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Evaluation of Pesticides and Trace Metal Contaminants in Grains, Fresh Fruits and Vegetables from Odoluwa Market Ile Oluji; Ondo State Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Vegetables, fruits and grains are sources of food rich in vitamins, minerals, and fibers and also have beneficial ant oxidative effects Pesticides and trace metals typically contaminate these food products. Pesticides and trace metals are not biodegradable and have the potential for accumulation in different body organs, leading to unwanted side effects This study investigated the concentration of pesticide residues and some selected Trace metals in Vegetables, fruits and grains from Odolua market Ile-Oluji Ondo State. Samples were collected randomly from the market, representative portion of the samples was chopped into small pieces and blended using a blender..Quantitative determination of the pesticide for Herbicides, organochlorine and organophosphate was carried out using Gas Chromatography-Mass Spectrometer after liquid-liquid

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extraction. Trace Metal was determined using Inductively coupled plasma - optical emission spectrometry (ICP-OES). The results reveal the presence of pesticide residues in all the samples. The mean concentration of pesticides in the samples was below the maximum residue limits (MRs) value for World health organization (WHO) while some were higher. The results also shows that all the trace metals analyzed are present in the samples except for Cadmium which is below the detection limit while Lead and Cobalt are only detected in one sample each. Some concentrations of the trace metals were below the permissible limit for WHO while others were higher than the permissible limit.

Keywords: Pesticide; water; trace metal; gas chromatography; ile-oluji; herbicides; fresh fruits.

1. INTRODUCTION

Fruits and vegetables are a vital component of a balanced diet, which is necessary for everyone's health to develop [1,2]. Global trade in fruits and vegetables is conducted to meet the increasing demand [1]. Leafy vegetables and fruits are frequently utilized in cooking. In addition to their nutritional value, they are utilized to improve the quality of soups made with leafy vegetables [3]. Their texture and hardness are mostly attributed to cellulose, hemicellulose, and pectin components [3].

Because they contain vitamins and mineral salts, fresh fruits and vegetables are very important in the diet. They also contain calcium, iron, sulfur, water, and potash [3]. They are essential protective foods that can be used to prevent and treat a variety of ailments as well as to maintain health [4]. Grains, which supply roughly 46% of calories and 52% of protein, and root crops/tubers, which give 20% of calories and 8% of protein, make up the majority of the diet in Nigeria. For the most majority of people worldwide, grains which are made up of cereals and legumes are the most important part of their diet.

The main causes of Nigeria's food insecurity are inefficient farming methods and losses from infestations after harvest. This has resulted in a high rate of food product contamination, which is primarily said to happen during processing and storage [5]. Any material or combination of materials designed to prevent, eradicate, or control any pest, including disease-carrying insects or unwanted plant or animal species that harm or otherwise obstruct the production, processing, storage, transportation, or marketing of food or agricultural commodities, is referred to as a pesticide.

Food may be poisoned by pesticides at higher concentrations due to contamination or as residues from treating crops. Because of cumulative exposure, residues from agricultural handling in food may pose a risk to children [6].

Pesticides are a bigger issue because of their poisonous qualities, persistence, bioaccumulation, lipophilicity, and negative effects on human health. By eating tainted fruits and vegetables, these chemicals can enter the human body. The main health effects linked to pesticides are reproductive effects, neurological problems, malignancies, birth defects, and endocrine disruptors. The length of exposure and the toxicity of a specific pesticide dictate its effect. There are two possible types of effects: acute and chronic. Rashes, diarrhea, vertigo, rashes, and blindness are possible acute consequences. According to [7]. chronic health implications include thyroid, cancer, and endocrine disturbance.

Given the importance of these items as essential parts of the human diet, the risk of heavy metal contamination in food cannot be understated. Rich in nutrients including fiber, vitamins, minerals, and carbs, vegetables, fruits, and grains also have advantageous antioxidative properties. Vegetable quality and safety are threatened by heavy metal contamination of vegetables resulting from soil and air pollution. Animals and human health are also at risk from heavy metal consumption through diet. There is evidence that heavy metals like Pb and Cd can cause cancer.

High rates of upper gastrointestinal disorders have been linked to high amounts of heavy metals (Cu, Cd, and Pb) in fruits and vegetables [8]. These incredibly stable substances have no worldwide limits and can withstand several decades in the environment before disintegrating. Grain legumes and cereals are frequently stored for extended periods of time by farmers and grain merchants, which puts them at risk of serious pest infestation and subsequent loss. In order to address these issues, the grains are routinely sprayed with pesticides, which can change the grains' nutritional content, taste, palatability, and food safety while also leaving harmful residues behind [9].

The deleterious health problems caused by toxicants are increasing due to their penetration and accumulation through the food chain, and their persistence in the ecosystem [10]. Such contaminants can cause acute and chronic diseases in the human body, such as lung cancer, renal dysfunction, osteoporosis, and cardiac failure [11] Numerous investigations have found varying degrees of herbicide residue, pesticide residue from organochlorine and organophosphorus, and trace metal contamination in foods such fruits, vegetables, and cereals [9-11]. Therefore, the objective of this research was to determine the levels of pesticide residues vegetables, Fruits and grains from Odoluwa markets, Ile, Oluji, Ondo State Nigeria and compare their residues content with FAO/WHO MRLs.

