Original Article

Assessments and bio-treatments of industrial effluents (a case study of two selected industries in Ilorin Metropolis)

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ABSTRACT

The assessments of effluents generated from two selected industries in Ilorin metropolis were carried out. Evaluation of hazardous effluents was carried out and provides data useful for both identification and for comparative risk assessment. The effluents were analysed for Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Total Solid (TS), Suspended Solid (SS), Dissolved Solid (DS), Chemical Oxygen Demand (COD), heavy metal, temperature and pH before the treatment with the microorganism isolated from the effluents. The results revealed that the effluents have high value of those parameters. *Aspergillus niger* and *Mucor* mucedo were isolated. The treatment of the effluents with the above organisms reduced the values to bearable level and pH became nearly neutral and increased in temperature almost to atmospheric temperature on the 25th days the parameters for industry A producing detergent soap were reduce to 0.24 of (COD),. 61.3 (TS), 5.0 (DS), 10.30 (SS), 34.5^{0}C (T), 7.01 (pH), 0.03 (Total Ion), 0.43 (DO), 0.30 (BOD), 0.58 (NO_3), 3.94 (SO_4), 0.27 (phenophtalein) (mg/L) respectively while the value for total manganese, total lead, total copper, total chromium and methyl orange alkalinity disappeared completely. In industry B, the parameters were reduced to 0.15 (COD), 61.2 (TS), 53.0 (D.S), 8.20 (SS), 34.5^{0}C (Temperature), 7.30 (pH), 0.2 (Total Iron), 0.10 (Total lead), 0.01 (Total Chromium), 0.32 (DO), 0.13 (BOD), 0.22 (NO_3), 3.78 (SO_4) mg/l, while the values for total manganese, total copper, phenolphthalein alkalinity and methyl orange alkalinity disappeared completely. This reduction in parameters are the upper limit for disposal into the surface water.

KEY WORDS: Assessment, microorganism, bioremediation, bioreactor.

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INTRODUCTION

Bioremediation can be defined as any process that uses microorganisms such as fungi, green plants, bacteria or their enzymes to return the natural environment altered by contaminants to its original condition. An example of a more general approach is the cleanup of oil spills by the addition of nitrate and or sulphate fertilizers

to facilitate the decomposition of crude oil by indigenous or exogenous bacteria or fungi (Lovely, 2003). Remediation of petroleum product from ground water is harder to achieve than surface soil because of the greater difficulty in distributing the nutrient throughout the zone of contamination and because of oxygen limitations (McGraw, 2002).

Primary biodegradation is more limited in scope and refers to the disappearance of the compound as a result of its biotransformation to another product. Compound that are readily biodegradable are generally utilized as growth substrate by single microorganism. Many of the component of petroleum product (and frequent ground-water contaminant), such as benzene, toluene, ethyl benzene and zylene are utilized by many general of bacteria as sole carbon sources for growth and energy (Martins, 2008). Biodegradation is the chemical breakdown of materials by a physiological environment. The term is often used in relation to ecology, waste management and environmental remediation (bioremediation). Organic material can be degraded aerobically with oxygen, or anaerobically, without oxygen. A term related to biodegradation is biomineralization in which organic matter is converted into minerals. Bio surfactant, an extracellular surfactant secreted by microorganisms, enhances the biodegradation process. Biodegradable matter is generally organic material such as plant and animal matter and other substances originating from living organisms, or artificial materials that are similar enough to plant and animal matter to be put to use by microorganisms (Diaz, 2008).

Anaerobic digestion is a series of processes in which microorganisms break down biodegradable material in the absence of oxygen. It is widely used to treat waste water sludge and organic waste because it provides volume and mass reduction of the input material (Heider, 2008). As part of an integrated waste management system, anaerobic digestion reduces the emission of landfill gas into the atmosphere. The large amount of bacteria genomic data provides unparallel opportunist for understanding the genetics and molecular basis of the degradation of organic pollutant. Bioavailability, or the amount of a substance that is physiochemically accessible to microorganisms is a key factor in the efficient biodegradation of pollutants. Waste water treatment also accelerates natural forces of biodegradation which is the breaking of organic matter so as not to cause pollution problems when the water is released into the environment (Parales, 2008; McLoed and Elitis, 2008).

