technologies that are themselves sustainable.

Moringa oleifera, *J. curcas* and, *G. gum* 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. *M. oleifera* exhibited the most favourable results followed by *G. gum* and lastly *J. curcas*. The results indicated that *M. oleifera* can reduce turbidity of shallow well water. *M. oleifera* results for more turbid water (200 NTU) was better than less turbid water. It was noted that pH of the samples increased as the concentration of the extracts increased. There was, in general, an overall reduction in the number of coliforms and *E. coli* after the water had been treated with *M.oleifera* has demonstrated that the mucilage extracted is a better flocculant than aluminium sulfate (Al₂(SO₄)₃), J. P., Folkard etal 1994)^{8,9}.

In addition GE is derived from a renewable resource and its disposal will involve simple organic degradation this situation define advantage compared with which requires a chemical or mechanical recovery process to avoid further pollution problems, particularly if the mucilage was used in large-scale water treatment solutions in Sudan, seed crude extract is used instead of alum by rural women to treat the highly turbid Nile water. (Boateng *et al.*, 1984)². *Moringa* seeds are very effective for high turbidity water and show similar coagulation effects to alum *Moringa* seeds also have softening properties in addition to being a pH correctant (alkalinity reduction), as well as exhibiting a natural buffering capacity, which could handle moderately high to high alkaline surface and ground waters. The *Moringa* seeds can also be used as an antiseptic in the treatment of drinking water (Hyde M. et al., 1989). Ongoing research is attempting to characterize and purify the coagulant components of *Moringa* seeds), and it is believed that the seed is an organic natural polymer (Megersa et.al. 2014)⁵. The protein powder is stable and totally soluble in water.

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Seeds of *S. potatorum* and *M. oleifera* contain materials that are effective as coagulant and direct filtration of water with *S. potatorum* seed or *M. oleifera* seed as coagulant brings about a substantial improvement in its aesthetic and microbiological quality. The method appears suitable for water treatment in rural areas of developing countries. It may not produce fecal coliform-free water, but definitely produces water with 'low risk' according to the microbiological water quality classification scheme of the World Health Organization, based on thermotolerant (fecal) coliforms, (WHO 1997). A simple arrangement for home water treatment would be to dose 10l of raw water (pre-settled if initial turbidity is c. 100NTU) with *S. potatorum* seed or *M. oleifera* seed as coagulant, mix by hand-stirring for 2–3 min, and filter the water directly through a 500-mm sand filter.

III. MATERIAL & METHODOLOGY

The 14 coagulants which are used in this study are *Zea mays*, *Cyamopsis tetragonoloba*, *Manihot esculenta*, *Cicer arietinum*, *Millettia pinnata*, *Tamarindus indica*, *Peltophorum pterocarpum*, *Carica papaya*, *Opuntia ficus-indica*, *Phyllanthus emblica*, *Solanum incunum*, *Pouteria zapota*, *Zizphus jujube*, *Jatropha curcas* for treatment of river and sewage water. The natural coagulants are collected from the local market of karimedu, Madurai, Tamilnadu, India

A. PREPARATION OF NATURAL COAGULANTS

The seed pods of *Cyamopsis tetragonoloba*, *Ziziphus jujuba*, *Millettia pinnata*, *Tamarindus indica*, *Peltophorum pterocarpum*, *Carica papaya*, *Phyllanthus emblica*, *Pouteria zapota*, *Cicer arietinum*, *Solanum incunum*, leaves of *Zea mays*, *Opuntia ficus-indica* and roots of *Manihot esculenta* are collected, and dried naturally by sunlight. And the seeds were removed from the pod manually. The dried plant parts were ground to fine powder by domestic blender. This powder was sieved through 600 μ m.

