WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 7.523
Volume 6, Issue 2, 1142-1150. Case Study ISSN 2277– 7105

PHYTOREMEDIATION OF TEXTILE WASTE WATER USING *AZOLLA PINNATA*: A CASE STUDY

Ugya A. Y.*[1], Imam T. S.[1] and Hassan A. S.[2]

[1]Biological Sciences Department, Bayero University Kano, Kano State, Nigeria.

[2]Biological Sciences Department, Federal University Dutse, Jigawa State, Nigeria.

Article Received on
05 Dec. 2016,

Revised on 15 Jan. 2016,
Accepted on 25 Jan. 2017

DOI: 10.20959/wjpr20172-7710

***Corresponding Author**
Ugya A. Y.
Biological Sciences Department, Bayero University Kano, Kano State, Nigeria.

ABSTRACT

The study involved a laboratory experiment on the use of *Azolla pinnata* in the phytoremediation of a textile waste water from United Nigeria Textile. The physiochemical characteristics of the waste water were determined before and after the treatment. The experiment lasted for three weeks and the rate of reduction was recorded. The highest rate of mean reduction was for heavy metals (Al, Mn, Ni and Cu). Other physiochemical parameters tested include Total Dissolved Solids (TDS), Chemical Oxygen Demand (COD), Nitrate, Biochemical Oxygen demand (BOD), Total suspended Solids (TSS), Dissolved Oxygen (DO), Sulphide, Phosphate, Oil and Grease, Ammonia and the pH. *Azolla pinnata* is a suitable candidate for effective phytoremediation of water from Kakuri stream.

KEYWORDS: Reduction %, Pollutants, Kakuri Stream, Textile, Macrophytes, Nigeria.

INTRODUCTION

Water is one of the nature's most important gift to humanity and all living things. The important of this gift of nature is such that without it man hardly exists as noted by (Maguvu and Mutengu, 2008; Ugya et al., 2015a). Health officials also emphasized the importance of drinking at least eight glasses of clean water every day to maintain good health (WHO 1985). Adequate water supply to any community is therefore, crucial and determining factor indicating the health condition of such community (WHO, 1985).

The world's ever increasing population and her progressive adoption of an industrial based lifestyle has inevitably led to an increased anthropogenic impact on the biosphere (Ugya and Imam, 2015).

Textile industries are major sources of this water pollution (Ghoreishi and Haghighi, 2003) due to the nature of their operations which requires high volume of water that eventually results in high wastewater generation. They are one of the largest of water users and polluters (Nemerow, 1978).

Kaduna (Lat. 10.52 °N, Long 7.44 °E) located in Kaduna State occupies central portion of Northern Nigeria (Kaduna, 2004). Founded in 1917 as an administrative headquarters of Northern Nigeria, it is presently one of the most important cities in the country. Apart from presently being the administrative headquarters of its state it has a high concentration of Federal Parastatals, Schools and other public institutions.

Industrially, it is one of the most developed cities in Northern Nigeria and textile industries are some of its dominating industries. It is on record that the first textile industry in Nigeria was established in this city (Jibrin, 2004) and this could be one of the reasons for its high population density (Olanrewaju, 2001), a reason for the importance of this study.

River Kaduna, a major river in the city receives the effluents from these industries. It does not only run across the entire city but also, it is a major tributary of the Niger River (Gefu and Kolawole, 2002), an indication of the extent to which pollutants in the effluent can reach (Figure 1). Physical, chemical, and biological technologies have been developed to treat this waste water and restore environmental quality; However their costs are high and most of them are difficult to use under field conditions, hence in such a condition there is an urgent need to study natural, simple and cost-effective techniques for control of pollution from industrial effluents (Ji et al., 2007; Ismail and Beddri, 2009). Viewing this fact phytoremediation was assumed to be very useful, as it is an innovative, eco-friendly and efficient technology in which natural properties of plant are used in engineered system to remediate hazardous wastes through physical, chemical and biological processes from wastewater and sewage (House, 1999; Ugya, 2015). Phytoremedation is the utilization of plants accumulation capabilities to remove contamination from water, soil and air, the capacity of aquatic plants to remove pollutants from water is well documented (Gijzen and Kondker, 1997; Ugya et al., 2015b). The recent application of phytoremediation technology

by *Azolla pinnata* in water treatment and management is quite interesting and revealing. This study was designed to assess the efficiency of *Azolla pinnata* in the phytoremrdiation of water from Kakuri stream since United Nigeria Textile waste water have become a potential threat to its Biota.

