

## Assessing Levels of Hazardous Metals in Soil and Medicinal Plant Samples from Asafo, Suame and Asante-Mampong Auto-Mechanic Workshops



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### Abstract

Contents of hazardous metals (Pb, As and Cd) were assessed in medicinal plants and soil samples from auto-mechanic workshops and background soils in Suame and Asafo suburbs of Kumasi and Asante-Mampong the administrative capital of Mampong - Municipal, Ghana with Atomic Absorption Spectrophotometer. Geo-accumulation index ( $I_{geo}$ ) by Muller was employed to determine the extent of contamination. SAWS was uncontaminated with As ( $I_{geo} = -2.43$ ), "moderately to heavily contaminated" with Pb ( $I_{geo} = 2.79$ ) and Cd ( $I_{geo} = 2.26$ ). MAWS was uncontaminated with Pb ( $I_{geo} = 0.02$ ), Cd ( $I_{geo} = 0.69$ ) and As ( $I_{geo} = -1.38$ ). AAWS was "moderately to heavily contaminated" with Pb ( $I_{geo} = 2.84$ ) and Cd ( $I_{geo} = 1.18$ ) but uncontaminated with As ( $I_{geo} = -1.38$ ). The mean concentration range of Pb recorded for medicinal plants samples at SAWS (2.48 - 38.97)  $\mu\text{g g}^{-1}$ , AAWS (1.64 - 18.16)  $\mu\text{g g}^{-1}$  and MAWS (5.92 - 19.24)  $\mu\text{g g}^{-1}$  were above the normal medicinal plant Pb concentration (0.2  $\mu\text{g g}^{-1}$ ) but below the critical plant concentration (30 - 300)  $\mu\text{g g}^{-1}$  with the exception of *Terminalia catappa* at SAWS. Mean Cd and As levels recorded at SAWS, AAWS and MAWS were within the normal range of medicinal plant Cd and As concentration of (0.1 - 2.4)  $\mu\text{g g}^{-1}$  and (0.02 - 7)  $\mu\text{g g}^{-1}$  respectively. The analysis of transfer factor, which was calculated as the ratio of hazardous metal concentrations in medicinal plant to those in the corresponding soil, indicated the uptake capabilities of hazardous metals from soil to medicinal plant. The highest transfer ratios of Pb (0.38 - 33.58) was recorded at MAWS while As (0.25 - 2.92) and Cd (0.95 - 4.07) was measured at SAWS.

**Keywords:** Hazardous metal; Medicinal plants; Geo-accumulation index ( $I_{geo}$ ); Transfer ratio

### Introduction

Hazardous metals are widely distributed in the Earth's crust and are classified among serious pollutants within the natural environment. Recently, the presence of hazardous metals in the ecosystem has become a global concern due to the perilous effects they pose to humans and other organisms when allowable limits are exceeded, persistence and potential bioaccumulation. Hazardous metals are capable of decreasing crop production due to the risk of bioaccumulation and biomagnifications in the food chain (Wuana and Okiye, 2011). Reports on dangers exhibited by Fe, Pb, Cr, Zn, Cu and presence in soils have been documented (Akoto et al., 2008). Natural activities such as atmospheric deposition and weathering contribute to the amount of hazardous metals in the vicinity. Through weathering from natural rock formations they spread widely in the environment, occurring in particulate or dissolved form in soils, water bodies and sea floor sediments. Volcanoes also release hazardous metals into the atmosphere. For example Cd enters the atmosphere through natural processes such as weathering and a volcanic emission is then deposited by precipitation into water bodies. These toxic chemicals can enter the environment through anthropogenic sources like application



of fertilizers, agrochemicals and other substances employed for soil amendment (Sofianska et al., 2013 and Senesi et al., 1999). Auto-mechanic workshops are perceived as sources of environmental hazardous metal pollution as activities such as welding and soldering, painting, repairing of lead accumulator cells by mechanics release hazardous metals into the environment (Pam et al., 2013). The disposal of spent lubricating oil, used vehicle brake parts, galvanized parts like fuel tanks and burning of tires increase the quantity of these toxic substances. Indiscriminate disposal of used computers and other electronic gadgets from electronic or auto-electrical workshops also accounts for the presence of hazardous metals in the environment. Once released into the ecosystem they can be washed into water bodies (both underground and surface) during rainfall affecting water quality and biota. According to Schmitt & Brumbaugh, 1990, whole fish samples from 109 streams in United States revealed high Zn and Cu content from Manoa streams.

