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Determination of Pesticide Residues in Commercially Available Cucumber (*Cucumis sativus* l.) Fruits in Ogbomoso Agricultural Zone, Oyo State, Nigeria

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Abstract

Pesticides usage in cultivated crops has the benefit of yield increase, especially when such pesticides control insect pests, weeds and diseases. However, the bane of toxic residues in the harvested produce is a major concern worldwide. The presence of pesticide residues in commercially available cucumber (Cucumis sativus L.) fruits from five major markets in the five Local Government Areas in Ogbomoso Agricultural Zone, Oyo State,. Nigeria, were determined. Samples collected were extracted using ethyl acetate and were cleaned up using florisil. Gas Chromatography-Mass Spectrometer (GC-MS) was used to determine the pesticide residues. Seventeen pesticide residues (which belong to organochlorine, organophosphate and pyrethroids) were detected in the analysed cucumber samples. The levels of the majority of the residues detected compared with the European Union Maximum Residue Limits (EU MRLs) standard values. The results show that 13.6% of organochlorine, 4.5% of organophosphate and 13.6% of pyrethroids pesticide residues exceeded EU MRLs values. However, 20.5% of organochlorine, 2.3% of organophosphate and 45.5% of pyrethroids pesticide residues were below EU MRLs value. The total percentage of the higher and lower mean residue levels as compared with the EU MRLs were estimated to be 31.7% and 68.3%, respectively. The findings indicate that the public is exposed to minimal health risk of pesticide residues through cucumber consumption in Ogbomoso Agricultural Zone, Oyo State, Nigeria.

Keywords: Cucumber, Pesticides residues, Pyrethroids, Organochlorines, Organophosphate

Introduction

Cucumber (Cucumis sativus L.) is a monoecious annual crop of Cucurbitaceae family which has been in cultivation and consumed by man for over 3000 years (Adetula and Denton, 2003). Its production is very popular in many areas of Africa and other parts of the world. Cucumber can be cultivated in both temperate and tropical environments. Hence, it is said to be a native of many regions of the world (Mortimore, 2015). Reports by Grubben and Denton (2004) showed that aside raw eating of cucumber fruits, young or ripe cucumber fruits can be used as cooked vegetables or made into chutney. Also, medicinal ability of its leaf juice has been reported in treating dyspepsia in children and in skin care (Messien, 1998). C. sativus can be significantly helpful to regulate both high and low blood pressure because it contains high content of Potassium (Kamran, et al., 2008). There are many constraints facing cucumber production in Nigeria such as weeds, insect pests and diseases. Insect pests attack cucumber mostly at seedling stage and such insect includes *Phyllotretha cruciferae, Diabrotica undecimpunctata, Epilachana vigintiopunctata* and *Monolepta spp* has been observed in Ogbomoso Agricultural Zone (Mansour, 2004). These insect pests can cause very significant damage to the crop; hence, the attempts to reduce losses have led to the use of various pesticides. Vegetable farmers use wide range of pesticides at different levels to reduce losses from pests and diseases. Some of the insecticides used belong to organochlorine, organophosphorus, carbamate, pyrethroids and neo-nicotinoid groups for the control of insect pests (Haag and Landahl, 2014). The use of pesticides in Asia, Africa, Central and South America is increasing due to high demand for good quality products and urgent need for self-sufficiency in food production in the various regions (Odewole, et al., 2018).

Many of the available pesticides in the developing world are not biodegradable, but toxic and due to their bioaccumulation in the soil can enter into food chain and become detrimental to human and the ecosystem (Banjo, et al., 2010; Adeola, 2012). Inadequate information and inability of the farmers to read the pesticide label due to illiteracy are reasons for the misuse and overuse of toxic chemicals. Also, some farmers, especially vegetable farmers do not wait long enough for the residues to wash off after spraying before

harvesting because of their high demand to market the farm produce and low perception of the toxic effects of pesticide residues in their produce. It has also been stressed that, most of the pesticide applied to agricultural lands may affect non-target organism, contaminates soil and water media (Tijani, 2006). This, in recent years especially in fruit vegetables, is raising questions about human health and ecological consequences (Smith, et al., 1998). Residues in food products from many conventional agriculture where pesticides are used has been adjudged to evoke acute and chronic effects in humans such as headaches, dizziness, convulsions, epilepsy, stroke, respiratory disorders, leukaemia, stomach and intestinal upset, spasm, heart attacks, cancer, brain and liver tumours, and death (Alavanja, et al., 2004; WHO, 2016; Shou-zhen, 2007; Kedia and Palis, 2008).

