ASSESSMENT FOR POTENTIAL HEAVY METAL CONTAMINATION IN SOILS FROM SELECTED AUTOMOBILE WORKSHOPS IN LAFIA, NASARAWA STATE

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Received: April 14, 2011; **Accepted:** September 18,2011

Abstract

Heauy metals content in soil from two automobile workshops and virgin land within Lafia in Nasarawa State were determined using x-ray fluorescence spectrometry method. Values obtained showed the metal concentration ranges; Ft 1.510-8.882 mffcf[1]/ *Cu* 0.047-0.36 mgkg[1]; *Ni 0.15-0.20 mgkg'; V 0.002-0.028 mgkg[1]; Mn 0.03-0.147 mgkg[1]; Cr* 0.020-0.054 *mgkg'; Ea 0.040-0.245 mgkg[1]; Zn* 0.002-0.144 *mgkg'; Mg 0.050-0.090 mgkg[1] and Pb 0.00-0.175 mgkg[1]. Fe and Pb had the highest concentrations in the auto sites considered. Although, an irregular variation in concentration was observed within the sites, most of the metals did not exceed their respective critical limits in soil. However, their continuous accumulation could pose a serious environmental threat if the situation remains uncontrolled.*

Keywords: *Heavy metal, au tomobile, soil, Lafia*

INTRODUCTION

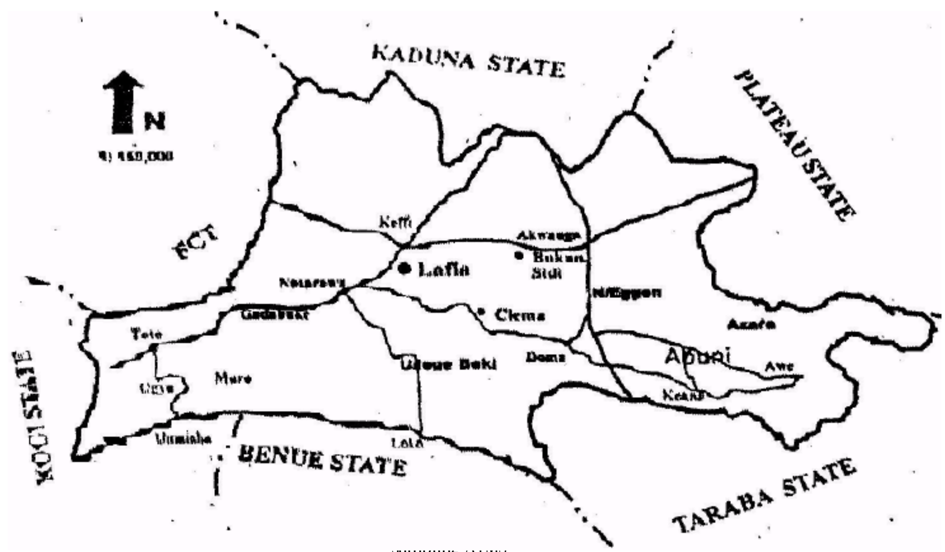
Advancement in technology has led to high level of industrialization leading to discharge of heavy mvuJv mta nur environment. The worldwide demand for lubricating oil for vehicle engines and mnrhmciics paftg and Other processes used in passenger's cars and heavy goods vehicle stands at about 3.5 million tons (Ademoroti, 1996). Presently in Nigeria, one of the major sources of poll tmavy mrtnl pollution iS aUtO-Hiechanical activities (Adcfliyi and Afolabi, 2002) During activities like overhauling of vehicle engines, metal fabrication and automobile panel beating, reasonable amount of spent engine oil and metal s nrr deposited Ott tOp Soil (T«resa *>t al_, Paintinw of vehicles «nd tyre vulcanizing iirg other activities that negatively affect th« qualities of 96ll9 arOUnd automobile workshops ,5wil pollutgil with spent engine oil had reduced snil mirrnbtfll ftCtiVity and Soil fertility status (MoCrath et al., 1995) In addition, increased automobile rcpflira/VTOrUshopS activilips in Nigeria due mainly to lar^ inflow of uocd vpmcW lulu Ihr Country **in** the lat« 1990s contributed markedly to the problem Of soil Cymamuuniiin In most cities. Automotive service and repair Shops ary amon^ the largest amall quantity generators Of haiardoim wastes, such na uwrl nil ond HuldSi difty Shop raf^s, used parts, asBCStOSJ from braVn pads and waste from solvents used tor cleaning: paftS arc litWrud within those nrwat (Ailt>morotl, 1'}%). Automobile used (wastp) oil contain oxidation products, and other metallic particlrs resulting ffOm machlnwry wpars, organic and inorganic chemicals used in oil additives and metals that are present in fuel are transferred to the crankcase during combustion (EEA, 2007). Wear metals that are formed in lube oils under harsh conditions becomes slightly oxidized, forms salts with the degradation products of the oil being soluble in the soil. The friction of motion in machinery causes micro-fine particles to shear off the surface and becomes suspended in the oil (Anonymous, 1995). The most dangerous waste commonly created in auto repair shops are from the solvents used to clean parts; most of the chemicals that make up the solvent are extremely dangerous to human and the environment and are usually expensive to dispose of and sometimes hazardous (Imevbore and Adeyemi, 1981). Used oil may contain components such as lead, cadmium, barium and other potentially toxic metals (Edeblri and Nwankwo, 1981). Spent engine oil runoff indirectly increases the native concentrations of some heavy metals (Adewole, 2006). 'ITic degraded soil leads to low crop yield (Rainbow, 2007) and reduced crop 'quality (Ad eoye et al., 2005). If not handled properly these chemicals can find their way into the air, soil, lakes and streams. (Adeniyi and Afolabi, 2002; Kadem ct al., 2004). Heavy metal pollution refers to cases where the contents of these elements in soils are higher than the allowed or permissible maximum concentration, which has harmful effects (Lentech, 2005). In almost all the towns in Nasarawa State, automobile workshops are found scattered all over the city, all categories of unprocessed wastes such as lubricating oil, junked cars, tyres, spare parts are indiscriminately dumped on every available space which are found to litter all parts of the workshops. Unfortunately, many of the available soils near these workshops are being cultivated particularly with maize, cassava and vegetables. This study is aimed at comparing the heavy metals load in soils from different auto-repair sites and undisturbed soil as control hence providing information on the quality of soil in the area.

