*Bajopas Volume 11 Number 1 June, 2018*

**http://dx.doi.org/10.4314/bajopas.v11i1.31**

***Bayero Journal of Pure and Applied Sciences, 11(1): 179 - 182***
*Received:* January, 2018
*Accepted:* May, 2018
**ISSN 2006 – 6996**

# RESPONSE OF SOME CYANOBACTERIAL SPECIES FOR ADSORPTION OF MANGANESE, COBALT AND NICKEL FROM UNTREATED TANNERY EFFLUENT IN KANO, NIGERIA

**Ado, G., Haruna, H, and Indabawa, I.I.**
Department of Plant Biology, Faculty of Life Sciences, Bayero University, Kano.
garbado05@gmail.com (08036350343)

***ABSTRACT***
***The research was conducted to monitor the performance of some endogenous species of Cyanobacteria for the adsorption of Manganese (Mn), Cobalt (Co) and Nickel (Ni) from untreated effluents of Fata Tanning Limited (FTL) in Kano between July 2014-June, 2015. Primary field investigation and laboratory analysis were the main sources of data in the study. The study areas were divided into three strata within which samples were collected using stratified sampling techniques from a depth of 0-30cm.The study assessed the adsorption capacity of some heavy metals namely; Mn., Co. and Ni using Atomic Absorbance Spectrophotometer (AAS). Indigenous cyanobacteria species identified and isolated were Anabaena variabilis, Lyngbya majusculata and Oscillatoria princeps using microscopy and standard phycological chart as described by Komerak and Anagnostidis, (1989). Bioremediation Bioassay was conducted to evaluate the adsorption capacity of the isolated organisms. The results showed that, tested organisms reduced the concentration level of heavy metals in the effluents to the standard limit proposed by FEPA (1997), WHO (1999) and (ICLARM, 1997). Anabaen was found to remove more Ni (4.13%) followed by Lyngbya (3.78%) all at 9 weeks after inoculation. Higher concentration of Mn (3.85%) and Co of (4.04%) were removed by Lyngbya and Oscillatoria at 9 weeks after inoculation. These findings indicated that all the tested organisms possessed great potential in removing heavy metals from untreated tannery effluents. These findings also showed that adsorption of heavy metals by the tested organisms increased with time from 3-9 weeks of inoculation and adsorption was significantly higher at 9 weeks after inoculation and some decline at 9 WAI***
**Keywords; Cyanobacterial species, Effluent, FTL and Heavy metals**

## INTRODUCTION

Release of heavy metal in large amounts from industries into and across Nigeria has resulted in many problems for both human health and aquatic ecosystem (Inthorn *et al.*, 1996). Thus everyone is being exposed to contamination from past and present industrial practices, emission in natural resources (air, water and soil) even in the most remote regions. The risk to human and environmental health is rising and there is evidence that this cocktail of pollutants is a contributor to the global epidemic of cancer, and other degenerative diseases (Puschenreite *et al.,* 2005). Once the metals enter in to the soil, they are strongly held by soil particles and there is little removal by plant uptake or movement down the soil profile. In low and medium contaminated soils, concentration of metals in crops is mostly not high enough to cause acute toxicity, but in the long run, it may cause chronic damage to human/animal health (Puschenreite*, et al.,* 2005). The challenge is to develop innovative and cost-effective solutions to decontaminate polluted environments, to make them safe for human habitation and consumption, and to protect the functioning of the ecosystems which support life. Bioremediation is the use of biological interventions of biodiversity for mitigation (complete elimination) of the noxious effects caused by environmental pollutants in a given site (Blanco**,** 2000). Bioremediation has been successfully applied for cleanup of soil, surface water, ground water, sediments and ecosystem restoration (Blanco, 2000). Bioremediation is generally contributed to the fate of hazardous wastes and can be used to remove these unwanted compounds from the biosphere (Ma *et al.,* 2011; Schroeder and Schwitzguebe, 2004).

Heavy metals enter into our environment from both natural and anthropogenic sources such as processing industries and incomplete combustion of burning fuel (Duffus, 2002). Manufacturing and distribution of products such as batteries, perfumes, soap, deodorant, metal scrap, textile, plastics, tanneries and garbage have resulted in the generation of a huge volume of waste. The composition of these wastes is an important source of environmental pollution, contributing to the heavy metal load in effluent (Haliru *et al.*, 2014). All heavy metals are toxic in effluent in concentrations above normal level. Addition of heavy metals to effluent may affect microbial proliferation and enzymatic activities, leading to a decrease in the rates of the biochemical process in the soil environment. Worldwide increasing level of industrialization and urbanization has lead to environmental pollution (Filazi *et al.*, 2003; Businelli *et. al,*, 2009).