Although, risk assessment of pesticide residues in contaminated vegetables is performed in developed countries (Akoto, et al., 2013; EFSA, 2013), residues emanating from different fruits are minimally explored in developing countries (Vieira, et al., 2014). In Nigeria and some underdeveloped countries, control programs for pesticide residues are often limited due to lack of human and materials resources. In most underdeveloped countries, pesticides are available everywhere and anyone can purchase pesticides and use as he wishes irrespective of its effect on the ecosystem. Thus, increased use of pesticides in agriculture has given rise to the occurrence of residues in fruit vegetables. It has been reported that vegetables that are eaten raw are expected to contain higher pesticide residue levels compared to other food groups of plant origin that are cooked or processed before consumption (Knezewvic and Serdar, 2009).

Therefore, pesticide residue monitoring is an important tool to control the quantity of pesticide in food. Regulatory authorities in many countries have been setting up monitoring systems for the agricultural products and the environment. This is done in order to ensure food safety and consumers' health protection in most countries, to ensure proper use of pesticide in terms of granted authorization and registration (application rates). In order to permit the free circulation of pesticide-treated products, Maximum residue levels of pesticides have been established as long as they comply with the fixed European Union Maximum Residue Limits (MRLs) or as may be stated by each country. Therefore, the aim of this study was to determine the pesticide residue levels in cucumber fruits sourced from various markets in Ogbomoso Agricultural Zone, Oyo State, Nigeria and to compare the determined pesticide residues with the European Union Maximum Residue Limits.

Materials and Methods

Sampling Locations

Cucumber samples used for the experiment were collected in five Local Government Areas (LGAs) that comprise Ogbomoso Agricultural Zones, Oyo State, Nigeria. The region's climate is known to be hot humid tropical falls in Southern Guinea Savannah of Nigeria. Cucumber fruits were obtained from sellers who purchased it directly from local farmers in the five LGAs of the study area. Locally grown cucumber fruits were obtained from each major market in the five LGAs of the study area. The LGAs and the respective market where samples were obtained are as follows: Ogbomoso North (Waso Market), Ogbomoso South (Araada Market), Surulere (Iresaapa Market), Orire (Iluju Market), Ogo-Oluwa (Odo-Oba Market).

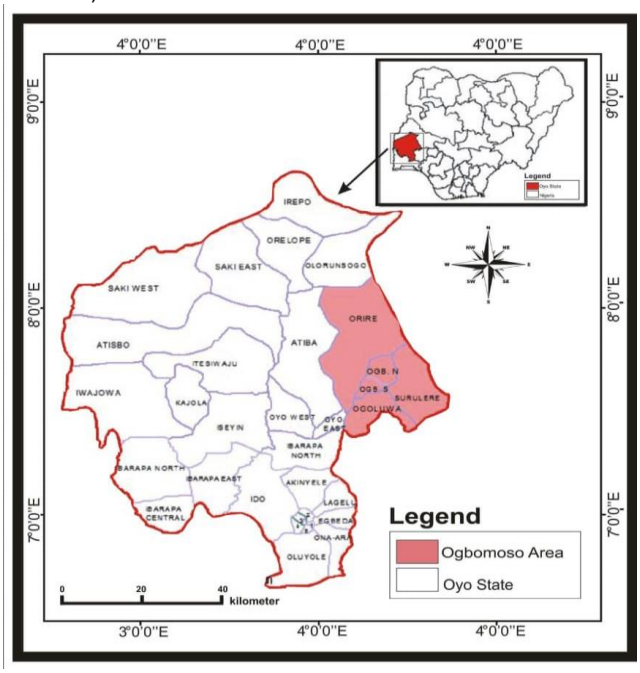


Figure 1: Map of Ogbomoso Agricultural Zone Showing the Five Local Government Areas of Oyo State Where Samples Were Collected

Sampling Procedure

Freshly harvested 1-3 kg each of cucumber fruits were obtained on 11th June, 2018 from two (2) different cucumber sellers in each market. Composite samples were prepared from the entire samples collected from each market by combining the samples together, and 5 kg each of the sample was weighed to represent a local government. The composite samples were kept separately in well

labelled brown envelopes and transported to the laboratory for analysis.