MATERIALS AND METHODS

Study Area

Th« study a«a is Lafia town, Nasarawa State, Nigeria. The study area is situated within the Lafia town located on longitude 8° 31 East and latitude 8° 29 North, The area is accessible through the major road from Keffi-Akwanga (Fig.l).

on the bench, decomposing object such as stick, stone were completely removed. The soil samples were left on a bench for four days to properly air dry at room temperature. 20.00 g of the dried sample was finely ground to pass through a 200-250 mesh sieve, dried in an oven at 105°C for Ih and cooled. There after the sample was intimately mixed with a binder in the ratio of 5.0 g sample to l.Og cellulose flakes and palletized at a pressure of 10-15 ton/inch in a palletizing machine. The prepared samples were analysed for the metals using energy dispersive x-ray fluorescence spectrometry (ED-XRFS) (MiniPAL 4 model (c) 2005). The metals present in the sample were identified from the energies of their characteristic radiation and concentrations evaluated from intensity measurements (Cooper, 1984).



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. 1 . Sample Location Map showing Latin Town and the sampling areas

Sample Collection

Pour soil samples were collected form two automobile workshops and one sample from vlrjrln liiinl MS * innlrol in each site making a total of Hvc samples designated as LA1-LA5 from Bukan Sidi and LB1-LB5 from fl^ma Doma road (1'ig 1) The soil samples were acoopcd out from a flCpth Of 15 Cm UEttlK uhrum«-plate trowel at interval of 15m and stored in properly labelled- I ii ily tlisme bags for analysis.