Seventy percent of Ghanaians employ medicinal plants and other herbal products for the management of both complex and simple diseases. Ghana's doctor-patient ratio is approximately 1:15, 259 patients per year (Citifmonline.com, 2014). The high doctor-patient ratio in the country reduce quality of care patients receive from doctors. Other health care workers such as "physician assistants" attend to 38,000 per year. Midwives and nurses also attend to 6000 and 1400 patients respectively in a year (Citifmonline.com, 2014). The current high costs of medical care and living in Ghana are fertile grounds to force patients to employ medicinal plants/herbal products to treat diseases. Traditional Medicine Practitioners are found in most Ghanaian communities (CDIP, 2014) making them more accessible to the patients.

Inhabitants of Suame, Asafo and Asante- Mampong and neighboring towns employ medicinal plants located at the auto-mechanic workshops to treat their ailments. Studies undertaken by researchers had revealed high content of hazardous metals such as Pb, Cd and As in auto-mechanic workshop soil (Adewole and Uchegbu, 2010). Medicinal plants absorb hazardous metals, store them in their tissues and are transferred to humans and other organisms through continuous ingestion (O'Neil, 1990). Elevated hazardous metal concentration in the raw materials and soils may imply that consumers are ingesting toxic chemicals which are deleterious to their health. Since limited study had been embarked upon to assess the extent of contamination of medicinal plants and soils at the auto-mechanic workshop the current was carried out.

## Materials and Methods

### Study Areas

The study was carried out at Suame and Asafo auto-mechanic Workshops, Kumasi and Mampong auto-mechanic Workshop at Asante- Mampong. Kumasi (6°35'N - 40°N, 1°30'W) is the capital town of Ashanti Region of Ghana and is situated at 250-300 m above sea level. It is the second most populous city after the nation's capital, Accra. It is estimated to have a population of two million, twenty-two thousand nine hundred and nineteen (2,022,919) and covers an area of two hundred and fifty-four square kilometers (254 km<sup>2</sup>). Suame auto-mechanic Workshop is made up of a cluster of Micro-, Small- and Medium- Scale enterprises with specialty mainly in vehicular repairs

and metal works. It occupies an area of 20 square miles. There are about 12,000 businesses and a work force of about 200,000. Asafo auto-mechanic workshop is also popular but covers a smaller area in comparison to Suame, but larger than Mampong auto-mechanic workshop. Asafo auto-mechanic workshop had a working population of 12,000. Mampong is the administrative capital of Asante-Mampong of Sekyere - West Municipal Assembly. Besides the sale of vehicular spare-parts, repair of lead accumulator cells, engineering materials, welding and other artisanal work are many women who sell food at these sites (Dartey et al., 2014). Mampong is 50 km north of Kumasi. The municipality is located within longitudes 0°05'W and 1°30'W and latitudes 6°55'N and 7°30'N, covering a total land area of about 2346 km<sup>2</sup> with a population more than 88,000 (Ghana districts, 2012).

### Sample Collection, Pretreatment and Analysis

Soil samples were collected at (0 to 0.15) m depth at the selected auto-mechanic sites since according to (Krishna & Grovil, 2007) hazardous metals contaminate top layer of soils at a depth of (0 to 0.40 m). Ten representative soil cores and medicinal plant samples (bark) were collected (Agyarko et al., 2010). This process was repeated at background sites (1000 m away). Medicinal plant samples were obtained from where soil samples were obtained. Medicinal plants samples were washed with distilled water to free them from contaminants. They were solar dried for 72 hours, crushed with a wooden mortar and pestle and sieved using a 2 mm mesh. Collected soil samples were solar dried for 48 hours and crushed down with pestle and mortar. They were sieved using 2 mm mesh. Soil and medicinal plant samples were kept in polyethylene bags. Samples were placed in well labeled plastic bottles and transported to Center for Scientific and Industrial Research (CSIR) - Soil Research Institute (SRI), Kwadaso, Kumasi for analysis.

