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# SUSTAINABLE FOOD SECURITY: PESTICIDE RESIDUES AND HEAVY METALS ACCUMULATION IN UGU VEGETABLE GROWN IN ATANI, ANAMBRA STATE

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## Abstract

*Pesticide residue an emerging contaminant that induce soil degradation, water pollution and health challenges in ecosystem. The objective of this study was to assess both organochlorine, organophosphate pesticide residues and some heavy metal levels in Ugu leafy vegetable grown in Atani farm fields and to compare the results with WHO standard limit. Application of field survey and appropriate laboratory analyses showed DDE mean value of 0.28±0.2 having a 0.0% compliance with WHO standard limit. Heavy metal Pb mean values ranged from 0.23±0.0, 0.55±5.0 and 0.13±0.0 for the Ugu leaf samples obtained from the four Ugu farm fields assayed, which also gave a 0,0% compliance with the WHO standard limit. ANOVA at significance level of 0.05 was employed in testing the research hypothesis. It showed a positive relationship between pesticides used for Ugu cultivation and pesticide residues on Ugu leaf samples ($p < 0.05$). The findings indicate the presence of heavy metals, organochlorine and organophosphates residues in all the Ugu leaf from the four farms assayed. While Pb and DDE were above WHO standards limit. This poses serious environmental concern due to persistent, toxicity and bioaccumulation of these contaminants detected on the leaves. It could lead to soil degradation, water pollution and pose health challenges on both ecosystem and humans, a bane of food security.*

**Keywords**: Emerging contaminants, Environmental degradation, Food Sustainability, Heavy metals, Pesticide Residues, Ugu Leafy Vegetable

## INTRODUCTION

Pesticide use has increased globally with increasing demand for food, modernization of agriculture, and pesticide marketing (Onuguh *et al***.**, 2022; Saravi & Shokrzadeh, 2011). Agrochemical is a mixed blessing to farmers as it has become an integral part of modern agriculture to improve, protect and eradicate pests' transmission of infectious diseases to crops (Govinda, 2014). However, the excessive use and misuse of pesticides in developing countries, its volatility and long-distance transportation leads to wide spread environmental contamination. In addition, non-patented, more toxic, environmentally persistent and inexpensive agrochemicals are in use extensively in developing nations creating serious acute health problems leading to local and global impacts on food sustainability in the phase of a changing climate (Dey, Choudhury & Dutta. 2013)

Although, remarkable progress has been made in the development of effective pesticides, the fact remains that a very small fraction of all applied pesticides is directly involved in the pesticidal mechanism. This implies that most of the applied pesticides find it way as 'residue' in both terrestrial and aquatic environment where it accumulates and exert potential, long term, adverse health effects (Crinnion, 2009**;** Winteringham, 1971). Ideally, the applied pesticides should only be toxic to the targeted organisms, biodegradable and eco-friendly to some extent (Rosell *et al.*, 2008), unfortunately, this is rarely the case as most of the pesticides are non-specific and may kill the organisms that are harmless or useful to the ecosystem. Generally, it has been estimated that only about 0.1% of the agrochemicals applied to crops reach the target organisms and the remaining bulk contaminates the surrounding environment (Carriger *et al.*, 2006). Studies by authors such as Ibrahim*, et al* (2018) showed the presence of organophosphorous in Ugu leaf samples they analysed in Akwnga farm field in Nigeria.

Fruits and vegetables are essential components of human diet after cereals due to the presence of vitamins and minerals that offer advantages over dietary supplement (Ibitomi, Oluwarotimi and Mohammed, 2016). A generous intake of fruits and vegetables prevent various types of diseases and keep a person energetic and active all through life (Zahir, Naqvi and Uddin, 2009). Thus, in order to meet the demand for these vegetables (Ugu), and other fruits in the phase of changing climate, it is essential to use pesticides to protect these crops, particularly during growth, storage and transport (Kolani, Mawussi & Sanda, 2016). Presently, there has been an increasing awareness on the need for including more vegetables in our diet in order to maintain healthy body. One of such important vegetables again is Ugu leaf known as Fluted Pumpkin in English and botanically known as Telfairia Occidentalis and of the cucurbitacase family (Onuguh *et al***.**, 2022: Uboh, Okon & Edet, 2013).

