Risk Assessment of Heavy Metals Level in soil and Jute Leaves (*Corchorus olitorius*) Treated with Azadirachtin Neem seed Solution and Organochlorine Pesticides

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Abstract—*Synthetic agrochemicals are increasingly being relied upon as the easiest of way eliminating pests on our farm. However, synthetic chemical increases heavy metals in the soil, which is then likely transferred to plants that grow on such soils, with the associated risks of long term toxicity to humans that consume them and other biota in the ecosystem. Nonetheless, some plants like the neem plant have been reported to contain components that are natural pesticides. This study was therefore to determine the comparative presence and concentration of some heavy metals in Jute leaves (Corchorus olitorius) treated with Azadirachtin Neem Seed Solution (ANSS) and Organochlorine Dichloro-diphenyl-trichloroethane (DDT) pesticides and the human health risk associated with their consumption. Jute plant treated with ANSS and DDT and their corresponding soils were collected in triplicate from 6 pots and a control without treatment using same soil and seed. Physicochemical properties of the soil samples were determined using a standard methods. The concentrations of Pb, As, Cd, Cr and Cu in the soil before and after planting and in the leaves were determined using Atomic Absorption Spectrophotometry. The potential health risk from the consumption of these vegetables was assessed using standard methods. Results obtained showed the presence of heavy metals (Pb, As, Cd, Cr and Cu) in Corchorus olitorius leaves and soils treated with each pesticide. Treatment with DDT pesticide elicited higher (P<0.05) heavy metals concentrations in the soil and vegetable compare to ANSS biopesticide treatment. The concentrations of Pb, As, Cd, Cr and Cu were 1.41, 2.06, 1.04, 1.85 and 3.78mg/kg respectively in Corchorus olitorius treated with DDT exceeded the WHO/FAO permissible limit of (0.3, 0.5, 0.2, 0.3, and 3.0mg/kg respectively) for edible vegetable. The Hazard Index (HI) of heavy metal contamination in the vegetables treated with ANSS and DDT was less than 1 suggesting it is safe for consumption, however the result shows that children are at greater risk from continuous consumption of Corchorus olitorius treated with DDT pesticide. The study concludes that the concentration of heavy metals in Corchorus olitorius treated with DDT pesticide exceeded the WHO/FAO permissible limits in vegetable. This showed that consumption of these vegetables treated with synthetic pesticide could pose health risk from heavy metal contamination.*

Keywords— **Azadirachtin, Corchorus olitorius, Dichlorodiphenyltrichloroethane, Health risk, Heavy metal.**

I. INTRODUCTION

In Nigeria, the loss of crops due to pest, plant disease and competition from weeds is quite very high. To avert these losses, farmers now increasingly deploy pesticides in their agronomic practices. Pesticides are chemical substances used in agricultural practices to aid the production and yieldby repelling, preventing, and destroying pests. Agrochemicals especially herbicides, insecticides and fungicide have resulted in the increase in crop production to a large extent, but their residual concentrations in the soil and potential environmental hazards in the ecosystem is of great concern. Pesticides produced to kill these pests in order to prevent these damages, especially those produced from synthetic materials also tend to have adverse effects on humans and environment in various ways (Yuguda *et al*., 2015).The continuous application of synthetic pesticides in agriculture over the years has caused accumulation of pesticidal residues such as heavy metals in the environment leading to various chronic illnesses and toxicity to non-target organisms.

Thus heavy metals from agrochemicals particularly pesticides not only contaminate soil and affect food quality butare subsequently transferred to human through the food chain (Olowoyo *et al*., 2011; Mutune *et al*., 2012) and could be responsible for series of health ailments in humans. Ninety percent of the applied synthetic pesticides like Dichlorodiphenyltrichloroethane (DDT) enter the various environmental resources as a result of run-off, exposing the farmers as well as consumers of the agricultural produce to severe health issues and sometimes take decades for some of these chemicals to break down. DDT affects the nervous system by interfering with normal nerve impulses. DDT causes the nerve cells to repeatedly generate an impulse which accounts for the repetitive body tremors seen in exposed animals (Rayindran *et al*., 2016). Therefore, increase attention has been given toward the development of alternate environmentally friendly pesticides that would aid an efficient pest management system and also prevent chronic health challenges.

