IOSR Journal Of Environmental Science, Toxicology And Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399. Volume 8, Issue 1 Ver. V (Feb. 2014), PP 09-14
www.iosrjournals.org

Soil pollution in two auto-mechanic villages in Benin City, Nigeria.

*[1]Idugboe, S.O, [2]P. Tawari-Fufeyin , [3]Midonu A.A

Animal and Environmental Biology, faculty of Life Sciences, University of Benin, P.M.B 1154, Benin City. Nigeria

Abstract: *This study was carried out to determine the level of soil pollution in two auto-mechanic villages in Benin City, Nigeria. Soil samples were collected in the rainy season months of July, 2012 and conventional analytical methods were employed for the determination of the physical and chemical parameters. The result revealed that TOC and TOM of the soils in the auto-mechanic village were high and above the level in the control station, indicating the presence of some organic matter and consequently micro-organisms involved in biodegradation in these sites. There was also a lower pH which was below the neutral level of 6.5 and higher conductivity values in the auto-mechanic village in comparison with the control which indicates acidity and the presence of soluble inorganic salts. Heavy metal analysis of the soil in the three stations showed the presence Fe, Zn,Mn, Pb,Cu,Cd,Cr, Ni, in the order of decreasing concentration in the soils of the auto-mechanic village all of which were above their concentration in the control soil,WHO and NESREA limit set for the concentration of the metals in soil. This study therefore shows pollution in the soils of the auto-mechanic villages which is due to the wastes generated in the auto-mechanic market.*
Keywords*: Heavy metal, Pollution, Auto-mechanic, village, Waste, Dump sites, WHO, NESREA.*

I. Introduction

A common practice in many Nigerian cities and towns is to allocate large tracts of land, sometimes reaching 5ha or more to groups of small scale auto-mechanic businesses and designate these as villages where they locate their workshops and repair yards to offer their services to the public. The larger the city the larger the number of such mechanic villages contained in it and studies have shown that there are environmental threats associated with this practice (Adekunle and Abegunde 2011). Activities conducted in these shops are typical of auto-mechanic repair shops and invariably involve working with and spilling of oils, greases, petrol, diesel, battery electrolyte, paints and other materials which contain heavy metals unto bare soil. According to Yakowitz (2008) a waste is any substance, solution or mixture for which no direct use is envisaged but which is transferred for processing, dumping, elimination by incineration or other methods of disposal.

Heavy metals are chemical elements mostly with density greater than 4 g/cm3 found in all kinds of soils, rocks and water in terrestrial and freshwater ecosystems. The very low general level of their content in soils and plants as well as the definite biological roles of most of them makes them microelements (Lacatusu, 1998).Heavy metal pollution occurs where the concentration of these elements in soils are higher than the maximum allowable concentration and this could be from a variety of sources as noted by Gazso (2001). Human economic activities such as coal and metal ore mining, chemical manufacturing, petroleum mining and refining, electric power generation, melting and metal refining, metal plating and to some extent domestic sewage are principally responsible. Some heavy metals such as Ni and Zn are essential to plants and animals in very low concentrations by serving as components of enzymes, structural proteins, pigments and also helping to maintain the ionic balance of cells (Kosolapov *et al.,* 2004). These and other trace elements are important for proper functioning of biological systems and their deficiency or excess could lead to a number of disorders.

Food chain contamination by heavy metals has become a burning issue in recent years because of their potential for accumulation in biosystems through contaminated water, soil and air. As observed by Begun *et al*. (2009), large quantities of pollutants have continuously been introduced into ecosystems as a consequence of urbanization and industrial processes. Metals are persistent pollutants that can be biomagnified in the food chains, thereby, becoming increasingly dangerous to human beings and wildlife. Therefore, assessing the concentrations of pollutants in different components of the ecosystem has become an important task in preventing risk to natural life and public health.

Literature search revealed that only few studies have been conducted on the level of soil pollution by auto-mechanic waste in Nigeria such as the study conducted in Iwo (Ipeaiyeda and Dawodu, 2008), Port Harcourt (Iwegbue, 2007), Akure (Ilemobayo and Kolade, 2008) and in the Imo river basin (Nwachukwu *et al.,* 2010). Hence, this study was conducted as there is a need for evidence from studies in more cities so that a more definitive conclusion can be made on the level of soil pollution by auto-mechanic waste in Nigeria.