The soil of Atani floodplain in Anambra State, Nigeria contribute significantly to the food production of the State. Atani the headquarter of Ogbaru are intensively cultivated, with huge distributors of Ugu leafs to the surrounding regions and thus have great need for pesticides use. According to Ibrahim *et al.*, (2018) in research they conducted on the Prevalence of Organophosphorous Pesticide Residues in Pumpkin Leaves Grown in Akwanga, Nasarawa State, Nigeria. They also found that during pesticide applications, many farmers do not follow recommended mixing concentrations on the instructions label. Some farmers also do not comply with the recommended pre-harvest intervals between pesticide applications and harvesting of fruits and vegetables which in turn leads to continuous contamination of the environment and toxic effect on humans by these residual pesticides.

These residues are washed away by runoff during heavy rainfall into water bodies (e.g. Ogbaru River) and impair it, thereby causing harm to aquatic life and making it unfit for human usage. To the soil quality, the toxicity of these pesticides affects the existence of soil microbes that helps in soil aeration and decomposition of organic compounds thereby leading to loss of soil nutrients, a bane to food sustainability (Anggoro, Sunoko & Rachmawati, 2017; Leonila, 2002). The farmers' health as well as public health is also at risk. This assertion was made during field observation by Amvrazi (2011). The researcher observed that farmers apply these agrochemicals without wearing appropriate personal protective equipment, thereby exposing themselves to health challenges that may result from agrochemical application. He also reported that farmers dispose containers of used pesticides improperly. While a closer look to the empty containers showed minute residues of agrochemicals remaining in the discarded containers which could impact on the environment despite the minute quantities.

Erhunmwunse, Dirisu and Olomukoro (2012) worked on the implications of pesticide usage in Nigeria and stated that pesticides can be classified based on the function (insecticides, herbicides and fungicides) or based on its chemical nature (organophosphorus, organochlorine and carbamates).The classification of pesticides based on the function is divided such as herbicides, which intends to control herbs and weeds; fungicide intends to control fungal infestations; rodenticides intends to control rodents and fumigants which are normally referred by the mode of application. While the classification of pesticides based on it chemical nature is divided into organochlorines, organophosphorus and carbamates pesticides.

The Organochlorine Pesticides (OCls), according to Damalas and Eleftherohorinos (2011), is chlorinated hydrocarbons that generally have oral toxicity and long residual action and are very stable chemical compounds which can withstand the action of various environmental factors including the biological system. To the duo, these OCls include dieldrin, methoxychlor, chlorinated, heptachlor, aldrin, endrin, toxaphene, mirex and lindane which were introduced in the 1940s and 1950s. A. study on pesticide use and risk perceptions among farmers in the cotton belt of Punjab showed that most of these OCls chemicals are insoluble in water and dissolve well in organic solvents and fats of organisms (Khan, Mahmood, and Damalas, 2015). They also stated that OCls are so toxic to the extent that its half-life as it relates to the rate of decay is known to take place between 2-25 years. All these shows how toxic, persistent and bioaccumulation it can be in the environment and its lethality to humans

The Organophosphorus Pesticides (OPs)**.** OPs pesticides consist of phosphoric acid esters and these are one of the main classes of insecticides that have been in use since the mid-1940s for agricultural activity (David, Grace, Chimezie & Unyimadu, 2008). In addition, they stated that OPs are relatively non-persistent in the environment and can only persist from a few hours to several months. In contrast to the OCls insecticides, Lucio (2006) reviewed current issues in organophosphate toxicology and asserted that OPs pose a serious problem as they contaminant soil and water since they are persistent for few hours to several months and can rarely enter the human food chain. She outlines the examples of OPs insecticides to include Chlorpyrifos, Parathio, Malathion etc.