Sample Preparation and Analysis

Smnll quantity of each representative soil samples placed In a separate clean paper for air drying

RESULTS AND DISCUSSION

The volume of work done in the different auto-repair shops has direct relationship with the heavy metal concentrations in each sample. Results of heavy metals in automobile workshops from BukanSidi and Clema are presented in Tables 1 and 2 while Table 3 is the normal and critical ranges of metals in soils .Earlier studies in auto repair workshops aimed at determining the levels of heavy metals in soils have been carried out by many authors (Teresa et al., 2005; Olayiwola, 2011; Oguntimehin and Ipinmoroti, 2008; Kabata-Pendias, 1995; Ewers, 1991).

The values of Fe obtained ranged between 6.581-7.833 mgkg'1 ± 0.637, CV% 8.930 and 7.064 8.882 mgkg-1 ± 0.799, CV% 10.293 from Bukan Sidi and Gema automobile workshops (Tables 1 and 2). The result obtained showed that the metal has higher concentration in all the two automobile workshops than the rest. The auto repair sampling sites showed higher concentrations of the metal than the t^ntrol site, though the level of the concentration is wtthin the tolerance limit (Table 3). The abundance of the metal in the sampling locations could be due to its relative abundance in soil or the anthropogenic source from the metal junkyard fftiwd in the auto mechanic site, Used oils that sink into the ground as leachates contain high proportion of Fe and Zn (Ogumimehin and Ipinmoroti, 2008) .Fe and Ni can be deposited from crankshafts wears and engine body damage (Anonymous, 1995). The control sites have lower values of the metal when compared with the automobile sites. Fe being relatively abundant in nature has no contamination/pollution (C/P) value, although Fe is not excluded in regards to toxicity in the environment (Department of Petroleum Resources,1991).Fe is an essential element required for respiration, photosynthesis and mnny other cellula* functions (Lenntech, 2005).

Next in abundance to Fe were Pb and Cu. Lead values ranged between 0.136-0.155 mgkg" ± 0.007, CV% 5.356 and 0.126 0.175 mgkg"1 ± 0.021, CV% of 14.328 from Bukan Sidi and Clema automobile workshops. Pb was not detected in the control samples ^Tables 1 and 2) .It has been reported that Pb has the highest composition of heavy metals in waste oil (Anonymous, 1995). Expectedly, the highest 'concentration of Pb was found in the samples LA1 LAS, LB1 and LB2 auto sites (Tables 1 and 2) .This study correlates with an earlier one carried out by Kloke (1980), Kabata-pendias (1995) and Ewers (1991). Unlike Fe, lead distribution follows a regular pattern predicated by the volume of work been carried out in the auto shop. Cu, Pb, Sb and Sn can be deposited to the soil from babbit metal bushing and metal bearing wears (Oguntimehin and Ipinmoroti, 2008). Generally, Pb added to gasoline in tetraethyl form as antiknock agent can be deposited from exhaust pipes in automobile workshops 0ensen, 1992). Pb is widely spread soil, plant and water contaminant, it enters the soil from many sources, it is a well-known toxicant that has several deleterious effect even at low concentration and has no known function in biochemical processes. Values obtained from the sampling locations have not exceeded the guideline limits of between lOO^OOmgkg"1 but may

Table 1: Concentrations of Heavy Metals in Soil Samples at Bukan Sidi Automobile Workshop