Sample Preparation

The procedure for sample preparation followed the methodology earlier described by Tijani (2006). The extraction was initiated by washing the cucumber samples with sufficient water and homogenized with a kitchen blender. Out of the cucumber mash, three replicates (10 g each) were transferred in 50 ml capacity Teflon tubes and the additional mash was stored in the freezer. A portion (10 g) of mash was mixed with 20 ml of ethyl acetate and then shaken vigorously for one minute and then vortexed for one minute. To separate the water from the sample, 6 g of anhydrous magnesium sulphate (MgSO4) and 1.5 g sodium chloride (NaCl) were added to the tubes. The samples were shaken and vortexed as above and then centrifuged for 5-7 min at 4000 rpm. A glass pipette was used to pipette 10 ml of the extract into a round bottom (RB) flask. The extract was then evaporated using a rotary evaporator until it was dried. To make sure there was no water remaining in the sample, 3 ml n-¬ hexane was added and the sample was again evaporated until dryness.

Clean-Up Procedure

The clean-¬ up procedure was executed using a combined florisil-alumina column (Haag and Landahl, 2014). The column was made by adding 5 g florisil, 5 g alumina and 0.5 g charcoal to a 100 ml flask. The solid material was dissolved in 20 ml n-¬ hexane and added to the RB-¬ flask and then poured into the column. The column was rinsed with 50 ml n-¬ hexane until equilibrium was reached and then 5 g anhydrous sodium sulphate (Na2SO4) was added. The dried extract was dissolved in 3 ml n-¬ hexane which was added and the RB-flask was put into an ultrasonic bath for 30 seconds. The extract was then added to the column. To elute the column, 20 ml n--hexane was added and when the n-¬ hexane surface was 2 cm above the packing, 80 ml of Dichloromethane (DCM) was added to the column. The DCM extract were collected into RB--flask and evaporated until dryness. To make sure that the sample was completely dry, 3 ml n--hexane was added and the extract was evaporated again. The extract was then dissolved with 4 ml n-hexane and 2 ml of the mix were transferred to a vial, using a glass pipette, for the chromatographic determination.

Chromatographic Analysis and Comparison with EU MLRs

The gas chromatography was coupled to mass spectrometry using Shimadzu Model Q 2010 GC-MS (Shimadzu, Japan) fitted with HP-5MS column of fused silica (30 x 0.25 x 0.25 mmd film thickness) and the carrier gas used was helium (99.99%). The injection was splitless and the split time was 1 min after injection using auto-sampler and the injection temperature was 250oC the pesticides. The temperature programme was from 100oC (held for 1 min) to 200oC at 10oC/min (held for 2 min) and to 280oC at 10oC/min (held for 2 min). The pesticide residues were identified by comparing the retention time of sample peaks with that of the standards (Fernández, et al., 2001). The levels of the pesticide detected were compared with the EU MRLs.

Results and Discussion

Organochlorine Pesticide Residues Level Detected in Cucumber Sourced from Sampling Locations

The chromatogram of organochlorine and pyrethroids is presented in Figure 2. The mean concentration of organochlorine pesticide residues detected in cucumber fruits obtained from the five locations compared with the standard values of European Union Maximum Residue Limits (EU MRLs) (Table 1) PF-38 and p,p`-DDE were detected in cucumber samples obtained from Ogbomoso North LGA (0.1125 and 0.0115 mg/kg, respectively) and Surulere LGA (0.3150 and 0.0025 mg/kg respectively). The detected PF-38 and p,.p`-DDE levels were lower than their respective EU MRLs of 0.02 and 0.05 mg/kg. The organochlorine pesticide residues detected may be as a result of long-time application rather than recent use due to their high persistence in the environment. Importation, sales and use of organochlorines have been banned by the European Union (Mokuwunye, et al., 2014) and that has actually reduced their use for agricultural purposes in the study area. Dichlorodiphenyl dichloroethane (DDD) and dichlorodiphenyl dichloroethylene (DDE) are metabolites of dichlorodiphenyltrichloro-ethane (DDT) which are more persistent than DDT itself and may persist for more than seven years in human being (Axmon and Rignell-Hydbom, 2006). The level of DDT metabolite detected from Ogbomoso North and Surulere LG were low. This suggests that organochlorine pesticide residues found could be due to soil accumulation of the pesticides (Mokuwunye, et al., 2014). Since, they break down very slowly in air, water, soil and in living organisms, they are subjected to long trans-boundary pollution movement. The organochlorines are carried over long distances via the atmospheric movement, human activities and body of migratory birds (WHO, 2003).