Through bioremediation, microorganisms are used to clean up oil spills and other types of organic pollution. Monitoring harmful chemicals especially heavy metals in industrial effluent for prevention and remediation of natural resources are required. The heavy metals in soil and well water affected by effluent water and irrigated plants with effluent water should regularly and closely be monitored. More than 200,000 sources of waste water are regulated by the National Pollutant Discharge Elimination System (NPDES) permit program. Various industries that use large amounts of water in their processes produce large amount of waste water (Parales, 2008).

Demand for biodegradability prediction is expected to increase with governments stepping up environmental regulations. Example: Development of quantitative structure activity relationship (QSARS) for biodegradation for instance, biochemical oxygen demand for chemical released into the environment with the aid of machine learning and other artificial intelligence methods (James, *et al*., 2004).

Bio-treatment which is the processing of waste using living organisms is an environmentally friendly, relatively simple and cost effective alternative physico-chemical clean-up options confined environments, such as bioreactors have been engineered to overcome the physical,

chemical and biological limiting factors of bio-treatment processes in highly controlled systems. The great versatility in the design of confined environments allows the treatment of a wide range of wastes under optimized conditions. Various techniques have been developed to assess biotreatment in confined environments (Meyer and Panke, 2008).

The importance of this study are to prevent health hazard of the people that are using those effluents in nearby villages and towns, prevent lung cancer, and also to protect aquatic lives and aquatic ecosystem.

The objective of this study is to:

(i) analyse the effectiveness of microorganisms to degrade environmental pollutants especially those that are produced during the manufacture and use of synthetic chemicals.
(ii) assessing the level of environmental pollution due to industrial effluents from selected industries.
(iii) determine the level of BOD, DO, SS, DS, TS, COD, carcinogenic metals and conditions of the effluents i.e. temperature and pH.
(iv) biostimulation by using the isolated microorganism to degrade the effluents.
(v) to compare the pollutants in effluents from industry A and B.

MATERIALS AND METHODS

Sampling locations

The industrial effluents of two different industries were collected from industry A at the site of discharge to the river along Asa Dam Ilorin Kwara State; and industry B at their points of discharge to the river along Unity Road, Ilorin.

Sample collection

The samples were collected in sterile bottles. During sample collection, the mouth of the sampling bottles were directed against current of the effluent sample were collected. They were taken to the laboratory for analysis.

Determination of physico-chemical parameters of the effluents temperature

This was measured using a mercury bulb thermometer. The thermometer was immersed below the surface of the sample and allowed to stay for five minutes after which the reading was recorded (Ademoroti, 1996).

Hydrogen ion concentration (H^+) pH

This was measured using a pH meter with glass electrodes. The electrode was inserted into the sample and the pH value was observed on the pH meter (model = Hanna pH 209 model HW 268).

Dissolved oxygen and BOD

The dissolved oxygen content of the sample was determined by the modified method of Winkler as described by Ademoroti (1996). BOD test was used to determine the relative oxygen requirements of industrial waste waters. The BOD test measures the dissolved oxygen consumed by microbial life while assimilating and oxidizing the organic matter that was present. The sample of effluent water was incubated for 5 days at 20^0C in the dark. The reduction in dissolved oxygen yielded a measure of the biochemical oxygen demand. The sample was treated with manganese sulphate, potassium iodide and also sulphide acid. The initial precipitate of manganese hydroxide $Mn(OH)_2$, upon acidification formed manganic sulphate which acted as an oxidizing agent to release free iodine from the potassium iodide. The iodine which is stoichiometrically equivalent to the dissolved oxygen in the sample was titrated with sodium thiosulphate.