One of the significant alternative strategies is, the use of neem plants (Binomial name: *Azadirachta indica*) (Chaudhary *et al*., 2017).The neem plant is a bitter tonic herb with anti-cancer properties, reduces inflammation and remove toxins, while promoting healing and improving all body functions. Apart from this, it has parasitic, insecticidal spermicidal properties and hence destroys a wide range of organisms such as pest (Kumar *et al*., 2015). It has been observed that the various medicinal values of neem are its constituent phytochemicals Present (Kwasi *et al*., 2011).The most active complex secondary metabolite present in the neem seed is Azadirachtin, which has been established as a pivotal insecticidal ingredient. It acts as an antifeedant, repellent, and repugnant agent and induces sterility in insects by preventing oviposition and interrupting sperm production in males. Azadirachtin has two profound effects on insects. At the physiological level, azadirachtin blocks the synthesis and release of molting hormones (ecdysteroids) from the prothoracic gland, leading to incomplete ecdysis in immature insects. In adult female insects, a similar mechanism of action leads to sterility. In addition, azadirachtin is a potent antifeedant to many insects. Neem as a repellent, prevents insects from initiating feeding. As a feeding deterrent, it causes insects to stop feeding (Rhoda *et al*., 2006).

Jute leaves (*Corchorus olitorius*) also known as ayoyo in Hausa, ewedu in Yoruba and kerenkeren in Igbo is a leafy vegetables mostly consumed by the Yoruba's in the western region of Nigeria where it is an important components of daily diets. Leafy-vegetables contain protein, essential minerals, fiber, vitamins, carotene and some essential amino acids required for normal metabolic activities of the body (Mavengahama, 2013; Conrad *et al*., 2018). These nutrients help to repair worn out tissues, reduce cancer risks, lower cholesterol levels, normalize digestion time, improve vision, fight free radicals, and boost immune system activity. The vegetables also act as antioxidants that help to protect human body from oxidant stress, cardiovascular diseases and cancers (Santhakumar *et al*., 2018).

Vegetables in developing countries are contaminated with high doses of pesticides. This can pose serious health risk to millions of individuals that consume them. These pesticides have heavy metals such Zinc (Zn), Cadmium (Cd), Lead (Pb), Copper (Cu), Cromium (Cr), Arsenic (As) etc. as their constituents. A lot of new pesticides whose actual chemistry are not known are continually infiltrating the markets and from all indication, no screening of these agrochemicals was conducted to permit entry into the country and the potential hazards should be of great concern. The result of this is the high accumulation residues of these agrochemicals in the environment with their consequent risk hazards (Liu *et al*., 2013) on human. Soil is the main reservoir of heavy metal and is the main source of pollution to the ecosystem at large. There are several pathways by which humans could be exposed to heavy metals contaminations. These could be through direct ingestion of the vegetables (food chain), direct ingestion of soil particles, dermal contact with soil particles, inhalation of soil dust and other particles from the air, oral and or dermal intake from groundwater.

Recent studies have shown that heavy metals contamination of food crops and its resultant health consequences is becoming a global issue (Shah *et al*., 2013; Nazir *et al*., 2015; Fonge *et al*., 2017). There is paucity of information on the heavy metals contents of vegetables from agrochemicals and their health risks especially in Nigeria that produce them. Risk assessment is an effective scientific tool which enables decision makers to manage and control sites so contaminated in a cost-effective manner while

http://dx.doi.org/10.22161/ijeab/4.3.24 ISSN: 2456-1878

preserving public and ecosystem health. Hence, this study was designed with the aim of determining heavy metals (As, Cd, Cr, Cu and Pb) contents in soil and *Corchorus olitorius* vegetable treated with two pesticides Azadirachtin neem seed solution and Dichloro-diphenyl-trichlororthane and the health risk associated with them.

II. MATERIALS AND METHODS

2.1 Sample collection

The research was conducted in the University of Nigeria, Nsukka. The top soil sample used was collected from Agricultural garden, University of Nigeria, Nsukka, using disinfected hand shovel from 6 inches (i.e. 15cm) below the surface. The soil was bulked, mixed thoroughly, air-dried at room temperature (20^{o}C) for seven (7) days. This was done to halt all the microbial activities in the soil. The air-dried samples were sieved using a 2mm sieve mesh size and also handpicked to remove debris and stones. The soil air-dried and sieved samples were analyzed for various soil physicochemical parameters before and after planting.