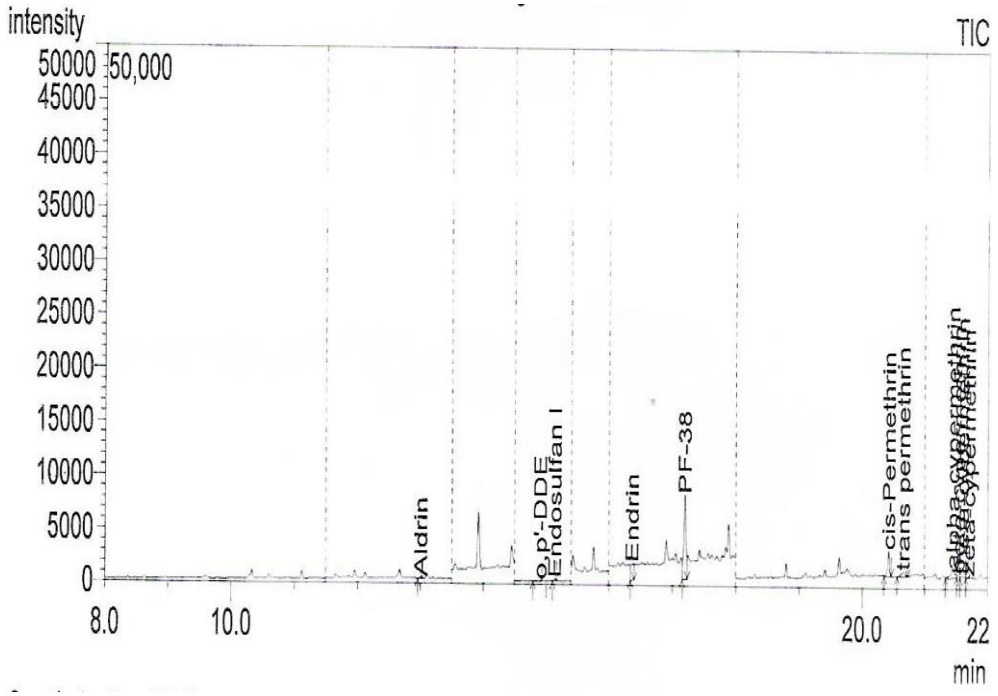


Figure 2: A Chromatogram of Organochlorine and Pyrethroid Residues in Cucumber Samples from Ogbomoso Agricultural Zone, Nigeria

Table 1: Organochlorine Residues in Cucumber Fruits Soured From Five Local Government Areas of Ogbomoso Agricultural Zone, Nigeria as Compared with the EU MRLs

Pesticide Residue	Chemical Formula	Concentration (mg/kg) of each local government OOLG	OSLG	OLG	ONLG	SLG	EU MRLS
Lindane	($C_6H_6Cl_6$)	0.0005	ND	0.0020	ND	ND	0.01
Aldrin	($C_{12}H_8Cl_6$)	0.0995	ND	0.0145	0.0215	0.0050	0.02
p,p'-DDE	($C_{14}H_8Cl_4$)	ND	ND	ND	0.0115	0.0025	0.05
Endosulfan I	($C_9H_6Cl_6O_3S$)	0.0485	ND	ND	ND	0.0022	0.05
Dieldrin	($C_{12}H_8Cl_6O$)	0.028	ND	ND	ND	ND	0.02
Endrin	($C_{12}H_8Cl_6O$)	ND	ND	ND	ND	0.0715	0.01
p,p'-DDD	($C_{14}H_{10}Cl_4$)	ND	ND	ND	0.0290	ND	0.05
PF-38	($C_{32}H_{38}ClN_3O_2)_{13}$	ND	ND	ND	0.1125	0.3150	0.02

Where value = Mean concentration; n=2, ND= Not Detected, EU MRLs= European Union Maximum Residue Limits (mg/kg), OOLG= Ogo- Oluwa Local Government Area, OSLG= Ogbomoso South Local Government Area, OLG= Orire Local Government Area, ONLG= Ogbomoso North Local Government Area and SLG= Surulere Local Government Area