The Carbamate Pesticides (CAs)**.** Carbamate compounds are esters of carbamic acid with formula RHNCOOR, that are commonly used as insecticides. These compounds are referred to as N-methylcarbamates. Derivatives of carbamic acid, thiocarbamic acid, and dithiocarbamic acid are used as herbicides. Carbamate pesticides are relatively polar, highly soluble in water, and chemically reactive. Some Carbamates of importance are Aldicarb, Carbaryl, Carbofuran, Ferbam, and Captan (Gupta, 2014). Lu (2005) conducted research on the risk factors to pesticide exposure and associated health symptoms among cut- flower farmers in Ghana and claimed that CAs was originally extracted from the Calabar bean, which grows in West Africa because the extracts of this bean contain physostigmine, a methylcarbamate ester which is the main component of CAs. Similar study by Palis, *et al*., (2006) on farmers at risk and their belief system towards pesticide safety in Japan. The result of the study showed that CAs is among the most popular pesticides for home use, both indoors, on gardens and lawns. Furthermore, they stated that the toxicity of the compound varies according to the phenol or alcohol group and one of the most widely used CAs insecticides is cabaryl.

Heavy metals is distinguished by soil chemistry as a special group of elements because of the toxic effect exerted on plants upon high concentrations. Among these heavy metals, only three heavy metals, i.e., Pb, Cd, and Hg, were mentioned in the Global Monitoring Program adopted by the UN in 1973 (cited in Vodyanitskii, 2016). However, there is no common opinion on the hazard degree of any particular heavy metal in soils. Bioaccumulation of heavy metals in the soil affects soil quality leading to contamination and pollution of the environment at man's detriment (Mtunzi et al., 2008; Madukasi & Agbazu, 2024).

However, mercury, lead, cadmium, silver, chromium and many others that are indirectly distributed as a result of human activities, could be very toxic even at low concentrations (Opaluwa *et al*., 2012). Heavy metals are extremely persistent in the environment because of their non-biodegradable nature, thermal stability and potential to accumulate to toxic levels, even at low concentrations. These metals can pose a significant health risk producing damaging effects on man and animals because there is no good mechanism for their elimination from the body (Abdulsalam & Bajoga, 2020). There is growing concern about the possibility of agricultural soil's contamination by heavy metals resulting in uptake by plants and their introduction in vital food chains affecting food safety (Pujar *et al*., 2012). The contamination is often a direct or indirect consequence of anthropogenic activities from urban and industrial wastes, via metal accumulation in soil by irrigating farmland with poor quality water, weathering of rocks, transportation and disposal of high metal waste on farmland and leaching from refuse dumpsite (Rahman & Mostafa, 2024; Abdulhamid1 *et al.*,2015). Soils may also become contaminated by land application of fertilizers, animal manures, pesticides and sewage sludge (Rahman & Mostafa, 2024). Based on the above insight on toxicity, bioaccumulation of pesticide residues and heavy metal in the environment also effects on human health, it is paramount to assess Ugu leafy vegetable grown in Atani ogbaru LGA to detect, identify and quantify level of pesticide residues and heavy metals accumulation on Ugu leaf grown in the study area.

## MATERIALS AND METHODS

*Study Area:*

Atani is the local government headquarter of Ogbaru and one of the sixteen major towns that make up the geo-political region of Ogbaru Local Government Area of Anambra State, its geographical coordinates are 6° 06' 629" to 6° 3'58.638" North on the latitude and on the longitude, it's 6° 74' 246" to 6° 44'32.874" East. Its elevation is about 30 meters above sea level. Within the Ogbaru structure, the closest towns bordering Atani are Ohita at 5.3km from the north and Akili Ozizor at 2.6 km from the south, the river Niger from the west and east is Idemili South (Ezenwaji, *et al.*, 2014). Atani is an agrarian community like other towns in Ogbaru, however, Atani farm field which is the case study of this research is located around the environs of Ogbaru River (River Niger). It lies in the agricultural belt of the state (Ezenwaji, *et al.*, 2014).