2.2 Experimental Design

The soil was divided into three groups and each group had triplicate bags. Group one were not treated with any pesticide, and served as control, group two were treated with ANSS biopesticide and group three were treated with DDT pesticides. Each pot contains 2kg of soil in a perforated polythene bag. Seven *Corchorus oliforius* (CO) seeds were planted in each bag. After two weeks of planting, the pesticides DDT and ANSS were sprayed on the test vegetables once every week for another five weeks to control pest except on the control groups. And the number of spot on *Corchorus olitorius* leaves damage by pest was observed by circling the damaged spot with a permanent marker

2.3 Preparation of ANSS and DDT

The seeds of neem plant Azadirachtin kernels (the seed of which the seed coat has been removed) were collected from agricultural garden and dried at 27^{o}C room temperature, then pulverized with a blender to obtain a homogeneous mixture. The pulverized seed (30g) was mixed in 1 litre of distilled water and left overnight in 2 litre cornical flask. The next morning, the solution was filtered through a fine cloth and used immediately for spraying. The same process was repeated for other week's application. Following the DDT pesticide label 2g of powdered chemical was added to 2liter of water. All necessary precaution was taken while mixing.

2.4 Determination of the Physico-Chemical Parameters

The soil pH samples were measured by potentiometric meter using a digital pH meter (Systronics type LI-101 ELICO). Soil samples (10 g) were stirred with 100ml of distilled water with a glass rod and the pH of the suspension was recorded. Physicochemical parameters of the soil before and after treatment were determined according to (Nimyel *et al.*, 2015).The physicochemical parameters measuredin all the four groups were soil texture, pH, total organic carbon, organic matter, total nitrogen, total phosphorus, exchangeable cation (sodium ion, magnessium and potassium ion). The Physico-chemical properties of the soil were analysed in order to check the biodegradable process.

2.5 Determination of Heavy metal

Samples of both soils and vegetables (1.00 ± 0.1g each) were placed into 100ml beakers separately, to which 15ml of tri-acid mixture (70% high purity HNO_3, 65%, $HClO_4$ and 70% H_2S0_4 in 5:1:1 ratio) were added. The mixture was digested at 80^{0}C till the solution became transparent. The resulting solution were filtered and diluted to 50ml using deionized water and analyzed for As, Pb, Cr, Cd, and Cu, by atomic absorption spectrophotometry (Barau *et al*., 2018).

2.6 HUMAN HEALTH RISK ASSESSMENT

2.6.1 Estimation of Bioaccumulation Factor (BAF)

The transfer coefficient was calculated by dividing the concentration of heavy metals in vegetables by the total heavy metals concentration in the soil. This index of soil – plant transfer or intake of metals from soil through vegetables was calculated using the following relationship described by (Olowoyo *et al*., 2010).

BAF = C_{veg}/C_{soil}----------------------1

Where; BAF represent the transfer factor of vegetable

C_{veg} = metal concentration in vegetable tissue, mg/kg fresh weight

C_{soil} = metal concentration in soil, mg/kg dry weight.

BAF > 1 indicates that the vegetable are en-riched in elements from the soil (Bio-accumulation) BAF < 1 means that the vegetables excluded the element from soil (excluder)

2.6.2 Estimation of the Daily Intake of Metal (DIM)

http://dx.doi.org/10.22161/ijeab/4.3.24 ISSN: 2456-1878

The Daily intake of metal was calculated using the following formula used by (Olowoyo and Lion, 2013).

ADDM = DI x MF_{veg}/WB--------------------------2

Where; ADDM = represents the average daily dose (mg,kg/d) of the metal

DI = is the daily intake of leafy vegetable (0.182 kg/d for adults and 0.118kg/d for children.

MF_{veg} = is the trace metal concentration in the vegetables tissues (mg/kg)

WB = represent the body weight of investigated individuals (55.7kg for adults and 14.2kg for children).

2.6.3 Estimation of the Potential Hazard of Metal to Human (Hazard Quotient HQ)

The Hazard Quotient (HQ) was used to calculate the possible human health risks associated with the consumption of vegetables harvested from the contaminated soils from Sewage areas. The following equation (Nabulo *et al.*, 2010) for calculating human health risk from consumption of leafy vegetables used to calculate the Hazard Quotient of vegetables.

HQ is the ratio between exposure and the reference oral dose (RFD)

If the ratio is lower than one 1, there will be no obvious risk.

HQ = ADDM/RFDM------------------------------------3

Where; ADDM = represents the average daily dose (mg,kg/d) of the metal

RFDM = is the reference dose (mg,kg/d)

RFDM = is define as the maximum tolerable daily intake of metal with no adverse effect

2.6.4 Estimation of Hazard Index (HI)

The hazard index (HI) was calculated to determine the overall risk of exposure to all the heavy metals via the ingestion of a particular vegetable crop (USEPA, 2002). The hazard index (HI) was calculated as the summation of the hazard quotient (HQ) arising from all the metals examined. The value of the hazard index is proportional to the magnitude of the toxicity of the vegetables consumed. HI > 1 indicates that the predicted exposure is likely to pose potential health risks. However, a hazard index >1 does not necessarily indicate that a potential adverse health effects will result, but only indicates a high probability of posing health risks.