MATERIALS AND METHODS

The *Azolla pinnata* plants used in this study were collected from a pond located in Nariya, Kabala New Extention Kaduna state, Nigeria and transported to the laboratory in clean plastic bags. Plants were carefully washed using tap water and then distilled water for one minute, to remove visible debris. Water sample were collected from United Nigeria Textile effluent point, Kakuri upstream, Kakuri mid stream and Kakuri downstream.

Azolla pinnata was kept on a filter paper to remove excess water and then transferred into plastic troughs having a capacity of five liters containing water from different points. Before transferring the test plant into the trough containing the water sample, the water characteristic were determined by analyzing some physiochemical parameters like TSS, TDS, BOD5, COD, Sulphide, pH, Phosphate, Nitrate, DO, Oil and grease and some heavy metals such (Al, Ni, Cu, Mn) (Ugya *et al*., 2015c).

After 21 days, the water was re-analyses. The value before phytoremediation was noted as initial value while the value after phytoremediation is indicated by final value. All the analysis was done using the methodology of APHA (1995) (1998).

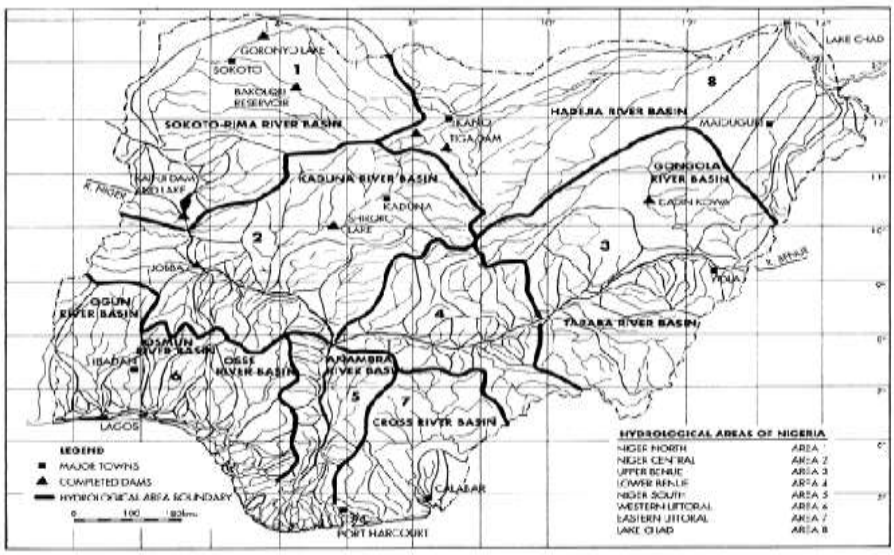

Figure 1: Hydrological Map of Nigeria Showing Kaduna River (Ita, 1994)

RESULT AND DISCUSSION

The result represented below shows that pH was reduce significantly in all the points. TDS was best reduced at point A, B and D if compared to point C. TSS was best removed at point A and D if compared to point C and B. Sulphide, COD, Oil and grease, Phosphate and Nitrate were greatly reduced in all the points. Ammonia was reduced best in point B, C and D if compared to point A. DO was best reduce in point B and C if compared to point A and D. BOD was best reduced in point A and B if compared to C and D. Heavy metals were greatly reduced in all the points except for Ni that was increased at point C and D.