II. Study Area.

Three (3) different stations were selected for this study which was carried out in Benin-City, Nigeria which is located between latitudes 06°19IE and 6°21IE of the Equator and longitude 5°34E and 5°44IE of the Greenwich Meridian with an average elevation of 77.8 m above sea-level. It has a population of about 1,147, 188 which contributes to the increased transportation needs and consequently the need for auto-mechanic villages in the City.

STATION 1

This is an uncontaminated site and is located in the faculty of life-sciences, University of Benin with coordinates 6.44602ºN of the equator and 5.59544ºE of the Greenwich Meridian with an elevation of 140m above sea level.

STATION 2

This is an auto-mechanic village located in Uwelu automobile spare parts market in Egor Local Government area and is located on 6.37683ºN of the Equator and 5.59139ºE of the Greenwich meridian with an elevation of 105m above sea level. The market is 400m by 300m in size with an estimated population of 800 spare parts dealers. Activities conducted in the market include; welding, dismantling of junked vehicles and engine gear boxes and repair of old vehicle parts by local artisans called 'Ojogwu'.

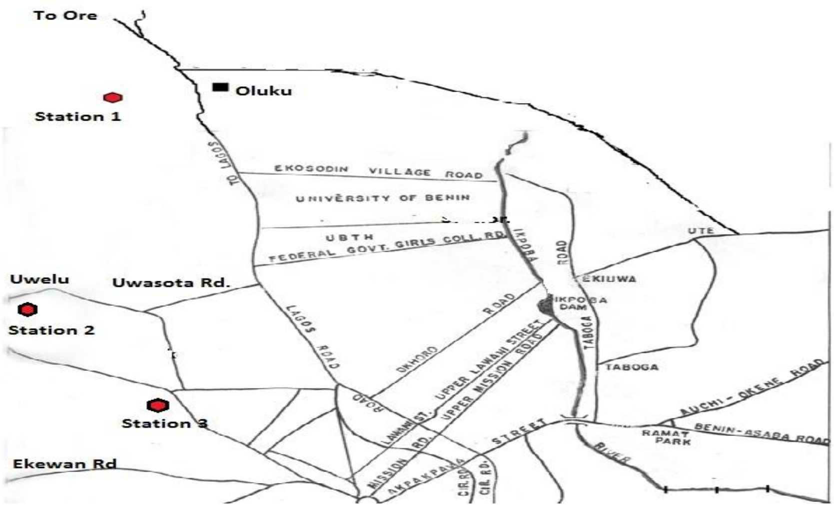
STATION 3

This is another auto-mechanic village located in Evbareke spare parts market in Egor Local Government Area and it is located on 6.36453ºN of the Equator and 5.60973ºE of the Greenwich meridian with an elevation of 100m above sea level. It was established 26 years ago and has an estimated population of 500 traders on a daily basis. Activities conducted in the market are mostly sales of brand new vehicle parts and food items. However, there are mechanic workshops within and around the market where purchased parts are fixed.

A **B**

Fig 1: **A.** Map of Nigeria showing Edo state, **B.** Map of Edo state showing Benin City, **C.**Map of Benin City showing study stations

c



III. Materials And Methods

Collection and analysis of Soil Samples

Soil samples were collected from the soil surface of the various stations with the aid of a hand trowel and transferred into previously labelled polythene bags and sealed. All the samples were transported to the laboratory where on arrival, analytical procedure commenced in earnest. These investigations were conducted in the month of July, 2012.

pH was measured using a pH meter, Total Organic Carbon and Total Organic Matter was determined using WALKLEY BLACK method. Soil texture was determined with the Bouyoucos and hydrometer method (APHA 1998). Sodium, potassium, magnesium and calcium were determined by treating 25g of the sample with 25ml of Ammonium ethanoic acid (CH3COONH4) and measured using the Atomic Absorption Spectrophotometer. Aluminium and hydrogen acidity were measured by adding 25ml of 1.0N Potassium Chloride (KCl) to 2.5g of the soil sample and treating with Sodium hydroxide (NaOH) using phenolphthalein as indicator. Heavy-Metals in the soil was analysed for using Atomic Absorption Spectrophotometer, Alpha Star Model 4.