B. COAGULATION STUDY

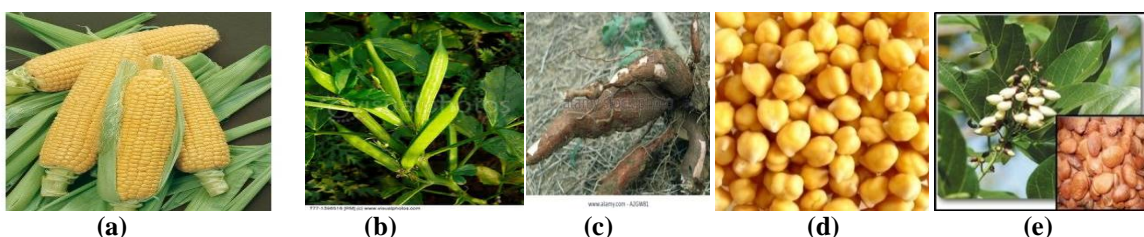
For the study the turbid water was collected from Vaigai River and the sewage water from local area, Madurai. 100ml of turbid water was dispensed in series of transparent disposable containers. The dose considered for the natural coagulants 0.1gm (100mg) was added to the container and vortex thoroughly. Then allowed to settle for 24hrs, turbidity was measured at 540nm using colorimeter. Turbid water without pulverized plant served as a control.

C. ANALYSIS OF PHYSICO-CHEMICAL PARAMETER OF WATER BEFORE AND AFTER TREATMENT

The following parameters was analyzed in the collected water samples before and after the addition of coagulants pH (pH meter with electrode, Elico India), Dissolved Oxygen (Winkler's method), Total Alkalinity, Chloride content, Salinity, Total Dissolved Solids, Ammonia, Nitrate, Biological Oxygen Demand, Total hardness Calcium, Vegetation analysis, Statistical analysis, Estimation of Iron by WONG's Method, Fluoride in SPADNS method, Sulphate by Gravimetric Method (Tamilnadu Water Testing Board, Mattudavani, Madurai).