Chemical Oxygen Demand (COD)

The chemical oxygen demand (COD) was to determine the quantity of oxygen required to oxidize the organic matter in the effluent sample under specific condition of oxidizing agent, temperature and time. Since the test utilizes a specific chemical

oxidation.

Procedure

One ml of the sample was pipetted into a flask and 10mls of 9.6N H_2SO_4 and 10ml of 0.0125N. $Kmn0_4$ was added and boiled in the water bath for exactly 30 minutes; and after, 10ml of standard ammonium oxalate was added. It was titrated while hot with standard $Kmn0_4$ until the pink colour was observed (ASTM, 1990).

Total solids

The method of Ademoroti (1996) and Stensel (2003) were employed directly to determine the total solids from the effluent samples. The clean evaporating dish was heated at 103^0C for one hour and allowed to cool, desicate and weighed. The aliquot sample was measured (100ml) and transferred to the pre weighed dish. This was evaporated to dryness in a drying oven at approximately 98^0C to prevent boiling and splattering of the sample. The evaporated sample was dried for 1 hour at 103^0C, allowed to cool, desicated and weighed until a constant weight was obtained.

Dissolved solids (FILTERABLE)

Filterable solids is defined as those solids capable of passing through a glass filter and dried to constant weight at 180^0C.

Procedure

The effluent sample was filtered through the glass fiber filter, rinsed with three 10ml portions of distilled water and vacuum was continuously applied for about 3 minutes after the completion of filtration to remove as much water as possible. 100ml of the filterate was transferred into a weighed evaporating dish and it was evaporated to dryness on a steam bath. The evaporated sample was dried for one hour at 180^0C cooled in a desiccator and weighed. The dryness cycle was repeated until a constant weight was obtained (Adebayo *et al*., 2009).

Suspended solids

The method of Stensel (2003) was used, whereby the effluent sample was filtered through a glass fiber filter, the filter retained the residue and was dried to a constant weight at 103^0C for 1 hour.

Carcinogenic metals

Iron (Fe^{+++})

Two methods were employed: Method of Stensel (2003) and the use of spectrophotometer. For spectrophotometer, the ferro ver iron reagent powder pillow was used. The iron meter scale was inserted into the sample and read directly at wavelength 510nm. The Stensel's method was used to determine the total iron present in the effluent sample. One hundred milliters of sample was pipetted into Erlenmeyer flask. 10ml of concentrated hydrochloric acid (HCl) was added to the sample and mixed together, drops of potassium permanganate ($Kmn0_4$) was added until a pink colour was persisted for a few minutes. The solution was boiled until the volume was reduced to approximately 100ml and allowed to cool to room temperature. Another drop of $Kmn0_4$ was added and the solution was poured into a cylinder. The distilled water was added to make up 100ml and was poured back into the flask. Ten milliters of potassium thiocyanate was added and mixed thoroughly. The colour produced was compared with the colour of untreated sample by using iron colour disc.

Total Manganese (Mn^{2+}) (Aquatester)

Periodate oxidation method was used as described by ASTM (1990) to determine the total manganese. This was done by measuring 50ml of the effluent sample into a flask and 2 drops of concentrated sulphuric acid was added and evaporated to dryness. It was allowed to cool and 50ml of periodate reagent was added to the residue in the flask. Then 0.2g of sodium paraperiodate was added,

the flask was placed in a beaker of boiling water for 30 minutes, cooled and made up the volume to 50ml with distilled water and mixed thoroughly. The colour was compared with untreated effluent sample by using colour disc.

Lead (Pb^{2+})

The total lead (Pb) in the effluent sample was determined by Hellige colour comparator as described by Ademoroti (1996) and Stensel (2003). Fifty milliliters of the sample was taken into the measuring cylinder, 2ml of tartrate cyanide solution was added and mixed together, 1ml of potassium hydroxide was added and was mixed immediately. The colour of both treated and untreated sample were compared by using lead colour disc. This colour comparison was made within ten minutes after the addition of sodium sulphate.