Table 1: Mean % Reduction of Physico-chemical parameters and heavy metals at point A

SN	Physico-chemical Parameter	Before Remediation	After Remediation	% Reduction
1	pH	9.87	6.98	29.2
2	TDS	1450	162	88.8
3	TSS	370	9	97.5
4	Sulphide	1.98	0.48	75.7
5	COD	2230	120	94.6
6	BOD	347	90	74.0
7	DO	3.8	1.65	56.5
8	Oil and Grease	15	8.6	42.7
9	Ammonia	2.5	1.7	32
10	Phosphate	3.78	0.60	84.1
11	Nitrate	10.96	0.136	98.8
12	Aluminium	0.05	0.017	66
13	Copper	2.45	0.165	93.2
14	Manganese	0.97	0.005	99.5
15	Nickel	0.86	0.15	82.6

Table 2: Mean % Reduction of Physico-chemical parameters and heavy metals at point B

SN	Physico-chemical Parameter	Before Remediation	After Remediation	% Reduction
1	pH	10.87	7.12	34.5
2	TDS	1250	170	86.4
3	TSS	247	170	31.1
4	Sulphide	1.35	0.45	66.6
5	COD	2456	546	77.8
6	BOD	356	40	88.8
7	DO	2.6	0.67	74.2
8	Oil and Grease	9	3.6	60
9	Ammonia	1.8	0.54	70
10	Phosphate	4.96	1.78	64.1

11	Nitrate	13.7	0.85	94
12	Aluminum	0.16	0.03	81.3
13	Copper	4.7	0.45	91
14	Manganese	1.76	0.01	99.4
15	Nickel	0.15	0.31	-

Table 3: Mean % Reduction of Physico-chemical parameters and heavy metals at point C

SN	Physico-chemical Parameter	Before Remediation	After Remediation	% Reduction
1	pH	9.65	7.34	23.9
2	TDS	1185	478	59.7
3	TSS	240	139	42.1
4	Sulphide	1.69	0.63	62.7
5	COD	1875	564	69.9
6	BOD	150	84	44
7	DO	4.9	0.78	84.1
8	Oil and Grease	6.9	2.67	61.3
9	Ammonia	3.2	0.03	99.1
10	Phosphate	3.19	0.19	94.0
11	Nitrate	11.54	0.98	91.5
12	Aluminum	1.04	0.08	92.3
13	Copper	2.82	0.02	99.3
14	Manganese	5.74	0.16	97.2
15	Nickel	0.05	0.88	-

Table 4: Mean % Reduction of Physico-chemical parameters and heavy metals at point D

SN	Physico-chemical Parameter	Before Remediation	After Remediation	% Reduction
1	pH	10.56	7.45	29.4
2	TDS	250	23.4	90.6
3	TSS	67	08	88.1
4	Sulphide	0.4	0.05	87.5
5	COD	1089	12.5	98.9
6	BOD	168	80	52.4
7	DO	7.5	04	46.6
8	Oil and Grease	ND	ND	ND
9	Ammonia	0.36	0.07	80.5
10	Phosphate	0.26	0.003	98.8
11	Nitrate	3.78	0.8330	77.9
12	Aluminum	0.07	0.001	98.5
13	Copper	3.46	1.9	45.1
14	Manganese	0.95	0.025	97.3
15	Nickel	0.35	0.001	100

The reduction in pH in all the points could be attributed to the fact that ammonia and nitrate were highly reduced by the test plant. This is because absorption of ammonia and other nitrogen compounds typically encourage biological reaction that produce hydrogen ion hence the reason why the pH of the water dropped (Taylor *et al.*, 1998). High pH reduction was also recorded when using other macrophytes by other researchers such as Ugya *et al* (2015d), Padhi *et al*., (2012), Dipu *et al*., (2011) and Mahmood *et al*., (2005). The reduction in pH is the reason why ammonia, phosphate and nitrate were reduced.