IV. EXPERIMENTAL RESULTS

A. FIG 1: COAGULANTS STUDIED

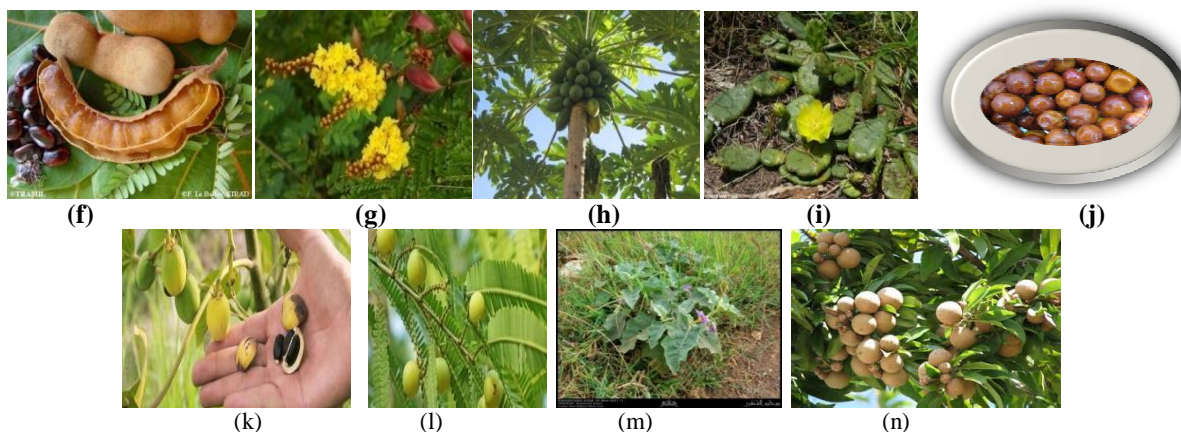


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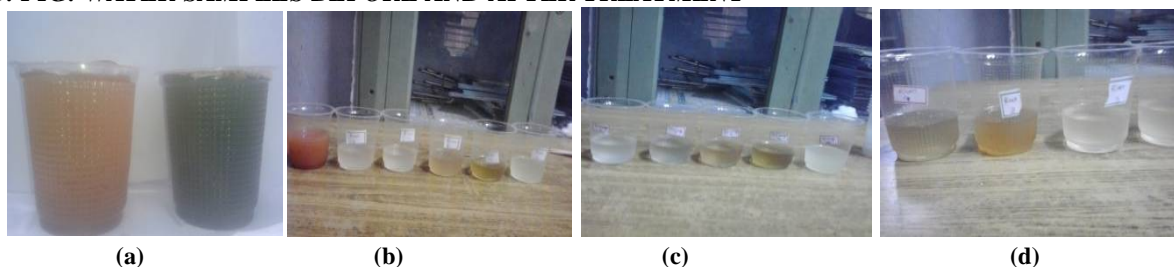
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a) *Zea mays* b) *Cyamopsis tetragonoloba* c) *Manihot esculenta* Crantz d) *Cicer arietinum* e) *Millettia pinnata* f) *Tamarindus indica* g) *Peltophorum pterocarpum* h) *Carica papaya* i) *Opuntia ficus-indica* j) *Ziziphus jujube* k) *Jatropa curcas* l) *Phyllanthus emblica* m) *Solanum incunum* n) *Pouteria zapota*

The above figures are the plant species used as coagulants for the treatment of water. Seed pods of (b),(d),(e),(f),(g),(j),(k),(l),(m),(n), leaves of (a), (i) and roots of (c) were examined.

B. FIG: WATER SAMPLES BEFORE AND AFTER TREATMENT



a) River & Sewage water before treatment b) & c) River water after treatment d) Sewage water after treatment
Figure - represents the nature of water sample both river and sewage water before and after treatment with the best five plant coagulants.

C. Table 1: PHYSICO - CHEMICAL STUDY OF RIVER AND SEWAGE WATER BEFORE TREATMENT

I. PHYSICAL EXAMINATION	BIS LIMIT	Permissible limit in the absence of alternative source	Lab no.	
	Acceptable limit		39591(1)	395923(2)
1. Appearance	-	-	Turbid & brownish	Turbid & blackish
2. Colour	5	15	Foul smell	
3. Odour	Unobjectionable			
4. Turbidity NT units	1	5	28	32
5. TDS mg/l	500	2000	196	1029
6. Electrical conductivity micro mho/cm	-	-	280	1470
II. CHEMICAL EXAMINATION				
7. pH	6.5-8.5	6.5-8.5	6.92	7.30
8. p H. Alakalinity as CaCO ₃	-	-	0	0

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9. Total Alakalinity as CaCO ₃	200	600	40	280
10. Total Hardness as CaCO ₃	200	600	80	340
11. Calcium as Ca	75	200	20	85
12. Magnesium as Mg	30	100	8	34
13. Iron as Fe	0.3	0.3	0	0
14. Manganese	0.1	0.3	0	0
15. Free Ammonia as NH ₃	0.5	0.5	0.4	1.8
16. Nitrite as NO ₂	0.5	0.5	0.3	0.4
17. Nitrate as NO ₃	45	45	5	14
18. Chloride as Cl	25	1000	40	290
19. Fluoride as F	1.0	1.5	0.8	1.0
20. Sulphate as SO ₄	200	400	8	2
21. Phosphate as PO ₄	0.5	0.5	0.2	1.6
22. Tidys Test 4hrs as O ₂	-	-	1.2	1.4
23. B.O.D	-	-	244	386
24. C.O.D	-	-	588	960

The results of table.1 represents primary physico - chemical examination of water samples (river -39591 & sewage 395923) before treatment does not possess any promising parameters for potable consumption especially with pH, TDS, BOD, levels are exceeding beyond the permissible limit.

