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Effect of Some Selected Plant Materials on Turbidity and Bacterial Density of Surface Water Used for Drinking in Ekiti State

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Abstract

Plant extracts of various parts have been used for water purification for many centuries. This present study was aimed at establishing the phytodisinfection potentials of selected plants at different concentrations (0.5, 1.0, 2.0, 3.0, 4.0, and 5.0 mg/ml) in purification of surface water samples from selected rural communities of Ekiti State. These plants include Jathropha curcas, Calotrophis procera, Moringa oleifera,Hibiscus sabdariffa and Bambara nut which showed appreciable turbidity and bacterial density reduction in a concentration dependent manner. Extract of Moringa showed the best activity (between 2.0 and 5.0 ml/l), followed by Jathropha and Calotrophis (between 3.0 and 5.0 mg/l) while Bambara nut and Hibiscus showed the least activities between (4.0 and 5.0 mg/l) which ranged between 50 and 90%, 25 and 55% and 20 and 40% reduction respectively. From this work, the use of locally available plant materials seems suitable, easier, cheap and environmentally friendly for water treatment. There is need to test the toxicity of the plant extracts to guarantee their safety as coagulants in the purification of water for human consumption.

Keywords: *Extracts, Coagulants, water purification, drinking treatment*

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INTRODUCTION

The removal of organic and inorganic material from raw water is essential before it can be disinfected for human consumption. In a water treatment works, this clarification stage is normally achieved by the application of chemical coagulants which change the water from a liquid to a semi-solid state [1]. This is usually followed by flocculation, the process of gentle and continuous stirring of coagulated water, which encourages the formation of 'flocs' through the aggregation of the minute particles present in the water.

Flocs can be easily removed by settling or filtration. For many communities in developing countries, however, the use of coagulation, flocculation and sedimentation is inappropriate because of the high cost and low availability of chemical coagulants, such as aluminium sulphate and ferric salts [2]. Water for human consumption must be free from all objectionable odour, turbidity, taste, enteric pathogenic bacteria or their indicators and must not fluctuate in its quality [3, 4] reported that the sanitary quality of water is the relative extent of the absence of suspended matter, colour, taste, unwanted dissolved chemicals, bacteria indicative of faecal pollution and other aesthetically offensive objects.

In many developing countries, potable water is collected from communal sources which are either unimproved, such as unprotected wells, springs, streams and rivers. In the purification of the water, traditional methods which are inexpensive and suitable under local conditions are employed [5]. However, through enlightment programe, the populace in the rural communities are encouraged on available water sanitation procedures such as boiling and filtration. One method that has been practiced by the people in some parts of the developing world is the use of locally available natural coagulants to remove turbidity and bacteria in surface water [6]. The

natural coagulation technology has the potential of replacing or supplementing costly water treatment chemicals in poor countries. In addition, the natural coagulants avoid the human and environmental problems that are associated with the use of water treatment chemicals [7].

Scientific investigations into coagulation potentials of other locally available natural coagulants like *Jathropha curcas, Calotrophis* latex, pawpaw latex, extract of bambara nut other than *Moringa oleifera* has not been extensively studied. This study was carried out to establish the phytodisinfection properties of selected plant materials in purification of selected surface water used for drinking in Ekiti State.

MATERIALS AND METHODS

Collection of Water Sample

All samples were collected according to the method of APHA [8, 9] .The water samples used for this work were collected from 18 selected surface water (streams) used for drinking from selected rural communities of Ekiti State in sterile non- reactive glass bottles. The water samples were collected with a volume of not less than 500 ml with a little space was left in the bottles to facilitate mixing by shaking.

The sample bottles were labeled names corresponding to the locations at which the samples were collected for easy identification. The samples were placed immediately on ice during transport to the laboratory prior to analysis.