Lindane was detected in cucumber fruits from Ogo-Oluwa and Orire LGAs at 0.0005 and 0.0020 mg/kg, respectively and the detected level was found to be lower than the standard EU MRLs of 0.01 mg/kg.(Table 1) This indicates that lindane had been used on the land, although the time of its usage could not be ascertained, since that was beyond the scope of this study. The detected level of lindane indicates that cucumber consumers in the named LGAs were safe because lindane is acutely toxic to man as its half-life is only 20 hours after exposure (Kang and Chang, 2011). The detected level of p,p'-DDD (0.0290 mg/kg) in cucumber obtained from Ogbomoso North LGA was lower than the EU MRL (0.05 mg/kg). Also, endosulfan I was detected at 0.0485 and 0.0020 mg/kg in the cucumber samples obtained from Ogo-Oluwa and Surulere LGAs, respectively; which was lower than the EU MRLs of 0.05 mg/kg. Lindane and endosulfan belong to WHO/EPA category II pesticides, which are moderately hazardous (WHO, 2010).

The presence of some organochlorines in the study area is an indication that they have been used or still in use. Previous studies have detected organochlorine insecticides residue in vegetables from China, Saudi Arabia and Ghana (Bempah and Donkur, 2011). This confirms that the pesticides are still in circulation despite the fact that

they have been banned. Adesina (2015) reported that banned pesticides are still in use in Oyo state especially on stored products. The detection of the above organochlorine may be as a result of long lime application than recent, though residue of the above organochlorine were lower than European residue limit but continuous consumption of vegetables or any food type with pesticide contamination may have negative consequences on human health in the long term (Thuy, 2015). Reports have shown that pesticides can accumulate in the tissues of organisms as they are not soluble (Donald, 2016).

The detected level of aldrin (0.0995 and 0.0215 mg/kg) in the cucumber samples collected from Ogo-Oluwa and Ogbomoso North LGAs, respectively was higher than that of EU MRLs of 0.02 mg/kg. However, the levels detected in the cucumber samples obtained from Orire and Surulere LGAs (0.0145 and 0.0050 mg/kg, respectively) were lower than EU MRL of 0.02 mg/kg. Aldrin has been reported to have neurotoxic, reproductive development tumorigenic effect as well as inducing vomiting and nausea in human (USEPA, 1975). Therefore, cucumber's consumers in Ogo-Oluwa and Ogbomoso North LGAs are at greater health risk of nervous system damage and cancer. It has been suggested that the hazardous level of aldrin could be as a result of its direct application to control pests of fruits and vegetables (Babayemi, 2016).

The detected levels of endrin and dieldrin (0.0715 and 0.0280 mg/kg, respectively) in the cucumber samples collected from Surulere and Ogo-Oluwa LGAs respectively were higher than the recommended EU MRLs of 0.01 and 0.02 mg/kg, respectively. These pesticides have been banned due to their persistence in the environment (Mokuwunye, et al., 2014). It has been established that Parkinson's disease, headache, dizziness, diarrheal, nervousness, confusion, nausea and vomiting are also potential symptoms of organochlorine toxicity (Honeycutt and Shirley, 2014). No organochlorine pesticide residue was detected in Ogbomoso South LGA. It is possible that the sprayed organochlorine are no more persistent or farmers in this area do not have cash crops where the insecticides could have been used in abundance. The available literature information on the use of different pesticides shows that 40% of all pesticides used belong to the organochlorine class of chemical (Gupta, 2004; FAO, 2005). Due to their low cost and the need against various pests, organochlorine insecticides such as DDT, hexachlorocyclohexane, aldrin and dieldrin are among the most widely used pesticides in some developing countries (Lallas, 2001). The concentration of the detected organochlorine residues in all the five LGAs were lower than the EU MLRs, except for Aldrin and Endrin which were higher than EU MRLs.

Eldrin, aldrin and dieldrin were classified as obsolete pesticides by WHO/EPA category II pesticides (WHO, 2010), these pesticides were higher than EU MRLs in Ogo-Oluwa, Ogbomoso North and Surulere LGAs. This is in consonant with the report of Bempah and Donkur, (2011) that pawpaw, tomatoes sourced from Accra Metropolis and imported apple purchased from markets within Accra has some organochlorine residue 59%, 27%, 20% respectively higher than EU MRLs. It has been reported by Olaniran (2016) that organochlorine was detected in cocoa bean produced in Ondo state and some pesticide residues were higher than EU MRLs. The high pesticide levels in these LGAs could result to health problems to farmers and general consumers.