The high reduction in Sulphide in all the points could be attributed to the fact that sulphide has been identified to play an important role in diverse [physiological processes in plants (Zhang *et al*., 2008). The high heavy metal reduction is correlated to be due to the uptake of sulphide by the test plant, since numerous research have shown that sulphide plays amneliorative role in protecting plants by increasing the proline content against heavy metals toxicity and heat stress as reported by Chen *et al*., (2012), Li *et al*., (2012a), Li *et al*., (2012b).

The high TSS and TDS removal could be attributed to the property of proper particle sedimentation by the test plant (Piyush *et al*., 2012). High BOD and COD removal is stated to be due to the fact that the presence of plants in waste water tend to deplete CO2 during the process of photosynthesis which favors COD and BOD reduction (Mahmood *et al*., 2005).

CONCLUSION

Water quality study of Kakuri Stream which is the receiving body of textile effluent has brought to the fore some important concerns that were muted by research works by many researchers which indicated the presence of several heavy metals in high concentration to cause contamination to biotic species of flora and fauna that, abound in the stream. Other parameters monitored such as the oxygen characteristics of the water in terms of COD, BOD and DO are all indicating toxicity above the threshold that can be purified by the stream. These studies shows that *Azolla pinnata* can be use effectively in the treatment of textile wastewater by reducing the toxicity on the flora and fauna since it is able to remove and degrade pollutants present in the stream to a significant level in all point.

REFERENCES

1. APHA. Standard Methods for the Examination of Water and Wastewater 20th Edition. American Public Health Association, American Water Works Association and Water

Environment Federation, Washington, DC; 1998.

2. APHA, AWWA, WPCF. "Standard Methods for the Examination of Water and Wastewater." American Public Health Association, Washington, DC; 1995.
3. Cheng, J. Wang W.H., Wu F.H (2013) Hydrogen Sulphide alleviates aluminum toxicity in barley seedling. *Plant and Soil* vol 362, n0 1-2 pp 301-318.
4. Dipu, S., Kumar, A.A and Thanga, V.S.G. Phytoremediation of dairy effluent by constructed wetland technology., Environmentalist, 2011; 31: 263-278.
5. Gefu J.O. and Kolawole A. (2002), Conflict in Common Property Resource Use: Experiences from an Irrigation Project, In: *9th Biennial Conference of the International Association for the Study of Common Property (IASCP)*, Victoria Falls, Zimbabwe, June 2002.
6. Ghoreishi S.M. and Haghighi R. (2003), Chemical Catalytic Reaction and Biological Oxidation for Treatment of non-Biodegradable Textile Effluent, *Chemical Engineering Journal*, 95: 163–169.
7. Gijzen H. and Kondker M. An Overview of the Ecology, Physiology, Cultivation and Application of Duckweed in Caption Report. Annex-1, Literature Review .Duckweed Research Project (DWRP). Dhaka, Bangladesh; 1997.
8. House, C.H. Combining Constructed Wetlands and Aquatic and Soil Filter for Reclamation and Reuse of Water. Ecoi. Eng. 1999; 12: 27-38.
9. Ita E.O. (1994), Aquatic plants and wetland wildlife resources of Nigeria, CIFA Occasional Paper, No.21, Rome, FAO, pp 52.
10. Ismail, Z. and Beddri, A. Potential of Water Hyacinth as a Removal Agent for Heavy Metals from Petroleum Refinery Effluents. Water Air Soil Pollut. 2009; 199: 57-65.
11. Ji, G.D. Sun, T. H. and Ni, R. J. Surface Flow Constructed Wetland for Heavy Oil – Produced Water Treatment. Bio. Technol. 2007; 98: 436-441.
12. Jibrin W. (2004), Dilemma of Textile Industries in Nigeria, In: *1st Economic Summit*, Arewa House Kaduna, April 2004.
13. Kaduna (2004), The Official Website of Kaduna State, Nigeria, www.kaduna-state.com, accessed on May 20th 2004.
14. Li, W.Y., Gong, Z.H., Mu (2012a) An Arabidopsis mutant *atcsr-2* exhibits high cadmium stress sensitivity involved in the restriction of H_2S emission, *Journal of Zhejiang University: Sciences B*. 13(12): 1006-1014.
15. Li, Z.G., Gong, M., Xie H., Yang, L and Li, J (2012)Hydrogen sulfide donor sodium hydrosulfide-induced heat tolerance in tobacco (Nicotiana tabacum L) suspension cells

and involvement of Ca^{2+} and calmodulin. *Plant Sciences* vol 185-186 pp 185-189.