SUmplp	Fe	Cu	Ni	V	Mn	Cr	Ba	Zn	Mg	Pb
I .Al	1.510	0.047	ND	0.022	0.038	0.020	0.071	0.002	0.078	ND
T A?	7,833	0.119	0.015	0.028	0.092	0.040	0.089	0.128	0.090	0.155
1 A3	6,644	0.115	0.023	0,002	0.108	0.034	0.089	0.120	0.084	0.145
T A4	6,581	0.119	0.015	0.022	0.108	0.040	0.143	0.104	0.078	0.145
1 -Ab	7,483	0,127	O.U23	0,022	0.085	0.034	0.062	0.120	0.084	0.136
fuVnn	7,1 W	0125	0.019	0,023	0.098	0.037	0.095	0,118	0:084	0.145
' in	5MST	±n.no7	±0.051	±0.003	±0.011	±0.003	±0.033	±0.010	±0.004	±0.007
]	Wi»^30	6127	2.681	13.282	11 856	9.362	35.773	8.530	5.832	5.356

Where LA1	ControlSample
LA2-LA5	B.ukan fiidi Automobile workshop samples
NH	Not detected
bO	StanrWd deviation
rv	**Coefficient Of variation**

Table ^-Concentrations of Heavy Metals in Soil Samples at Clema Automobile Workshop

Sample	Fe	Cu	Ni		Mn	Cr	Ba	**Zn**	Mg	Pb
LB1	1.902	0.047	0.030	0.019	0.030	0.013	0.040	0.004	0.072	ND
LB2	8.882	0.120	0.160	0.016	0.147	0.054	0.179	0.160	0.06	0.175
Lb3	7.344	0.140	0.080	0.028	0.082	0.042	0.240	0.090	0.050	0.165
LB4	7.064	0.220	0.200	0.013	0.092	0.034	0.082	0.144	0.072	0.126
LB5	7.763	0.360	0.040	0.020	0.100	0.047	0.151	0.124	0.050	0.145
Mean	7.763	0.210	0.120	0.019	0.104	0.044	0.163	0.129	0.059	0.152
SD	±0.799	±0.108	±0.075	±0.006	±0.028	±0.008	±0.066	±0.028	±0.009	±0.021
CV%	10.293	51.87362.657		34.643	27.718	19.150	40.550	22.20716.257		14.328

Where LB1 LD2-LD3 ND SD cv

Control Sample

-Clema Automobile workshop samples

Not detected

Standard deviation

Coefficient of variation

Table 3: Normal and Critical Range of Metals in Soils (mgkg1) Kabata (1984); MB = Not specified

Element	Normal range in soil	Critical range in soil
rb	2 300	100 400
Z,n	1 900	70 400
Ni	2 750	100
Mn	20 1000	1500 3000
Lu	2 250	60 125
Hfl	625	NS
Te	7(K)[]-55i)()()	NS
Cr	5 1500	75 100
V	3 500	50 100

become toxic over time (Table 3).

Values for Cu obtained ranged between 0.119-0.135 mgkg¹ ± 0.007, CV% 6.127 and 0.120-0.360 mgkg'¹ ± 0.108, CV% 51.873 (Tablesl and 2). Result obtained indicated significant concentration in the sampling sites within the normal range with the automobile sites having higher concentrations than the control samples; this is an indication *of* addition from-auto repair activities in the area. Cu, Fe, Pb, and Zn showed a significant (C/P) value proportional to the level of work in the different auto shops as BSUblished by Lacatusu (1998). Cu is specifically absorbed or fixed tn soil, higher concentration of Cu in tlw soil is usually an indication of addition from smelters, fertiliecrs, sewage eludge and other wastes (Dragun, 1988).Most soils contain only 20-30 mgkg¹ total copper (Gilkes, 1981).