Digestion and analysis were carried out at Council for Scientific and Industrial Research -Soil Research (CSIR-SRI) at Kwadaso, Kumasi, Ghana. Dry Ashing method of digestion was adopted from the protocol of Perkin -Elmer manual for atomic absorption spectrophotometry. This involved weighing 8g each of the selected medicinal plant samples into crucibles made of porcelain. The contents of crucibles were dried at 110°C and moistened with magnesium nitrate (50% w/v). Ashing started immediately in a controlled muffle carbolated furnace at a temperature of 450°C and left overnight to ensure complete oxidation of organic components of the sample. The ash of each sample was dissolved in 20 ml of concentrated nitric (HNO<sub>3</sub>) and perchloric (HClO<sub>4</sub>) acids in a ratio of 9:4 in a 200 ml digestion tube. It was then heated in a block digester to allow thorough dissolution of ash in acid. Heating continued until the brown fume of nitric acid ceased and the sample turned clear. The digestion was stopped and distilled water added to obtain a total volume of 20 ml. The final solution was filtered through a 0.45µm pore size membrane filter paper (Whatman filter paper No. 41) to obtain a particle-free solution. Heavy metal concentration were determined (in triplicates) using VARIAN SPECTRA AA220 Zeeman Atomic Absorption Spectrometer (AAS) (Varian Canada Inc). The instrument setting and operational conditions were in accordance with the manufacturers specifications.

**Data analysis**

The geo-accumulation index, (I-geo) was employed to evaluate the extent of pollution of hazardous metals in soil samples. The geo-accumulation index relation employed was:

$$I_{geo} = \log_2 (C_n \text{ Sample} / 1.5 \times B_n) \text{ (Muller, 1969)}$$

Where,

$C_n$  = measured concentration of metal in the soil ( $\mu\text{gg}^{-1}$ )

$B_n$  = background value of heavy metal in  $\mu\text{gg}^{-1}$ ; and 1.5= background matrix correction factor.

The transfer factor is the ratio of the concentration of a specific metal in the plant to the measured concentration of that metal in the soil (Agyarko et al., 2010; Chojnacka et al., 2005).

**Results and Discussion**

**Soil Metal Content**

Soil is regarded as an important resource for providing fundamental human needs, food and habitable environment (Wild, 1995). Rural and urban soils may accumulate hazardous metals released into the ecosystem. These hazardous metals are non-biodegradable and persist in the soil for a long time (Kirpichtchikova et al., 2006). Accumulated hazardous metals beyond permissible levels through anthropogenic activities have adverse effects on organisms (D'Amore et al., 2005). Soils from the study areas exhibited variation in Pb, Cd and As contents (Table 1). It could be inferred that auto-mechanic workshop soils had higher metal load in relation to the background soils with the exception of few. Lead is a poisonous hazardous metal with retention time 150- 5000 years (Sobolev and Begonia, 2008). While AAWS contained the highest Pb content ( $161.07 \mu\text{gg}^{-1}$ ), the lowest ( $6.62 \mu\text{gg}^{-1}$ ) was obtained in SBS and ABS. Both MAWS and MBS recorded Pb amounts ( $17.63 \mu\text{gg}^{-1}$ ) and ( $11.54 \mu\text{gg}^{-1}$ ) respectively. Soil Pb levels ( $6.62 - 169$ )  $\mu\text{gg}^{-1}$  was within the normal range values for soil Pb (2 - 300)  $\mu\text{gg}^{-1}$  (Radojevic and Bashkin, 2006).

Cadmium concentration ( $2.10 \mu\text{gg}^{-1}$ ) the highest among the soil samples was observed in AAWS. Suame auto-mechanic workshop and ABS had same Cd level ( $0.43 \mu\text{gg}^{-1}$ ). Cadmium content in the rest of the samples was SBS ( $0.03 \mu\text{gg}^{-1}$ ), MAWS ( $1.80 \mu\text{gg}^{-1}$ ) and MBS ( $0.60 \mu\text{gg}^{-1}$ ).

