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EFFECT OF *MORINGA OLEIFERA* SEEDS ON BACTERIAL QUALITY OF DRINKING WATER IN RURAL COMMUNITIES OF ONDO SOUTHWESTERN, NIGERIA

Aromolaran, Olukemi

Department of Biological Sciences, Wesley University of Science and Technology, Ondo, Nigeria
kemiaramolaran@gmail.com

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ABSTRACT

The physicochemical and bacteriological quality of drinking water in the rural communities of Ondo was examined and treated with the seeds of *Moringa oleifera*. The water samples were analyzed for some physicochemical parameters and pour plate technique was used to determine the presence of bacterial pathogens. Multiple tube fermentation technique was used for the determination of Most Probable Number, after which the water samples were treated with *Moringa oleifera* seeds for two hours. Bagbe and Uleon streams had unpleasant odour, while streams of Aba Titun, Otasan and Igbuowo were odourless. All the water samples were within the temperature range of 26°C-27°C and pH range of 6.61-7.27, but were all turbid except the water from Aba Titun. The pathogens that were identified from the water samples include: *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis*, *Serratia* sp. and *Salmonella* sp. The treatment significantly reduced the turbidity by between 50 and 66%. The colony forming unit per milliliter of all the water samples exceeded the standard limit of 1.0×10^2 /ml for drinking water (WHO) but the treatment profoundly decreased the total viable count by between 54.3 and 96.2%. The total coliform count was also reduced by between 56.6 and 100%. The presence of bacterial pathogens in drinking is of public health concern as they may cause gastro-intestinal water borne diseases. *Moringa oleifera* seeds serve as a low cost, efficient and effective treatment for drinking water, especially for the rural communities, where there is poor access to potable water.

Key words: Drinking Water, *Moringa oleifera*, Microbial Quality, Water Treatment, Ondo

INTRODUCTION

According to the World Health Organization and UNICEF, over one billion people worldwide do not have access to safe, drinkable water and about forty percent of the world's population lack basic sanitation (Willey *et al.*, 2008). Unavailability of safe drinking water in many developing countries poses a great threat to health, economic productivity and quality of life of the people (Ishaku *et al.*, 2011). A preliminary investigation revealed that a large percentage of rural dwellers in Nigeria do not have access to safe drinking water. They depend largely on surface run-off such as streams, rivers, ponds and unprotected wells (Ishaku *et al.*, 2011; Shittu *et al.*, 2008). Water supplies from these sources are usually contaminated with organic, inorganic and microbial impurities (Edema *et al.*, 2001; Shittu *et al.*, 2008). These water sources are susceptible to water borne diseases such as typhoid fever, cholera, dysentery *etc.* (Ishaku *et al.*, 2011). Many infectious diseases are transmitted by water through the faecal oral route. Five million children die annually from diseases contracted through drinking water and one sixth of the world

population is sick (Bauwer, 2013; USEPA, 2005). The treatment of this poor drinking water is of primary concern, particularly in the rural areas.

Improved adequate safe water supply will lead to reduction of human suffering, increased productivity capacities that at the end will reduce health care cost (Ishaku *et al.*, 2011). Since good quality water is not available, treatment with chemicals is expensive, inaccessible to the villagers and chemical treatment could also cause some diseases such as cancers. Biological treatment is considered the most cost-effective and the safest.

Moringa oleifera belong to the family *Moringaceae* (order *Brassicales*) and is cultivated across the tropics. The seed is edible and has some medicinal uses. The plant is commonly called 'Horse-radish tree' (Ambi *et al.*, 2011). Earlier studies have found *Moringa oleifera* seed to be non-toxic and recommended for use in developing countries (Ayotunde *et al.*, 2011). The leaves, seeds, flowers and immature pods of this tree are edible and they form a part of traditional diet in many parts of the tropics (Anwor and Rashid, 2007). The leaves are