$HI = \sum HQ_{As} + HQ_{Cu} + HQ_{Pb} + HQ_{Cd} + HQ_{Cr}$-----------------4

STATISTICAL ANALYSIS

The data obtained were analysed using IBM Statistical Product and Service Solution (SPSS) version 20 and Microsoft excel 2013. The results were expressed as mean ± standard deviation (SD). One way analysis of variance (ANOVA) was carried out as $p<0.05$ considered statistically significant. Duncan's multiple range test (DMRT) was used to compare mean values of test groups and control as well as differences within group means of the various test groups.

III. RESULTS AND DISCUSSION

3.1 Physicochemical properties of soil samples before and after planting

Table 1presents the summary of the physicochemical properties of soil samples. The pH of the soil before planting (control soil with no pesticide), soil with no pesticide after planting, soil with Azarachtin neem seed solution (ANSS), and soil with dichloro-diphenyl-trichloroethane (DDT) were 6.89, 6.82, 6.28 and 5.25 respectively. Thelow pH (5.25) at soil with DDT might probably be due to the synthetic organochlorine pesticide use on the soil. The total nitrogen, phosphorus, organic matter, and organic carbon content in the soil before planting (control soil with no pesticide), soil with no pesticide after planting, soil with ANSS, and soil with DDT were (1.94, 20.74, 2.70 and 2.52), (1.90, 20.60, 2.81, 2.59), (1.84, 18.98, 2.74, 2.26), and (1.59, 18.12, 2.31, 2.77 %) respectively. They was significantly ($p < 0.05$) difference between DDT soil and ANSS soil.The soil with DDT has the least total Nitrogen content of 1.59%. Similarly, soil with DDT have the least total phosphorus content with 18.12%. The total Organic Carbon content of the soils ranged from 2.52% at control to 2.77% at DDT. The result was similar to (Alex, 2012) which organic carbon ranged from 1.03% to 2.11% and decreased with depth from Gongulon Agricultural Site, Maiduguri, Borno State, Nigeria. The exchangeable Cations K^{+}, Mg^{2+} and Na^{+}in control soil, ANSS soil and DDT soil were (1.89, 13.19, 8.18), (1.66, 12.22, 7.85) and (1.32, 11.27, 7.18Meq/100g) respectively. This result changes the soil physicochemical parameters, especially the soils treated with DDT pesticides. This increases the heavy metals in the soil, which is then likely transferred to plants that grow on such soils, with the associated risks of long term toxicity to humans that consume them and other biota in the ecosystem (Table 1).

Table 1: Physicochemical properties of soil samples before and after planting

Soil Properties	Control(Before) No pesticide	No pesticide after planting	Soil with ANSS after planting	Soil with DDT after planting
Texture	loamy	loamy	loamy	loamy
pH	6.89 ± 0.03^{a}	6.82 ± 0.04^{a}	6.28 ± 0.04^{b}	5.25 ± 0.03^{c}
Total nitrogen %	1.94 ± 0.03^{a}	1.90 ± 0.03^{a}	1.84 ± 0.02^{b}	1.59 ± 0.08^{c}
Total phosphorus %	20.74 ± 0.19^{a}	20.60 ± 0.1^{a}	18.98 ± 0.07^{b}	18.12 ± 0.15^{c}
Organic matter %	2.70 ± 0.10^{a}	2.81 ± 0.01^{a}	2.74 ± 0.11^{a}	2.31 ± 0.06^{b}
Organic carbon %	2.52 ± 0.01^{b}	2.59 ± 0.02^{b}	2.26 ± 0.03^{c}	2.77 ± 0.06^{a}
K^{+} meq/100g	1.89 ± 0.08^{a}	1.87 ± 0.02^{a}	1.66 ± 0.04^{b}	1.32 ± 0.06^{c}
Mg^{2+} meq/100g	13.19 ± 0.02^{a}	13.15 ± 0.03^{a}	12.22 ± 0.08^{b}	11.27 ± 0.04^{c}
Na^{+} meq/100g	8.18 ± 0.06^{a}	8.11 ± 0.04^{a}	7.85 ± 0.03^{b}	7.18 ± 0.06^{c}

Results expressed as Mean ± SD. Mean values with same superscript letters on the rows are considered not significant (P>0.05). n=3

3.2 Physical observation on the number of spot on *Corchorus olitorius* damage by pest

Table 2 represent thetotal numbers of damaged leaves treated with ANSS and DDT pesticide also a control without treatment. The observations was started after two weeks of planting to the six weeks. The group with no treatment recorded the highest damage with 26 damage spot on the leaves, while *Corchorus olitorius* treated with ANSS and DDT recorded 8 and 5 respectively. The both pesticides reduces the effect of pest on the leaves. DDT pesticides recorded the least damage due to its effectiveness. Despite the effectiveness of DDT it can increase toxic substances in the leaves and soil which pose risk to human. The counted spots were marked to avoid repetition of already counted spot (Table 2).

