



International Journal of **Biological Chemistry**

ISSN 1819-155X



Academic
Journals Inc.

www.academicjournals.com

Impact of *Moringa* Seed Extract on the Physicochemical Properties of Surface and Underground Water

A.O. Oluduro and B.I. Aderiye

Department of Microbiology, University of Ado-Ekiti, Ado-Ekiti, Nigeria

Abstract: An investigation on the impacts of *Moringa* seed extract on the physicochemical properties of surface and underground water in Ado-Ekiti, Nigeria was carried out. *Moringa oleifera* seed contains 37.8% protein, 36.2% fat, 3.67% crude fibre and 9.48% ash. It is also rich in magnesium (129.6 mg L^{-1}), potassium (103.5 mg L^{-1}), sodium (70.1 mg L^{-1}), calcium (34.6 mg L^{-1}) and iron (5.4 mg L^{-1}). The seed extract lowered the pH of the water samples while the concentration of some essential minerals such as potassium, sodium, iron and magnesium increased appreciably after the seed treatment. The Biological Oxygen Demand (BOD_5) value observed in *Moringa* treated surface water sample was greater (4.0 mg mL^{-1}) than that obtained in underground water sample (1.2 mg mL^{-1}). The seed extract achieved 90 and 95% sedimentation of the suspended particles in underground and surface water samples, respectively. Sedimentation was best achieved with 0.03 mg mL^{-1} of the seed extract.

Key words: Mineral nutrients, *Moringa oleifera*, surface water, underground water, suspended particles, chemical components

INTRODUCTION

Moringa oleifera LAM commonly referred to as drumstick or horse radish tree belongs to the family Moringaceae with 14 known species of which *M. oleifera* is the most widely known and utilized species (Vedcourt, 1985). It is native to sub-east Asia, the Pacific Caribbean Island and South America (Jayaraj *et al.*, 2004), with 9 of the known species indigenous to Africa, 2 to Madagascar, 1 to Arabia and the last 2 to India. The tree is known for its multi purpose attributes, wide adaptability and ease of establishment. The leaves, fruits and immature pods of *M. oleifera* are edible and form part of the traditional diets in many countries of the tropics and sub tropics (Mougli *et al.*, 2005).

In the tropics, most rural and sub-urban populace has poor or no access to potable water supply, thus resulting to the use of water from seasonal rains, ponds, rivers and streams for drinking and domestic purposes (Aderiye *et al.*, 1992, 2005). Despite the billions of Naira being expended yearly by the Federal Government of Nigeria and some international agencies on potable water supply still the problem remained unabated (Odeyemi, 1988).

A Center for Disease Control Report (2001) indicated that 21% of associated waterborne outbreaks were attributed to parasitic agents such as *Entamoeba giardia*, *Cryptosporidium* sp. and *Cyclospora* sp. Surface water usually contains impurities of decaying organic matter (vegetables and animals), sand and finely divided clay, some dissolved mineral salts and microorganisms. These water types are usually prone to pollution by domestic and industrial wastes (Vermali and Narunla, 1981).

Underground water contain negligible amount of suspended organic impurities removed while passing through sand layers on the earth, but may contain appreciable amount of mineral impurities such as Mg^{2+} , Fe^{2+} , HCO_3^- , CO_3^{2-} and SO_4^{2-} and finely divided clay (Vashoev and Narain, 1985). The principal physical manifestation of contamination of water is turbidity caused by the presence of silt

clay asbestos and organic matter that scatter light. These particles also interfere with disinfection processes used to render water free of pathogens (Madigan *et al.*, 2000). This can be eradicated through the process of flocculation, sedimentation or filtration.

Numerous metals have received attention on both environmental contaminants and toxicological hazards. For instance, arsenic, cadmium and lead are widely distributed in the environment and their occurrence in drinking water is considered an important pathway of potential exposure of man to various diseases such as cancer, kidney diseases and impaired cognitive function (Millstone, 1999).

A number of flocculating agents of plant and soil origin for water and wastewater treatment existed before the advent of synthetic chemicals (Ndabigengesere *et al.*, 1995). *M. oleifera* seeds have been used traditionally as natural flocculants to clarify drinking water (Mougli *et al.*, 2005). These seeds possess strong coagulative and antimicrobial properties (Jayaraj *et al.*, 2004). The present study therefore examines the impact of *M. oleifera* seed extract on the physicochemical properties of water for consumption.