Performance of Selected Plant Extracts as Natural Coagulants and Phytodisinfectant

Sedimentation jars test of Pritchard was employed to determine the coagulation properties of the plant extracts used for this study [10]. Seven glass beakers of 200 ml capacity were filled with the water samples obtained from selected rural communities of Ekiti State. One beaker serves as control while the other six were dosed with each plant extract in turn, with concentrations of 0.5, 1.0, 2.0, 3.0, 4.0 and 5.0 mg/ml. The water samples in the beakers were mixed at high speed of 200 rpm for 60 sec as recommended by Kebreab A. Rapid mixing for a few seconds is important after adding a coagulant to obtain a uniform dispersion of the coagulant and to increase the opportunity for particle to particle contact. The solution is allowed to stand to allow the coagulated particles to settle to the bottom. After 24 h of settlement, the supernatant was then filtered through a whatman filter paper NO.542 to produce a degree of filteration. The turbidity and total viable count of the water samples were assessed before and after the treatment regime.

RESULTS AND DISCUSSION

Table 1 showed the coagulation potential of different plant extracts at different concentrations on the turbidity of the selected surface water used for drinking from selected communities of Ekiti State. Moringa, Jathropha, Hibiscus, Calotrophis, Bambara nut were the selected plants at different concentrations (0.5, 1.0, 2.0, 3.0, 4.0 and 5.0 mg/l). Moringa extract showed no turbidity in jars containing the plant extracts at 2.0, 3.0, 4.0 and 5.0 mg/l.

The extracts of Jathropha and Calotrophis removed the turbidity of water samples at 3.0, 4.0 and 5.0 mg/l. It was found out that nearly all the water samples remained turbid after 24 h of the study except for samples treated at 5.0 mg/l of the extract. Bambara nut extract followed the same trend like Hibiscus in turbidity reduction potential. All the water samples remained turbid at 0.5, 1.0, 2.0, 3.0 mg/l, only 4.0 and 5.0 mg/l showed 100% reduction in the turbidity.

Table 2 showed the potency of the crude extracts of the natural coagulants as phytodisinfection agents in the water samples. Only the extracts of Moringa, Calotrophis and Jathropha showed antibacterial activity. Moringa seed extracts showed between 20 and 90% bacterial reductions in a concentration dependent manner. There was reduction in the total bacterial load in a concentration dependent manner which ranged between 20 and 90%. Only 5.0 mg/l reduced at 100% in some of the water. The extracts of Jathropha also followed the bacterial reduction manner of Calotrophis. The reduction power was in the range of 20–40% while at 5.0 mg/l, few of the water samples had 100% total bacterial reduction.

Table 1: *Coagulative Potentials of the Extracts of the Coagulants on the Turbidity of the Selected Surface water.*

	Selected Surface Water/Percentage Coagulation Activity of the Aqueous Extract of the Coagulants																	
Concentration/ Plant Extract	**AFL**	**OBD**	**OGB**	**ASO**	**OLDA**	**ARM**	**EKSA**	**AJAM**	**OLRI**	**OMOK**	**OKSO**	**APER**	**OBUK**	**OGAN**	**EJU**	**AGP**	**YEYBA**	**ELYIN**
0.5—MO	24	63	36	30	13	11	100	12	14	15	26	13	10	17	14	12	44	23
JC	19	28	24	29	13	08	100	18	10	13	21	14	06	16	12	09	36	14
HS	10	17	12	15	05	05	35	06	08	07	11	07	05	09	06	06	15	06
CP	15	34	25	28	10	09	100	12	12	18	18	17	10	13	12	06	19	17
BN	07	13	11	12	06	04	23	09	10	09	11	06	05	08	05	05	11	05
1.0—MO	59	100	100	84	62	45	100	60	46	38	59	55	28	40	73	100	100	65
JC	54	100	83	74	44	27	100	60	55	35	54	29	27	37	37	26	100	49
HS	24	37	39	43	28	18	56	28	32	23	27	12	14	18	21	13	23	19
CP	46	68	54	53	32	22	100	34	32	61	51	37	28	36	28	21	38	42
BN	19	17	23	18	21	15	37	28	22	19	16	10	25	17	12	12	13	14
2.0—MO	100	100	100	100	100	100	100	100	100	100	100	74	100	100	100	100	100	100
JC	100	100	100	100	82	53	100	100	100	74	100	60	50	84	73	57	100	100
HS	58	47	52	47	59	39	67	55	57	46	72	52	44	62	54	34	51	67
CP	69	100	90	85	72	64	100	63	65	100	100	68	62	66	49	66	67	76
BN	33	36	43	56	32	56	45	52	48	41	55	38	39	65	54	36	52	56
3.0—MO	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
JC	100	100	100	100	100	100	100	100	100	100	100	90	80	100	100	92	100	100
HS	58	65	48	78	72	63	58	62	49	74	49	32	29	38	74	65	39	78
CP	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
BN	36	42	29	36	47	56	44	53	47	68	44	28	29	42	67	62	38	52
4.0—MO	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
JC	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
HS	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
CP	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
BN	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