Arsenic is a toxic metal with no known function in the human body. If the rate of accumulation becomes higher than the body's ability get rid of the metals they become toxins. Ingestion of sub-lethal doses of As may result in bone marrow depression and haemolysis (IPCS, 1980). Arsenic amounts ( $0.11 - 1.80$ )  $\mu\text{gg}^{-1}$  fell within ( $0.1 - 40$ )  $\mu\text{gg}^{-1}$  the normal range for soil As. Asafo auto-mechanic workshop soil had highest As content ( $1.80 \mu\text{gg}^{-1}$ ) while a lowest value ( $0.11 \mu\text{gg}^{-1}$ ) was recorded in MWS. Suame background soil (SBS) and ABS unusually had

higher As content ( $0.91 \mu\text{gg}^{-1}$ ) than SAWS ( $0.12 \mu\text{gg}^{-1}$ ) and MBS ( $0.29 \mu\text{gg}^{-1}$ ).

Emissions from vehicles are deemed as a major source of contamination at auto-mechanic workshops (Adriano, 2001). Repairs and servicing, spraying of vehicles, welding and soldering, auto body straightening, metal scraps disposal contribute to release of hazardous metals. In lead accumulator cells Pb serves as electrodes while tetraoxosulphate (VI) acid act as electrolyte. Auto electricians servicing lead accumulator cells dispose of electrolytes indiscriminately into the vicinity. The highest Pb ( $161.07$ )  $\mu\text{gg}^{-1}$  observed in the current study was below that at Apir auto-mechanic workshop soil ( $283 \text{mgkg}^{-1}$ ) in Makurdi the capital of Benue State and Adekaa ( $665 \text{mgkg}^{-1}$ ) in Gboko also in Benue State (Pam et al., 2013). Cadmium is non-essential and classified among the deleterious hazardous metals (Holan and Volesky, 1994). The half -life is about 18 years (Forstner, 1995). Soil Cd was below those found in Apir auto-mechanic workshops ( $11.74 - 21.84$ )  $\text{mgkg}^{-1}$  and Gboko auto-mechanic workshops ( $7.04 - 21.6$ )  $\text{mgkg}^{-1}$  (Pam et al., 2013). Again soil Cd ( $0.41 - 17.23$ )  $\text{mgkg}^{-1}$  and Pb ( $18.25 - 15100$ )  $\text{mgkg}^{-1}$  levels observed in a study conducted by (Adelekan & Abegunde, 2011) showed levels above the current study. The levels of Cd recorded might have originated from lubricating oils, tire wear and metal alloys used as hardners in engine parts (Dabkowska- Naskret, 2004). Lack of proper disposal of these substances has been implicated for the existence of Pb, Cd and As in the environment (Igbwe et al., 2006). Table 2 & Table 3.

**Table 2:** Pollution Grades of Geo-accumulation Index (I-geo) of Metals (Muller, 1969)

I-geo class	I-geo value	Contamination Intensity
0	$I\text{-geo} < 0$	Uncontaminated
1	$0 < I\text{-geo} < 1$	Uncontaminated to moderately contaminated
2	$1 < I\text{-geo} < 2$	Moderately contaminated
3	$2 < I\text{-geo} < 3$	Moderately to heavily contaminated
4	$3 < I\text{-geo} < 4$	Heavily contaminated
5	$4 < I\text{-geo} < 5$	Heavily to extremely contaminated
6	$5 < I\text{-geo}$	Extremely

**Table 1:** Hazardous Metal Contents of Auto-Mechanic Workshop Soils and Background Soils from Selected Study Sites in  $\mu\text{gg}^{-1}$

Suame Auto-Mechanic Workshop Soil			Suame Background Soil			Asafo Auto-Mechanic Workshop Soil			Asafo Background			Mampong Auto-Mechanic Workshop			Mampong Background Soil		
Pb	Cd	As	Pb	Cd	As	Pb	Cd	As	Pb	Cd	As	Pb	Cd	As	Pb	Cd	As
161.07	0.43	0.12	6.62	0.03	0.91	169.79	2.10	1.80	6.62	0.43	0.91	17.63	1.80	0.11	11.54	0.60	0.29