MATERIALS AND METHODS

Processing of Seeds

M. oleifera seeds were collected from Ibodi, a village close to Akure in Ondo State, Nigeria. The study was carried out at the laboratory of the Department of Microbiology, University of Ado-Ekiti, Nigeria. The seeds were dried and dehusked mechanically by removing the seed wings and coat. The white kernels were ground to a fine powder using the laboratory blender (Sanyo, Japan). The *Moringa* powder was dried and kept for use. Whenever required, the *M. oleifera* seed extract was prepared by dissolving two grams of the seed powder in 200 mL distilled water and stirred for 5 min. The suspension was filtered using a muslin cloth and referred to as the extract (Madsen *et al.*, 1987). Varied concentrations (i.e., 0.01, 0.02 and 0.03 mg mL⁻¹) of the seed extract were used for water treatment.

Source of Water

Water samples were collected from two sources; underground (well) and surface waters (Odo Ayo stream). The well was located at No. 8, Dalimore Street, Ado-Ekiti. It is 10 m deep and about 1.5 m in diameter without any concrete rings as the wall. The water sample from the surface water was collected from Odo Ayo stream located north-west of the University of Ado-Ekiti campus, off Iworoko Road, Ado-Ekiti. The stream was the major source of surface water used by the immediate community around the University of Ado-Ekiti. The stream flows mainly during the rainy season. Water samples were collected between June and August for 3 consecutive (2004-2006) years when rainfall was above 425 mm.

Analytical Methods

The seeds were analysed for ash, crude fat, crude protein, soluble carbohydrate, crude fibre and total iodine content. Similarly, the chemical component of fresh and post-treated water samples were determined according to the method of AOAC (1990). The oil was extracted with petroleum ether (40-60°C) using a soxhlet extractor for 6 h. The Micro Kjeldhal procedure was adopted for the determination of protein.

The mineral analysis was carried out on dried *M. oleifera* seed and *Moringa* treated water samples using an Atomic Absorption Spectrophotometer (AOAC, 1990). Determination of anions such as sulphate, nitrate and phosphate ions and total suspended solid, total dissolved solid, Biological Oxygen Demand (BOD₅) and Dissolved Oxygen (DO) concentrations were carried out as described by the procedures of Anonymous (1997).

RESULTS AND DISCUSSION

M. oleifera seed powder contains 37.8% protein, 36.2% fat, 3.67% crude fibre and 9.48% ash (Table 1). It is also rich in magnesium (129.6 mg L⁻¹), potassium (103.5 mg L⁻¹) sodium (70.1 mg L⁻¹), calcium (34.6 mg L⁻¹), iron (5.4 mg L⁻¹), zinc (5.4 mg L⁻¹) and copper (0.4 mg L⁻¹). The temperature of the untreated underground and surface water samples remained unchanged (30 and 31°C, respectively) even after 96 h of treatment with *Moringa* seed. Similarly, the pH of the untreated surface water did not change. However, there was a significant change in the pH value of untreated underground water sample when compared to those samples obtained from the surface water (Table 2). These results agree with those of Muyibi and Elvison (1995) who reported a slight decrease in the acidity of treated water especially during storage, even though the changes were not significant.

The pH range observed in the study fell within the range of the least desirable level (6.8) and permissible level, (6.5-8.5) recommended by the World Health Organization (1996) for drinking water. The change in pH may be due to precipitation of insoluble products of the reaction between *M. oleifera* seed and the hardness-causing ions in the surface and underground water. The use of *M. oleifera* therefore appears to have several technical and economic benefits.

Table 1: Some chemical components of *Moringa oleifera* seed

Components of <i>Moringa</i> seed powder	Concentration
Proximate component (%)*	
Moisture	3.67
Ash	9.48
Fats	36.20
Carbohydrate	2.57
Crude fibre	3.67
Crude protein	37.80
Mineral nutrient (mg L⁻¹)	
Potassium	103.00
Calcium	34.60
Magnesium	129.60
Copper	0.10
Zinc	5.40
Iron	5.40
Sodium	70.10

*On dry matter basis

Table 2: Effect of *Moringa oleifera* seed extract on the temperature and pH of surface and underground water

Water samples	pH				
	Sampling period (h)				
	Fresh	24	48	72	96
Surface water					
Temperature (°C)	31.00	31.00	31.00	31.00	31.00
Untreated water	8.60	8.60	8.50	8.50	8.50
Treated water					
Concentration (mg mL⁻¹)					
0.01	8.60	6.60	6.50	6.40	6.10
0.02	8.60	6.60	6.30	6.20	6.00
0.03	8.60	6.60	6.40	6.30	6.00
Underground water					
Temperature (°C)	30.00	30.00	30.00	30.00	30.00
Untreated water	7.60	7.50	7.50	7.40	7.40
Treated water					
Concentration (mg mL⁻¹)					
0.01	7.60	6.42	6.40	6.21	6.02
0.02	7.60	6.30	6.21	6.10	6.00
0.03	7.60	6.30	6.20	6.80	6.00

M. oleifera treated water samples contained 4.8 mg L^{-1} sulphate ion and 0.8 mg L^{-1} phosphate (Table 3). The Total Suspended Solids (TSS) and Total Dissolved Solid (TDS) concentrations were 0.52 and 0.49 mg L^{-1} , respectively. The BOD_5 values recorded in *Moringa* treatment were 4.00 mg L^{-1} in surface water sample and 1.20 mg L^{-1} in underground water sample as against 37.0 and 12.0 mg L^{-1} in the untreated surface and underground water samples, respectively. This suggests that the untreated surface water was more polluted than the underground water used.