2. METHODOLOGY

2.1 Sample Collection, Preservation, Preparation, and Storage

Based on the positions of every place in the market, the sampling spots were arbitrarily chosen independently. The samples were taken for a month in order to analyze the pesticide residues. A composite of subsamples of the same commodity obtained by random sampling was used to create each representative of the sample. The samples served as representations of the goods that people in Ile Oluji Town frequently consumed. The sample was done in compliance with the general guidelines and procedures outlined in the European Commission (EC) directive [12] for determining maximum residue levels (MRLs) in food products. To prevent contamination and deterioration, two kilograms of each sample were packed in sterile polythene bags inside an ice chess box, labeled, and then taken to the laboratory for analysis.

2.1.1 Vegetables and fruits

A 200 g sample, which served as a representative portion, was chopped into small pieces and blended using a blender. According to [13] the homogenized samples were kept at 4°C in stainless steel jars.

2.1.2 Grains and pulse

To minimize interference, superfluous materials were removed from the sample. To achieve homogeneity, a portion of the sample weighing about 200.0g was taken and ground to a particle size of about 20 mesh. The ground samples were properly labeled and kept at 40 degrees Celsius in a glass bottle in the refrigerator.

2.2 Extraction of Pesticide Residues, Clean-up of Samples Extracts and Gas Chromatography – Mass spectrometer (GC –MS) Analysis

A 50 mL centrifuge was filled with an aliquot of 15 g of homogenized material, and 15 mL of acetonitrile was added. After a minute of vortexing the liquid, 4 grams of magnesium sulfate and 1 gram of sodium chloride were added. To prepare for cleanup, the sample was centrifuged and the supernatant was extracted. In order to clean up, the supernatant was transferred into a another tube that held 50 mg of primary and secondary amine (PSA).

150 mg of magnesium sulfate and 50 mg of graphite carbon black (GCB) were added. After being agitated and centrifuged, the extract aliquots were combined with 1 milliliter of toluene and subjected to analysis using an Agilent 8860A Gas Chromatograph, which was connected to a 5977C inert Mass Spectrometer (Agilent Technologies) equipped with an electron-impact source and triple axis detector [14,15].

2.3 Trace Metal Analysis

The samples were washed using tap water and deionized water and dried at 70 ˚C for 48 hours. The dried samples were pulverized by a blender followed by ashing. Approximately 2.5 g of powdered samples was weighed and placed into porcelain crucibles for ashing. The samples were burnt gradually at temperatures of 105, 150, 270 and 570 ºC for 4 hours, at the final temperature, 5.0 mL of HCl: HNO_3: H_2O_2 (1:3:1 v/v) mixture was added two times and evaporated to dryness. The residue was centrifuged after dissolving in 10.0 mL of 1.0 M HNO_3. And finally, the concentrated trace metals in the samples was determined using ICP-OES [16].

3. RESULTS AND DISCUSSION

The concentration of herbicide residue in the vegetables is presented in Fig. 1.

The concentration of organochlorine pesticides (OCP) in fruits from Odolua Central Market, Ile Oluji, is presented in Fig. 2.

The concentration of organophosphate pesticide (OPP) in grains and pulses from Odoluwa Central Market, Ile Oluji, is presented in Fig. 3.

The results (Table 1) shows the concentration of trace metals in vegetables from Oduduwa Central Market, Ile Oluji

Our results (Table 2) shows the concentration of trace metals in fruits from Odoluwa Central Market, Ile Oluji

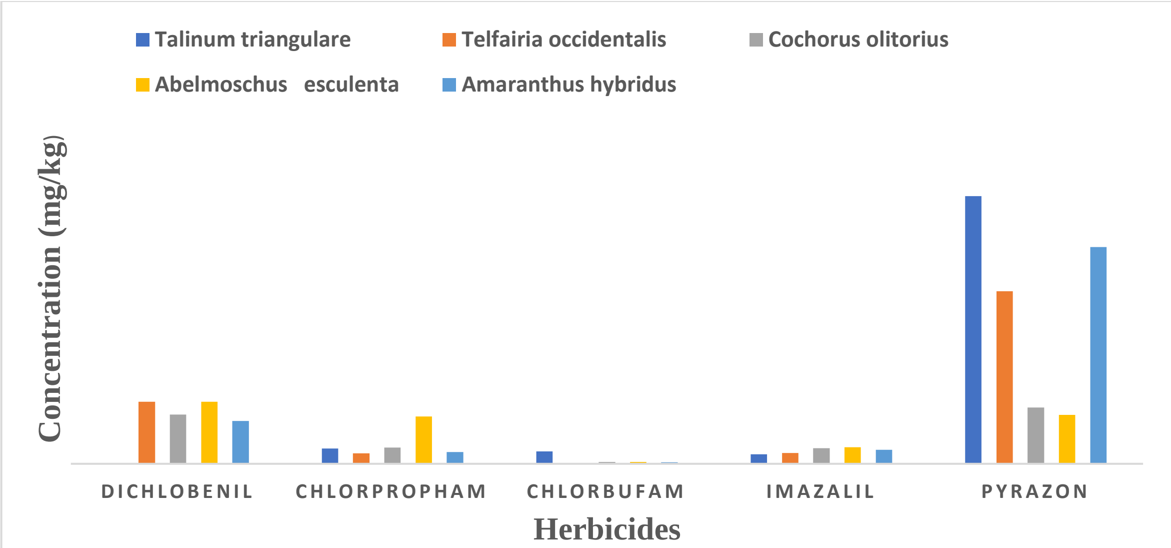

Fig. 1. Concentration of herbicides in vegetables from Odolua Central Market Ile Oluj