IV. Results

Results from the soil analysis (Table 1) showed that the soil samples from the auto-mechanic villages were of the Sandy loamy texture while that of the control was loamy. TOC, TOM and conductivity were higher in the soil samples from Evbareke than those from Uwelu and both stations recorded higher values of these parameters than the control station. pH was higher in the soil from Uwelu than Evbareke, both values were lower than that of the control station. Among the Cations; magnesium and potassium had higher concentrations in the soil samples from Uwelu than those of Evbareke and these were also higher in both stations than in the control. Sodium and calcium had higher concentrations in the samples from Evbareke than those of Uwelu, and these parameters were higher in the soils of the auto-mechanic village than in the control.

Heavy metal analysis of the soils in the three stations revealed the presence of Iron(Fe),Zinc(Zn),Manganese(Mn), Lead(Pb),Copper(Cu),Cadmium(Cd),Chromium(Cr), Nickel(Ni) in the order of decreasing concentration in the soils of the auto-mechanic villages. Although, they had higher concentrations in the soils from Evbareke than those from Uwelu with the exceptions of manganese and cadmium which were higher in samples from Uwelu than Evbareke dump site. The concentrations of heavy metals in both soils were considerably higher than those of the control and were above the maximum allowable limits of NESREA and WHO.

TABLE 1: Mean results of Physical and Chemical properties of soil

PARAMETER	CONTROL	UWELU	EVBAREKE	NESREA STANDARD	WHO STANDA RD
Soil texture	Loamy Sand	Sandy Loamy	Sandy Loamy	–	–
Total Organic Carbon (%)	0.93	4.69	6.06	–	–
Total Organic Matter (%)	1.61	8.11	10.48	–	–
Conductivity (µs/cm)	44.10	87.11	112.30	–	–
Ph	7.04	5.97	5.13	–	–
Magnesium (meq/100g)	0.02	0.05	0.03	–	–
Potassium (meq/100g)	BDL	0.03	0.02	–	–
Sodium (meq/100g)	0.03	0.08	0.12	–	–
Calcium (meq/100)	0.01	0.02	0.07	–	–
Aluminum Acidity (meq/100g)	0.03	0.11	0.31	–	–
Hydrogen Acidity (meq/100g)	BDL	0.05	0.19	–	–
Iron (mg/kg)	291.231	742.621	1032.21	20	30
Zinc (mg/kg)	11.710	71.292	92.69	1	5
Copper (mg/kg)	1.152	16.270	22.83	1	
Chromium (mg/kg)	0.493	3.313	9.92	0.05	0.05
Cadmium (mg/kg)	0.062	21.421	19.86	1	
Lead (mg/kg)	0.932	15.162	33.69	1	
Nickel (mg/kg)	0.181	1.190	2.23		
Manganese (mg/kg)	14.523	54.212	30.52		0.04

BDL = Below Detectible Limit of the Equipment used.

V. Discussion

Analysis of the soil samples revealed that Conductivity was higher in Evbareke than Uwelu, and both had conductivity value that was considerably higher than the control station. This finding is in-line with the study done by Akpoveta *et al.,* (2010) for automobile dumpsites at Agbor and Abraka, Nigeria. The high conductivity may be attributed to the availability of a high amount of metal substances in the wastes at the auto-mechanic village whose content are eventually leached into the underlying soils and hence leads to an increase in the concentration of some ions such as sodium, calcium, aluminium and hydrogen in the soils as shown in table 1.

Low pH value was recorded for the soil from the auto-mechanic village in comparison to control and it was below the neutral level of 6.5 indicating that both soils were acidic. A similar report was obtained by Iwegbue *et al*., (2009) for motor mechanic waste dumps around Port Harcourt, but the values were lower than those reported by Akpoveta *et al.* (2010) in metal scrap waste dumpsites.

The high levels of total organic carbon in the soils of the auto-mechanic villages indicated the possible presence of Organic matter content which normally increases following the addition of carbonaceous substances as was the case in this study due to the presence of used oil and other carbonated fluid in the auto-mechanic villages and according to Osuji *et al.,* (2006a) this might cause an increase in the presence of soil micro-organisms which are in the business of breaking down organic compounds in soils.

Result showed that heavy metals concentrations in the soil samples were higher in the auto-mechanic village than the control. According to Nwachukwu *et al.,* (2010), engine oil and other transmission fluids collect heavy metals such as lead, cadmium, zinc, iron and copper when an automobile engine is running and they remain in the used oil. When it is discharged, it increases the concentration of heavy metals in soils and was responsible for the higher concentration in the auto-mechanic village soils than the control which is not exposed to high volume of waste engine oil. A similar result have been reported by Nwachukwu *et al.,* (2010) from Okigwe, Orji and Nekede mechanic villages in Imo state, Nigeria and by Adekunle and Abegunde (2011) from auto mechanic villages in Ibadan, Nigeria. These high levels observed may be connected with the large amounts of waste engine oil and other chemical fluids discharged in the markets, metal scrap deposits, welding and other wastes that are potential sources of heavy metals.