Organophosphate Pesticide Residues Detected in Cucumber Sourced from Sampling Locations

The chromatogram of organophosphate residues is presented in Figure 3. The mean concentrations of Phosphamidon and azinphos-methyl in the collected cucumber samples (0.0125 and 0.0290 mg/kg, respectively) were slightly higher than the recommended EU MRLs of 0.01 and 0.20 mg/kg, respectively in Ogo-Oluwa LGA Table 2. Previous study by Mahugija (2017) revealed high concentration of organophosphate residue in spinach, cabbage and onion in Dar es Salaam city, Tanzania. Racke (1993) reported that organophosphate pesticide is used extensively in farms, thereby, exposing numerous food crops to its residues without any significant degradation. Symptoms of organophosphate toxicity include headache, seizures and loss of consciousness, muscle twitching, general weakness, anxiety, depression, coma, tremor and reduced muscle coordination, miosis, urination, diarrhoea, diaphoresis, lacrimation, excitation, and salivation (Moore, 2009). In cucumber samples collected from Surulere LGA, phosphamidon mean concentration (0.0075 mg/kg) was found to be lower than the EU MRL (0.01 mg/kg). However, no organophosphate pesticide residue was detected in cucumber samples obtained from Ogbomoso North, Ogbomoso South and Orire LGAs.

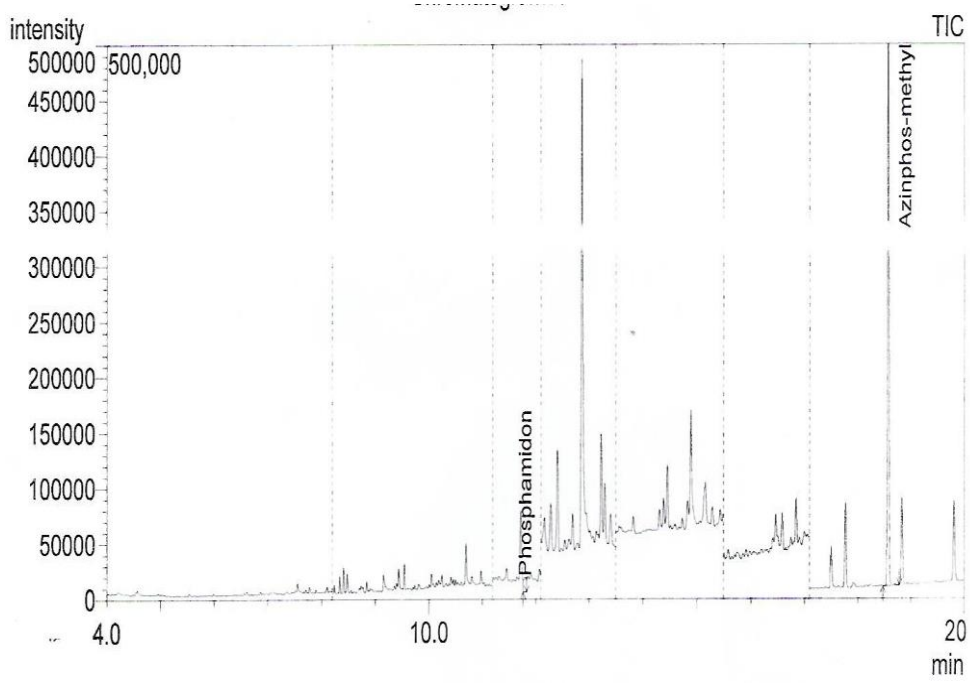


Figure 3: A Chromatogram of Organophosphate Pesticide Residues Detected from Cucumber Samples from Ogbomoso Agricultural Zone, Nigeria

Table 2: Organophosphate Residues in Cucumber Fruits Soured From the Five Local Government Areas in Ogbomoso Agricultural Zone, Nigeria As Compared With the EU MRL

		Mean Concentration (mg/kg) of each local government					
Pesticide Residue	Chemical Formula	OOLG	OSLG	OLG	ONLG	SLG	EU MRLS
Phosphamidon	($C_{10}H_{19}ClNO_5P$)	0.0125	ND	ND	ND	0.0075	0.01
Azinphos-methyl	($C_{10}PN_3H_{12}S_2O_3$)	0.2090	ND	ND	ND	ND	0.20

Where value = Mean concentration; n=2, ND= Not Detected, EU MRLs= European Union Maximum Residue Limits (mg/kg), OOLG= Ogo- Oluwa Local Government Area, OSLG= Ogbomoso South Local Government Area, OLG= Orire Local Government Area, ONLG= Ogbomoso North Local Government Area and SLG= Surulere Local Government Area.