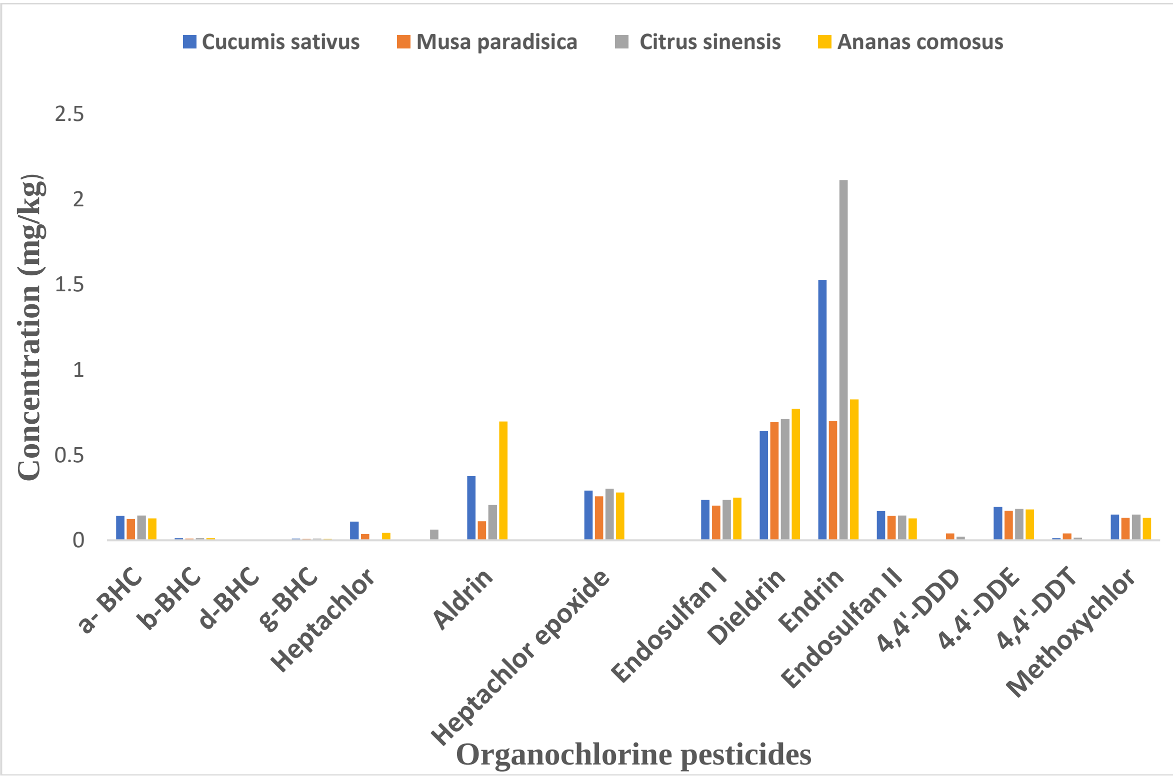

Fig. 2. Concentration of Organochlorine pesticides (OCP) in Fruits from Odolua Central Market Ile Oluji

Table 1. Concentration of Trace metals in vegetables from Odoluwa Central Market Ile Oluji

Element(wavelength(nm)	***Units***	***Talinum triangulare***	***Telfairia occidentalis***	***Cochorusolitorius***	***Abelmoschusesculenta***	***Amaranthus hybridus***	***WHO /FAO***
Fe 238.204	mg/kg	402.7794	371.1646	414.2253	407.525	461.827	425.5
Pb 220.353	mg/kg	BDL	BDL	BDL	0.7137	BDL	0.3
Cr 267.716	mg/kg	5.4165	10.8868	8.6015	BDL	5.5845	0.05
Mn 257.610	mg/kg	55.4383	80.4863	57.0274	122.3266	104.3178	500
Co 238.892	mg/kg	BDL	BDL	BDL	BDL	BDL	50
Cd 214.439	mg/kg	BDL	BDL	BDL	BDL	BDL	0.1
Zn3213.857	mg/kg	137.7281	179.8273	138.0919	268.3025	162.8495	100
Cu27.395	mg/kg	29.4596	36.7388	27.841	51.3206	44.5291	73.3
Ni231.604	mg/kg	9.9288	20.3422	14.3934	25.3909	6.2	NS

FAO: Food and Agriculture Organization; WHO: World health Organization ;mg/kg: milligram per kilogram; NS: Not stated; BDL: Below Detection limit

Table 2. Concentration of Trace metals in Fruits from Odoluwa Central Market Ile Oluji

Element(wavelength(nm)	***Units***	***Cucumis sativus***	***Musa paradisiaca***	***Citrus sinensis***	***Ananas comosus***	***WHO /FAO***
Fe 238.204	mg/kg	218.0834	113.8062	57.1946	34.8987	425.5
Pb 220.353	mg/kg	BDL	BDL	BDL	BDL	0.3
Cr 267.716	mg/kg	4.502909	BDL	6.8669	2.4442	0.05
Mn 257.610	mg/kg	4.7676	10.7404	15.1985	17.6617	500
Co 38.892	mg/kg	BDL	BDL	BDL	BDL	50.0
Cd 214.439	mg/kg	BDL	BDL	BDL	BDL	0.1
Zn 213.857	mg/kg	119.6764	146.9532	152.2261	145.8761	100
Cu 327.395	mg/kg	57.2559	43.7978	45.3242	44.3998	73.3
Ni 231.604	mg/kg	19.7477	12.876	9.1335	10.1382	NS