Copper (CU^{2+}) (Aqua Tester)

The Hellige comparator method was also employed in this test. Fifty milliliter of the sample was measured into the flask. 2ml of Dithiocarbonate reagent was added and mixed. The colour was compared with a blank comprising 2ml Dithiocarbonate and 50ml of distilled water using copper disc. The colour comparison was made within 20 minutes of addition of the reagent (Stensel, 2003).

Total Chromium (Cr)

The Hellige comparator method was employed. 50ml of sample was measured into the flask, and 25ml of freshly prepared carbazide reagent was added and mixed immediately. The colour was compared with an untreated sample using the chromium colour disc within 5 – 15 minutes of the addition of carbazide reagent.

Nitrate (NO_3)

This was carried out by colorimetric method. Ten milliliter of the sample was measured into a Nessler tube and the same amount of distilled water (10ml) was measured into another Nessler tube. 0.5ml of brucine and 20ml of concentrated sulphuric acid was added to each tube. Potassium Nitrate was added drop by drop into the tube that contained distilled water until colour match was obtained (Adebayo *et al.,* 2009).

Sulphide (Aqua Tester)

Fifty milliliters of the sample was measured into the cylinder. 5mls of antimony reagent was added and mixed. The colour was compared with untreated sample using the sulfico colour disc (Stensel, 2003).

Phenolphthalein Alkalinity

One hundred milliliters of sample was placed in Erlenmeyer flask, 2 drops of Phenolphthalein indicator was added. Titration with 0.1 HCl from the burette until the colour changes from pink to colourless (Stensel, 2003).

Methyl Orange Alkalinity

One hundred milliliters of the sample was placed in Erlenmeyer flask, 2 drops of methyl orange indicator was added, the solution was titrated with 0.1 HCl until the first appearance of permanent pink colour after which the sample was boiled, it was titrated again with 0.1 HCl. The amount of 0.1 HCl used for the two titration gave the amount of methyl orange alkalinity.

Isolation and enumeration of Microorganisms of the effluent samples

The isolated fungi were determined by using PDA media. Potato dextrose agar (PDA) was prepared for fungi. This was carried out by preparing the media and autoclaved at 121^0C for 15 minutes. 1ml of the effluent sample was seeded into sterile petridish aseptically and appropriately labelled. This was thoroughly mixed to ensure even distribution of the dilution in the petridishes. The plates were incubated for 48 hours for fungi at room temperature. The subcultured was repeated until pure

culture was obtained. Slant stock culture was prepared from pure culture and incubated at room temperature.

Characterization and Identification of Microorganisms Isolated from the Sample

Fungi was identified using wet mount and cotton–blue – in – lactophenol and observed under the microscope with X40 objective lens.

Biodegradation of the Effluent Sample by the Isolated Fungi

The method of Adebayo *et al.* (2009) was directly employed. Fresh sample from the industries were aerated and sterilized to destroy all other organisms. 25mls of sterile water was pipetted into the stock cultures and wash the spores into the autoclaved effluent water in the conical flasks. All the components of the (Zapek-dox agar were added to the sample except the agar and the carbon source). Then the conical flasks were kept inside bioreactor with the sparker inserted to supply oxygen to the organism. The mouth of the flasks placed on the shaker were plugged with the cotton wool, this was to allow the penetration of air because the micro-organisms that cause degradation consume large amount of oxygen for their metabolism of the organic content of the effluent. After 5 days intervals the samples were carried out at the initial stage. This was done for 25 days and the results were compared to be sure whether the micro fungi isolated from the effluent samples were good degrader of organic matter.

RESULTS

The following results were obtained from the analysis of the effluent samples. The first results were gotten before the treatment of the effluent samples and the second results were obtained after the treatment with the isolated microorganism. One type of microorganism was isolated each from the different effluent samples. The organisms were fungi which include *mucor mucedo* from industry B effluent samples and *Aspergillus niger* from industry A effluent sample. The organisms were recognized by their colour, shape, edge and with the aid of microscope, according to Nester and Roberts (1998), Alexopolos and Mims (1979).