The concentration of some essential minerals such as potassium (99.23%), sodium (31.8%), iron (209%) and magnesium (192%) increased while there was a decrease in zinc (Table 4). The increase in concentration of some minerals may be attributed to the richness of the seed itself and the probable high solubility rate of each nutrient. The concentration of calcium increased by 35.88% in surface water within the first week of storage and later reduced by 22.89% at the end of the 4th week. The reduction in calcium ion concentration may be due to binding with insoluble chemical components of *Moringa* seed during flocculation thus forming calcium complex. According to Von Maydell (1986), the portability of water can be affected most especially when some minerals are found in concentrations higher than desirable. Similarly, Eliert *et al.* (1981) reported that the portability of water was affected if zinc existed in a concentration above the desirable level of 5.0 mg L^{-1} .

Table 5 shows the effect of *Moringa seed* on suspended particles in the water samples. Sedimentation of the suspended particles was 95% in surface water and 90% in underground water after 96 h of storage, as against 30 and 40% sedimentation recorded in untreated surface and underground water samples, respectively. This revealed that the seed has the potential to sediment and

Table 3: Some physicochemical properties of untreated and treated water samples

Source of water	SO ₄ (ppm)	PO ₄ (ppm)	NO ₃ (ppm)	pH	Temp (°C)	Turbidity	TSS (ppm)	TDS (ppm)	Iodine (ppm)	BOD ₅ (mg L ⁻¹)	DO (mg L ⁻¹)
Surface water*											
Untreated	0.8	ND	25	7.0	31	0.100	1.30	0.80	0.0002	37.00	3.66
<i>Moringa</i> seed treated water	4.8	0.12	ND	6.7	31	0.001	0.52	0.49	0.0002	4.00	4.06
Underground water**											
Untreated	28.4	8.0	1.2	7.6	28	0.010	2.00	0.021	0.1100	12.00	3.46
<i>Moringa</i> seed treated water	15.0	0.8	8.0	6.8	28	0.012	0.04	0.021	ND	1.20	1.78

*: Surface water-Odo Ayo stream; **: Underground water-well water; ND: Not Detected; TSS: Total Suspended Solid; TDS: Total Dissolved Solid; BOD₅: Biological Oxygen Demand; DO: Dissolved Oxygen

Table 4: Effect of *Moringa oleifera* seed extract* on the mineral components of surface and underground water

Source of sample	Mineral composition (mg mL ⁻¹)						
	Potassium	Calcium	Sodium	Iron	Zinc	Copper	Magnesium
Surface water							
<i>M. oleifera</i> seed	103.50	34.60	70.10	5.40	5.40	0.1	129.6
Untreated water	3.00	27.00	15.00	4.00	5.00	ND	34.5
Storage period (weeks)							
1st	13.10	37.31	34.01	5.55	8.01	ND	37.7
2nd	14.40	36.60	35.50	5.70	7.80	ND	38.8
3rd	20.10	30.10	35.50	5.70	6.70	ND	39.0
4th	26.10	28.80	35.20	5.70	5.40	ND	41.4
Underground water							
Untreated water	5.20	18.00	24.00	1.14	5.00	ND	31.1
Storage period (weeks)							
1st	14.10	13.50	22.00	1.10	61.00	ND	33.8
2nd	15.00	12.00	24.00	2.00	2.20	ND	35.0
3rd	20.10	11.80	28.10	2.80	2.00	ND	38.3
4th	24.10	10.10	29.10	3.40	2.00	ND	40.3

*: Concentration of the seed extract used (0.02 mg mL^{-1})

Table 5: Effect of *M. oleifera* seed extraction suspended particles in surface and underground water

Water sample	Interaction period (h)									
	Surface water					Underground water				
	Frh*	24	48	72	96	Frh*	24	48	72	96
Untreated water (OD at 540 nm)	0.10	0.08	0.07	0.07	0.070	0.10	0.09	0.08	0.07	0.060
Treated water (mg mL ⁻¹)										
0.01	0.10	0.08	0.08	0.07	0.050	0.10	0.09	0.04	0.02	0.050
0.02	0.10	0.08	0.07	0.06	0.040	0.10	0.08	0.03	0.01	0.020
0.03	0.10	0.03	0.02	0.01	0.001	0.10	0.04	0.02	0.01	0.005

Frh* : Fresh water sample, OD: Spectrophotometric reading at 540 nm

clarify the body of water. Jahn (1988) and Madsen *et al.* (1987) reported about 80-90% reduction in turbidity in water treated with *M. oleifera* seed. According to Finch and Smith (1986) reduction in turbidity was associated with improvement in bacteriological quality: A feature well known from flocculation and sedimentation procedures as applicable to treatment of sewage for human consumption. This study revealed the potentials of *M. oleifera* seed to influence the chemical composition of water treated for consumption.