FAO: Food and Agriculture Organization; WHO: World health Organization ;mg/kg: milligram per kilogram; NS: Not stated; BDL: Below Detection limit

Table 3. Concentration of Trace metals in Grains/Pulses from Odoluwa Central Market Ile Oluji

Element(wavelength(nm)	Units	*Phaseolus vulgaris*	*Zea mays*	*Sorghum bicolor*	*Panicum sumatrense*	WHO /FAO
Fe 238.204	mg/kg	392.066	128.824	109.377	152.995	425.5
Pb 220.353	mg/kg	BDL	BDL	BDL	BDL	0.3
Cr 267.716	mg/kg	14.043	BDL	14.359	4.690	0.05
Mn 257.610	mg/kg	87.193	55.447	75.460	61.077	500
Co 38.892	mg/kg	5.303	BDL	BDL	BDL	50.0
Cd 214.439	mg/kg	BDL	BDL	BDL	BDL	0.1
Zn 213.857	mg/kg	324.877	122.029	179.119	136.369	100
Cu 327.395	mg/kg	31.880	23.112	28.504	24.954	73.3
Ni 231.604	mg/kg	6.645	BDL	3.967	1.634	NS

FAO: Food and Agriculture Organization; WHO: World health Organization ;mg/kg: milligram per kilogram; NS: Not stated; BDL: Below Detection limit

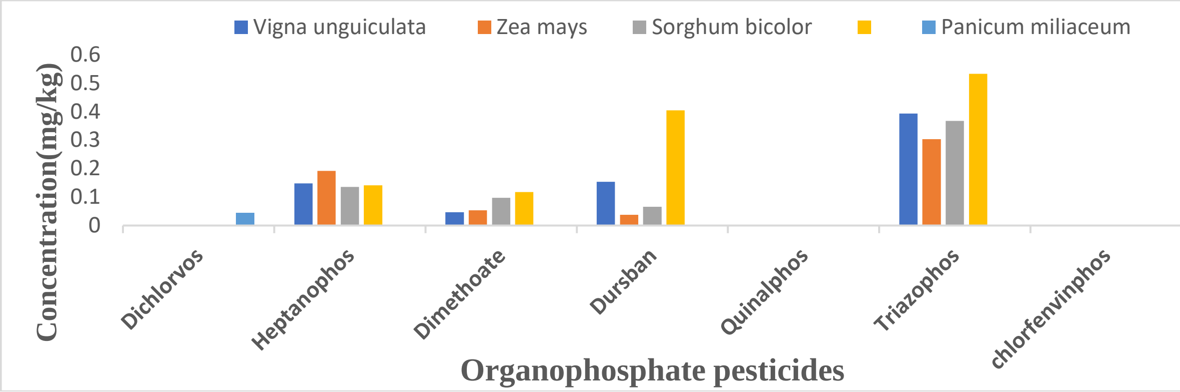

Fig.3. Concentration of Organophosphate pesticide (OPP) in Grains/Pulses from Odoluwa Central Market Ile Oluji

The results (Table 3) shows the concentration of trace metals in grains and pulses from Odoluwa Central Market, Ile Oluji

4. DISCUSSION

4.1 Pesticides Analysis

The Concentrations in (mg/kg) of pesticides in different vegetables, fruits and Grains collected from Odoluwa market in Ile Oluji were presented in Figs. 1–3. The pesticides results were segmented into three classes as shown in the figures. Fig. 1 presents the concentration of Herbicides residue in the Vegetables, Fig. 2 presents the concentration of Organo Chlorine residue in the fruits while Fig. 3 presents the concentration of Organophosphate residue in the grains.

4.2 Herbicides in Vegetable Samples

The purpose of the study was to determine the effects of herbicides on vegetables after they were used on farm weeds and herbs. The results of the study indicate that all vegetables, with the exception of *Talinum triangulare* (water leaf), which contains all pesticides except Dichlobenil, which is below the detectable limit, have herbicide residue. For Talinum triangulare, 0.0006 - 0.1231 mg/kg; for Telfairia occidentalis (pumpkin leaf); Cochorus olitorius (jute leaf); Abelmoschus esculenta (okra); and Amaranthus hybridus (amaranth green leaf), the herbicide concentration ranges are 0.0088 - 0.1911 mg/kg, 0.0014 - 0.0401 mg/kg, and 0.0012-0.1548 mg/kg, respectively. With the exception of Talinum triangulare, the concentration of chlorbufam seems to be lower in all vegetable samples. The findings indicate that applying pesticides to weeds has an impact on the farm's produce.

