Bioscience Research Communications
Vol. 13, No. 4, August 31, 2001
Printed in Nigeria

0795-8072/2001 $3.00 + 0.00


BRC 200029/13403

# Removal of Heavy Metals from Raw Water Using *Moringa oleifera* Lam

G. A. Bolaji and O. Martins

Department of Agromet and Water Management, University of Agriculture, Abeokuta, Nigeria

(Received March 30, 2000)

ABSTRACT: Problem of heavy metal pollution to domestic water sources is becoming acute in both urban and rural areas. The methods of managing water resources to avoid contamination is not yet available to the grassroots populace who are directly affected by this incidents. Industrial and vehicular emissions release several forms of heavy metals into the environment and, since there is no proper regulation, water sources are seriously exposed to pollution. The research was targeted at finding a solution to this problem by investigating an available forest plant that can be suitably used for removing heavy metals from domestic water supply. This paper give account of how *Moringa oleifera* Lam, a common forest plant was used for removing heavy metal contaminating from polluted water samples.

Key Words: Environmental pollution; Heavy metals; *Moringa oleifera* Lam.

## Introduction

The population explosion being experienced around the world especially in developing countries and the coherent rapid industrialization have put increasing demands and ecological pressure on water supply. It is becoming increasingly difficult to protect water from the hustle and bustle of the daily human activities, especially, in the large cities of developing world. Unfortunately, water is not equally distributed on earth and even, where supplies appear abundant, problems arise because of pollution. This is particularly true in highly populated industrial areas where large volumes of wastewater are discharged continuously into streams and rivers.

*To whom correspondence should be addressed.
E-mail: bolaji@unaab.edu.ng

A metal is loosely defined as an element that forms a salt compound by the addition of acid. The toxicity of metals depends on the degree of oxidation of a given metal ion together with the form in which it occurs.

The ionic form of a metal is the most toxic form in which it occurs. The ionic form of a metal is the most toxic form. Toxicity tends to be reduced in the environment by the formation of complexes with organic matter such as fulvic and humic acid. Under certain conditions metallo-organic compounds may be formed which exhibit greater toxicity than the ionic form. Metals in waters therefore exist in truly dissolved, colloidal and suspended forms. The proportion of these forms varies for different metals and for different water conditions (Brown *et al*, 1996).

Water pollution by letals resulting from anthropogenic impact is causing serious ecological problems in many parts of the world (Butler *et al*., 1996). This situation is worsened by lack of natural elimination processes for metals. As a result, metals shift from one compartment within the ecosystem to another. Where sufficient accumulation of metals occur within the biota, the metals are further accumulated through the food chain transfer and reach concentrations that become a threat to biological survival.

Incidence of heavy metal pollution of rivers an streams by anthropogenic inputs are nowadays not uncommon in almost all developing countries (Machuwa, 1992). Among the greatest threats to health is the presence of toxic metals in drinking water. This residue that usually comes from industrial waste and particulate matter from automobile exhaust include lead, mercury, zinc, cadmium and copper. High concentrations or prolonged exposure have been proven to cause a number of irreversible physiological damages to the central nervous system. Unlike the industrialized countries where the analytical instruments are readily available, most developing countries face acute shortages of both equipment and qualified personnel. Even several techniques being used for the removal of metals from contaminated water are not applicable in developing countries.

Abeokuta, a fairly industrialized town is recently experiencing some level of industrial metal processing and cloth dyeing. Uncontrolled disposal of domestic and industrial wastes is not uncommon in the city. This study is very important because, the disposed effluents usually flow into city drainage system, then into streams that traverse the terrain and serve some communities downstream. Therefore, it is very necessary to research in easily available forest plants that can be used in domestic water purification.

