International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 6, Issue 11 [November. 2017] PP: 40-45

Removal of Heavy Metals from Contaminated Water Using *Moringa Olefeira* Seed Coagulant in Yola and Its Environs

Hong, A.H, Burmamu, B. R, Umaru, A. B and Sadiq, U. M.
Department of Agricultural and Environmental Engineering, Modibbo Adama University of Technology, Yola, Nigeria
Corresponding e – mail: haliruali@yahoo.com

Abstract: *The quality and accessibility of drinking water are of paramount and great importance to human health. Contaminated water may contain toxic chemical and disease causing agents that might be risk to public health, therefore water quality monitoring and surveillance are required. Analyses of heavy metals were performed before and after treatment of water with Moringa Oleifera seed coagulant by using Buck Scientific VGP 210 model Atomic Absorption Spectrophotometer (AAS). The results showed that Moringa Oleifera seed coagulant were capable of absorbing and remove heavy metals tested in the collected water samples. The concentration of heavy metals before and after treatment were; Cd (0.02 and 0.00 mg/L), Cu (0.02 and 0.01mg/L), Mn (0.92 and 0.44mg/L), Zn (0.20 and 0.10mg/L), Fe (2.60 and 1.20 mg/L) and Ni (0.10 and 0.03mg/L) respectively. The efficiency of heavy metal removal by Moringa Oleifera seed coagulant were found to be 50% for Cu, 100% for Cd, 50% for Zn, 53.8% for Ni, 70% for Mn and 52.2% for Fe. In this study, Moringa Oleifera seed coagulant has proved to be very effective in the removal of heavy metal levels in our domestic water. The technique is recommended for use in heavy metal removal from contaminated water sources as most of our water treatment systems do not remove heavy metal sufficiently.*

Key words:- *Heavy metal, Moringa Oleifera, Contamination, Treatment, Coagulant, Seed.*

Date of Submission: 10-11-2017 Date of acceptance: 09-12-2017

I. Introduction

Water is used for several purposes by humans but the level of purity of the water consumed is very critical and crucial since it has a direct effect on human health. The quality and accessibility of good drinking water still remain a great challenge to most developing nations like Nigeria. One of the major challenges often faced by surface and ground water sources are the issue of water contamination and pollution from domestic, industrial and agricultural sources. Water pollution occurs when a body of water is adversely affected by the addition of large amount of material to the water body, making it unfit for whatever intended usage. The water pollutants are normally classified into physical, chemical and biological origin depending on the source of the pollutants.

Among the category of water pollutants, chemical pollutant particularly heavy metals are the most harmful pollutant and are of particular concern due their toxicities to human health. They find their way into water bodies as effluent waters from domestic homes, from manufacturing industries and agricultural application of chemical as well as from heaps of solid refuse dump sites. The resultant effect is the pollution and contamination of surface and ground water sources.

Hong *et al,* (2013) reported high concentration level of Pb, Cd, Cr and Ni in ground water samples that are used for domestic and irrigation purposes in Yola and its Environs. Musa *et al,* (2014) in their study of Pb concentration in boreholes and well water in Zaria reported Pb concentration that ranged from 0.000786 to 0.059 mg/L with 91% of the samples above the 0.01mg/L WHO drinking water guideline. Galadima *et al.* (2010) conducted a research study on the concentration levels of heavy metals in waste water from student halls of Usman Danfodiyo University, Sokoto. The results indicated high level of Fe, Pb, and Cr which are 20 times above the recommended limit. Garba *et al,* (2010) reported a mean arsenic concentration level of 0.34mg/L in drinking water from hand dug wells, boreholes and tap waters in Karaye Local Government area, Kano State. The detected level of arsenic are of serious concerns to regulatory agencies because they are by far exceeded the limit of 0.01mg/L recommended by WHO Standard.

Heavy metals are generally not removable even after the treatment at treatment plant and thus, long time exposure can cause human health risk of heavy metal contamination/pollution of water, soil and subsequently the transfer of heavy metal into the food chain to affect body organs like spleen, kidney and lungs (Hong et al, 2014). Therefore there the need to find a simple, reliable and cost effective method of water treatment to reduce the level of heavy metals in water samples using the application of plant material *Moringa*

Oleifera seed coagulant that is sustainable, simple, available locally, eco- friendly and household level point of use water treatment coagulation/technology most suitable for developing countries where major population use water of impaired quality for drinking purposes.