Table.2: Physical observation on the number of spot on CO damage by pest

Number of weeks	**Physical observation on number of damage spot**		
	No treatment	CO treated with ANSS	CO treated with DDT
2	2	2	2
3	5	1	-
4	10	2	2
5	5	2	1
6	4	1	-
Total spot in six weeks	26	8	5

CO= *Corchorus olitorius*

3.3 Heavy metal Concentration in soils treated with ANSS and DDT pesticide

Table 3presents the summary of the mean concentrations (mg kg-1) of heavy metals Lead (Pb), Copper (Cu), Chromium (Cr), Cadmium (Cd), and Arsenic (As) analysed in the soil samples at Soil with ANSS, DDT and soil without pesticide. The concentration of As, Pb, Cu, Cd, and Cr in soil with ANSS, DDT and without pesticide were (2.05, 2.14, 0.71, 0.32, 3.35), (3.74, 5.83, 1.58, 0.78, 5.46), and (2.05, 2.44, 0.73, 0.31, 3.64) respectively. The level of metals obtained in this study were all below the FAO/WHO, permissible limit in soil. Analysis of variance (ANOVA) revealed a significant ($p < 0.05$) variation in the concentrations of the five elements in the soil, which is an indication of the extent of metal pollution in the soils. The mean Pb content in DDT pesticide recorded the highest values compared to all other metals. It ranged between 0.76 to 5.83 mg kg-1 in Cd and Pb respectively. Generally, the soil heavy metal concentrations decreased in the order Pb >Cr> As > Cu > Cd. The control soils had significantly lower heavy metals than all the soil with pesticide. The lower Cd in the DDT pesticides soil could be attributed to very low Cd levels in the Pesticides. The soil heavy metals were all below the WHO/FAO, permissible limits. The

http://dx.doi.org/10.22161/ijeab/4.3.24 ISSN: 2456-1878

result was similar to the findings of Nimyel *et al*., 2015 that the control soils had significantly lower heavy metals than all the farm soils except Cr. The lower Cr in the pesticides contaminated farm soil could be attributed to very low Cr levels in the Pesticides. The soil heavy metals in the vegetable farm soils were below the WHO/FAO permissible limits. The study revealed that the concentrations of most of the elements were significantly ($p < 0.05$) higher at the soil with DDT pesticide compared to the other soil samples (Table 3). Soil with ANSS biopesticide generally had the lowest concentrations of most of the metals analyzed. Contrary to this finding, (Barau *et al*., 2018) reported high concentration of heavy metals in soil contaminated with synthetic pesticide (Table 3).

Table.3: Heavy metal concentration in soils treated with ANSS and DDT pesticide

Heavy Metals (mg/kg)	Treatments			
	Soil with ANSS	Soil with DDT	Control Soil with out pesticide	PL(mg/kg) in soil FAO/WHO, 2001)
As	2.05 ± 0.02^{b}	3.74 ± 0.12^{a}	2.05 ± 0.03^{b}	20
Pb	2.14 ± 0.14^{c}	5.83 ± 0.04^{a}	2.44 ± 0.13^{b}	50
Cu	0.71 ± 0.03^{b}	1.58 ± 0.10^{a}	0.73 ± 0.18^{b}	100
Cd	0.32 ± 0.03^{b}	0.78 ± 0.04^{a}	0.31 ± 0.03^{b}	3.0
Cr	3.35 ± 0.06^{b}	5.46 ± 0.07^{a}	3.64 ± 0.37^{b}	100

Results expressed as Mean ± SD. Mean values with same superscript letters on the rows are considered not significant (P>0.05). PL= Permissible limit. n=3