Iron had the highest concentration in the soils of the three stations sampled and such levels of iron concentration have also been reported by Abidemi (2011) for Automobile workshops in Osun state. The observation here confirms that most soils contain appreciable quantities of iron.

High copper (Cu) concentrations were recorded for the auto-mechanic villagein comparison to the control stations and these exceeded NESREA standard for copper in soil. This may have resulted from electrical components such as wires in addition to waste oil and according to Adekunle and Abegunde (2011), on copper rich soils only a limited number of plants have a chance of survival. This could be responsible for the absence of vegetation around the auto-mechanic village.

Lead (Pb) occurs naturally in all soils in concentrations ranging from 1 to 200 mg.kg-1 with a mean value of 15 mg.kg^{-1} (Chirenje *et al.,* 2004). Lead concentrations in this study exceeded the NESREA limit for lead in soil for the auto-mechanic village, though it was lower in the control. The lead concentrations recorded in this study were lower than those reported in other studies by Adekunle and Abegunde (2011) from some mechanic villages in Ibadan. This may be due to lower amount of used automobile batteries - which are a ready source of lead. Some exceptionally high values of lead have also been reported in the literature and most were in one way or the other connected to manufacturing sites of vehicle batteries. Adie and Osibanjo (2009) found a range of 243-126,000 mg.kg-1 in soils from the premises of a battery manufacturing plant. Nwoko and Egunjobi (2002) found Pb concentrations which were described as being highly elevated in soil and vegetation in an abandoned battery factory site. Elevated levels of lead in soils is of environmental and health concern. An example is the reported case of 10,000 mg.kg-1 found in top-soils in a village in Zamfara State, Nigeria (Purefoy, 2010). In that case, local miners, unknown to them, for a long time were bringing Pb associated with gold ores sourced from surrounding mines for processing in the village, putting the villagers at serious risk and several deaths were reported. Elevated Pb values are due to on-going lead deposition in soils within the mechanic villages and its consequent retention in the soil upper layers. This is much more obvious when the Pb values are compared to those measured at the control site and this provides further evidence that Pb is gradually building up in the soil on locations of these mechanic villages.

Cadmium was detected in all three soils but the concentration in the control soil was far lower than the auto-mechanic village. According to (Jarup, 2003, Ebong *et al.,* 2008) the presence of Cadmium could be due to the dumping of PVC plastics, nickel-cadmium batteries, motor oil and disposal sludge in the auto-mechanic village. The presence of cadmium in automobile waste dump soils have also been reported by Uba *et al* (2007) and Myung (2008).

Chromium was detected in the sampled soils for all three stations and the level was above both NESREA and WHO limit for the soils from the auto-mechanic village but below the limits in the control soil. It is one of those heavy metals whose environmental concentration is steadily increasing due to industrial growth, especially the development of metal, chemical and tanning industries. Other sources through which chromium enters the environment are air and water erosion of rocks, power plants, liquid fuels, brown and hard coal, and industrial and municipal waste. Although there is no risk of chromium contamination on a global scale, local permeation of the metal to soil, water or the atmosphere might result in excessive amounts of this pollutant in biogeochemical circulation (Wyszkowska, 2002). As observed by Ghosh and Singh (2005) the non-biodegradability of chromium is responsible for its persistence in the environment; once mixed in soil, it undergoes transformation into various mobile forms before ending into the environmental sink (Bartlett and James, 1983; Bartlett, 1988). Although Cr toxicity in the environment is relatively rare, it still presents some risks to human health since chromium can be accumulated on skin, lungs, muscles fat, and it accumulates in liver, dorsal spine, hair, nails and placenta where it is traceable to various heath conditions (Reyes-Gutiérrez *et al.,* 2007).