Study Area

Yola in Adamawa State is located in the north- eastern part of Nigeria with a population of 3,737, 223 people and occupying a land mass of 36917km^2. Jimeta the capital State is located between longitudes 12° 26' E and Latitude 9° 16' N along the banks of River Benue (Adebayo, 1999). The Benue River originated from the Cameroun Mountains to the east of Adamawa State (**Fig 1)**. The River lies to the north- west of Yola and varying in elevation from 180 to 300 meters above sea level. It is the main source of water supply for Yola and it flows sufficiently throughout the year to supply the water demand capacity of 8,300 m^3/hour by direct pumping from the river in addition to some wells and boreholes (Saidu, 2011). Yola experiences an annual rainfall above 960mm with the peak period in August to September. The minimum and maximum temperatures in the area are 21.2° and 34.5°C respectively. In the dry season, the water is polluted by sewage from domestic, industrial and agricultural operations.

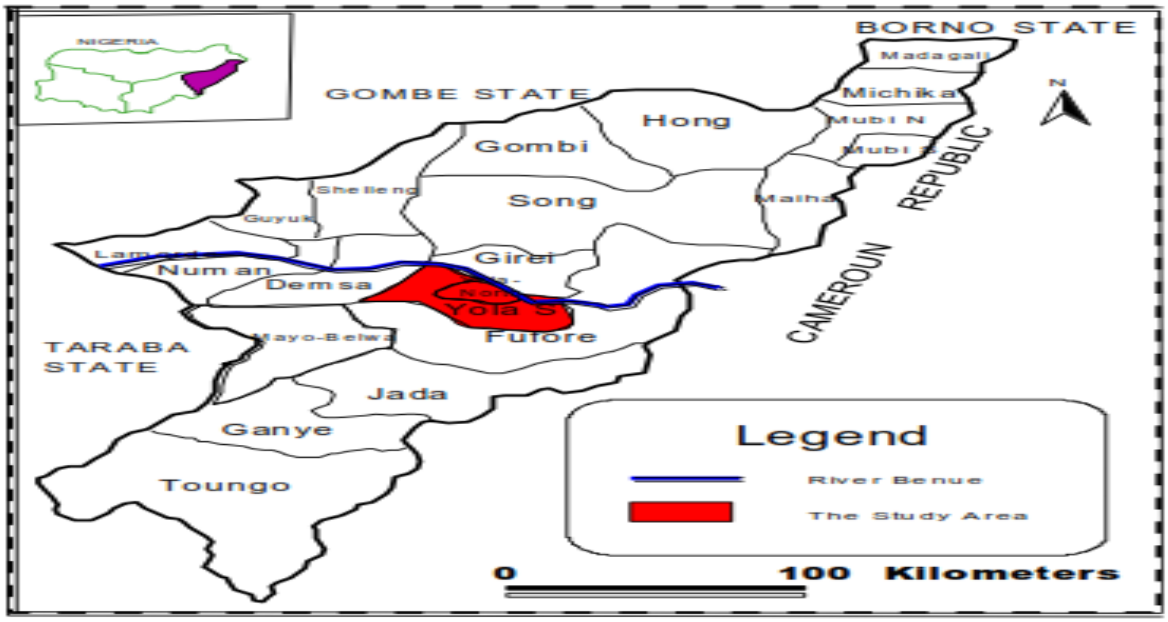

Figure 1: Map of Adamawa State showing Yola the study area

II. Materials And Methods

Water Sample Collection and Preparation

Eight sampling point were chosen at random along the River length to have the best representative of water source. At each point 1 liter bottle pre- cleaned with acid and having a fitted coke was used for water sample collection using grab sampling method. Composite samples were then later made by mixing the samples to have a good representative sample. The samples were digested with concentrated nitric acid (HNO_3) to ensure that they are free of organic impurities. Ten milliliter (10ml) of nitric acid was added 50ml of each sample in a 250ml conical flask. The mixture was evaporated to half of its volume on a hot plat after which it was allowed to cool and filtered using whatman 4 micron pore size filter paper. The filtrate was added up to a volume of 100ml using distilled water.