*Study Area*

The research was carried out at three villages located around Abeokuta, the capital of Ogun State. Ogun State is situated in the southwestern Nigeria, lying between longitude 2°31'E and 5°37'E and between latitude 6° 20'N and 8° N. The three villages selected for the study are located around Abeokuta, on road axis linking the main city. They are Kobape along Abeokuta-Sagamu road, Olufowora along Abeokuta-Ibadan road and Itori along Abeokuta-Lagos road (Figure 1). Domestic water supply in these villages is worse as the people rely on rivers, streams, ponds and wells for water supply.

## Materials and Methods

*Moringa oleifera* Lam

The tree, *Moringa oleifera* Lam is a native of the Sub-Himalayan region of India. It is a medium-sized tree that belongs to *Moringaceae* family. The family conmsists of the single genus *Moringa*. There are two common species; *M. oleifera* and *M. concanensis*, the former being vegetative species. *M. oleifera* is distinguished by leaves usually tripinnate leaflets 12-18mm long, petides yellow or white without red streaks, and the tree is medium sized. *Bi-pinnate leaves, leaflet 15-30mm long, petals with red streaks or reddish at the base, characterize M. concanensis* and the tree is large.

*Moringa oleifera* Lam grows well in almost all types of soil except stiff clays, but sandy loam are the best. It is strictly a tropical plant and grows well in the plains. It is predominantly a crop of dry land and arid tracts where it has been found to perform satisfactorily (Sundarara *et al*., 1970, Gopalakishnan, 1978).

The tree can be propagated from seed or cuttings, but cuttings are usually preferred because they grow roots easily. It is noted that plants raised from seeds produced fruits of inferior quality. Further, cuttings of fairly large size, planted in moist soil strike roots easily and grow to sizeable trees within six to eight months.