Nickel (Ni) had the lowest concentration in this study and it was above WHO concentration for nickel in soil, in the three stations sampled. Lenntech (2009) pointed out that the nickel content in soil can be as low as0.2 mg.kg-1 or as high as 450 mg.kg-1 although the average is about 20 mg.kg-1 which is consistent with the concentration obtained for the control station. Global input of nickel to the human environment is approximately 150,000 and 180,000 metric tonnes per year from natural and anthropogenic sources respectively, including emissions from fossil fuel consumption, and the industrial production, use, and disposal of nickel compounds and alloys (Kasprzak *et al.,* 2003) which could be responsible for the higher concentration found in the auto-mechanic village. Nickel is known to accumulate in plants and with intake of too large quantities of Ni from plants grown on nickel rich soils (such as tea, beans, vegetables), there are higher chances of developing cancers of the lung, nose, larynx and prostrate as well as respiratory failures, birth defects and heart disorders (Duda-Chodak and Blaszczyk, 2008; Lenntech, 2009). Exposures by inhalation, ingestion or skin contact occur in nickel and nickel alloy production plants as well as in welding, electroplating, grinding and cutting operations which are done in auto-mechanic workshops. In 2008, nickel received the shameful name of “Allergen of the year” (Gillette, 2008) and according to the report the frequency of nickel allergy is still growing.

In the after-effect of heavy metal pollutions, the role of pollutant bounding or leaching increases which determine their bioavailability and toxicity. Heavy metal pollution of the soil also has negative side effects on vegetation as confirmed by Anoliefo *et al.* (2001) where they showed a phytotoxic effect of soil collected from abandoned mechanic village and reported that the soil depressed and inhibited plant growth.

Finally, the higher concentrations of heavy metals in Evbareke in comparison to Uwelu auto-mechanic village may be attributed to the relative porosity of the soils or difference in ability to retain heavy metals at the soil particle surface (Lenntech, 2009).

VI. Recommendation and Conclusion

This study reveals that the physical and chemical parameters studied had higher values in soil samples from Evbareke than those of Uwelu. The study also relates high levels of heavy metals in the soils of the two stations with wastes generated from auto mechanic activities which indicate heavy metal contamination. The values of Pb obtained from this study were above the permissible level for soils by NESREA and this raises significant environmental concern and calls for urgent attention and appropriate response. Soil samples from some the waste dump sites also exceeded the regulatory limits in the cases of Cr, Cu, and Cd. Strict compliance to regulatory limits in waste to be released from these automobile markets into the environment is recommended. Also, phyto-remediation measures of soil as reported by Adekunle and Abegunde (2011) should also as a matter of urgency be started at these locations.

References

[1]. Abidemi, O. O. (2011). Levels of Pb, Fe, Cd and Co in soils of Automotive workshop in Osun State, Nigeria. *Journal of applied sciences and environmental management.***15(2):** 279-282.

[2]. Adelekan, B. A. and Abegunde, K. D. (2011). Heavy metal contamination of soil and ground water at automobile mechanic villages in Ibadan, Nigeria. *International journal of physical sciences.***6(5):** 1045-1058.

[3]. Adie GU, Osibanjo O (2009). Assessment of soil pollution by slag froman automobile battery manufacturing plant in Nigeria. Afr. J. Environ. Sci. Technol., 3(9): 239-250.

[4]. Akpovata, O. V., Osakwe, S. A., Okoh, B. E. and Otuya, B. O. (2010). Physico-chemical Characteristics and Levels of Some Heavy Metals in Soils around Metal Scrap Dumps in some parts of Delta State, Nigeria. *Journal of applied sciences and environmental management.* **14(4):** 57-60.

[5]. Bartlett RJ, James B (1983). Behavior of Chromium in Soils: VII. Adsorption and Reduction of Hexavalent Forms. J. Environ. Qual., 12 (2): 177-181.

[6]. Bartlett RJ (1988). Mobility and Bioavailability of Chromium in Soils. Adv. Environ. Sci. Technol., 20: 267-304.

[7]. Begum A, Ramaiah M, Harikrishna, Khan I, Veena K (2009). Analysis of Heavy Metals Concentration in Soil and Litchens from VariousLocalities of Hosur Road, Bangalore, India. E-J. Chem., 6(1): 13-22.

[8]. Chirenje T, Ma L, Reeves M, Szulczewski M (2004). Lead Distribution inNear- Surface Soils of Two Florida Cities: Gainesville and Miami. Geoderma, 119: 113–120.

[9]. Duda-Chodak A, Blaszczyk U (2008). The Impact of Nickel on HumanHealth. J. Elementol., 13(4): 685-696.

[10]. Ebong, G.A., Akpan, M.M. and Mkpene, V.N (2008). Heavy metal content of municipal and rural dumpsite soils and rate of accumulation by Carica papaya and Talinum triangulare in Uyo Nigeria. E-Journal of Chemistry, 5(2) : 281-290.