4.3 Organochlorine in Fruits Samples

The results from Fig. 2 shows the presence of organochlorine residue in the fruits sold in the market in the range of (0.0007 mg/kg for d-BHC - 0.6410 mg/kg for Dieldrin) in *Cucumis sativus* (Cucumber); (0.0005 mg/kg for d-BHC - 0.7010 mg/kg for Endrin) in *Musa paradisica* (Banana) ; (0.0024 mg/kg for d-BHC - 0.7116mg/kg for Dieldrin) in (*Citrus sinensis*)Oranges and (0.0029 mg/kg for d-BHC - 0.8266 mg/kg for Endrin) in *Ananas comosus* (Pineapple).The results trend shows less concentration of BHC and high concentration of Methoxychlor, Endosulfan, Endrin and Dieldrin. Because pesticides reduce toxins produced by food-infecting organisms, boost productivity, and require less work, most farmers and commercial producers spray fruits with pesticides multiple times during growth, which accounts for the presence of pesticide residues in the fruit [17] There are portions of the pesticide residue concentration that are below the MRLs and others that are above the MRLs. This is consistent with the findings of [18] who found that citrus fruits and vegetables in the Jordan Valley that were irrigated with water containing different pesticides exceeded MRL.

Comparably, a 2013–2014 study conducted in Algeria on 13 different fresh fruits and vegetables found that 12.5% of 160 samples had pesticide residues over the maximum residual level (MRL) [19,20]. The prudent use of such prohibited pesticides in storage and/or uptake when on the field on extensively polluted or treated soil with organochlorines could be one of the sources of these contaminations or residues above MRLs [9].

The detection of traces of banned OCPs like Dichlorodiphenyltrichloroethane (DDT) and high levels of banned aldrin above the MRL

4.4 Organophosphorus in Grains

The results from Fig. 3 presents the concentration of the pesticide residue for various Organophosphorus (OPP) Pesticides compounds in milligrams per kilogram (mg/kg). The table displays the results of pesticide residue analysis in grains, specifically focusing on various Organophosphorus Pesticides compounds. The grains analyzed in this study include : *Phaseolus vulgaris* (beans),(maize) , *Sorghum bicolor* (Guinea corn) and *Panicum sumatrense* **(** millet). The results reveal the presence of pesticide residues in the grains from Odolua Market, Ile Oluji. Dichlorvos, an OPP compound, was detected only in the millet sample at a concentration of 0.0457 mg/kg. Heptanophos, another OPP compound, was found in varying amounts across the different grain samples. It was detected in beans at a concentration of 0.1479 mg/kg, in maize at 0.1919 mg/kg, in Guinean corn at 0.1353 mg/kg, and in millet at 0.1410 mg/kg.

Dimethoate, Dursban, and Triazophos were also detected in the analyzed grain samples. Dimethoate showed concentrations ranging from 0.0468 mg/kg to 0.1176 mg/kg across the different grains. Dursban exhibited concentrations varying from 0.0376 mg/kg to 0.4047 mg/kg, with the highest concentration found in the millet sample. Triazophos concentrations ranged from 0.3037 mg/kg to 0.5331 mg/kg, with the highest concentration found in the millet sample.

The grains contain pesticide residues, which makes people worried about the possible health dangers of consuming them. The health of humans may be negatively impacted by pesticide residues, including toxicity over time. To reduce pesticide contamination in grains, the evaluation's conclusions point to the necessity of appropriate oversight, legislation, and the application of sound agricultural practices [20].

In order to guarantee food safety, farmers, market players, and regulatory bodies must work together to put safety precautions including appropriate pesticide application, following safety protocols, and routinely checking the amount of pesticide residue in grains into practice. Furthermore, consumer education and awareness initiatives can be extremely important in educating people about the possible dangers of pesticide residues and encouraging safe eating habits. The World Health Organization's (WHO) maximum residue limits (MRLs) are exceeded by the pesticide residue concentrations found in beans, guinea corn, cowpea, and maize, according to the pesticide residue study of the grains.

The WHO MRL is 0.1 mg/kg for beans and maize and 0.5 mg/kg for cowpea and guinea corn. There are worries regarding possible health risks connected to consuming these grains because of the presence of pesticide residues over the MRL.

4.5 Trace Metal Analysis

The mean concentrations (mg/kg) of selected Trace metals assessed from the Vegetables ,fruits and grains from Odolua market Ile-Oluji Ondo State are shown in Tables 1 to 3.

4.6 Iron (Fe)

The mean concentration of Fe in the Vegetable samples ranged from 371.1646 to 461.827 mg/kg The highest value was recorded in *Amaranthus hybridus* whilst the minimum value was recorded in *Telfairia occidentalis*. The mean concentration of Fe in the Fruit Samples ranged from 34.8987 to 218.0834 mg/kg. The highest value was recorded in *Cucumis sativus* while the minimum value was recorded in *Ananas comosu,* The mean concentration of Fe in the Grain Samples ranged from 109.377 to 392.066 mg/kg. The highest value was recorded in Phaseolus vulgaris while the minimum value was recorded in Sorghum bicolor The mean concentration of Fe for all the vegetable samples were below the WHO/FAO Limit except for *Amaranthus hybridus* which are higher than the limit. The mean concentration of Fe for all the fruits and the grain samples were below the WHO/FAO Limit for trace metals in food.

4.7 Lead (Pb)

The mean concentration of Pb in the Vegetables ,fruits and grains from Odolua market are below the detectable limits except for *Abelmoschu esculenta* with the concentration of 0.7137 mg/kg , which is above the WHO/FAO limits for trace metals in food. Pb can be harmful the body and can enter into the human system through air, water and food and cannot be eliminated through fruits and vegetable washing [21]. The traces of lead found in the *Abelmoschu esculenta* sample might be due to the concentration in the polluted area where these vegetables were cultivated. The concentration of Pb in this study is similar to (0.19 and 0.76 mg/kg) in apple as reported by [22].