good source of protein, vitamin A, B and C and minerals (Dahot, 1988). The dry seed suspension has coagulation properties and it is used in place of alum to reduce turbidity in Nile water (Muyibi and Evison, 1994). The seed has been used as natural coagulant in the Sudan and other part of Africa (Eilert *et al.*, 1981; Olayemi and Alabi, 1994). *Moringa oleifera* has proven to be one of the most effective primary coagulants for waste water treatment (Madsen *et al.*, 1987). The seeds of *Moringa oleifera* have been used effectively to clarify highly turbid water with 90-99 percent of the bacteria removed (Sutherland *et al.*, 1990). The coagulation properties of *Moringa oleifera* have been found effective in clarifying turbidity of raw water (Oluwalana *et al.*, 1997). The active agent, 4-(4-O-acetyl- α -L-rhamnopyranosyloxy) benzyl isothiocyanate in *Moringa oleifera* was isolated by Eilert *et al.* (1981) and identified as an active antimicrobial agent which is readily soluble in water and is non-volatile.

The aim of this study was to determine the bacterial quality of drinking water available in some rural areas in Ondo, Southwestern Nigeria and to determine the effect of *Moringa oleifera* seeds treatment on drinking water before recommendation for use in these rural communities.

MATERIALS AND METHODS

Study Area

Ondo State has eighteen local government areas out of which three were used for this study. The local government areas considered for this study are: Ile Oluji/Oke Igbo, Odigbo and Ondo East. The state lies between latitude 5°45' and 7°52'N and longitude 4°20' and 6°05'E. The land area is about 15,500km³ with estimated population of 3,440,024.

Collection of Water Samples

Water samples were collected from various streams at different locations in rural communities within the three local government areas (Ile Oluji/Oke Igbo, Odigbo and Ondo East) in the State. These streams are the main source of drinking water in these rural communities. The water samples were collected at the users' fetching point into 1.5L sterile bottles and were transported to the laboratory in ice-bag for analysis.

Physicochemical Analysis

The physicochemical analyses that were carried out include the determination of temperature, pH, turbidity, odour, presence of particles, nitrite and chloride using the standard methods for water analysis (Ademoroti, 1996).

Bacteriological Analysis

Bacteriological analyses were determined as described by Shittu *et al.* (2004). Pour plate technique was employed in determining the colony-forming units (cfu/ml) on Plate Count Agar (Oxoid) and bacterial colony was done in triplicate. The presence of coliform was determined by Most Probable Number techniques. The result obtained was compared with FAO standard for the estimation of coliform per 100ml of water sample (FAO, 1990). Confirmatory tests were then carried out on positive MPN tubes to confirm the presence of *E. coli*. Pure colonies obtained by streaking on nutrient agar plates were subjected to some biochemical tests and further characterized by using Bergey's Manual of Determinative Bacteriology (Sneath, 1986).

Treatment of Water Samples

Mature seeds of *Moringa oleifera* plant were removed from the pods and the seed coats were removed to obtain clean seeds. Equivalent of one seed weight (0.3g) was used to treat a litre of water sample. The seeds were crushed into fine powder using mortar and pestle. The fine powder was mixed with a small amount of sterile water to form a paste. The paste was then mixed with 250ml of sterile water and was shaken for one minute to activate the coagulant property of the seed. The solution was filtered through a fine muslin cloth into the water sample to be treated. The treated water sample was stirred rapidly for one minute, then left to rest for two hours. The particles and contaminants settled at the bottom and the purified water was carefully poured into sterile container. 20ml of the treated water samples were taken for analysis to determine the efficiency of the treatment (Folkard *et al.*, 1999).

RESULTS AND DISCUSSION

The physical properties of the water samples examined are presented in Table 1. The unpleasant odour in Sample A and E could be as a result of

fecal disposal along the channel of the stream and poor hygienic condition of the stream. All the samples were characterized by the presence of particles and colour except sample D which was in good hygienic condition.

The chloride content of the water sample ranged from 7.19- 17.72mg/l while the nitrate content ranged from 2.37- 13.37mg/l. The high level of nitrate in Aba-Titun stream might be due to agricultural run-off.