MO=Moringa oleifera, JC=Jathropha curcas, HS=Hibiscus sabdariffa, CP=Calotrophis procera, BN=Bambara Nut.

Table 2: *Effect of Crude Extracts of the Coagulants on the Bacterial Density of the Selected Surface Water.*

	Selected Surface Water/Percentage Bacterial Density Reduction Potential of the Aqueous Extract of the Coagulants																	
Concentration/ Plant Extract	**AFL**	**OBD**	**OGB**	**ASO**	**OLDA**	**ARM**	**EKSA**	**AJAM**	**OLRI**	**OMOK**	**OKSO**	**APER**	**OBUK**	**OGAN**	**EJU**	**AGP**	**YEYBA**	**ELYIN**
0.5—MO	24	34	34	26	37	39	33	35	37	36	26	34	35	37	37	51	12	35
JC	24	32	33	25	30	29	29	34	35	35	24	32	34	35	36	51	34	33
CP	06	15	04	05	07	06	05	04	03	05	05	05	05	04	06	06	16	07
1.0—MO	31	42	41	40	43	50	38	40	40	48	33	45	41	45	42	56	19	40
JC	31	40	37	32	37	39	42	40	40	43	27	39	40	41	44	54	11	41
CP	21	23	11	11	10	19	17	11	09	16	16	19	12	11	15	14	28	22
2.0—MO	46	58	56	58	56	66	58	54	53	62	36	64	50	56	45	67	23	57
JC	42	55	47	36	40	44	59	50	48	57	37	50	48	49	54	62	22	52
CP	36	37	19	21	20	35	32	23	19	29	32	34	23	22	25	24	43	35
3.0—MO	59	75	66	74	73	80	74	72	67	82	50	79	61	66	61	81	53	76
JC	55	69	51	52	58	60	80	64	52	75	42	51	58	54	65	71	38	67
CP	56	58	33	35	35	58	57	32	28	48	47	53	35	35	42	31	59	75
4.0—MO	75	93	82	91	90	100	100	91	86	100	66	94	75	77	80	95	80	95
JC	79	88	65	70	73	77	100	78	64	90	55	67	64	65	81	81	53	83
CP	78	75	44	45	45	80	75	46	42	69	65	76	47	51	49	54	81	91
5.0—MO	93	100	95	100	100	100	100	100	100	100	87	100	92	93	94	100	100	100
JC	92	100	83	89	91	90	100	99	80	100	69	82	98	78	92	90	72	100
CP	100	100	60	64	64	100	100	67	58	90	87	100	62	67	68	75	100	100

MO=Moringa oleifera, JC=Jathropha curcas, HS=Hibiscus sabdariffa, CP=Calotrophis procera, BN=Bambara Nut.

The use of natural materials of plant origin to clarify turbid surface water is not a new idea, these natural coagulants which can be readily propagated and easily accessible to common persons would offer solution to our plagued water population in Nigeria. The use of natural materials of plant origin to clarify turbid surface water is not a new idea, these natural coagulants which can be readily propagated and easily accessible to common persons would offer solution to our plagued water population in Nigeria. It has been reported that seeds of *Moringa oleifera* found mostly in many areas of Northern Nigeria to have been used in purification of turbid water which has been supported by results of many researches.