Table 1: Initial determination of parameters in the effluent sample incomplete sentence

Parameters	Sample from Industry A	Sample from Industry B
Chemical Oxygen Demand (CODmg/L)	4.8	5.6
Total Solids (mg/L)	432.0	486.0
Dissolved Solids (mg/L)	368.0	426.0
Suspended Solids (mg/L)	64.0	60.0
Temperature	25.5^0C	25.5^0C
pH	8.5	8.3
Total Iron Fe (mg/L)	2.3	1.9
Total Manganese Mn (Mg/L)	0.7	0.5
Total Lead Pb (mg/L)	0.15	0.13
Total Copper Cu (mg/L)	3.7	2.6
Total Chromium Cr (mg/L)	0.7	0.45
Dissolved Oxygen (1^{st} day) (mg/L)	4.4	5.2
Dissolved oxygen (15^{th} day) (mg/L)	0.6	0.8
Biochemical Oxygen Demand (mg/L)	3.8	4.4
Nitrate NO_3 (mg/L)	4.1	3.2
Sulphate SO_4 (mg/L)	16.0	13.5
Phenolphthalein Alkalinity (mg/L)	3.1	2.3
Methyl orange Alkalinity (mg/L)	1.2	0.8

Table 2: The results obtained after the effluent sample have been treated with isolated microorganisms for 5 days.

Parameters	Sample from Industry A	Sample from Industry B
Chemical Oxygen Demand (CODmg/L)	3.50	4.90
Total Solids (mg/L)	264.0	291.0
Dissolved Solids (mg/L)	232.0	256.0
Suspended Solids (mg/L)	32.0	35.0
Temperature	28.8^0C	28.8^0C
pH	8.00	8.10
Total Iron Fe (mg/L)	1.83	1.5
Total Manganese Mn (Mg/L)	0.50	0.4
Total Lead Pb (mg/L)	0.13	0.12
Total Copper Cu (mg/L)	3.20	2.3
Total Chromium Cr (mg/L)	0.50	0.39
Dissolved Oxygen D.O. (Mg/L)	4.20	4.80
Biochemical Oxygen Demand (mg/L)	3.50	3.80
Nitrate NO_3 (mg/L)	3.80	2.70
Sulphate SO_4 (mg/L)	14.00	11.30
Phenolphthalein Alkalinity (mg/L)	2.80	2.10
Methyl orange Alkalinity (mg/L)	1.00	0.60

Table 3: The results obtained after the effluent sample have been treated with isolated microorganisms for 10 days.

Parameters	Sample from Industry A	Sample from Industry B
Chemical Oxygen Demand (CODmg/L)	3.05	3.80
Total Solids (mg/L)	121.0	156.0
Dissolved Solids (mg/L)	112.0	132.0
Suspended Solids (mg/L)	19.0	24.0
Temperature	30.0^0C	30.0^0C
pH	7.79	7.80
Total Iron Fe (mg/L)	1.52	1.30
Total Manganese Mn (Mg/L)	0.42	0.34
Total Lead Pb (mg/L)	2.51	2.10
Total Copper Cu (mg/L)	0.11	0.10
Total Chromium Cr (mg/L)	0.47	0.32
Dissolved Oxygen D.O. (Mg/L)	2.53	2.90
Biochemical Oxygen Demand (mg/L)	2.98	3.27
Nitrate NO_3 (mg/L)	3.21	2.53
Sulphate SO_4 (mg/L)	11.52	9.00
Phenolphthalein Alkalinity (mg/L)	2.30	1.82
Methyl Orange Alkalinity (mg/L)	0.82	0.40

Table 4: The results obtained after the effluent sample have been treated with isolated microorganisms for 15 days.