C. TABLE 2: BEST FIVE PLANTS IDENTIFIED TO EFFECTIVELY TREAT RIVER WATER

S.No	Plant Name	pH			TDS			BOD			Total Coliform/100 ml			
		PS	BT	AT	PS	BT	AT	PS	BT	AT	PS	BT	AT	
1.	<i>Zea mays</i>	6.5 - 8.5	6.92	6.60	500	196	244	0	48	100	0	48	36	
2.	<i>Cicer arietinum</i>			6.70						287			100	32
3.	<i>Tamarindus indica</i>			6.60						231			100	38
4.	<i>Pouteria zapota</i>			6.60						210			120	42
5.	<i>Millettia pinnata</i>			6.80						217			120	36

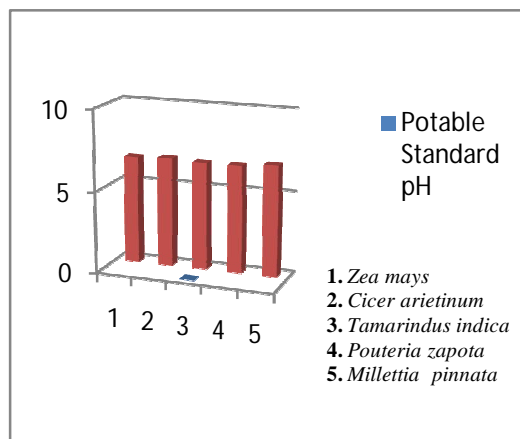
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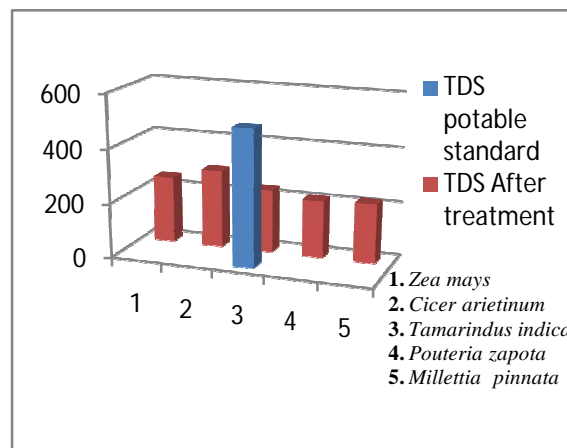
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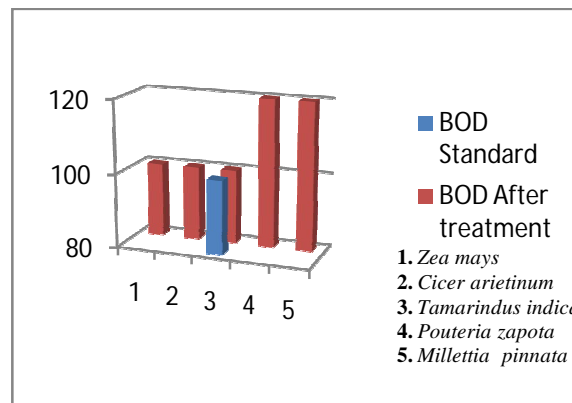
D. FIG (I), (II) AND (III) POTABLE STANDARD (PS) PH ,TDS,BOD BEFORE TREATMENT (BT) AND AFTER TREATMENT (AT) WITH BEST FIVE PLANT SPECIES IN RIVER WATER.



(i)



(ii)



(iii)

Table 2, Figure IV.C (i), (ii) & (iii) represents the reduction of parameters pH, TDS, BOD and total coliform count /100ml treated with best five plant species in river water compared to the initial level before treatment.