3.4 Heavy Metal Concentration in *Corchorus olitorius* treated with ANSS and DDT pesticide

Table 4presents the summary of the mean concentrations (mg kg) of heavy metals Lead (Pb), Copper (Cu), Chromium (Cr), Cadmium (Cd), and Arsenic (As) analysed in *Corchorus olitorius*treated with ANSS, DDT and a control without pesticide.The mean concentrations of heavy metals in the vegetables are shown in Table 3. The concentration of As, Pb, Cu, Cd, and Cr in vegetable with ANSS, DDT and without pesticide were (0.35, 0.05, 0.05, 0.09, 0.35), (2.06, 1.41, 3.78, 1.04, 1.86), and (0.35, 0.03, 0.03, 0.07, 0.31). The level of metals obtained in vegetable with DDT were all above the FAO/WHO permissible limit in vegetable. The permissible limit for As, Pb, Cu, Cd, and Cr in vegetables are 0.5, 0.3, 3.0, 0.2 and 0.3 mg/kg.In the vegetable analyzed for heavy metals, *Corchorus olitorius* treated with DDT pesticide generally had higher heavy metals concentrations than the other treated with ANSS.Vegetable treated with DDT exceed the WHO/FAO permissible limit of metal in vegetable. These differences were significant (P<0.05). Heavy metals and nutrients absorbed by the roots are usually translocated and allocated to different parts of the plants which could limit the concentrations in the leaves. However, availability of metals in the soil and continuous absorption by the roots could lead to higher concentration in the leaves.

The mean concentrations of the heavy metals in *Corchorus olitorius* treated with DDT pesticide decreased in the order Cu > As > Cr > Pb > Cd in table 4. Cu had the highest concentration (3.78 mg/kg) in the vegetable which exceed the permissible limit (3.0mg/kg).The range was from 1.04 mg/kg at Cd to 3.78 mgkg-1 at Cu. The increase in Cu could be attributed to continuous application of DDT pesticide used. In a similar study, (Pradhan and Kumar, 2014) reported a range of Cu values from 11.08 mg/kg to 23.07 mg/kg in a study conducted in China. According to (Maobe *et al*., 2012) high levels of copper can cause metalfumes fever with flu-like symptoms, hair and skin decolouration, dermatitis, irritation of the upper respiratory tract, metallic taste in the mouth and nausea. Also (Dixit *et al*., 2015) reported that copper is indeed essential, but in high doses it can cause anaemia, diarrhea, headache, metabolic disorders, vomiting, liver and kidney damage, stomach and intestinal irritation on human health. All the metals analyse on *Corchorus olitorius* treated with DDT pesticide exceed FAO/WHO, permissible limit compared with the treatment of ANSS. Jabeen *et al*., 2010 reported that cadmium causes both acute and chronic poisoning, adverse effect on kidney, liver, vascular and the immune system.(Barakat, 2011) reported that high dose of chromium is observed to cause Bronchopneumonia, chronic bronchitis, diarrhea, emphysema, headache, irritation of the skin, itching of respiratory tract, liver diseases, lung cancer, nausea, renal failure, reproductive toxicity, and vomiting. Nagajyoti *et al*., 2010 reported that Lead can cause serious injury to the brain, nervous system, red blood cells, low IQ,

http://dx.doi.org/10.22161/ijeab/4.3.24 ISSN: 2456-1878

impaired development, shortened attention span, hyperactivity, mental deterioration, decreased reaction time, loss of memory, reduced fertility, renal system damage, nausea, insomnia, anorexia, and weakness of the joints when exposed to high lead. The presence of heavy metals in varying concentrations in vegetables under investigation could be attributed to the presence of these trace metals in the pesticides in discriminately used on the vegetable. Previous studies have reported the presence of these metals in pesticides (Shah *et al*., 2013; Nazir *et al*., 2015; Fonge *et al*., 2017).

The mean concentrations of the heavy metals in *Corchorus olitorius* treated with ANSS bio pesticide decreased in the order As > Cr > Cd > Pb > Cu. As had the highest concentration (0.35 mg/kg) in the vegetable which is below the permissible limit (0.5mg/kg).The range was from 0.05 mg/kg at Pb and Cu to 0.35 mgkg-1 at As. The presence of As in the vegetation samples could be attributed to the atmospheric condition and human activities in the area. The concentration of Arsenic is in line with the findings of (Barau *et al*., 2018) on vegetables treated with pesticide. According to (Luo *et al*., 2011) atmospheric deposition is a major factor for high metal accumulation in plantsamples, and this could therefore be the cause of the Arsenic in the samples analysed. All the metals analyse on *Corchorus olitorius* treated with ANSS bio pesticide were below FAO/WHO, permissible limit. ANSS bio pesticide do not add metals in the soil and on the leaves, they cause less or no toxic effect on vegetables and are biodegradable. The mean concentrations of the heavy metals in *Corchorus olitorius* treated with no pesticide were all below the FAO/WHO, permissible limit. The range was from 0.03 mg/kg at Pb and Cu to 0.35 mg/kg at As. The differences in the accumulation of these metals in the vegetables under study could be attributed and not limited to the varying physiological phenomenon such as absorption rate of different metals viz a viz soil physicochemical properties, choice of plants in selecting which mineral is allocated andstored in its parts among other factors (Alloway, 1990) (Table 4).