## MATERIALS AND METHODS

### Study Area

Kano is a city in Northern Nigeria (11° 59. 981N, 008° 31. 491E) which is the largest city in Nigeria with population density of 2.66 per hectare (UNEP, 2004). Kano is home to 70% of Nigerian tanneries. The study was carried out on effluents from Fata Tanning Limited (ATM) (11° 88. 571N, 008° 48. 325E) located at Challawa Industrial Area in Kumbotso Local Government in Kano State. Effluents were sampled on monthly basis from July, 2014 to June, 2015.

### Determination of Heavy Metals of the Effluent.

Metals contents were determined prior to inoculation of isolated Algal species. All collected samples were placed inside sampling box containing ice prior to analysis in the Laboratory. Concentrations of three heavy metals (Fe, Cu and Hg,) were determined using AAS VGP 210 Model. The instrument was set up at wave lengths specific to each element to be analyzed. Five milliliter (5ml) of the samples was used one after the other without delay between them. Distilled deionized water was added frequently between each reading. Readings of the absorbance were obtained by observing the steady galvanometer readings in 1-2 minutes. Determination of each sample was carried out in triplicate to get representative results.

### Sample Concentration

In the Laboratory, 10mls of the preserved effluent samples were centrifuged in a graduated tube at 1500rpm for 30 minutes, using a centrifuge machine (Model Merlin 502-000). One ml of sample concentrate (sediment) was pipette on a slide for identification of algal species.

### Isolation and Identification of Algal species

Pure culture of Algal species was obtained by Capillary Pipette Isolation method as described by (Bold, 1972). This involves putting several droplets of sample on a slide and covered with the cover slip using a capillary pipette. The drops were examined under microscope; *Anabaena, Lyngbya and Spirulina* among others were obtained. The drop was removed with a sterile capillary pipette and transferred into a prepared (BG 11) medium and incubated in the bioreactor (Kadiri and Opute, 2013) at 24 °C for 48hr. Algal cells were viewed using a light microscope attached to a camera, identified using standard Phycological Keys and morphological criteria as described by Palmer, (1980); Komerak and Anagnostidis, (1989).

### Algal culture and Purification

Blue Green-(BG 11) modified medium was used. Three genera of algae identified (*Anabaena. Lyngbya and Oscillatoria*) were cultured in 50mls BG 11 media and incubated for three weeks in a photo bioreactor (PBR) in which the specimen grown. It is a closed system incorporates light and all required essential nutrients. The organisms were harvested when the biomass reached exponential/log phase. The cultures were treated using a combination of antibiotics such as Chloramphenicol 25mg/L, Penicillin 10mg/L and Griseofulvin 50mg/L. Therefore, the ratio was 5mg: 2mg: 10mg of Chloramphenicol, Penicillin and Griscofulvin to 200mls of media as described by Kaul and Gautan, (2000).

### Bioremediation Bioassay

Twenty Seven Conical Flasks were prepared in which a single flask was filled with 200ml of effluent and inoculated with a three week dense individual algal suspension as described by Shahidulrahman, (2004). The set up was replicated three times and allowed until 3Weeks, 6Weeks and 9Weeks. Adsorption capacity of algal species was estimated using the following formula $\frac{wc-c}{c}$ X 100 (Kadiri and Opute, 2013). Where (wc) is the final concentration of heavy metal in the algal species after inoculation for time (t) and (C) is the initial concentration of heavy metal in algal species before inoculation.

## RESULTS AND DISCUSSION

The polluting metals such as Zn, Cd, Cu, Cr and Ni have high atomic number with a density greater than 5g/cm$^3$ or 6g/cm$^3$ (Bellamy, 2007; Wild, 1996). These metals are the cause of environmental pollution from a number of sources including lead in petrol, industrial effluents and leaching of metal ions from soil into the water bodies (Lane *et al*., 2005). Aquatic organisms require varying amount of heavy metals such as Fe, Zn and Cu for metabolic activities, but excessive level can be detrimental to the organisms hence the term "trace" (Lane *et al*., 2005). Current study revealed the heavy metals adsorption capacity of some algal species. Awasthi and Rai (2004) reported that trace level of heavy metals in the body of lower plant organism boost their yield and growth. Similarly, algae use metals as part of nutrients, for instances they use iron during photosynthesis while chromium is use for metabolism (Zang *et al*., 1996).