Preparation of *Moringa Oleifera* Seed Powder

Dry *Moringa Oleifera* pod were bought from Jimeta market in Yola. The pod shells were removed manually, the kernels were the grounded to powder in a domestic blender and sieved through 600 micron meter stainless steel sieve

Figure 2: Showing *Moringa oleifera* pods, seeds and grounded *Moringa* powder

Aqueous Extract Preparation

Aqueous extract were prepared using 200ml of distilled water and 25g of *Moringa Oleifera* seed powder, mixed by a magnetic stirrer for 60 minute and settled for 20 minutes. *Moringa Oleifera* aqueous extract was filtered finally through 20µm filter paper.

Coagulant Activity Test

Jar test was conducted to determine the effective dosage of coagulant to reduce the heavy metal level of the samples. The standard procedure was 1 minute of rapid mixing (120 rpm) followed by 15 minute slow mixing (30 rpm) for flocculation and 60 minute of settlement.

Figure 3: Showing Aqueous Extraction and Coagulant Activity Test

Filtration Test with roughing Filter

Vertical flow roughing filters was used to filter the water treated which flows in sequence through three filter compartments filled with coarse, medium and fine filter material. The size of the filter material fractions ranged between 16 – 25mm, 8 – 16mm and 3 – 8mm. The roughing filtrations were conducted directly after coagulation and flocculation processes with *Moringa Oleifera.* Vertical flow roughing filter were operated at 0.3 to 1.0 m/hour filtration rates. The separated solids which mainly accumulate in the coarse filter fraction next to the filter bottom can be easily flushed out with water stored in the filter.

The coagulation – flocculation was done using shelled blended, aqueous extract of *Moringa Oleifera* seed powder. These coagulants were extracted by using standard method. Optimum doses of 10ml of coagulants were used for different water samples containing heavy metals in 50ml of water samples. The optimum dosage is the minimum dosage of coagulant corresponding to the removal of heavy metals present in the water samples. At optimum dosage of 10ml of coagulant the final heavy metal concentration were tested and analyzed using AAS VGP 210 Model.

Data Analysis

Eight samples each of the digested water extracts before and after treatment of water with *Moringa Oleifera* seed powder and coagulant, the concentration levels of Cu, Cd, Zn, Ni and Fe in the water samples before and after treatment were analyzed with AAS VGP 210 Model after calibrating the machine with satisfied standard materials. The results of the heavy metal analysis are presented in the Table 1 below:

Table 1: Heavy Metal concentration levels in water before and after Treatment with *Moringa Oleifera* seed coagulant

S/N	Cu (mg/l)		Cd (mg/l)		Zn (mg/l)		Ni (mg/l)		Mn (mg/l)		Fe (mg/l)	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
1	0.02	0.02	0.02	0.00	0.14	0.06	0.04	0.00	0.12	0.04	1.90	0.92
2	0.00	0.00	0.02	0.00	0.14	0.10	0.02	0.02	0.82	0.05	2.60	1.70
3	0.00	0.00	0.02	0.00	0.12	0.06	0.04	0.02	1.48	0.68	3.42	1.26
4	0.02	0.02	0.02	0.02	0.12	0.08	0.02	0.00	1.22	0.52	2.88	1.56
5	0.06	0.00	0.00	0.02	0.14	0.08	0.00	0.00	1.02	0.30	3.48	1.68
6	0.02	0.02	0.02	0.00	0.28	0.16	0.14	0.04	0.82	0.38	2.00	0.92
7	0.02	0.00	0.02	0.00	0.14	0.06	0.14	0.06	0.86	0.40	2.56	0.78
8	0.02	0.00	0.00	0.00	0.14	0.08	0.16	0.08	1.00	0.72	1.56	0.70
Mean	0.02	0.01	0.00	0.00	0.02	0.10	0.10	0.03	0.92	0.44	2.60	1.20
WHO/FAO STD 0.20				0.01		2.00		0.02		0.20		5.00
FEPA STD				0.05		5.00		1.00		0.05		0.30
(%) efficiency of Heavy metal removal		50		100		50		53.8		70		52.2
STD Standard,												

III. RESULTS AND DISCUSSION

The results of heavy metal concentration levels of Cu, Cd, Zn, Ni, Mn and Fe in domestic water tested before and after treatment of the water with *Moringa Oleifera* seed coagulant is presented in Table 1 above. The treated final extract of the water sample were compared with WHO/FAO, FEPA Standard limits for the permissible level in domestic water for human consumption and to assess the level of treatment/removal of the heavy metal contamination level in domestic water.