Table.4: Heavy Metal Concentration in CO treated with ANSS and DDT pesticide

Heavy Metals (mg/kg)	**Treatments**			
	CO treated with ANSS	CO treated with DDT	Control CO with no pesticide	PL (mg/kg) in vegetable FAO/WHO, (2016)*,(2001)**
As	0.35 ± 0.04^{b}	2.06 ± 0.04^{a}	0.35 ± 0.02^{b}	0.5*
Pb	0.05 ± 0.02^{b}	1.41 ± 0.02^{a}	0.03 ± 0.13^{b}	0.3*
Cu	0.05 ± 0.03^{b}	3.78 ± 0.11^{a}	0.03 ± 0.02^{b}	3.0**
Cd	0.09 ± 0.01^{b}	1.04 ± 0.02^{a}	0.07 ± 0.01^{b}	0.2*
Cr	0.35 ± 0.05^{b}	1.86 ± 0.03^{a}	0.31 ± 0.02^{b}	0.3*

Results expressed as Mean ± SD. Mean values with same superscript letters on the rows are considered not significant (P>0.05).
PL= Permissible limit. CO = *Corchorus olitorius* n=3

3.5 Estimation of Bioaccumulation Factor (BAF)

Table 5 shows the Bioaccumulation factor (BAF) of heavy metals from the soil to plants, which is the ratio of the concentration of metals in plants to the total concentration in the soil. The bioaccumulation factors of metals As, Pb, Cu, Cd, and Cr obtained in CO treated with ANSS, CO treated with DDT and Control CO with no pesticide were (0.07, 0.28, 0.07, 0.28, 0.07), (0.55, 0.24, 2.39, 1.36, 0.33), and (0.17, 0.01, 0.04, 0.22, 0.08) respectively. The BAF for the same metal in the farm lands were significantly different from those for control and according to the type of plants. The highest BAF value obtained were in *Corchorus olitorius* (CO) treated with DDT Cu(2.39) and Cd (1.36).Plants are known to take up and accumulate trace metals from contaminated soil (36). The BAF value for the same metal in the CO treated with DDT pesticide were significantly different from those treated with ANSS. The BAF of all other elements in the treatment are within normal range less than 1. Any value of BF >1 indicates the plants as hyper accumulator and could be used in bioremediation of heavy polluted soil.The soil-plant BAF of different heavy metals showed the following order- $BAF_{Cu}>BAF_{Cd}>BAF_{As}>BAF_{Cr}>BAF_{Pb}$. Where TF > 1 indicates the vegetable are en-riched in elements from the soil (Bio-accumulation). TF < 1 means that the vegetables exclude the element from soil (Excluder). The result of (Barau *et al*., 2018) BAF suggest that all the vegetables under study viz, pepper, tomato and onion were hyper accumulators of Cr and Cd with the highest accumulation of Cr in pepper (10.20).

http://dx.doi.org/10.22161/ijeab/4.3.24 ISSN: 2456-1878

BAF > 1 indicates that the vegetable are en-riched in elements from the soil (Bio-accumulation).

BAF < 1 means that the vegetables exclude the element from soil (Excluder) (Table 5).

Table.5: Estimation of Bioaccumulation Factor (BAF)

Heavy Metals (mg/kg)	BAF		
	CO treated With ANSS	CO treated with DDT	Control CO with no pesticide
As	0.07	0.55	0.17
Pb	0.28	0.24	0.01
Cu	0.07	2.39	0.04
Cd	0.28	1.36	0.22
Cr	0.07	0.33	0.08

CO = *Corchorus olitorius*

3.6 Daily Intake, Potential Hazard of Metal (Hazard Quotient) individual

Table 6 shows the hazard quotient and Daily intake was calculated for both adults and children from trace metals in leaves of *Corchorus olitorius*. The daily intake of heavy metals (DIM) was estimated according to the average vegetable consumption. The estimated DIM through the food chain is given in Table 6, for both adults and children. The DIM values for heavy metals were significantly little high in the vegetables grown with DDT pesticide. The values obtained were from *Corchorus olitorius* treated with DDT pesticide for both adults and children.