*Research Design:*

In this study, field survey and experimentation design were adopted in order to achieve the research aim and objectives. The experimental design focused on Ugu leaves sampling and sample analyses to determine the amount of pesticide residues (Organochlorine and Organophosphate) and some toxic heavy metals (Mercury, Cadimum, Lead and Arsenic) on the leafy vegetable and to infer the effects of the contaminants on humans and the environment. In terms of field survey design, a personal observation was applied in collecting information on type of agrochemicals most popular among the Ugu farmers of Atani area, the application methods and used agrochemical containers disposal.

*Field Observation and Survey:*

Field observation was conducted as part of the data collection exercise. A hand-held GPS was used to determine coordinates where Ugu leaf samples were taken in the study area. While for the field survey, questionnaire was administered to the Ugu farmers to ascertain awareness level of the farmers on the effects of pesticide residues on human health and the environment

*Sample Collection and Preparation:*

The sampling technique used for the study was quarterly random sampling (Ugu farm was divided into four sections and randomly select a section where the Ugu leaves were collected) without giving any preference to a particular section. For effective comparative study of the extent and dangers of pesticides residues on Ugu vegetables produced in the study area, four 30g each of Ugu vegetable samples from four quartered Ugu farm field were collected randomly and labelled USA, USB, USC and USD (US represent Ugu Samples). The samples were collected in a clean polyethylene bag labelled and inserted in a cool box and transported to the laboratory for analyses of pesticide residues of organochlorine and organophosphate origins as well as some persistent heavy metals (Lead, Arsenic, Mercury and Cadmium).

Sampling took place early in the morning (from 8am – 11am) before the effects of the sun could be felt. This was to avoid heating of the atmosphere and by extension to the leaves avoiding trans-evaporation.

*Extraction of Vegetable Samples*

The method of extraction used for the vegetables was USEPA method 3510 for extracting pesticides residues in non-fatty crops, using ethyl acetate as the solvent. Sodium hydrogen carbonate (NaHCO3) was used to neutralize any acid that may be present and the vegetable samples were washed thoroughly with distilled water. Twenty grams (20 g) of each sample was placed in a mortar and anhydrous sodium sulphate (Na2SO4) was used to remove water from the sample. The weighed sample in a mortar was grounded to a paste using a pestle. The paste was transferred into a conical flask with the help of a spatula and 400 mL of ethyl acetate was added and shaken thoroughly. A 5g portion of sodium hydrogen carbonate (NaHCO3) was added to the mixture followed by 20 g of anhydrous sodium sulphate (Na2SO4), the entire mixture was shaken vigorously for one hour. This process was to ensure that enough of the pesticide residues dissolved in the ethyl acetate. The procedure was repeated for the four samples and the mixture was filtered into a labelled containers before centrifugation at a speed of 1800 rpm for 5 minutes. The organic layer was decanted into a container and 1:1 mixture of 5 mL ethyl acetate and cyclohexane was added.

*Determination of Pesticide Residues.*

The Shimadzu GCMS (GC - 17A) QP 2010 installed with a 35% diphenyl, 65% dimethylpolysiloxane column was used for the chromatographic separation. The oven was programmed as follows: initial temperature 40˚C, 1.5 minutes, to 150˚C, 15 minutes, 5˚C/minute to 200˚C, 7.5 minutes, 25˚C/minute to 290˚C with a final holding time of 12 minutes and a constant column flow rate of 1 ml/minute. The detection of the organophosphorus pesticides was performed using the GC-MS and GC coupled with Electron Capture Detector (ECD) for organochlorine pesticides. Detection of pesticides was performed using the GC-ion trap MS with optional MSn mode. The scanning mode offer enhances selectivity over either full scan or selected ion monitoring (SIM). The retention time, peak area and peak height of the sample were compared with those of the standards for quantification.