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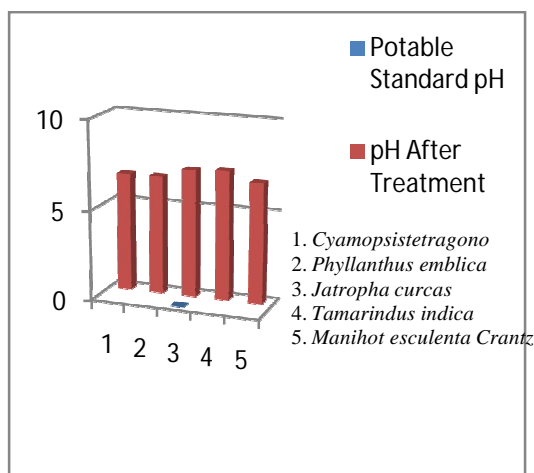
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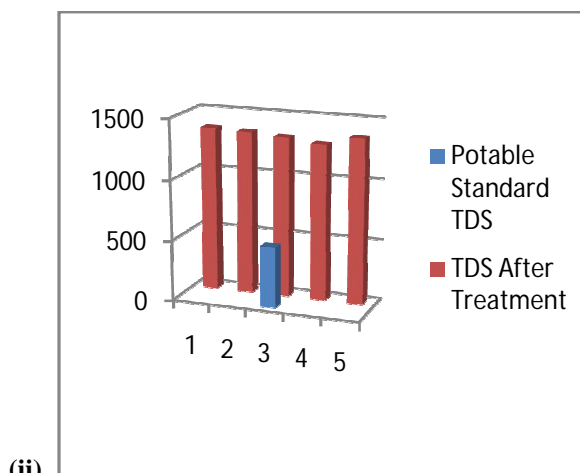
E. TABLE 3: BEST FIVE PLANTS IDENTIFIED TO EFFECTIVELY TREAT SEWAGE WATER

S · N o ·	Plant Name	pH			TDS			BOD			Total Coliform/100 ml		
		PS	BT	AT	PS	BT	AT	PS	BT	AT	PS	BT	AT
1	<i>Cyamopsis tetragono</i>	6.5-8.5	7.30	6.60	500	1029	1358	100	386	160	0	44	46
2	<i>Phyllanthus emblica</i>			6.60			1344			120			58
3	<i>Jatropha curcas</i>			7.10			1323			180			56
4	<i>Tamarindus indica</i>			7.20			1288			150			58
5	<i>Manihot esculenta Crantz</i>			6.70			1358			140			52

F. D. FIG (I),(II) & (III) POTABLE STANDARD (PS), PH ,TDS,BOD AND TOTAL COLIORM COUNT BEFORE TREATMENT (BT)AND AFTER TREATMENT (AT) WITH BEST FIVE PLANT SPECIES IN SEWAGE WATER.



(i)



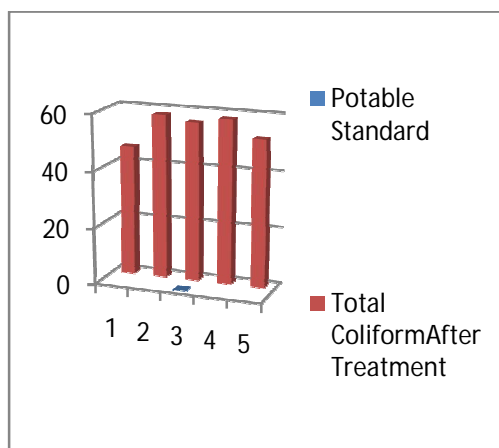
(ii)

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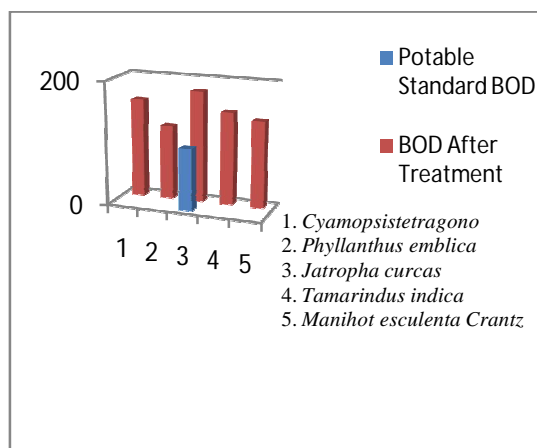
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(iii)



(iv)

Table.3 & Fig IV.D.(i),(ii),(iii)&(iv) represents effective reduction of parameters pH, TDS, BOD and total coliform count/100ml treated with best five plant species in sewage water compared to the initial level before treatment.