REFERENCES

- Aderiye, B.I., S.O. Igbedioh and A.A. Adebobuyi, 1992. Incidence of coliforms in well waterborne diseases: Environmental considerations and empirical evidence from Owo, Nigeria. *Acta Mediterr. di Patalog. Infect. Tropic.*, 11: 1-6.
- Aderiye, B.I., S.A. Laleye and A.T. Oke, 2005. Evaluation of sanitary standards of bukaterias at the Federal Polytechnic, Ado-Ekiti, Nigeria. *Sci. Focus*, 10: 110-115.
- Anonymous, 1997. Water quality testing and control course. Outreach Department, pp: 8-57.
- AOAC, 1990. Official Method of Analysis. 15th Edn., Association of Official Analytical Chemists, Washington DC.
- CDC (Center for Disease Control), 2001. Safe Water System Handbook for the Developing World. A Handbook for Implementing House Basic Water Treatment and Safe Storage Projects. Human Service and US Department of Health. Center for Disease Control and Prevention, Atlanta GA., 1: 10-13.
- Eliert, U., B. Wolters and W. Nahrstedt, 1981. The antibiotic principle of *Moringa oleifera* and *Moringa stenopetalla*. *Plant Medica*, 42: 55-61.
- Finch, G.R. and D.W. Smith, 1986. Batch coagulation of a lagoon for faecal coliform bacteria as an indicator of enteric pathogens. *Water Res.*, 2: 169-175.
- Jahn, S.A.A., 1988. Using *Moringa* seeds as coagulants in developing countries. *J. Am. Water Works Assoc.*, 80: 48-50.
- Jayaraj, A.F., J. Bolleddula, K.L. Olson and G.N. Muraleedharan, 2004. Insulin secretagogues from *Moringa oleifera* with cyclooxygenase enzymes and lipid peroxidation inhibitory activities. *Helvetica Chimica Acta*, 87: 317-326.
- Madigan, M.T., J.M. McArtinko and J. Parker, 2000. Brock Biology of Microorganisms. 9th Edn., Prentice-Hill, Inc., New Jersey, pp: 419-429, 908.
- Madsen, M., J. Schlundt and E.F.E. Omer, 1987. Effect of water coagulation by seeds of *Moringa oleifera* on bacterial contaminations. *J. Trop. Med. Hyg.*, 90: 101-109.
- Millstone, E., 1999. Lead and Public Health: The Dangers for Children. Taylor and Francis, Washington DC., pp: 97-100.

- Mougli, S., H. Marisa, C. Stephane, F. Flourian, C. Pierre, S. Catherine, M. Oliver, F. Ryth, M. Phillipe and M. Nicolas, 2005. Structure, function, characterization and optimization of a plant derived antibacterial peptide. *Antimicrob. Agents Chemother.*, 49: 3847-3857.
- Muyibi, S.A. and L.M. Elvison, 1995. *Moringa oleifera* seeds for softening hard water. *Water Res.*, 29: 1099-1105.
- Ndabigengesere, A., K.S. Narasiah and B.E. Talbot, 1995. Active agents and mechanism of coagulation of turbid waters using *Moringa oleifera*. *Water Res.*, 29: 703-710.
- Odeyemi, O., 1988. Prospects and limitations of using solar energy for water disinfections. In: *Solar Water Disinfection. Proceedings of a Workshop*. Brace Research Institute, Montreal, Quebec, Canada, pp: 34-43.
- Vashoev, D. and L. Narain, 1985. *Water Resources Engineering*. 3rd Edn., Edward Arnold Publishers, USA., pp: 898-948.
- Vedcourt, B., 1985. A synopsis of the *Moringaceae*. *Kew Bull.*, 40: 1-24.
- Vermali, O.P. and A.K. Narunla, 1981. *Applied Chemistry. Theory and Practice*. 4th Edn., Longman, pp: 139-145.
- Von Maydell, H.J., 1986. Trees and Shrubs of the Saheli. Their characteristics and uses. *Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) Germany*, pp: 334-337.
- WHO, 1996. *Guidelines for Drinking Water Quality*. Vol. 1, Recommendations. World Health Organization, Geneva.