**Table 3:** Geo-accumulation Index ( $I_{geo}$ ) and Classification

SITES	Pb	Cd	As
Suame	2.79 Moderately to heavily contaminated	2.26 Moderately to heavily contaminated	-2.43 Uncontaminated
Asafo	2.84 Moderately to heavily contaminated	1.18 Moderately contaminated	0.28 Uncontaminated
Mampong	0.02 Uncontaminated	0.69 Uncontaminated	-1.38 Uncontaminated

Geo-accumulation index ( $I_{geo}$ ) classification by Muller, (1969) was employed to determine the extent of metal pollution of the soils. The three (3) auto-mechanic workshop soils showed differences in pollution levels. Suame auto-mechanic workshop (SAWS) was found to be uncontaminated with As ( $I_{geo} = -2.43$ ). The soil was rather observed to be polluted with Pb ( $I_{geo} = 2.79$ ) and Cd ( $I_{geo} = 2.26$ ) and might be classified as “Moderately to heavily contaminated”. Asafo auto-mechanic workshop soil was not contaminated with As ( $I_{geo} = 0.28$ ) but contaminated with Pb ( $I_{geo} = 2.84$ ) and Cd ( $I_{geo} = 1.18$ ). Mampong auto-mechanic workshop soil had these  $I_{geo}$  values for the various metals: Pb ( $I_{geo} = 0.02$ ), Cd ( $I_{geo} = 0.69$ ) and As ( $I_{geo} = -1.38$ ). The soil was thus uncontaminated.

**Hazardous metal content in Medicinal Plants**

Medicinal plants with a tendency of accumulating metals can be blamed for dietary uptake of deleterious hazardous metals by human and animals. In minute amounts metals are needed for life’s processes. For example, humans require different concentrations of hazardous metals such as iron, cobalt, copper, manganese, molybdenum and zinc. Also copper is essential to the human body because it is a component of many enzyme systems such as cytochrome, oxidase and ceruloplas-

min, an iron-oxidizing enzyme in blood (Sarpong et al., 2012). But excessive amounts are toxic to organisms. The medicinal plant samples exhibited differences in Pb concentration. Auto-mechanic soils demonstrated higher Pb levels than background soils. Lead amounts in the auto-mechanic soils ranged from (1.64 - 196.92)  $\mu\text{g}\text{g}^{-1}$  while that of background soils was (0.01 - 19.62)  $\mu\text{g}\text{g}^{-1}$ . *Jatropha curcas* (MAWS) recorded highest Pb (196.92)  $\mu\text{g}\text{g}^{-1}$  and the lowest was in *Spondias mombin* (1.64)  $\mu\text{g}\text{g}^{-1}$  (AAWS). Concerning Pb in the background soils *Terminalia catappa* (19.62)  $\mu\text{g}\text{g}^{-1}$  (MBS) and *Cola nitida* (0.01)  $\mu\text{g}\text{g}^{-1}$  (SBS) had the highest and lowest Pb levels respectively. *Terminalia catappa* (38.92)  $\mu\text{g}\text{g}^{-1}$  (SAWS), *Psidium guajava* (20.88)  $\mu\text{g}\text{g}^{-1}$  (SAWS), *Jatropha curcas* (196.92)  $\mu\text{g}\text{g}^{-1}$  (MAWS), *Anarcadium occidentale* (38.20)  $\mu\text{g}\text{g}^{-1}$  (MAWS) and *Psidium guajava* (108.28)  $\mu\text{g}\text{g}^{-1}$  (MAWS) had Pb concentrations above the normal range (0.2 - 20)  $\mu\text{g}\text{g}^{-1}$  (Table 4). However, *Terminalia catappa* (38.92)  $\mu\text{g}\text{g}^{-1}$  (SAWS), *Jatropha curcas* (196.92)  $\mu\text{g}\text{g}^{-1}$  (MAWS), *Anarcadium occidentale* (38.20)  $\mu\text{g}\text{g}^{-1}$  (MAWS) and *Psidium guajava* (108.28)  $\mu\text{g}\text{g}^{-1}$  (MAWS) were within the critical plant concentration beyond which the medicinal plant could be toxic to humans. With exception of the aforementioned plants the rest of the medicinal plant samples (*Alstonia boonei* de Wild, *Spondias mombin*, *Mangifera indica*, *Azadirachta indica*, *Milletia thonningia*, *Anarcadium occidentale* and *Psidium guajava* Linn (SAWS) were within the acceptable Pb range of (0.2 - 20)  $\mu\text{g}\text{g}^{-1}$ .