Parameters	Sample from Industry A	Sample from Industry B
Chemical Oxygen Demand (CODmg/L)	1.99	2.10
Total Solids (mg/L)	99.0	11.10
Dissolved Solids (mg/L)	82.0	97.0
Suspended Solids (mg/L)	17.0	15.0
Temperature	32.0^{0}C	32.0^{0}C
pH	7.61	7.62
Total Iron Fe (mg/L)	1.01	0.98
Total Manganese Mn (Mg/L)	0.15	0.25
Total Lead Pb (mg/L)	1.92	1.89
Total Copper Cu (mg/L)	0.07	0.05
Total Chromium Cr (mg/L)	0.32	0.23
Dissolved Oxygen D.O. (Mg/L)	1.92	2.10
Biochemical Oxygen Demand (mg/L)	2.10	2.53
Nitrate NO_3 (mg/L)	2.51	2.01
Sulphate SO_4 (mg/L)	8.73	7.32
Phenolphthalein Alkalinity (mg/L)	1.87	0.73
Methyl orange Alkalinity (mg/L)	0.48	0.25

Table 5: The results obtained after the effluent sample have been treated with isolated microorganisms for 20 days.

Parameters	Sample from Industry A	Sample from Industry B
Chemical Oxygen Demand (CODmg/L)	0.87	1.30
Total Solids (mg/L)	71.0	72.0
Dissolved Solids (mg/L)	58.0	62.0
Suspended Solids (mg/L)	13.0	10.0
Temperature	34.0^{0}C	34.0^{0}C
pH	7.21	7.50
Total Iron Fe (mg/L)	0.44	0.53
Total Manganese Mn (Mg/L)	0.03	0.05
Total Lead Pb (mg/L)	0.28	0.35
Total Copper Cu (mg/L)	0.03	0.02
Total Chromium Cr (mg/L)	0.06	0.19
Dissolved Oxygen D.O. (Mg/L)	0.74	0.87
Biochemical Oxygen Demand (mg/L)	1.20	1.32
Nitrate NO_3 (mg/L)	1.68	1.48
Sulphate SO_4 (mg/L)	6.10	5.12
Phenolphthalein Alkalinity (mg/L)	1.02	0.48
Methyl orange Alkalinity (mg/L)	0.08	0.01

Table 6: The results obtained after the effluent sample have been treated with isolated microorganisms for 25 days.

Parameters	Sample from Industry A	Sample from Industry B
Chemical Oxygen Demand (CODmg/L)	0.24	0.15
Total Solids (mg/L)	61.3	61.2
Dissolved Solids (mg/L)	51.0	53.0
Suspended Solids (mg/L)	10.30	8.20
Temperature	34.5^{0}C	34.5^{0}C
pH	7.01	7.30
Total Iron Fe (mg/L)	0.03	0.2
Total Manganese Mn (Mg/L)	—	—
Total Lead Pb (mg/L)	—	0.10
Total Copper Cu (mg/L)	—	—
Total Chromium Cr (mg/L)	—	0.01
Dissolved Oxygen D.O. (Mg/L)	0.43	0.32
Biochemical Oxygen Demand (mg/L)	0.30	0.13
Nitrate NO_3 (mg/L)	0.58	0.22
Sulphate SO_4 (mg/L)	3.94	3.78
Phenolphthalein Alkalinity (mg/L)	0.27	—
Methyl orange Alkalinity (mg/L)	—	—

Characterization of Isolates

Mucor mucedo

The colonies of these fungi covered the surface of potato dextrose agar plate, it appeared whitish in colour with mycelium.

Aspergillus niger

This was the most dominant fungi isolated on potato dextrose agar with spread mycelium and sporulated with black coloured and punctiform shape. The conidia were budded of in chains from the sterigmata on vesicle carried by conidiophores.