*Analytical procedure for heavy metals determination*

The air-dried vegetable samples were sieved using Whatman Filter Paper (2mm). One gram of each of the vegetable sample was weighed using electronic balance (Model: WT5002) into a 50ml beaker, 5ml of analytical grade acid HN03 and HCl were added. Mixture was allowed to stay for 5mins, and was heated at a temperature of about 80-900C for one hour thirty minutes using electric hot plate (HP 220, UTEC products Inc., Albany N. Y., USA) until a clear solution was obtained. After cooling, the solution was made up to a final volume (50ml) with distilled water in a volumetric flask. Similar procedure was carried on 1g air-dried soil samples. The metals (cadmium, lead, mercury and arsenic) were determined using Atomic Absorption Spectrophotometer (AAS) Analysis of each sample was replicated and the mean results reported in mg/kg.

*Statistical Methods of data Analyses:*

The obtained data were plotted with the aid of Microsoft excel software and IBM SPSS Statistical software to show pictorial relationship between organochlorine, organophosphate and heavy metals properties of Ugu leaf samples. Generated data were statistically analysed using general descriptive statistics such as mean, mode, range, standard mean error, standard deviation, variance and coefficient of variance. One-way Analysis of Variance (ANOVA) at significant level of 0.05 was used to test the research hypothesis.

## RESULTS AND DISCUSSION

Nowadays, due to the advances in crop production and cultivated food crops, there is an increase in the pollution of heavy metals and chemical residues. Thus, there is a need for continuous evaluation of their presence and concentration in crops to aid in mitigating and preventing any public health issues that could occur as a result of food consumption. Results obtained from laboratory analysis of organochlorine residue on Ugu leaf samples showed that the assayed pesticide residues of organochlorine origin were present on the leafy vegetables. However, only dichlorodiphenyldichloroethylene (DDE) residue was above the WHO standard for maximum pesticide residue limit (Table 1). This is an indication of toxicity accumulation on the leafy vegetable other than trace metal that naturally bioaccumulate in the environment. In this study some heavy metals were detected but only Pb was higher than the WHO standard limit in three out of the four farm fields assayed (Table 3). Again, it's an indication of persistent, bioaccumulation and toxicity associated with pesticides and heavy metals induced pollution synergy in the environment, which can be deleterious to the ecosystem. Dichlorodiphenyldichloroethylene (DDE), is a breakdown product of the pesticide DDT which has been linked to adverse health effects in humans, including potential impacts on the nervous system, liver, reproductive system, and may increase the risk of certain cancers (Vincenzo *et al.,* 2020)**.**

**Table 1: Organochlorine Residues in Ugu leaf Samples of Atani Ugu farm field.**

| Parameters | Ugu Samples (US) (mg/kg) Sample A | Sample B | Sample C | Sample D | WHO MRL Standard (mg/kg) |
|---|---|---|---|---|---|
| Aldrin | 0.008 | 0.009 | 0.007 | 0.008 | 0.020 |
| Lindane | 0.003 | 0.006 | 0.005 | 0.007 | 0.100 |
| Alachlor | 0.501 | 0.607 | 0.527 | 0.554 | 1.000 |
| DDE | 0.230 | 0.304 | 0.273 | 0.280 | 0.100 |
| DDT | 0.010 | 0.102 | 0.089 | 0.105 | 0.500 |
| Endosulfan | 0.852 | 1.030 | 0.856 | 0.780 | 1.000 |

The data obtained from laboratory analysis of organophosphate residue on Ugu samples from the four fields is presented on Table 2. All the organophosphates origin analysed were detected reasonably as the analysed organochlorine origin. However, chlorpyrifos and parathion were in excess in farm field B and C samples respectively and were above the WHO standard limit. It has been shown that organophosphorus pesticides have a higher acute toxicity than organochlorines, but organophosphate origins have the advantage of being degraded rapidly in the environment. Also, organochlorine compounds have been banned in most countries but their residues still appear as pollutants in food as well as the environment due to its persistent and bioaccumulation in environmental matrix. (Abdulhamidl *et al.,* 2015; Rea, 1996**)**. These findings support the synergy of lead toxicity with pesticide residues that are toxic, persistent and bioaccumulate in the environment **(**Alengebawy *et al*.,2021).