**Table 5:** Concentration ranges of Hazardous metals ( $\mu\text{g}\text{g}^{-1}$ ) in Plants and Critical Plants Concentrations

Hazardous Metal	Normal range in Soils	Normal range in Plants	Critical Plant Concentration
Pb	2 – 300	0.2	30-300
Cd	0.01- 2	0.1-2.4	5-30
As	0.1-40	0.02-7	5-20

Radojevic and Bashkin (2006)

**Table 4:** Hazardous Metal Content ( $\mu\text{g}\text{g}^{-1}$ ) in the bark of Medicinal plants from the three (3) Sites

Medicinal Plants	Suame Auto-Mechanic Workshop Soil			Suame Background Soil			Asafo Auto-Mechanic Workshop Soil			Asafo Background Soil			Mampong Auto-Mechanic Workshop Soil			Mampong Background Soil		
	Pb	Cd	As	Pb	Cd	As	Pb	Cd	As	Pb	Cd	As	Pb	Cd	As	Pb	Cd	As
<i>Alstinei boonei de Wild</i>	14.32	1.16	0.32	0.09	0.01	0.01	6.68	1.32	0.06	0.12	0.03	0.01	5.92	0.32	0.09	1.72	0.03	0.19
<i>Spondias mombin</i>	15.30	1.63	0.30	0.04	0.02	0.01	1.64	0.56	0.12	0.07	0.02	0.01	13.72	0.17	0.04	2.92	0.01	0.12
<i>Mangifera indica</i>	13.25	1.75	0.09	0.06	0.03	0.01	18.16	0.36	0.13	0.04	0.02	0.01	6.62	2.44	0.16	5.44	0.06	0.14
<i>Terminalia catappa</i>	38.92	1.02	0.30	0.05	0.02	0.01	8.64	0.97	0.36	0.07	0.04	0.01	9.56	2.37	0.13	19.62	0.12	0.06
<i>Azadirachta indica</i>	19.23	1.44	0.21	13.26	0.13	0.04	10.32	0.09	0.03	0.11	0.03	0.03	17.36	0.68	0.10	5.08	0.36	0.05
<i>Milletia thonningia</i>	7.64	0.41	0.10	2.16	0.21	0.03	10.63	0.32	0.10	12.26	0.09	0.04	12.04	1.88	0.08	8.48	0.56	0.08
<i>Jatropha curcas</i>	2.48	0.60	0.20	0.43	0.05	0.02	12.84	2.16	0.61	3.45	0.18	0.04	196.92	2.36	0.11	3.24	0.08	0.13
<i>Cola nitida</i>	3.32	0.77	0.03	0.01	0.02	0.01	2.75	0.56	0.21	0.42	0.06	0.02	19.24	1.33	0.05	18.56	0.20	0.06
<i>Anarcadium occidentale</i>	9.12	0.64	0.24	12.42	0.59	0.01	5.23	1.24	0.18	0.02	0.03	0.01	38.20	0.68	0.23	6.24	0.16	0.04
<i>Psidium guajava Linn</i>	20.88	0.96	0.35	1.26	0.11	0.03	1.98	0.46	0.05	13.28	0.03	0.09	108.26	0.92	0.09	2.24	0.03	0.04

NB: Suame Auto-mechanic Workshop Soil (SAWS); Suame Background Soil (SBS); Asafo Auto-mechanic Workshop Soil (AAWS); Asafo Background Soil (ABS); Mampong Auto-mechanic Workshop Soil (MAWS); Mampong Background Soil (MBS)