16. Mahmood, Q., Zheng, P., Islam, E., Hayat, y., Hassan, M.J., Jilani, G. and Jin, R.C. Lab scale studies on water hyacinth (*Eicchornia crassipes* mart solms) for biotreatment of textile waste water. Caspian J. Env.Sci., 2005; 3(2): 83-88.
17. Maguvu, E. S. and Mutengu, S. (2008). An Investigation into the Factors Limiting Effective Water Supplyin Rurual Areas of Zimbabwe. A case study of Zhomba in Gokwe North District, Journal of Sustainable Development in Africa, 10(1): 120-138.
18. Nemerow, N.L. (1978) Industrial Water Pollution: Origins, Characteristics and Treatment. Addison-Wesley, Reading, Massachusetts, pp 738.
19. Olanrewaju D.O (2001), Urban Infrastructure: A Critique of Urban Renewal Process in Ijora Badia, Lagos, *Habitat International*, 25: 373–384.
20. Padhi SK, Sahu SK, Kumari A, Bharati S, Ansari S. Phytortemediation as an Alternative for Treatment of Paper Industry Effluent by Using Water Hyacinth (*Eicchornia crassipes)*-A Polishing Treatment. INT Journal of Research in Chemistry and Environment. 2012; 2(95-99): 2248- 9649.
21. Taylor, D.J., Green, N.P.O. and Stout, G.W (1997). Biological Sciences, R. Soper. University Press, 984pg.
22. Ugya, A.Y., S.A. Umar and A.S. Yusuf (2015a) Assessment of well water quality: A case study of Kaduna South local Government area, Kaduna state Nigeria. Merit Res. J. Environ. Sci. Toxicol., 3: 39-43.
23. Ugya, A.Y., I.M., Toma. and Abba A. (2015b) Comparative Studies on the Efficiency of Lemna minor L., Eicchornia crassipes and Pistia stratiotes in the phytoremediation of Refinery Waste Water. *Sciences World Journal*, 10(3).
24. Ugya, A.Y. and T.S. Imam (2015). The efficiency of *Eicchornia crassipes* in the phytoremediation of waste water from Kaduna Refinery and petrochemical company. IOSR *J. Environ. Sci. Toxicol*. Food Technol., 9: 43-47.
25. Ugya, A.Y., (2015). The efficiency of *Lemna minor* L. in the phytoremediation of Romi stream: A case study of Kaduna refinery and petrochemical company polluted stream. J. Applied Biol. Biotechnol., 3: 11-14.
26. Ugya, A.Y., S.M. Tahir and T.S. Imam, (2015c). The efficiency of *Pistia stratiotes* in the phytoremediation of Romi stream: A case study of Kaduna refinery and petrochemical company polluted stream. *Int. J. Health Sci. Res.*, 5: 492-497.
27. Ugya, A.Y., T.S. Imam and A.S. Hassan, (2015c). The use of *Ecchornia crassipes* to remove some heavy metals from Romi stream: A case study of Kaduna Refinery and

Petrochemical company polluted stream. *IOSR J. Pharm. Biol. Sci.*, 10: 43-46.

28. WHO (1985). Guideline for Drinking Water Quality vol. 3. Drinking Water Quality Control in Small Community Supplies. World Health Organisation, Geneva.
29. Zheng, H., Hu, L.Y., Hu, K.D., Wang S.H. and Luo J.P. (2008) Hydrogen Sulphide Promote Wheat Seed Germination and Alleviate Oxidative Damage Against Copper Stress. *Journal of Integrative Plant Biology*. 50(12): 1518-1529.