[11]. Ghosh M, Singh SP (2005). Comparative Uptake and Phytoextraction Study of Soil Induced Chromium by Accumulator and High Biomass weed Species. Appl. Ecol. Environ. Res., 3(2): 67-79.

[12]. Gillette B (2008). Nickel named ‘Allergen of the Year’. ACDS adds to listof substances warranting more attention. Dermat. Times, 4: 15-16.

[13]. Heinike HJ, Eckelman W, Thomasson AJ, Jones RJA, Montanarella L, Buckley B Gazso LG (2001). The Key Microbial Processes in the Removal of ToxicMetals and Radionuclides from the Environment. *J. Occup. Environ. Med.*, 7(3): 178–185.
[14]. Ilemobayo O, Kolade I (2008). Profile of Heavy Metals from AutomobileWorkshops in Akure, Nigeria. J. Environ. Sci. Technol., 1: 19-26.
[15]. Imegbue, C. M. (2007). Metal fraction in soil profiles at automobile mechanic waste dumps around Port Harcourt. *Waste management resources***25**(6):585-593.
[16]. Ipeaiyeda, A. R. and Dawodu, M. (2008). Heavy metal contamination of top soil and dispersion in the vicinities of reclaimed auto-repair workshops in Iwo, Nigeria. *Bull. Chemical society of Ethiopia* **22**(3): 339-348
[17]. Jarup, L. (2003). Toxicity of heavy metals and sources in the environment. British MedicalBulletin 68: 167 – 182.
[18]. Kasprzak KS, Sunderman Jr FW, Salnikow K (2003). NickelCarcinogenesis. Mutat. Res., 533: 67-97.
[19]. Kosolapov DB, Kuschk P, Vainshtein MB, Vatsourina AV, Wiebner A, Kasterner M, Miler RA (2004). Microbial Processes of Heavy Metal Removal from Carbon Deficient effluents in constructed wetlands. Eng. Life. Sci., 4(5): 403–411.
[20]. Lacatusu R (1998). Appraising Levels of Soil Contamination and Pollution with Heavy metals. Env., Sci. **45:** 453-567
[21]. Lenntech, W. T. (2009). Chemical Properties, Health and Environmental Effects of Copper. Lenntech WaterTreatment and Purification Holding B. V. www. Lenntech . comeriodic/element/cu.htm
[22]. Myung, C.J.(2008). Heavy metal concentrations insoils and factors affecting metal uptake by plants in the vicinity of a Korean, CU-W Mine. Sensors 8, 2413-2423.
[23]. Nwachukwu, M. A., Feng, H. and Achilike (2010). Integrated Studies for Automobile waste Management and Environmentally Friendly Mechanic Villages in the Imo River Basin, Nigeria. *African Journal of Environmental Science and Technology.***4(4):** 234-249.
[24]. Nwoko CO, Egunjobi JK (2002). Lead Contamination of Soil andVegetation in an Abandoned Battery Factory Site in Ibadan, Nigeria. J. Sustain. Agric. Environ., 4(1): 91-96.
[25]. Osuji LC, Iniobong DI, Ojinnaka CM (2006a). Preliminary investigationof Mgbede-20 oil-polluted site in Niger Delta, Nigeria. Chem. Biodiv.3: 568-577.
[26]. Purefoy C (2010). Lead clean-up in Nigerian Village is Life-or-DeathRace Against Time. Cable News Network.
[27]. Reyes-Gutiérrez LR, Romero-Guzmán ET, Cabral-Prieto A, Rodríguez- Castillo R (2007). Characterization of Chromium in Contaminated SoilStudied by SEM, EDS, XRD and Mössbauer Spectroscopy. J. Miner. Mater. Characterization Eng., 7(1): 59-70.
[28]. Uba, S., Uzairu, A., Harrison, G.F.S., Balarabe, M.L.and Okunola, O.J.(2008). Assessment of heavy metals bioavailability in dumpsites of Zaria metropolis, Nigeria. African Journal of Biotechnology, 7(2) : 122-130.
[29]. Wyszkowska J (2002). Soil Contamination by Chromium and itsEnzymatic Activity and Yielding. Polish J. Environ. Stud., 11(1): 79- 84.
[30]. Yakowitz, H. (1988). Identifying, Classifying and Describing Hazardous Wastes. *United Nation Environmental Programme.* **2:** 345-897