Highest level of Cd was contained in *Magnifera indica* (2.44  $\mu\text{gg}^{-1}$ ) (MWS) while the lowest was in both *Alstonia boonei* (0.01  $\mu\text{gg}^{-1}$ ) SBS and *Spondias mombin* (0.01 $\mu\text{gg}^{-1}$ ) (MBS).The Cd content in medicinal plants was in the range (0.01 - 2.44)  $\mu\text{gg}^{-1}$ . Except *Magnifera indica* (MWS) all the medicinal plants were within the acceptable range (0.1 - 2.4)  $\mu\text{gg}^{-1}$ . Cadmium levels were SWS (0.64 - 1.75)  $\mu\text{gg}^{-1}$ ; SBS (0.01 - 0.59)  $\mu\text{gg}^{-1}$ ; AAS (0.09 - 2.16)  $\mu\text{gg}^{-1}$ ;  $\mu\text{gg}^{-1}$  ABS (0.03 - 0.18)  $\mu\text{gg}^{-1}$  MWS (0.17 - 2.37)  $\mu\text{gg}^{-1}$  and MBS (0.01 - 0.56)  $\mu\text{gg}^{-1}$ . Cadmium amounts were less than critical plant concentration (5 - 30)  $\mu\text{gg}^{-1}$ . The study showed that the medicinal plant samples from both auto-mechanic and backgrounds sites (Table 5) would not be toxic to humans and animals.

Table 5 revealed different As loads in the medicinal plants from the three sites. Suame auto-mechanic workshop had As load of (0.03 - 0.35)  $\mu\text{gg}^{-1}$ ; SBS (0.01- 0.04)  $\mu\text{gg}^{-1}$ ; AAS (0.05 - 0.61)  $\mu\text{gg}^{-1}$ ; ABS (0.01 - 0.09)  $\mu\text{gg}^{-1}$ ; MWS (0.04 - 0.23)  $\mu\text{gg}^{-1}$ ; MBS (0.04 - 0.19)  $\mu\text{gg}^{-1}$ . Highest As level (0.61)  $\mu\text{gg}^{-1}$  was in *Jatropha curcas*. The lowest As value (0.01)  $\mu\text{gg}^{-1}$  was in *Alstonei boonei de Wild* (SBS), *Spondias mombin* (SBS), *Terminalia catappa* (SBS), *Cola nitida* (SBS), and *Anarcadium occidentale* (ABS). Arsenic levels were below the normal range (0.02 - 7)  $\mu\text{gg}^{-1}$  and (5 - 20)  $\mu\text{gg}^{-1}$  which was the critical plant concentration (Table 4). The medicinal plants analyzed pose no health threat to humans and animals.

### Transfer ratio

The transfer ratio for Pb in SAWS was higher than SBS for all the medicinal plants except *Anarcadium occidentale* Linn (1.88) (SBS). The transfer ratio for Pb in AAWS was lower than ABS. The highest transfer ratio for Pb was 3.02 for *Anarcadium occidentale* Linn (ABS). Mampong auto-mechanic workshop had the highest transfer ratio for Pb with value 33.58 in *Alstonia boonei de Wilde*. The lowest transfer ratio (0.01) for Pb was detected in *Alstonei boonei de Wild* (SBS), ***Spondias mombin***

(SBS), and ***Mangifera indica*** (SBS). (Table 6).

Medicinal plants (SAWS) had transfer ratio for Cd higher than SBS. The highest ratio was (4.07) in *Magnifera indica* (SAWS) while the lowest was (0.33) in *Alstonia boonei* (SBS). Apart from *Milletia thonngii* (0.21) (ABS) the transfer ratio of Cd was higher in all the medicinal plant samples in AAWS than ABS. The highest transfer ratio was (0.46) (AAWS).