G. TABLE 4: BACTERIOLOGICAL EXAMINATION OF RIVER AND SEWAGE WATER BEFORE TREATMENT

Bacteriological Examination	BIS LIMIT		Lab no.	
	Acceptable limit	Permissible limit in the absence of alternative source	39591(1)	395923(2)
1. Standard plate count per ml	-	500 organism / ml	118	360
2. Total coliform per 100 ml	-	0 / 100 ml	52	120
3. Fecal coliform per 100 ml	0	0 / 100 ml	48	110
4. Fecal Streptococcus/100ml	0	0 / 100 ml	20	44

Table. 4 shows the both the water samples (river & sewage) does not possess any promising acceptable and permissible limits on the standard bacteriological examination before treatment.

H. TABLE 5: BACTERIOLOGICAL EXAMINATION OF RIVER WATER AFTER TREATMENT

Bacteriological Examination	BIS LIMIT															
	Acceptable limit	Permissible limit	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Standard	-	500 organisms	66	62	50	64	68	72	54	50	56	52	54	54	56	62

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plate count per ml		m / ml														
2. Total coliform per 100 ml	-	0 / 100 ml	36	38	28	32	36	38	42	40	46	40	42	42	48	56
3. Fecal coliform per 100 ml	0	0 / 100 ml	24	26	20	24	20	20	26	24	34	24	26	26	30	34
4. Fecal Streptococcus per 100 ml	0	0 / 100 ml	4	6	4	6	4	4	6	8	10	8	12	10	12	12

I. TABLE 6: BACTERIOLOGICAL EXAMINATION OF SEWAGE WATER AFTER TREATMENT

Bacteriological Examination	BIS LIMIT		1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Acceptable limit	Permissible limit														
1. Standard plate count per ml	-	500 organism / ml	62	66	70	74	82	86	82	60	70	68	66	62	68	76
2. Total coliform per 100 ml	-	0 / 100 ml	46	48	56	62	44	54	68	66	62	60	52	56	58	64
3. Fecal coliform per 100 ml	0	0 / 100 ml	40	38	44	60	46	52	48	62	58	54	48	52	64	52
4. Fecal Streptococcus per 100 ml	0	0 / 100 ml	10	8	12	10	12	12	12	10	12	10	14	12	8	6

Table 5& 6 shows marked reduction of standard plate count /ml, total coliform count , fecal coliform count and fecal *Streptococcus* count /100ml in water samples (river & sewage) after treatment with *Carica papaya* and *Manihot esculanta*Crantz.

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**J. TABLE 7: ANALYSIS OF WATER CLARITY AFTER TREATMENT
(Turbidity Study Of Water)**

S. No	Plant Name	OD Value (Before treatment)		OD Value (After treatment)	
		River Water	Sewage Water	River Water	Sewage Water
1.	<i>Zea mays</i>	0.51	0.29	0.10	0.10
2.	<i>Cyamopsis tetragonolobo</i>			0.24	0.15
3.	<i>Manihot esculenta Crantz</i>			0.07	0.09
4.	<i>Cicer arietinum</i>			0.11	0.17
5.	<i>Millettia pinnata</i>			0.06	0.13
6.	<i>Tamarindus indica</i>			0.19	0.10
7.	<i>Peltophorum pterocarpum</i>			0.10	0.13
8.	<i>Carica papaya</i>			0.09	0.14
9.	<i>Opuntia ficus-indica</i>			0.09	0.14
10.	<i>Phyllanthus emblica</i>			0.13	0.16
11.	<i>Solanum incunum</i>			0.23	0.21
12.	<i>Pouteria zapota</i>			0.26	0.11
13.	<i>Ziziphus jujuba</i>			0.06	0.11
14.	<i>Jatropha curcas</i>			0.06	0.11
	CONTROL (Charcoal)			0.09	0.10

Table.7 shows drastic reduction in turbidity *Ziziphus jujuba*, *Jatropha curcas*, *Manihot esculanta Crantz*, *Millitia pinnata*, *Carica papaya*, *Opuntia ficus – indica* within a day in river water and of *Zea mays*, *Cicer arietinum*, *Tamarindus indica*, took 3 days for clarification, in both the water samples.