DISCUSSION

This study proves that microorganisms have ability to degrade and transform variety of organic and chemical materials in an effluent and this has lead to their use in bioremediation process. The initial temperature of effluents sample was 25.5^{0}C for both industrial effluents and increased to 34.5^{0}C after 25 days of decomposition using bioreactor method. This was because the organisms utilized oxygen to degrade organic matter due to increase in their metabolic activities. The pH decreased from 8.3 to 7.30 after bioremediation and this was near to neutral range. This agrees with John (2006) and API (2008) who reported that industrial effluents usually have a neutral pH after decomposition. The COD value obtained for fresh effluents was similar to the observation of John (2006) who recorded 5mg/L of Chemical Oxygen Demand (COD). The Dissolved Oxygen (DO) content for both industries was high at the initial stage and this was in line with the report of Watanabe and Kasai (2008) and Akamo (2007). This DO value later reduced to 0.43 (mg/L) for industry A and 0.32 (mg/L) for industry B on the 25th day of bioremediation. This is because the higher the organic matter, the higher the dissolved oxygen (Adebayo *et al;* 2009). During decomposition, oxygen was used up by the microorganism. The presence of components of suspended matter (SS) and those in dissolved form

(DS) was in line with the report of Geldreich (1999).

The microorganisms used for decomposition degraded the suspended and dissolved solids to less toxic solids which made up the total solids. It was reported by Atlas (2008) that industrial effluent contain component of suspended matter which include cellulose, protein, fat all in collided state, and those in dissolved form included sugars, fatty acid, alcohol, salts and colourless in organic ion. Therefore, there was no specific value for suspended and dissolved solid that make up the total solid before the discharge, but can only be monitored by comparing the initial result obtained before the degradation of the effluent with the final result obtained after decomposition and this was done for the effluent sample used in this study.

The Biochemical Oxygen Demand (BOD) obtained after remediation of the effluent sample was reduced compared to the initial value. This was in line with the report of Ademoroti (1996) who said that 70 – 80% of BOD of industrial effluent was satisfied in 5 to 15 days because it was believed that 10 – 15 days organic matter present in an effluent would have been degraded by specific microorganism and it was so in this study. The final results of carcinogenic metals present in the effluent sample were reduced compared to the initial result. The present of those metals in the effluent may be due to wear and tears of machinery or from by-products from the production line or from other source such as petroleum products e.g. diesel, grease, engine oil that are been used in the industry. This supported the observation of John (2006), who observed the presence of those metals in the waste water. Brim *et al* (2000) reported that monitoring of these harmful chemicals especially metals in industrial effluent for prevention and degradation of natural resources are required. The present of heavy metals in this work was favourably compared with the report of Elson and Hass (2009) who observed that toxic metals include heavy metals and metal compounds that negatively affect people's health were present in industrial effluents. Few of them (metals) are necessary to support life, however, in large amounts, they become toxic. They may build up in biological systems and become a significant health hazards. The remaining metals after degradation were less toxic and this water could be released to the water course. Interest in the microbial biodegradation of pollutants has intensified in recent years as humanity strives to find sustainable ways to clean - up contaminated environment.

CONCLUSION

Problems

The effluents contain a lot of pollutants that can pose hazardous threat to the aquatic life. However, the present study has been able to reduce some of these pollutants. Also contain heavy metals that can be transferred to human through food chain.

From the study carried out, the results revealed that the effluents from selected industries contained toxic and harmful components. The reduction of those materials to non-toxic level was made possible by the adoption of microfungi (*A. Niger* and *Mucor mucedo*) for the treatment of the effluents.

Since every production process of the two industries used in this study involves waste generation which contains toxic and harmful components, it is therefore suggested that the microfungi mentioned above should be considered for biological treatment of the effluents; and possibly extend the use of microorganisms to other industrial effluents. Also, the microorganisms to be used for bioremediation should be improved upon by genetic engineering. In comparison, Industry A (producing detergent soap) contain lesser pollutants than Industry B producing bottled beverages). This is because, from table VI most of the dangerous metals disappeared completely

from the effluent on 25th days of degradation.

Importance of the Study

The important of this study include:

- To prevent health hazard of the people that are using those effluents in nearby villages and towns.
- To prevent lung cancer.
- To protect aquatic lives and aquatic ecosystem.

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