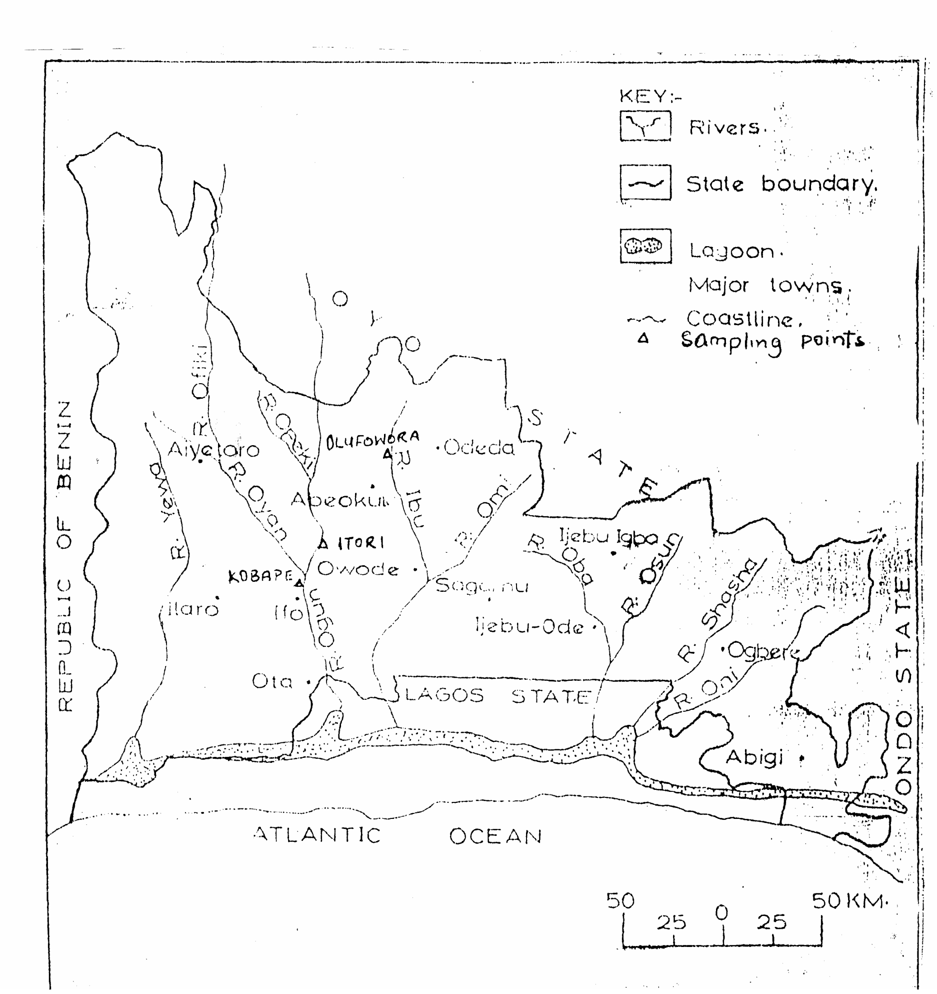


Fig. 1: Drainage Patterns in Ogun State of Nigeria.

*Sampling*

Three locations were selected within the vicinity of Abeokuta city for the purpose of the study. The villages are; Kobape along Abeokuta-Sagamu road, Olufowora village along Abeokuta-Ibadan road and Itori village along Abeokuta-Lagos road. It was presumed that rivers and streams that traverse these villages must have received some level of heavy metal contamination which have emanated from industrial activities within and outside Abeokuta city.

Sampling points were located in places chosen for the study. Water samples were collected below the water surface using four-liter plastic containers. Before sampling, the containers were properly washed with 10% hydrochloric acid (HCl)and thoroughly rinsed with de-ionized distilled water. All samples were tightly sealed and immediately transported to the laboratory inside ice packed insulated boxes, for analysis. In the laboratory, the samples were filtered using 0.45 micron-meter filter paper with the filtrates acidified to pH 2 in order to keep the metals in solution. The samples were stored in the dark cold boxes. Sampling was carried out twice a week in the early hours (6.00 a.m.) in the morning for two months.

*Moringa* seeds selected were dried, weighed and pounded in a mortar. A suspension of 0.6g/litre was obtained solution that was prepared by mixing 0.6g of grounded seeds with 1 liter of water and filtered after agitating it for 5 minutes. The solution was allowed to stand undisturbed for 120 minutes. From this solution, 30ml was taken for analysis.

Metallic concentration of both the raw and the clarified water samples were determined by subjecting it to the Atomic Absorption Spectrophotometric machine (called AAS machine). The concentration of some major heavy metals present in the water sample was obtained as readings in milligram per liter (mg/l).

## Results and Discussions

Tables 1 - 3 shows the concentration of heavy metals in the raw water of the three villages sampled before and after treatment. The rate of absorption of the heavy metals present by the seed treatment is also reflected in the Tables.

Table 1: Heavy metals concentration of water samples obtained from Kobape village before and after treatment with *Moringa oleifera*.

| | Raw Water | | Treated Water | |
|---|---|---|---|---|
| Name of Metal | Absorbance | Conc. (mg/l) | Absorbance | Conc. (mg/l) |
| Copper (Cu) | 0.0063 | 0.262 | 0.008 | 0.007 |
| Zinc (Zn) | 0.0030 | 0.11 | 0.0096 | 0.036 |
| Iron (Fe) | 0.0262 | 0.747 | 0.0001 | -0.002 |
| Lead (Pb) | 0.0010 | 0.200 | 0.0001 | 0.03 |

Table 2: Heavy metals concentration of water samples obtained from Olufowora village before and after treatment with *Moringa oleifera*.

| | Raw Water | | Treated Water | |
|---|---|---|---|---|
| Name of Metal | Absorbance | Conc. (mg/l) | Absorbance | Conc. (mg/l) |
| Copper (Cu) | 0.0011 | 0.012 | 0.0006 | 0.007 |
| Zinc (Zn) | 0.0030 | 0.01 | 0.0241 | 0.098 |
| Iron (Fe) | 0.095 | 0.222 | 0.0037 | 0.078 |
| lead (Pb) | 0.0003 | 0.10 | 0.0001 | 0.02 |