Fig. 1 shows the pH of the water samples which were within the World Health Organisation recommended level for potable water, ranging from 6.5-8.5(EPA, 2002; WHO, 2004). The turbidity of the water shows the presence of disease causing microorganisms, organic matter and dissolved salt (Shittu *et al.*, 2004). *Moringa oleifera* seeds reduced the turbidity of the water sample from between 50 and 66.6% (Fig. 2). Sample D shows no turbidity, which conforms to the standard of drinking water (EPA, 2002; World Health Organization, 2004).

Table 2 shows the result of the bacteriological analysis of the water samples. The total viable count for all water samples were quite high ranging from 0.06×10^4 cfu/ml to 1.95×10^4 cfu/ml. Stream A has the highest microbial load of 1.95×10^4 cfu/ml, while that of stream D has the least value. The high microbial count in stream A is due to high discharge of human waste along the channel. The seeds of *Moringa oleifera* were very effective in reducing the microbial load in all the water samples with the percentage reduction ranging from 56.6-100%. In a related study, Madsen *et al.* (1987) reported that the seed caused turbidity reduction of 80-99.5% and bacterial reduction of 90-99.9% within the 1-2 hours of treatment. The reduction of the microbial population in the water samples may be due to the presence of the active agent, 4-(4-O-acetyl- α -L-rhamnopyranosyloxy) benzyl isothiocyanate in *Moringa oleifera* seeds, which binds to charged particulates in the water and settles at the bottom to form flocs (Folkard *et al.*, 1999). The treated

water can be decanted and the sediments poured-off.

The Most Probable Number (MPN) for presumptive total coliform count was high except the water sample from Aba-Titun. The total coliform counts for all the water samples were high when compared to EPA Maximum Contamination Level (MCL) for coliform bacteria in drinking water of zero total coliform per 100ml of water (EPA, 2002). The high number of coliforms implies fecal contamination of the water samples (USEPA, 2005) and poor hygienic practices associated with local communities (Shittu *et al.*, 2008). The seeds of *Moringa oleifera* have been effective in reducing the coliform count from between 64.3% and 96.2%.

The bacteria species identified from the water samples include *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis*, *Serratia* sp. and *Salmonella* sp. (Table 4). The primary sources of these bacteria in water are animal and human wastes. Most of these bacteria have been isolated from community drinking water supplies in Nigeria (Edema *et al.*, 2001; Inyang and Aderemi, 2001).

The bacteria species have significant health implications (WHO, 2004). These bacteria have also been implicated in outbreak of waterborne diseases in some parts of the country (Onuh and Gonchi, 1998). The presence of *E. coli* in all the water samples signifies fecal contamination (EPA, 2002; Shittu *et al.*, 2008).

The results of this preliminary study have shown that the quality of drinking water in some rural communities in Ondo is poor and that the seeds of *Moringa oleifera* are effective for water purification in the study area, hence it can serve as an alternative natural source of water purification in the rural communities of Ondo, where there is poor access to potable water. There is need for further studies to determine the interaction of the seed with other substances in the water sample.

Table 1: Physicochemical Analysis of the Water Samples

Samples	Parameters							
	Odour	Colour	Particle	Temp. (°C)	pH	Turbidity	*Chloride	*Nitrate
A	unpleasant	Slightly turbid	present	26 ⁰ C	6.7	0.04	11.97	2.37
B	odourless	cloudy	present	27 ⁰ C	6.5	0.04	17.71	7.68
C	odourless	Slightly turbid	present	26 ⁰ C	7.3	0.06	10.06	11.48
D	odourless	colourless	none	27 ⁰ C	6.7	0.00	11.98	13.37
E	unpleasant	Slightly turbid	present	27 ⁰ C	6.6	0.06	7.19	9.59
WHO	odourless	colourless	none		6.5-8.5	0.00	250	10