Cr values obtained ranged between 0.034 0.040 mgkg' ±0.003, CV% 9.362 and 0.034 0.054 mgkg'¹ ±0.008, CV% 19.150 (Tables 1 and 2). These values indicated a low concentration in all the sampling media not in significant concentration when compared to the control sites where lower concentration* were observed. Although ,used oils that sink into the ground as leachates contain high prvporiinn, of these mctalii Cu, Pb and Sb from Iwiinit metal ftruGhings,Cr and MO from piston nng3 and BOals, Cu and Sn from metal bearing WCarG iWi and PB from crankshafts wear and engine body uanif.gr (Anonymous,l995) Cr is known to po«« tmcic effect to its consumers when ingested.

zn showed a yiywfkant concentration frum Bukan fildi and Cluuu automobile workshops with ranged Values of 0,lQi-01 *m* mgkg' ±0.010, CV% 8.530 and nnqn.m$_n$n mgkg-' ± 0.028,cv% 22.207 when compared w tlw control sites (Table 1,2 and 3) Zn W^v pi udominnntly prCGCm in all tlw sites in almost the some concentration but irrrguiar in site LB2.In thiB study tun metal showed a minimal risk to the nmuimnmcnt. However, tlw mctiii concentration may Uoconw lii^U whpn it is not controlled. En ess 7n i an-result in flOflftC health complirations 3UCh as fatiijuyi diMiiiwss and ncutropcnia (HPSS and Ek:hmid>2UUil),

RwnUotitalnrii for Mnran^odlwtwHRnO.OSS-O.lOH mgkg;^<+0.01i,CV% 11 S'lnand 0.082 O.M/mgkp;'¹* o.fl5fl$_r$ CV% Z7.71B rCSUectivoly (Txblesl $_{fl}$nd 2). The Mn COnOWntrallon is insignificant &S Indkaled in the result .Lower Values of thw metal may be due to the naWty uf **n*\\ in thr nrca Or thC Volume of activities involving the metal in ihp ^uto shop. High levels; of Mn *are* known to OCCUJ for Soil rlrh in iron oXldGS or hydroxides (Alma and Henry, 1983)

The values of Xi ranged between 0.040-0.20C mgkg" "' ± 0.075 ,CV% 62.567 and 0.015-0.023 mgkg" ± 0.051,CV% Z684 3.1;Mg ranged from 0.050-0.072 mgkg¹ ± 0.09, CV% 16.26 and 0.084-0.009 mgkg¹ ± 0.004, CV% 5.83; Ba 0.062-0.143 mgkg¹ + 0.066, CV% 40.55 and 0.082-0.240 mgkg¹! 0.033, CV% 35.77; V 0.002-0.028 mgkg¹ ± 0.006, CV% 34.64 and 0.013-0.028 mgkg¹ ± 0.003,CV% 13.28 (Tables 1 and 2).All these metals seems to have the same lower concentrations with a regular distribution pattern, especially in site LA1-LA5 while an irregular distribution pattern was observed for Ba and Ni in LBl-LB5,respectively.In site LA1 Ni was below the detection limit of the instrument used for the metal analysis, this is surprising as all other sites had Ni. The age of the mechanic workshops seem to have direct relationship with the variations of these metal concentrations.

Similarly, the results obtained from the two automobile workshops indicated that Clema ranked highest in terms of concentrations of Fe in sample LB2-LB5 and lowest in Ba, Pb, Cr and V concentrations while Bukan Sidi ranked highest in Fe, Pb, Cu, lowest in V concentrations. Also, all the metals in the sampling sites were within the normal ranges (Table 3). In addition, a comparison of the values of these metals from the automobile workshops with control sites and their mean indicated lower concentrations in the former than the later, except for Mg in Clema auto-site with ranged value of 0.059 0.009 mgkg¹. The observed trends above may be as result of varying factors such as age of site, type of soil formation and possibly the work load of automobile activity on the sites (Ewers, 1991)

CONCLUSION

Based on the result presented and observations made, the mechanic workshops acted as anthropogenic sources of the heavy metals to the Lafia sample soils. And may pose serious threat to the environment .To curb this menace, the premises of the auto-mechanic workshops should be properly cemented to avoid seepage into the soil. The used oil and other waste from the auto repair could be re-processed to remove the heavy metals in an environmentally friendly manner. Consequently, stricter environmental protection laws are to be observed in this regard.

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