Cobalt adsorption capacity of the cyanobactria species from FTL effluent is shown in Table 1. The results indicated that cobalt adsorption of the tested organisms remained low at 3WAI (Weeks After Inoculation). When incubation period was extended to 9weeks, adsorption was significantly increased to (4.04%) in *Oscillatoria*. For *Anabaena* and *Lyngbya,* adsorption were also significantly ($P<0.05$) high at 9WAI. Study on the use of algae for removing heavy metals ions from waste water by Mehta and Gaur (2005) revealed similar observation where comparative analysis between algae and *Arthrobacter* species showed that the ability of *Arthrobacter globiformis* to remove Gold from the solution was better than that of *Spirulina platensis* and they attributed the ability of algae to remove the gold to fact that the cell wall consists of a variety of polysaccharides and protein and hence offer a number of active sites capable to bind metal ions. However, difference in the cell wall composition of different groups of algae causes significant difference in the type and amount of metal ion binding to them (Mehta and Gaur, 2005). This study also agrees with finding of Kumar and Gaur, (2011) who stated that the genus of *Lyngbya* and *gloeocapsa* removed chromium from tanneries discharge and used it for metabolism at 12 weeks after their inoculation than 6 weeks after inoculation.

The result of Manganese adsorption capacity by some algal species from FTL is presented in Table 2. The result indicated that *Lyngbya* adsorbed the highest values of Mn (3.85%) at 9WAI. *Anabaena and Oscillatoria* recorded 3.44% and 3.39% respectively. Mn is an essential element for all known living organisms including humans at low doses of intake. But at much higher doses, toxic effects can occur. Manganese can enter the environment through releases from tannery industries that make use of Mn compounds (ATSDR, 2004). This work agrees with the work of Solisio *et al*., (2006) who reported the considerable potential adsorption of many metals by *Spirulina platensis*.

Nickel adsorption capacity of the different species of cyanobacteria from the Fata Tanning Limited (FTL) is recorded in Table 3. The result showed that *Anabaena* had the highest Ni adsorption capacity of 4.13% at 9WAI. *Lyngbya* recorded 3.78% at 9WAI while. *Oscillatoria* had 3.29% all in 9WAI . This finding is in conformity with the report of Semyalo, (2009) who stated that significant milligrams of Ni were absorbed by *Chlorella vulgaris* in tannery effluent in the sixth week of period of inoculation.

**Table 1 : Cobalt Adsorption Capacity (%) of Some Algal Species from FTL Effluents**

| **Organisms** | **3WAI** | **6WAI** | **9WAI** |
|---|---|---|---|
| *Anabaena* | 3.02c | 3.16b | 3.59a |
| *Lyngbya* | 2.12c | 2.94b | 3.17a |
| *Oscillatoria* | 3.64c | 3.87b | 4.04a |
| **SE** | | **1.06** | |

Means along columns with different letters differ significantly (P<0.05). Keys: WAI: Weeks After Inoculation, FTL : Fata Tanning Limited, SE: Standard Error

**Table 2: Manganese Adsorption Capacity (%) of Some Algal Species from FTL Effluents**

| **Organisms** | **3WAI** | **6WAI** | **9WAI** |
|---|---|---|---|
| *Anabaena* | 1.70c | 2.61b | 3.44a |
| *Lyngbya* | 2.36c | 3.52b | 3.85a |
| *Oscillatoria* | 2.18c | 3.20b | 3.39a |
| **SE** | | **1.29** | |

Means along columns with different letters differ significantly (P<0.05). Keys: WAI: Weeks After Inoculation, FTL : Fata Tanning Limited, SE: Standard Error

**Table 3: Nickel Adsorption Capacity (%) of Some Algal Species from FTL Effluents**

| **Organisms** | **3WAI** | **6WAI** | **9WAI** |
|---|---|---|---|
| *Anabaena* | 3.59c | 3.91b | 4.13a |
| *Lyngbya* | 2.60c | 3.62b | 3.78a |
| *Oscillatoria* | 2.31c | 3.07b | 3.29a |
| **SE** | | **0.55** | |

Means along columns with different letters differ significantly (P<0.05). Keys: WAI: Weeks After Inoculation, FTL : Fata Tanning Limited, SE: Standard Error

**Conclusion**

The overall findings of the study revealed the adsorption capacity of some algal species, the test organisms were found to reduce the level of heavy metal concentrations from the effluents of Fata Tanning Limited (FTL) to the recommended limit agreed by World Health Organization (WHO) and Federal Environmental Protection Agency (FEPA). All the three test organisms adsorbed great amount of Ni while *Lyngbya* was found to sequestered large percentage of Mn.

**Contribution of Authors**

1. Garba Ado and Hajara Haruna ;- were responsible for carrying out the experiment.
2. Isyaku Ibrahim Indabawa;- responsible for the statistical analysis of the work

Conflict of interest;- Nil

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