**Table 2: Organophosphate Residues in Ugu leaf Samples of Atani Ugu farm field**

| Parameters | Sample A | Ugu Sample (US) (mg/kg)<br>Sample B | Sample C | Sample D | WHO MRL Standard (mg/kg) |
|---|---|---|---|---|---|
| Chlorpyrifos | 0.389 | 0.531 | 0.420 | 0.481 | 0.500 |
| Malathion | 1.281 | 0.591 | 0.672 | 1.389 | 2.000 |
| Diazinon | 0.211 | 0.249 | 0.273 | 0.382 | 0.500 |
| Parathion | 1.823 | 2.182 | 2.436 | 1.154 | 2.000 |
| Carbaryl | 0.409 | 0.641 | 0.441 | 0.356 | 1.000 |
| Terbufos | 0.122 | 0.189 | 0.134 | 0.142 | 0.500 |

Heavy metals analytical results of Ugu leaf samples shown on Table 3. From the table, metals like lead on samples A, B and C, cadmium on sample B and arsenic on sample D were relatively above the WHO standard for maximum pesticide residue limit while mercury was same as the WHO standard for maximum pesticide residue limit. The presence of these metals on Ugu leaves indicates toxicity. This is due to Pb, Cd, As and Hg are highly toxic substances used in formulation of certain poisons such as herbicides and pesticides. These substances enter the environment through usage as fertilizers and pesticides leading to accumulation on plants and effects on other organisms through food chain. Therefore, overall implication of the findings from this study is the synergetic effect of exposure to pesticide residues and heavy metals in an environment. The synergetic effect is toxicity at a low concentration once it finds it way into the food chain as demonstrated on the Ugu leaf samples analysed. Studies suggested that the combined exposure to pesticides and heavy metals could have synergistic effects where the overall toxicity may be greater than the sum of the individual effects (Khan, Mahmood & Damalas, 2015; Yakubu, 2015). Heavy metals in pesticide formulations includes arsenic (As), cadmium (Cd), lead (Pb), and mercury (Hg) among others.

The presence of heavy metals in pesticides raises concerns about potential health risks, including cancer and non-carcinogenic effects, especially through dermal contact, ingestion, and inhalation. At the study area, the farmers were observed applying pesticides on the field without any personal protective equipment (PPE). Heavy metals as well as pesticides residues can accumulate in the soil and water, leading to environmental contamination and posing risks to ecosystems, damage plant life a critical danger to sustainable food security in an inversive climate (Alengebawy, 2021) These effects of heavy metals and pesticide residues on the environmental leads to soil, water even air contamination results to various health problems like cancer, neurological damage, and reproductive issues, as well as harming ecosystems and reducing crop yields (Omeje, Ezema & Eze, 2024; Ibitomi, Oluwarotimi & Mohammed, 2016). This poses a bane for food security in the phase of changing climate.

**Table 3: Heavy Metals in Ugu leaf Samples of Atani Ugu farm field**

| Parameter | Sample A | Ugu Sample (US) (mg/kg)<br>Sample B | Sample C | Sample D | WHO MRL Standard (mg/kg) |
|---|---|---|---|---|---|
| Lead | 0.230 | 0.550 | 0.130 | 0.050 | 0.100 |
| Cadmium | 0.120 | 0.220 | 0.100 | 0.150 | 0.200 |
| Mercury | 0.030 | 0.010 | 0.040 | 0.050 | 0.050 |
| Arsenic | 0.070 | 0.080 | 0.060 | 0.160 | 0.100 |

Using the percentage compliance with regulatory standard WHO, 2019. The WHO guideline values for maximum residue limit were used for comparative compliance test as shown on Table 4. The nearer the percentage value obtained is to 0.0 %, the higher the toxicity and dangerous the parameter is to the environment and human health. The findings revealed the concentrations of dichlorodiphenyldichloroethylene (DDE) and lead (Pb) to be above the WHO maximum residue limit, while aldrin, lindane, alachlor, dichlorodiphenytrichloroethane (DDT), endosulfan, chlorpyrifos, malathion, diazinon, parathion, carbaryl, terbufos, arsenic, mercury and cadmium concentrations were below WHO acceptable standard limit. Percentage Compliance for Organochlorine and Organophosphate Residues and Heavy Metals with WHO Standards Limit.