The mean concentration level of Cu before treatment with *Moringa Oleifera* seed coagulant in water samples was 0.02 m/L, after treatment, the mean value dropped from 0.02mg/L to 0.01 mg/L indicating that the concentration level of Cu has drastically reduced and the efficiency of removal was estimated to 50%. Eneji et al, 2011, Ravikumar and Sheeja, 2013, Akaahan, et al, 2014 reported similar value of concentration reduction from 5mg/L to 0.25mg/L and have recorded an efficiency of Cu removal of 95%. The Cu concentration levels were within the permissible limit of FEPA, 1991, WHO, 2004 and FAO, 1992 Standards.

Cadmium concentration level after treatment reduced from 0.02mg/L to 0.00mg/L indicating total removal of Cd from the water source with an estimated efficiency of 100%. From our study, Moringa Oleifera proved to be an effective treatment method for heavy metal polluted water at the optimum dosage of 10ml (Table 1). Studies have shown that exposure to high concentrations levels of Cd in drinking water could become toxic to body organ like kidney (WHO, 2004). However, the result of this study were within the acceptable limit of FEPA, 1991 and concurred with others as reported in Aderinola et al, 2009, Yahaya et al, 2012, Asante et al,

2013 and Hong et al, 2014. The concentration level of Zn in water after treatment with *Moringa Oleifera* seed coagulant was also found to drop from 0.02mg/L to 0.01mg/L with an efficiency of removal of 50%.

Ni concentration level after treatment was found to be lowered from 0.10 mg/L to 0.03mg/L level indicating a Ni concentration removal efficiency of 53.8%. The concentration level of Ni as obtained in this study concurred to those reported in surface water by (Wangboje and Ekundayo, 2013, Tabinda *et al*, 2013 and Enuneku *et al*, 2013. However, the results of Ayas et al, 2007 differed significantly from this study; no Ni was detected in the water of Nallihan Bird Paradise in Turkey.

The mean concentration level of Mn before treatment ranged from (0.12 – 1.48mg/L), after treatment, the concentration level of Mn in the water sample was in the range of (0.04 – 0.72mg/L). The mean concentration value was found to drop form 0.92mg/L to 0.44mg/L, thus reducing the concentration of Mn as low as 0.44mg/L level with a calculated efficiency of Mn concentration removal of 70%.

The mean concentration of Fe in domestic water before treatment with *Moringa Oleifera* seed coagulant was 2.60mg/L, after treatment and filtering the mean value dropped from 2.60mg/L to 1.20mg/L indicating an efficiency of removal of Fe calculated as 52.2%. Fe observed reduction in concentration level of Fe in water put the water within the acceptable bench mark of 5.00mg/L and 0.30mg/L set out by WHO/FAO and FEPA Standards. It could be observed in this study that the concentrations levels of Cu, Cd, Zn, Ni, Mn and Fe were found to comply with the permissible limits of both nation and international acceptable standards of water quality for domestic purposes including human consumption despite their health impact from short and long time exposure.

IV. CONCLUSIONS

Heavy metals concentration levels of domestic water sources were analyzed before and after treating the water using *Moringa Oleifera* seed coagulant that are locally cheap and available in Yola and it environment. The concentration levels of Cu, Cd, Zn, Ni, Mn and Fe in the tested samples were drastically reduced to the acceptable standard of water quality for human consumption, therefore, this simple water treatment/purification at the household level will be adopted in Yola community in other to safeguard public health hazard of exposure to heavy metals via consumption of contaminated water from the affected sources. The efficiency of the heavy metal removal by using Moringa Oleifera seed coagulant recorded as 50% for Cu, 100% for Cd, 50% for Zn, 53.8% for Ni, 70% for Mn and 52.2% for Fe indicated the reliability of this treatment method as heavy metals are not easily removable at the conventional water treatment plant. It is therefore recommended that other heavy metals like Pb, Cr, and Hg should also be tested as Moringa Oleifera seed is an eco – friendly and cheaper method of water purification which replaces the chemical method of water purification at the household level.

REFERENCES

[1]. Adebayo, A.A (1999). Adamawa State region a Geographical Synthesis. 1st Edition Paraclete Publishers, Yola, Nigeria. pp. 1-19.

[2]. Aderinola, O.J, Clarke, E.O, Olarinnmoya, O.M, Kusemiju, V, Anateku, M.A. (2009). Heavy metal in surface waters, sediments, fish and perwinkles of Lagos Lagoon. Am. Eurasian J. of Agric. Environ. Sci. 5(5): 609 – 617.