Pyrethroids Pesticide Residues Level Detected in Cucumber Sample Sourced from Sampling Locations

The level of Lambda-cyhalothrin (0.0155 mg/kg) detected in cucumber samples from Ogbomoso North LGA was lower than the EU MRL of 0.05 mg/kg. Also, the level of trans-permethrin and alpha-cypermethrin detected across the five LGAs were lower than the EU MRLs (0.05 and 0.20 mg/kg). The cucumber samples collected from Ogbomoso North and Surulere LGAs had higher mean concentration of trans-permethrin and alpha-cypermethrin (0.3060 and 0.2105 mg/kg, respectively) than the EU MRLs (0.05 and 0.20mg/kg respectively). Also, the levels of theta-cypermethrin and zeta-cypermethrin detected in the cucumber samples obtained from Ogo-Oluwa, Ogbomoso South, Ogbomoso North and Surulere LGAs (0.1345, 0.1050, 0.0490 and 0.0405 mg/kg) and (0.1345, 0.1050, 0.0310 and 0.0120 mg/kg), respectively. They were lower than the recommended EU MRL (0.20 mg/kg). cis-permethrin (2.5735, 5.1585 and 0.5970 mg/kg, respectively) was found to be higher than the EU MRLs valve of (0.05 mg/kg) in Ogo Oluwa, Ogbomoso South and Surulere LGAs, respectively. It was however found to be lower (0.0218 mg/kg) than the EU MRL in cucumber obtained from Ogbomoso North LGA On the other hand, beta-cypermethrin mean concentration of 0.0220 and 0.0070 mg/kg in the cucumber samples from Ogbomoso North and Surulere LGAs, respectively was lower than the standard EU MRL (0.20 mg/kg) but was found to be slightly higher than the EU MRL in cucumber obtained from Ogo-Oluwa LGAs (Table 3). The level of cypermethrin isomers (alpha-cypermethrin, beta-cypermethrin, theta-cypermethrin and zeta-cypermethrin) detected ranged from 0.0070 to 0.3155 mg/kg. This is in consonance with Zawiyah et al., (2007) where the level of cypermethrin detected in tomato (0.290 mg/kg) was lower than the EU MRL value of 0.50 mg/kg. Furthermore, permethrin in two optical

stereoisomers (Cis and Trans) were detected across the LGAs and their levels ranged from 0.0071 to 5.1585 mg/kg except for cis-permethrin, which was not detected in Orire LGA. Pyrethroids pesticide may cause varieties of symptoms which include nausea, vomiting, diarrhoea, mucosal irritations, salivation, tearing, motor coordination disorder, chorea, inertia, tremors and clonic seizures, epidermal lesions, sore throat, abdominal pain, gastrointestinal mucosal irritation, salivation, respiratory distress and headaches in human (Costa, et al., 2013; Skolarczyk, et al., 2017).

Comparative Summary of Detected Pesticide Residues with Eu Mrls

Of the total detected pesticide residues, 13.6% of organochlorine, 4.5% of organophosphate and 13.6% of pyrethroids residues were higher than the EU MRLs (Table 4). Pyrethroids was the commonest pesticides used by most cucumber farmers in the study area due to pest complexes problem associated with cucumber. Chemical control is the most popular option due to lack of viable alternative control to pests and this do result to indiscriminate application of pesticides (Ntow, et al., 2006). Limited knowledge about pesticide label due to illiteracy of most farmers leads to liability to follow proper precautions and dosage which usually leads to pesticide abuse especially at pre harvesting stage (Szpyrka, et al., 2015). It has been reported that processing techniques like storing, washing, and peeling procedures lead to the decrease of pesticide residues in greenhouse cucumbers and the peeling procedure has the greatest impact on residual reduction (Leili, et al., 2016). Also, the pesticide residues studied in field-sprayed and processed fruits and vegetables were reported that the commercial processing procedures led to a large reduction in the level of pesticide residues in the finished products (Chavarri, et al., 2004). However, 20.5% of the detected residues organochlorine, 2.3% of organophosphate residue and 45.5% of pyrethroids residues were lower than the EU MRLs. The total percentage of residues with higher and lower mean concentration compared to the EU MRLs were 31.7% and 68.3%, respectively (Table 4). It was reported by Okihashi, et al., (2005) that levels of pesticides residues in agricultural products are influenced by environmental factors and other habits such as spraying close to maturity stage due to pest pressure.