V. DISCUSSION

A. ESTIMATION OF CLARITY OF WATER AFTER ADDITION OF PULVERIZED SEED POWDER

Clarity of water was examined by using turbid water, when the plant extract was included the turbidity showed a drastic decrease. (Table 7), in case of *Ziziphus jujuba*, *Jatropha curcas*, *Manihot esculanta Crantz*, *Millitia pinnata*, *Carica papaya*, *Opuntia ficus – indica* within a day in river water. (Fig IV.B (b) & (c)). In case of *Zea mays*, *Cicer arietinum*, *Tamarindus indica*, took 3 days for clarification, in case of *Solanum incunum*, water becomes brown in colour, (Fig IV.B (d)).

B. PHYSICO – CHEMICAL PARAMETERS OF WATER BEFORE AND AFTER TREATMENT

The water samples (river and sewage) were treated with selected plant powder and physico-chemical parameters (appearance, colour, odour, NT units, TDS, electrical conductivity) chemical examination (pH, total alkalinity, hardness, calcium, magnesium, iron, manganese, free ammonia, nitrite, nitrate, chloride, fluoride, sulphate, phosphate, BOD and COD), showed reduction after treatment (Table 1), indicates that results of before treatment and Table 2 and Table 3 indicates the results of after treatment of water samples .

C. MICROBIAL QUALITY OF WATER

After clarification and physico-chemical parameters study the clarified was collected and bacteria were enumerated: The following bacteriological examination was done for the water samples (river and sewage): Standard plate count/ml, Total coliform/100ml, Fecal coliform/100ml, Fecal *Streptococcus*/100ml (Table 4,5& 6) shows before and after treatment of water samples. The clarified water was readily diluted to 10⁻³ when the serially diluted water samples were used for bacterial enumeration, water treated with *Carica papaya*, *Manihot esculanta Crantz*, seed powder showed lesser number of bacteria as compared to that of control. Fecal coliform count was significantly reduced in powder of

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the 14 plant species examined 5 of the best plant species was selected and examined for significant reduction of physico-chemical parameters, clarification and microbial quality compared with the potable standard (Table 2 & 3) for both river and sewage water.

VI. CONCLUSION

The present study, “A study on assessment of water quality treated with selected plant species”, aims at the clarification of water using selected plant species showed significant reduction of turbidity for *Zea mays*, *Ziziphus jujuba*, *Jatropha curcas*, *Manihot esculanta Crantz*. The quality of water was also assessed by examining the physico-chemical parameter using pulverized powder of plant parts reveal, *Zea mays*, *Cicer arietinum*, *Manihot esculanta Crantz* possess properties to reduce the harmful physical and chemical components in water.

Purity of water in terms of microbial load was also assessed showed significant reduction in the number of colonies after treatment with *Carica papaya*, *Manihot esculanta Crantz*. Based on the above observations following recommendations was suggested Pulverised powders of plant species could be used as ecofriendly alternative for water treatment.

In this study powders of dried leaves of *Zea mays*, powders of root of *Manihot esculanta Crantz*, seeds of *Ziziphus jujube*, showed clarification property which can be used for water treatment. Seeds of *Phyllanthus emblica* showed significant reduction of coliform count can be used for water treatment, *Zea mays* (Table 6). *Manihot esculanta Crantz* powder also showed significant reduction of coliform count when compared to the standard after treatment (Table 7)

The standard test result examined for five plant species include pH, TDS, BOD, and total coliform per 100ml showed significant reduction in all parameters after treatment.

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