The HQ of metals through the consumption of vegetables for both adults and children were given in Table 6. The HQ of heavy metal in *Corchorus olitorius* treatment with DDT pesticide were Pb(0.01 and 0.03), Cd(0.01 and 0.04), Cu(0.00 and 0.01), As(0.01 and 0.03) and Cr(0.02 and 0.05) in both adult and children respectively. The HQ values for heavy metals were significantly high in *Corchorus olitorius* treated with DDT pesticide than the treatment with ANSS. The values obtain in HQ in *Corchorus olitorius* treated with DDT pesticide and *Corchorus olitorius* treated with ANSS pesticide were less than 1 (<1) as shown on table 6, which indicated that consumption may not lead to accumulation of these metals in the body. The results of (Barau *et al.*, 2018) of HQ obtained suggest high health risk from Pb, As and Cd contamination in both adults and children and only a slight health risk of Zn (1.058) contamination in children consuming onion. The HQ for Pb ranged between 1.29 to 2.22 in adults and 2.63 to 15.30 in children. In the adult's category, the HQ for As was 1.29 to 2.44 while 0.52 to 2.89 was recorded for children (Table 6).

3.7 Estimation of hazard index (HI) of metal for individuals

The calculated HI for both Adult and children in both *Corchorus olitorius* treated with ANSS, DDT and control were all less than 1. The result showed that children are more likely to be affected with continuous consumption of*Corchorus olitorius* treated with DDT pesticide in table 7. The result of this study regarding the HI revealed that *Corchorus olitorius* vegetable grown with ANSS and DDT are safe for consumption. (Akande and Ajayi, 2017) also observed high values of HI greater than 1 on vegetables grown on peri-urban farm. Similarly (Barau *et al.*, 2018) also indicate that Children had the greatest health risk than adults from heavy metal contaminated vegetables fumigated by pesticides (Table 7).

Table 7: Estimation of hazard index (HI) of metal for individuals

	HI for Individuals			
	Individuals	CO with ANSS	CO with DDT	CO with no pesticide
	Adult	0.00	0.05	0.00
HI=∑HQ (HM)	Children	0.02	0.16	0.02

HI = Hazard index. ∑ = Summation of the Hazard Quotient (HQ) arising from all the heavy metals (HM) examined. CO = *Corchorus olitorius*

Table 6: Daily Intake, Potential Hazard of Metal (Hazard Quotient) individual

Heavy metals	DIM and HQ for individuals				
	Individuals	Hazard	CO with ANSS	CO with DDT	CO with no pesticide
Pb	Adult	DIM	0.00	0.00	0.00
		HQ	0.00	0.01	0.00
	Children	DIM	0.00	0.01	0.00
		HQ	0.00	0.03	0.00
Cd	Adult	DIM	0.00	0.00	0.00
		HQ	0.00	0.01	0.00
	Children	DIM	0.00	0.00	0.00
		HQ	0.00	0.04	0.00
Cu	Adult	DIM	0.00	0.01	0.00
		HQ	0.00	0.00	0.00
	Children	DIM	0.00	0.03	0.00
		HQ	0.00	0.01	0.00
As	Adult	DIM	0.00	0.01	0.00
		HQ	0.00	0.01	0.00
	Children	DIM	0.00	0.02	0.00
		HQ	0.01	0.03	0.01
Cr	Adult	DIM	0.00	0.01	0.00
		HQ	0.00	0.02	0.00
	Children	DIM	0.00	0.02	0.00
		HQ	0.01	0.05	0.01

CO = *Corchorus olitorius*, DIM = Daily intake of metal, HQ = Hazard quotient

IV. CONCLUSION

The presence of heavy metals (Pb, Cd, Cr, As and Cu) from application of synthetic pesticide and bio pesticide in*Corchorus olitorius* plant was detected and the corresponding farm soil. The bioaccumulation factor for the vegetable showed that they exclude the element from soil (Excluder).The concentration of heavy metals in *Corchorus olitorius* treated with DDT pesticide exceeded the WHO/FAO permissible limits in vegetable. This showed that consumption of these vegetables treated with synthetic pesticide pose health risk from heavy metal contamination because of pesticides applications. People need to break the habit of using harmful inorganic pesticides such as DDT and switch to rising organic ones such as ANSS that break down quickly in the sunlight and in the soil. The faster a chemical breaks down, the sooner the soil can return to a healthy state. Most organic pesticides are also safe to use around people and pets. They can easily be washed from vegetables making them healthier for use.

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