Keys: A-Bagbe;B-Igburowo;C-Otasan;D-Aba-titun;E-Uleon
*-mg/l

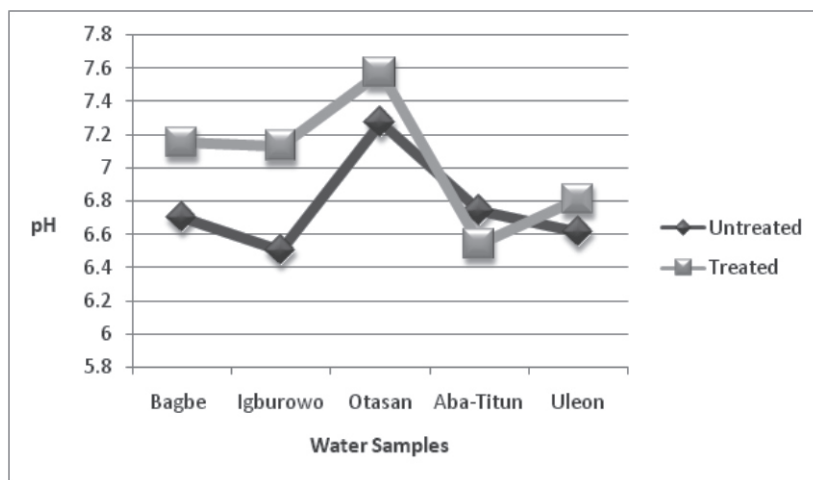


Fig.1: Effect of Treatment on pH of Water Sample

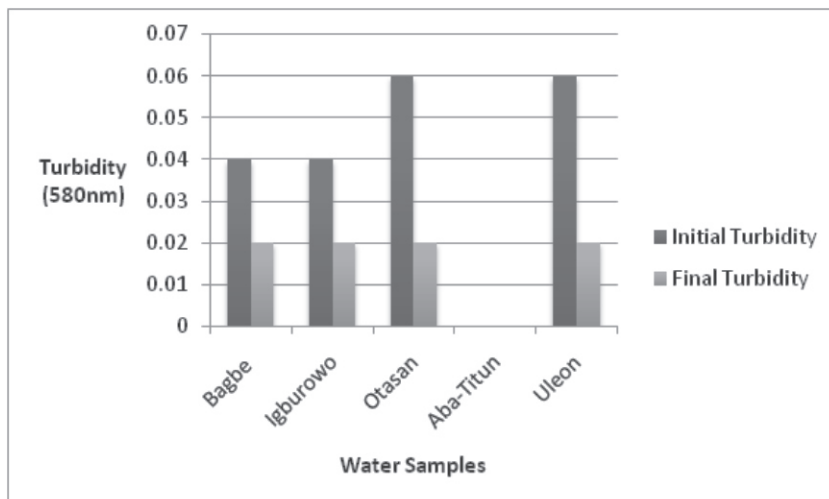


Fig. 2: Effect of Treatment on Turbidity of Water Samples

Table 2: Bacteriological Analysis of Water Samples

Sample code	Total Coliform Count			Total Viable Count		
	Untreated	Treated	% Reduction	Untreated	Treated	% Reduction
A	1.95×10 ⁴	0.1×10 ⁴	94.9	9.9×10 ³	4.3×10 ³	56.6
B	0.44×10 ⁴	0.12×10 ⁴	72.7	1.7×10 ³	0.6×10 ³	64.7
C	0.14×10 ⁴	0.05×10 ⁴	64.3	0.4×10 ³	0.00×10 ³	100.0
D	0.06×10 ⁴	0.01×10 ⁴	83.3	0.1×10 ³	0.00×10 ³	100.0
E	0.53×10 ⁴	0.02×10 ⁴	96.2	4.5×10 ³	0.00×10 ³	100.0

Keys: A-Bagbe;B-Igburowo;C-Otasan;D-Aba-titun;E-Uleon

Table 3: Some Presumed Bacteria Isolated from Water Samples

	A	B	C	D	E
<i>Escherichia coli</i>	+	+	+	+	+
<i>Staphylococcus aureus</i>	-	-	+	+	+
<i>Bacillus subtilis</i>	+	-	+	-	+
<i>Serratia</i> sp.	-	-	-	+	-
<i>Salmonella</i> sp.	+	+	+	+	+

Keys: A-Bagbe;B-Igburowo;C-Otasan;D-Aba-titun;E-Uleon (Present +; Absent -)

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