Table 3: Heavy metals concentration of water samples obtained from Itori village before and after treatment with *Moringa oleifera*.

| | Raw Water | | Treated Water | |
|---|---|---|---|---|
| Name of Metal | Absorbance | Conc. (mg/l) | Absorbance | Conc. (mg/l) |
| Copper (Cu) | 0.0030 | 0.033 | 0.0007 | 0.008 |
| Zinc (Zn) | 0.0001 | 0.030 | 0.0153 | 0.059 |
| Iron (Fe) | 0.0847 | 2.830 | 0.0012 | 0.024 |
| Lead (Pb) | 0.0000 | 0.01 | 0.0002 | -0.070 |

In Table 1, the water sample obtained from Kobape village has the concentration of Copper before treatment as 0.262mg/l and reduced to 0.007mg/l after treatment. The concentration of Zinc in the water sample reduced from 0.11mg/l to 0.03mg/l after treatment. Iron concentration in the water sample was 0.747mg/l and reduced to - 0.002mg/l after treatment. Also, Lead concentration of 0.20mg/l in the water sample was reduced to 0.03mg/l. The negative sign is due to interference of other heavy metals.

Table 2 shows the result of treating water samples obtained from Olufowora village with *M. oleifera* seed powder. The concentration of Copper in the raw water was 0.012mg/l and reduced to 0.007mg/l after treatment. The concentration of Zinc was 0.01mg/l and increased to 0.098mg/l after treatment. The concentration of Iron in the water sample was 0.222mg/l and decreased to 0.078mg/l after treatment. The results. The concentration of lead in raw water was 0.10mg/l and decreased to 0.02mg/l after treatment.

The results on Table 3 were obtained in respect of water samples from Itori village. The concentration of Copper in the water sample was 0.033mg/l and reduced to 0.008mg/l after treatment. Zinc concentration increased from 0.03mg/l before treatment to 0.059mg/l after treatment. The concentration of Iron in the water sample was 2.83mg/l in the raw water and reduced to 0.024mg/l after treatment. Lead has a concentration of 0.01mg/l in the raw water sample and a reading of -0.07mg/l was recorded after treatment. The negative sign indicate interference of other heavy metals.

*Conclusion*

The powdered seeds of *Moringa oleifera* mixed with raw water at a concentration of 0.6g/l reduced the concentration of heavy metals contained in the water sample. Though the concentration of Zinc and lead slightly increased in some cases, however, these increases are negligible in terms of the standard requirements for drinking water quality.

## References

Ayoade, J.O. (1975). Water Resources and their Development in Nigeria, pp. 581.

Iloeje, N.P. (1976). A New Geography of Nigeria. Longman, London, pp. 221.

Smethurst, G. (1979). Basic Water Treatment for Application Worldwide.

Borne, P. (1980). Water and Sanitation

Gopalakrishna, P.K. *et al*. (1980). Economic Botany, pp. 276 - 283.

Jahn, S.A.A. (1986). Proper Use of African Natural Coagulants for Rural Water Supplies.

Folkhard, G.K. *et al* (1986). Waterlines, Vol. 5(2), pp. 23.

Keay, R.W.J. (1989). Trees of Nigeria. Clarendon Press, Oxford, 476p

Sangodoyin, A.Y. (1989). Water Quality Influence and Maintenance of Rural Boreholes in Nigeria, pp. 97.

Ray, K. (1996). Water for Thirsty Cities. In: Proceedings of United Nations Conference on Human Settlements. Nairobi, Kenya, pp. 1 - 3.

Brown *et al* (1996). Gravel Bed Hydroponics (GBH) treatment of Metal Contaminated Wastewater (Monograph No. 6).

Hensen, G. and Richards, N. (1999). New World Water (1999 Edition), pp. 37 - 38..