4.8 Manganese (Mn)

The mean concentration of Mn the Vegetable samples ranged from 55.4383 to 122.3266 mg/kg The highest value was recorded in *Abelmoschus esculenta* whilst the minimum value was recorded in *Talinum triangulare*. The mean concentration of Mn in the Fruit Samples ranged from 4.7676 to 17.6617 mg/kg. The highest value was recorded in *Ananas comosus* while the minimum value was recorded in *Cucumis sativus,* The mean concentration of Mn in the Grain Samples ranged from 55.447 to 87.193 mg/kg. The highest value was recorded in Phaseolus vulgaris while the minimum value was recorded in Zea mays. The mean concentrations (mg/kg) of selected Trace metals assessed from the Vegetables, fruits and grains from were below the WHO/FAO Limit for trace metals in food.

4.9 Copper (Cu)

The mean concentration of CU the Vegetable samples ranged from 27.841 to 51.3206 mg/kg The highest value was recorded in *Abelmoschus esculenta* whilst the minimum value was recorded in *Cochorus olitorius*. The mean concentration of Cu in the Fruit Samples ranged from 43.7978 to 57.2559 mg/kg. The highest value was recorded in *Cucumis sativus* while the minimum value was recorded in *Musa paradisica,* The results obtained from this study was observed to be higher when compared to some published results 1.22 and 2.13 mg/kg; 1.27 and 2.13 mg/kg and 2.51 and 0.95 mg/kg as reported by [22,23] respectively for the concentration of Cu in watermelon, orange and banana. The mean concentration of Cu in the Grain Samples ranged from 23.112 to 31.880 mg/kg. The highest value was recorded in Phaseolus vulgaris while the minimum value was recorded in Zea mays. The mean concentrations (mg/kg) of selected Trace metals assessed from the Vegetables ,fruits and grains from were below the WHO/FAO Limit for trace metals in food.Though the concentration of Cu in all the sample were below the permissible limits , the presence of Cu in the sample may be as a result of long time usage of Copper Sulphate as fungicide for cocoa in this region.

4.10 Zinc (Zn)

The mean concentration of Zn the Vegetable samples ranged from 137.7281 to 268.3025mg/kg The highest value was recorded in *Abelmoschus esculenta* whilst the minimum value was recorded in *Talinum triangulare* The mean concentration of Zn in the Fruit Samples ranged from 119.6764 to 152.2261 mg/kg. The highest value was recorded in *Citrus sinensis* while the minimum value was recorded in *Cucumis sativus* The mean concentration of Zn in the Grain Samples ranged from 122.029 to 324.877mg/kg. The highest value was recorded in Phaseolus vulgaris while the minimum value was recorded in Zea mays. The mean concentrations (mg/kg) of selected Trace metals assessed from the Vegetables fruits and grains from were all above the WHO/FAO Limit for trace metals in food.Excess zinc concentration in the body accumulates in the body. Although zinc is not a human carcinogen, but excessive intake of zinc through contaminated food chain could lead to vomiting, dehydration, abdominal pain, lethargy and dizziness [24].

4.11 Nickel (Ni)

The mean concentration of Ni the Vegetable samples ranged from 9.9288 to 25.3909 mg/kg The highest value was recorded in *Abelmoschus esculenta* whilst the minimum value was recorded in *Talinum triangulare* The mean concentration of Ni in the Fruit Samples ranged from 9.1335 to 19.7477 mg/kg. The highest value was recorded in *Cucumis sativus* while the minimum value was recorded in *Citrus sinensis* The mean concentration of Ni in the Grain Samples ranged from 1.634 to 6.645mg/kg. The highest value was recorded in Phaseolus vulgaris while the minimum value was recorded in Panicum sumatrense , the concentration was below detection limit in Zea mays . The mean concentrations (mg/kg) of selected Trace metals assessed from the Vegetables fruits and grains for WHO/FAO Limit for trace metals in food was not stated. The consumption of nickel is dependent on its physicochemical procedure and the major target organs for nickel-induced toxicity are the lungs the higher respiratory tract for inhalation and the kidney [25].

4.12 Chromium (Cr)

The mean concentration of Cr the Vegetable samples ranged from 5.4165 to 10.8868 mg/kg The highest value was recorded in *Telfairia occidentalis* whilst the minimum value was recorded in *Talinum triangulare*. The mean concentration of Cr in the Fruit Samples ranged from 2.4442 to 6.8669 mg/kg. The highest value was recorded in *Citrus sinensis* while the minimum value was recorded in *Ananas comosus* and below detection limit in *Musa paradisica* The mean concentration of Cr in the Grain Samples ranged from 4.690 to 14.359 mg/kg. The highest value was recorded in Sorghum bicolor while the minimum value was recorded in Panicum sumatrense, the concentration was below detection limit in Zea mays . The mean concentrations (mg/kg) of selected Trace metals assessed from the Vegetables, fruits and grains from were above the WHO/FAO Limit for trace metals in food.