In Malawi, it was observed that muddy water mixed with powdered moringa seeds resulted in purified water after an hour just in it has been filtered with a chemical substances like the common water coagulant, alum. Pitchand [10] observed that at a dose concentration of 50 mg/l to reduction in turbidity was produced in shallow wells water in Malawi suing extracts of *Moringa oleifera, Jathropha curcas* and *Gua gum*; at 20 mg/l, these extract produced 99% reduction in turbidity which produces values lower than the WHO [11] guideline of 5NTU.

The quality of drinking water has been decreased during this century due to discharge of waste water resources as well as due to environmental pollutants. The major global health problems, cross adaptations of microbial population to structurally related chemicals, may play an important role in the practical development and application of bioremediation technique [12].

The knowledge of purification of polluted domestic water supply sources using locally available seeds has got both direct and indirect ways of enhancing sustainable development in rural communities. It has been seen from literature that apart from Jathropha , all other natural coagulants used in this study are either been used as food or used for the production of other food, medicine in nature and can be used to control erosion. Oluduro and Aderiye [8, 13] observed that moringa seed extract was able to sediment suspended particles to about 95% in surface water within 96 h of storage as against 30% sedimentation recorded in untreated surface water. This also revealed that the seeds have the potential to sediment and clarify the body of water as noted by above named scientists. According to Kaggwa, [14] reduction in turbidity was associated with improvement in bacteriological quality.

This has responsible for the antibacterial activity of the crude extract of these natural coagulants. They have been found to reduce the bacterial load of the surface water studied. This is a feature well known from flocculation and sedimentation procedures as applicable to treatment of wastes water for human consumption [13]. Yongabi noted that the coagulative effect of Moringa seeds was bitter than that of alum and some notable natural coagulants [14].

This explains the fact that the seeds of this plant showed the best coagulative potential over those of jathropha plant, hibiscus plant, calotrophis plant and bambara nut used in this work. Eilert *et al*., [15, 16] also noted that the coagulative property of moringa seeds. The work of Eilert and co supports the antibacterial activity of *Moringa oleifera* seeds against *E. coli*, *Klebisiella* sp *Staphylococcus* sp and *Bacillus* sp. This supported this present work in which the extract of moringa seeds showed the best activity in reducing the total bacterial count and total coliform count in the water studied. It also compared favorably with the extract of jathropha plant against multiple antibiotic resistant bacterial isolates. A similar study conducted by Ali *et al.*, [7, 17] showed that *Moringa oleifera* seeds gave turbidity removal from 43.9, 91 and 333NTU to 1.99, 1.40 and 2.20NTU respectively corresponding to the 0.05, 0.15 and 0.30 mg/l. Kebreab *et al.* also published similar report and recommended the seeds as a viable coagulant in water and waste water treatment [2, 4, 18]. Other coagulants such as Oka gum, *Calotrophis procera, Cicer cercitinun, Dolicho's lablab, Jathropha carcus, Hibiscus sabdariffa, Sclerotium sp, Garcinia kola,* papaya latex, have been found to be effective in treating waste water. The findings of [15, 9] indicated that these coagulants coagulated well above 75% of the particles in the samples leading to a clear supernant. Folkard *et al.* [18] reported the antibacterial of extracts of *H.*

Sabdariffa, M. Oleifera, J. Curcas, P. tuberregium against *E.coli, Klebsiella aeruginosa, Klebsiella pneumonia, S. aureus*, and *B. subtilus* which corroborate this study when the extracts of the used coagulants possessed antibacterial activity on the MDR isolates. Nancy *et al*. and Dawson *et al.* [19, 20] also reported the antibacterial activities of different extracts of coagulants and disincentive activity.

CONCLUSION

The use of locally available plant materials such as the ones used in this study (*Moringa oleifera, Hibiscus sabdariffa, Calotrophis procera, Jathropha curcas and Bambara nut*) significantly improved the quality of the water samples in terms of turbidity and total bacterial reduction. Among the plant materials, *Moringa oleifera* was found to be most effective followed by *Jathropha curcas* and *Calotrophis procera* in both turbidity and bacterial density reduction. The WHO guideline for turbidity was achieved with these plant materials although there was reduction in the total bacterial count but insufficient to fall within the guideline. However isolating and purifying the active agent(s) from the plant and the optimum conditions for the phytodisinfection should be considered.

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