[3]. Akaahan, T.J.A, Araoye, P.A, Azua, E.T. (2014). Physico-chemical characteristics and macro-invertebrates of River Benue at Markurdi, Benue State, Nigeria. Int. J. Sci. and Technology. Pp. 2(6): 32 – 39.

[4]. Asante, F, Agbeko, E, Addae G, Quaino, A.K (2014). Bioaccumulation of heavy metals in water, sediments and tissues of some selected fishes from Red Volta. Nangidi in the upper East Region of Ghana. British J. of Appl. Sci. and Technology. 4(4): 594 – 603.

[5]. Ayas, Z, Ekmekei, G, Yerh, S.V, Ozmen, M, (2007). Heavy metals accumulation in water, sediments and fishes of Nallihan Bird Paradis, Turkey. J. of Environ. Biol. 28(3):545- 549.

[6]. Eneji, I.S, Sha'Ato, R. Annune, P.A. (2011). An assessement of heavy metal loading in River Benue in Markurdi metropolitan area Northcentral Nigeria. J. of Environ. Monit. Assessement. Pp. 159 -165.

[7]. Enuneku, A, Ezemonye, L.I, Adebeli, F (2013). Heavy metals concentration in surface water and bioaccumulation in fish (clarias gariepinus) in river Owan Edo state, Nigeria. European Int. J. of Sci. and Toxicology. 2(7): 31 – 39.

[8]. FEPA, (1991). Guideline and Standards for Environmental Pollution Control in Nigeria. Federal Environmental Protection Agency (FEPA), Nigeria 1991.

[9]. FAO, (1992). Wastewater treatment and use in agriculture. Food and Agricultural Oganization Irrigation and drainage paper 47. FAO corporate document repository.

[10]. Garba, Z.N., Hamza, S.A, and Galadima, A. (2010). Arsenic Levels Speciation in Fresh Water from Karaye Local Government, Kano State, Nigeria. International Journal of Chemistry, Vol. 20, No.2, (2010) 113 – 117.
[11]. Galadima, A., Muhammad, N.U. and Z.N, Garba. (2010). Spectroscopic investigation of heavy metals in waste water from University students halls of residence, International Journal of Chemistry , Vol. 20. No. 4, (2010) 239 – 244.
[12]. Hong, A.H., Law P. L., Selaman, O.S. (2014). Physicochemical quality assessment of pollutants in River Benue water in Jimeta/Yola Metropolitan, Adamawa State North Eastern Nigeria. American Journal Environ. Protection. 3(2): 90 – 95.
[13]. Musa, H., Vakasai, I.A and Musa, A.H. (2004). Determination of lead concentration in well and borehole water in Nigeria. Chemclass Journal, 14 – 18.
[14]. Ravikumar, K, and Sheeja, A.K. (2013). Heavy metal removal from water using Moringa Oleifera seed coagulant and double filtration. Int. J. Sci. Eng. Research. 1(2:11): 131- 132.
[15]. Saidu, I, (2011). Evaluation of Effluent Management Practices in Yola, Adamawa State, Nigeria.
[16]. Int. J. Innovations in Environ. Sci. and Technology. 3(2): 40 – 44.
[17]. Tabinda, A.B, Bashir, S, Ya,sar, A, Hussan, M. (2013). Metals concentration in the riverine water , sediments and fishes from river Ravi at Balloki headwork. J. Animal. Plant Sci. 23(1):76 – 84.
[18]. Yahaya, A, Adegbe, A.A, Emuroth, J.E (2012). Assessment of heavy metal content in the surface water of Oke – Afa canal Isolo, Lagos, Nigeria. Arch. Applied Sci. Res. 4(6): 2322 – 2326.
[19]. Wangboje, O.M, Ekundayo, O.T (2013). Assessment of heavy metal in surface water of the Ikpoba Reservoir, Benin City, Nigeria. Nigerian J. of Technology. 32(11): 61 – 66.
[20]. WHO, (2004). Guideline for Drinking Water Quality. 3rd Edition Vol. 1 Recommendation, Geneva, 515.

Hong, A.H, Burmamu, B.R, Umaru, A.B and Sadiq, U.M. "Removal of Heavy Metals from Contaminated Water Using Moringa Olefeira Seed Coagulant in Yola and Its Environs." International Journal of Engineering Inventions (IJEI), vol. 6, no. 11, 2017, pp. 40-45.