4.13 Cobalt (Co)

The mean concentration of Co in the Vegetables ,fruits and grains from Odolua market are below the detectable limits except for Phaseolus vulgaris with the concentration of 5.303mg/kg , which is below the WHO/FAO limits for trace metals in food.

4.14 Cadmium (Cd)

The mean concentration of Co in the Vegetables ,fruits and grains from Odolua market are below the detectable limits.

5. CONCLUSION

The study's findings demonstrated that the vegetables ,fruits and grains from the markets that were examined and frequently eaten by residents in the communities were tainted with various concentrations of pesticides and Trace metals. The findings also showed that while some of the examined vegetables, fruits, and grains had pesticide and heavy metal concentrations below the WHO-acceptable standards making them safe for ingestion by humans, others had concentrations beyond the WHO-acceptable limits, which could present a major health risk.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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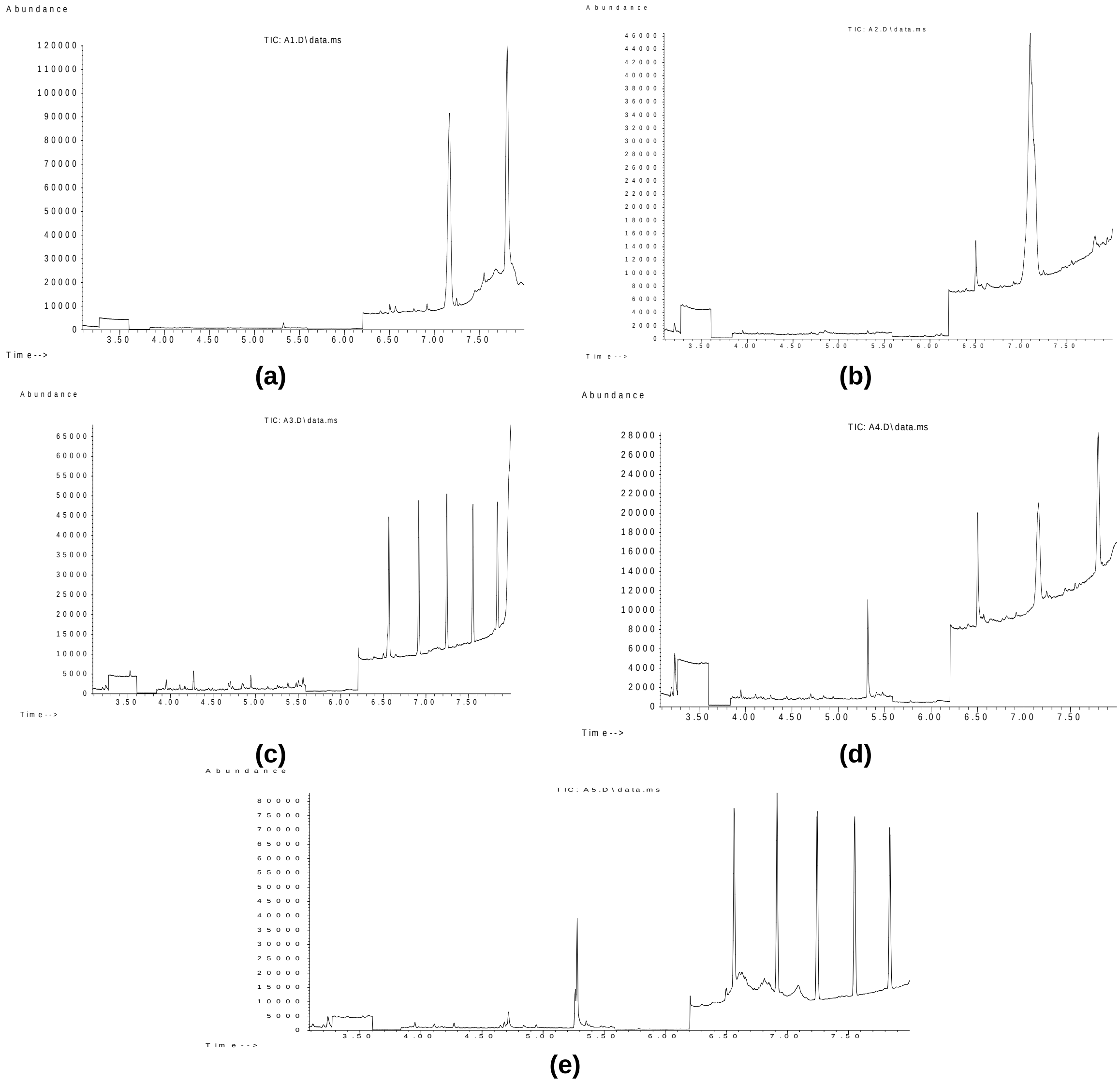
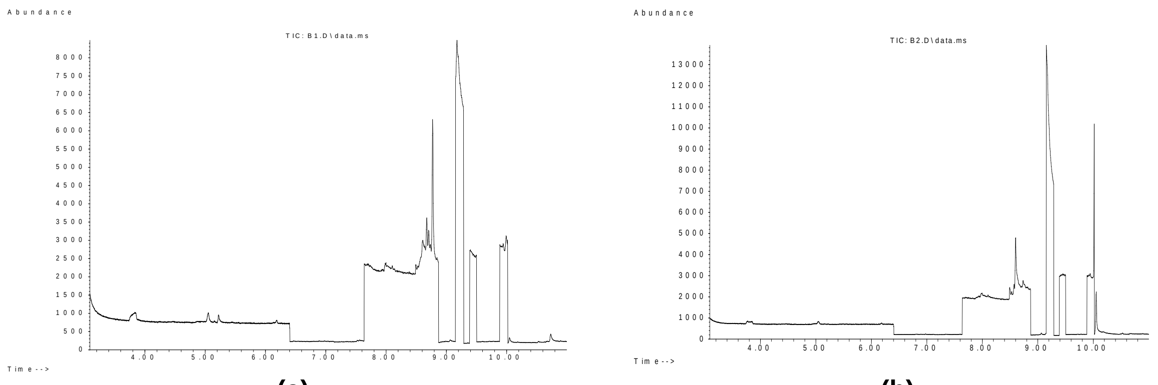
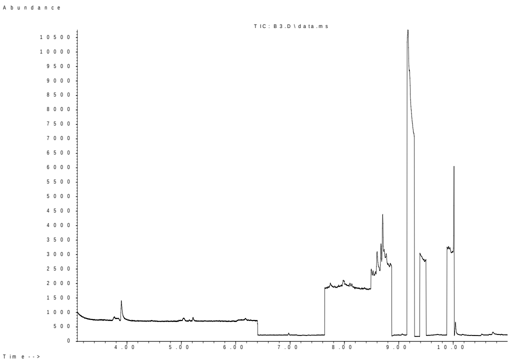
APPENDIX