**Table 4: WHO guideline values for maximum residue limit**

| Parameters - | Maximum Value | Minimum Value | Mean Value | WHO M.S. Limit | Percentage Compliance |
|---|---|---|---|---|---|
| PESTICIDE RESIDUES OF ORGANOCHLORINE ORIGIN | | | | | |
| Aldrin | 0.009 | 0.007 | 0.008 | 0.020 | 60% |
| Lindane | 0.007 | 0.003 | 0.005 | 0.100 | 95% |
| Alachlor | 0.607 | 0.501 | 0.554 | 1.000 | 45.3% |
| DDE | 0.304 | 0.230 | 0.267 | 0.100 | 0.0% |
| DDT | 0.105 | 0.010 | 0.058 | 0.500 | 84.6% |
| Endosulfan | 1.030 | 0.780 | 0.954 | 1.000 | 75.8% |
| PESTICIDE RESIDUES OF ORGANOPHOSPHATE ORIGIN | | | | | |
| Chlorpyrifos | 0.531 | 0.389 | 0.455 | 0.500 | 10% |
| Malathion | 1.389 | 0.591 | 0.983 | 2.000 | 50.9% |
| Diazinon | 0.398 | 0.211 | 0.305 | 0.500 | 44.2% |
| Parattion | 2.436 | 1.154 | 1.795 | 2.000 | 51% |
| Carbaryl | 0.641 | 0.356 | 0.498 | 1.000 | 53.8% |
| Terbufos | 0.189 | 0.122 | 0.155 | 0.500 | 85.3% |
| HEAVY METALS | | | | | |
| Lead | 0.550 | 0.500 | 0.525 | 0.100 | 0.0% |
| Cadmium | 0.220 | 0.100 | 0.160 | 0.200 | 26% |
| Mercury | 0.050 | 0.010 | 0.034 | 0.050 | 32% |
| Arsenic | 0.150 | 0.048 | 0.097 | 0.100 | 7% |

## CONCLUSION AND RECOMMENDATION

This study investigated the presence and concentration of pesticide residues and some heavy metals on leafy vegetables (Ugu) cultivated on Atani farm fields. Studies have enumerated adverse effects of pesticides usage and heavy metals synergetic toxic effects on plants and environment. The study identified types of pesticides used in Ugu cultivation at the study area to be Organochlorine and organophosphates origins. The results of the analysed Ugu leaf samples showed that DDE an organochlorine pesticides residue and heavy metal Lead (Pb) were above the WHO standards limit. The implication is that if pesticide use persists in the area in ugu cultivation without regulation and change attitude on the part of farmers, it will cause more havoc to the environment and human health in coming years, a challenge to food security. The presence of endosulfan and DDT, Class 1 (highly toxic) agrochemicals is of a great concern. Endosulfan and DDT are banned in most countries due to high toxicity, hence the study suggests the ban on production and importation of these obnoxious pesticides in Nigeria. Cultural methods of weed and pest control should be advocated. This is due to its eco-friendly nature in agricultural pest control. If the herbs to be eliminated can easily be uprooted, then it is more advisable to do manual elimination. Finally, further research should be carried out in study area, especially as it relates to soil and ground water pollution from pesticides residues. Almost all the pesticide residues investigated were detected on the leafy vegetable. Thus, there should be continuous monitoring of this essential dietary components to ensure it consumption does not predispose the consumer to heavy metal and pesticides toxicities, as continuous consumption could potentially threaten people's health while intensify food insecurity.

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