The transfer ratio for As was highest in *Psidium guajava* (SAWS) with value (2.92). *Alstonei boonei de Wild* (SAWS) and *Spondias mombin* (SAWS) had a value (2.67). *Cola nitida* possessed transfer ratio (0.25) (SAWS). This lowest value was higher than all the medicinal plants in SBS except *Azadirachta indica* (0.43) (ABS). Also lowest transfer ratio of As in SAWS was higher than AAWS except *Jatropha curcas* (0.34), *Milletia thonningia* (ABS) (0.33), *Jatropha curcas* (0.33), *Psidium guajava* Linn (0.75) (ABS). Transfer ratio of As in medicinal plant samples from MAWS had higher values than those in MBS. *Anarcadium occidentale* (MAWS) recorded (2.09) the highest, with the lowest (0.36) in *Spondias mombin* (MAWS).The lowest of As in MAWS was highest than all except *Alstonia boonei de Wilde* (0.66) (ABS), *Spondias mombin* (0.41) (ABS), *Mangifera indica* (0.48)(ABS) and *Jatropha curcas* (0.45)(ABS).

### Conclusion

Release of hazardous metals into the ecosystem either through natural or anthropogenic processes should be of concern to all as they built up in plant parts and eventually finds their way into the food chain. The presence of Pb, Cd and As may cause acidification of soils. Microorganisms find it difficult to thrive on these soils. Locally, herbal manufacturers employ medicinal plants in synthesizing their products. With these medicinal plants contaminated, the final products would be unwholesome hence unfit for human consumption. The medicinal plants must be screened for the presence of these toxic contaminants before use.

**Table 6:** Transfer Ratio

Medicinal Plant	Suame Auto-Mechanic Workshop Soil			Suame Background Soil			Asafo Auto-Mechanic Workshop Soil			Asafo Background Soil			Mampong Auto-Mechanic Workshop Soil			Mampong Background Soil		
	Pb	Cd	As	Pb	Cd	As	Pb	Cd	As	Pb	Cd	As	Pb	Cd	As	Pb	Cd	As
	TRANSFER RATIO																	
<i>Alstonei boonei de Wild</i>	0.09	2.70	2.67	0.01	0.33	0.01	0.04	0.63	0.03	0.02	0.07	0.08	33.58	0.18	0.82	0.15	0.05	0.66
<i>Spondias mombin</i>	0.10	3.79	2.67	0.01	0.67	0.01	0.01	0.28	0.07	0.01	0.05	0.08	0.78	0.09	0.36	0.25	0.02	0.41
<i>Mangifera indica</i>	0.08	4.07	0.75	0.01	1.00	0.01	0.11	0.17	0.07	0.01	0.05	0.08	0.38	1.36	1.45	0.47	0.10	0.48
<i>Terminalia catappa</i>	0.24	2.37	2.5	0.01	0.67	0.01	0.05	0.46	0.20	0.01	0.09	0.08	0.54	1.32	1.18	1.70	0.20	0.21
<i>Azadirachta indica</i>	0.12	3.34	1.75	2.00	0.33	0.43	0.06	0.04	0.02	0.02	0.07	0.25	0.98	0.38	0.91	0.44	0.60	0.17
<i>Milletia thonningia</i>	0.05	0.95	0.83	0.33	0.67	0.03	0.06	0.15	0.18	1.85	0.21	0.33	0.68	1.04	0.73	0.73	0.90	0.28
<i>Jatropha curcas</i>	0.02	1.39	1.67	0.07	1.67	0.02	0.08	1.02	0.34	0.52	0.42	0.33	11.17	1.31	1.00	0.28	0.33	0.45
<i>Cola nitida</i>	0.02	1.79	0.25	0.002	0.67	0.01	0.02	0.27	0.12	0.06	0.14	0.17	1.09	0.73	0.46	1.61	0.27	0.21
<i>Anarcadium occidentale</i> Linn	0.06	1.49	2.00	1.88	1.97	0.01	0.03	0.62	0.10	3.02	0.07	0.08	2.17	0.38	2.09	0.54	0.05	0.14
<i>Psidium guajava</i> Linn	0.13	2.23	2.92	0.19	0.66	0.03	0.01	0.19	0.03	2.01	0.07	0.75	6.18	0.51	0.82	0.94	0.8	0.14

NB: Suame Auto-mechanic Workshop Soil (SAWS); Suame Background Soil (SBS); Asafo Auto-mechanic Workshop Soil (AAWS); Asafo Background Soil (ABS); Mampong Auto-mechanic Workshop Soil (MAWS); Mampong Background Soil (MBS)

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