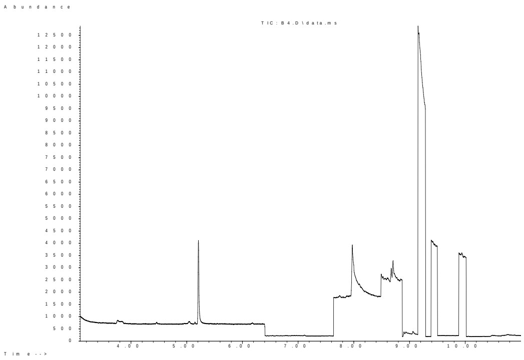


Graph 1. GC- MS Spectra of (a) *Talinum triangulare* (b) *Telfairia occidentalis* (c) *Cochorus olitorius* (d) *Abelmoschus esculenta(e) Amaranthus hybridus*



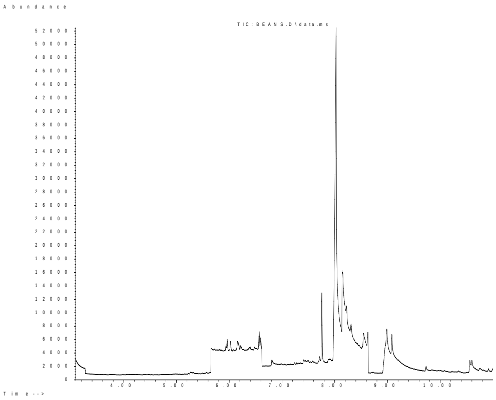


(c)

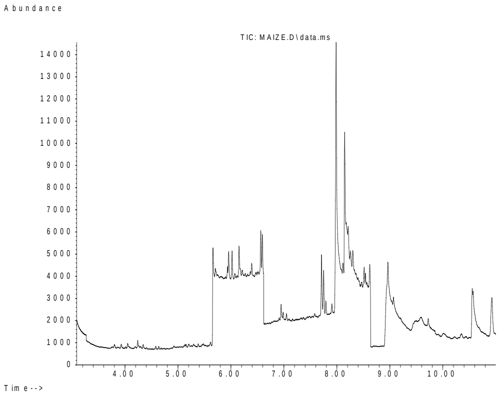


(d)

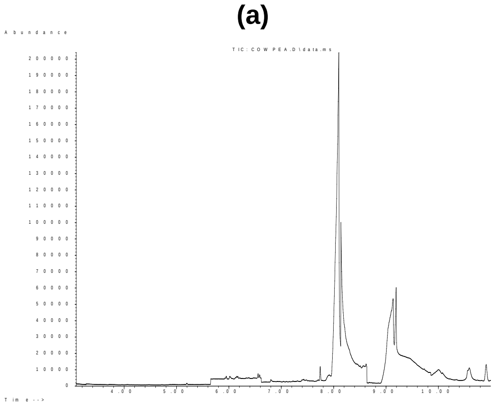
Graph 2. GC- MS Spectra of (a) *Cucumis sativus* (b) *Musa paradisica* (c) *Citrus sinensis* (d) *Ananas comosus*



(a)



(b)



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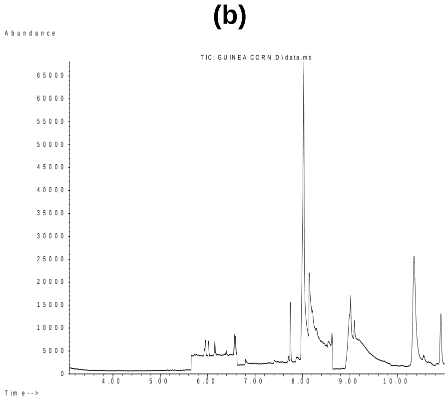

(d)

Graph 3.GC- MS Spectra of (a) *Phaseolus vulgaris* (b) *Zea mays* (c)*Sorghum bicolor*(d) *Panicum sumatrense*

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