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# SCREENING OF SOME ALGAL SPECIES FOR ADSORPTION OF IRON, COPPER AND MERCURY FROM UNTREATED TEXTILE EFFLUENT IN KANO, NIGERIA

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**ABSTRACT**
***The research was carried out to screen endogenous species of algae for the adsorption of heavy metals from untreated effluents of Africa Textile Manufacturer (ATM) 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 heavy metals namely: Iron (Fe), Copper (Cu) and Mercury (Hg) by some algal species using Atomic Absorbance Spectrophotometer (AAS). Indigenous algal species identified and isolated were Anabaena planctonica, Microcystis aeruginosa and Spirulina major using microscopy and standard phycological chart as described by Komerak and Anagnostidis, (1989). Bioremediation Bioassay was conducted to assess 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). Spirulina major was found to sequester more Cu (22.80%) followed by Microcystis aeruginosa (21.34%). Higher concentration of Fe (5.77%) and Hg (5.15%) were removed by Microcystis aeruginosa. These findings indicated that all the tested organisms possessed great potential in removing heavy metals from untreated textile 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.***
***Keywords; Algal Species, ATM, Effluent 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). Heavy metal mobilization in the biosphere by human activities has become an important process in the geochemical cycling of these metals (Chen *et al.*, 2005). This is evident in industrial areas where stationary and mobile sources release large quantities of heavy metals into the effluent, atmosphere, soil and vegetation that exceed the natural emission levels (Bilos *et al.*, 2001; Olukanmi and Adeoye, 2012).

## MATERIALS AND METHODS

### Study Area

Kano is a city in Northern Nigeria (11$^{o}$ 59. 981N, 008$^{o}$ 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 Africa Textile Manufacturer (ATM) (11$^{o}$ 88. 571N, 008$^{o}$ 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 The 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, *Microcystis aeruginosa, Anabaena planctonica and Spirulina major* 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 $^{o}$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. Five species of algae identified (*Anabaena planctonica, Microcystis aeruginosa* and *Spirulina major*) 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 Fe, Cu, Hg, Cd, Zn 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).

Iron adsorption capacity of the algal species from ATM effluent is shown in Table 1. The results indicated that iron adsorption of the tested organisms remained low at 3WAI (Weeks After Inoculation) except for *M. aeruginosa* which recorded a significantly higher ($P<0.05$) iron adsorption at 3WAI. When incubation period was extended to 6weeks adsorption was significantly increased to 4.87% in *M. aeruginosa*. For *S. major* and *A. planctonica* adsorption remained significantly ($P<0.05$) low at 6WAI. However, at 9WAI all the test organisms recorded significantly ($P<0.05$) higher iron adsorption. 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 *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 Copper adsorption capacity by some algal species from ATM is presented in Table 2. The result indicated that *Spirulina major* adsorbed the highest values of Cu (18.91% and 22.80%) at 6WAI and 9WAI respectively. *Microcystis aeruginosa* recorded 21.34%. For *Anabaena planctonica*, significant adsorption of Cu was recorded at 9WAI with 20.76%. Copper 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. Copper can enter the environment through releases from textile industries that make use of copper compounds (ATSDR, 2004). This findings indicated that *Spirulina major and Anabaena planctonica* reduced the level of copper to the standard level of 0.058mgKg $^{-1}$ day$^{-1}$ (ATSDR, 2008) and these work agree with the work of Solisio *et al*., (2006) who reported the considerable potential adsorption of many metals by *Spirulina platensis*.

Mercury adsorption capacity of the different species of algae from the Africa Textile Manufacture (ATM) is recorded in Table 3. The result showed that *Microcystis aeruginosa* had the highest mercury adsorption capacity of 4.56% and 5.15% at 6 and 9 WAI respectively. For *Spirulina major* the adsorption was significant (P<0.05) at 9WAI only with 4.93%. The adsorption capacity of mercury for *Anabaena planctonica* was not significant (P>0.05) throughout the incubation period when compared with adsorption capacity of *M. aeruginosa and S. major*. This finding is in conformity with the report of Semyalo, (2009) who stated that significant milligrams of mercury were absorbed by *Coelastrum microporum* in tannery effluent in the sixth week of period of inoculation.

**Table 1 : Iron Adsorption Capacity (%) of Some Algal Species from ATM Effluents**

| **Organisms** | **3WAI** | **6WAI** | **9WAI** |
|---|---|---|---|
| *A. planctonica* | 2.27 e | 2.78 de | 4.36 abcd |
| *M. aeruginosa* | 4.45 abc | 4.87 ab | 5.77 a |
| *S. major* | 3.17 cde | 3.67 bcd | 4.38 abc |
| **SE** | | **0.14** | |

**Means along columns with different letters differ significantly (P<0.05). Keys: WAI: Weeks After Inoculation, ATM : Africa Textile Manufacturer, SE: Standard Error**

**Table 2: Copper Adsorption Capacity (%) of Some Algal Species from ATM Effluents**

| **Organisms** | **3WAI** | **6WAI** | **9WAI** |
|---|---|---|---|
| *A. planctonica* | 12.30cde | 13.96c de | 20.76a |
| *M. aeruginosa* | 11.33de | 16.60abcd | 21.34a |
| *S. major* | 13.27 cde | 18.91ab | 22.80 a |
| **SE** | | **2.57** | |

**Means along columns with different letters differ significantly (P<0.05). Keys: WAI: Weeks After Inoculation, ATM : Africa Textile Manufacturer, SE: Standard Error**

**Table 3: Mercury Adsorption Capacity (%) of Some Algal Species from ATM Effluents**

| **Organisms** | **3WAI** | **6WAI** | **9WAI** |
|---|---|---|---|
| *A. planctonica* | 3.07d | 4.07c | 4.42bc |
| *M. aeruginosa* | 3.00d | 4.56ab | 5.15a |
| *S. major* | 3.90cd | 4.36c | 4.93ab |
| **SE** | | **0.21** | |

**Means along columns with different letters differ significantly (P<0.05). Keys: WAI: Weeks After Inoculation, ATM : Africa Textile Manufacturer, 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 Africa Textile Manufacturer (ATM) 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 Cu while *Microcystis aeruginosa* were found to sequestered large percentage of Fe and Hg.

**Contribution of Authors**

**1. Garba Ado ;-** Carried out the methodology of the studies and compiled the entire work.

**2. Lawan Abdu Sani;-** responsible for the statistical analysis of the work

**Conflict of interest;**- Nil

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