Table 3: Pyrethroid Residues in Cucumber Fruit Soured from the Five Local Government Areas in Ogbomoso Agricultural Zone, Nigeria as Compared with the EU MRL

		Mean Concentration (mg/kg) of Each Local Government					
Pesticide Residue	Chemical Formula	OOLG	OSLG	OLG	ONLG	SLG	EU MRLS
Lambda cyhalothrin	(C23H19ClF3NO3)	ND	ND	ND	0.0155	ND	0.10
Cis-permethrin	(C21H20Cl2O3)	2.5735	5.1585	ND	0.0218	0.5970	0.05
Tran-permethrin	(C21H20Cl2O3)	0.0115	0.0230	0.0370	0.3060	0.0071	0.05
Alpha-cypermethrin	(C21H20Cl2O3)	0.1540	0.0115	0.0095	0.0145	0.2105	0.20
Beta-cypermethrin	(C21H20Cl2O3)	0.3155	ND	ND	0.0220	0.0070	0.20
Lambda cyhalothrin	(C23H19ClF3NO3)	ND	ND	ND	0.0155	ND	0.10

Where value = Mean concentration; n=2, ND= Not Detected, EU MRLs= European Union Maximum Residue Limits (mg/kg), OOLG= Ogo- Oluwa Local Government Area, OSLG= Ogbomoso South Local Government Area, OLG= Orire Local Government Area, ONLG= Ogbomoso North Local Government Area and SLG= Surulere Local Government Area

Table 4: Comparison of Detected Pesticide Residues with European Union Maximum Residue Limit Based on Pesticide Class (%)

Class of Pesticide	Number of pesticide residues having higher values than EU MRLs (%)	Number of pesticide residues having lower values than EU MRLs (%)
Organochlorine	6 (13.6%)	9 (20.5%)
Organophosphate	2 (4.5%)	1 (2.3%)
Pyrethroids	6 (13.6%)	20 (45.5%)
Total	14 (31.7%)	30 (68.3%)

Conclusion

This study indicates that cucumber farmers in Ogbomoso are using pesticide product in reasonable way and the detected pesticide residues may not be highly potent to pose major health problems to the consumers. Although there was higher concentration of Aldrin and Endrin which were among the pesticides that have been band for many years, its long persistence in the soil, caused them to be found in some of the cucumber samples. Although, two pyrethroid residues (Cis-permethrin and Trans- permethrin) were detected in high levels, pyrethroids are believed to be biodegradable. Some pesticides are persistent in nature and can bioaccumulate and be biomagnified in the tissues of organisms at the higher trophic level. Therefore, it is recommended that cucumber farmers should carry out soil test before planting cucumber, in order to avoid soil pre-loaded with persistent pesticide residues. Also, there is the need for proper education and enlightenment of farmers on how to use pesticides to avoid problems associated with pesticide poisoning.

Moreover, greater priorities must be given to develop strategies for pesticide reduction in cucumber production through farmer training on safe pesticide use, and promote alternatives to chemical pest control such as botanicals or biological control. Promotion of safe pesticide use should be enforced by regulatory agencies at the farm and retail level. It is also critical to raise awareness among the general public, who may be directly or indirectly exposed to pesticides, about the risk of these pesticides and how to reduce this risk.

Conflict of Interest

The authors wish to confirm that there are no known conflicts of interest associated with this publication

References

Adeola, R.G. (2012). Perceptions of environmental effects of pesticides use in vegetable production by farmers in Ogbomoso, Nigeria. Global Journal of Science Frontier Agricultural & Biological, 121 (4).

Adesina, G. O., Babarinde, S. A., Olaniran, A. O. (2015). Assessment of selected food products for pesticide residue in major markets of Oyo state, Nigeria. International Letters of Chemistry, Physics and Astronomy 54 pp 47-55

Adetula, O., Denton, L. (2003) Performance of vegetative and yield accessions of cucumber (Cucumis sativus L.) Horticultural Society of Nigeria (HORTSON) Proceedings of 21st annual conference.

Akoto, O., Andoh, H., Darko, G., Eshun, K., Osei-Fosu, P. (2013). Health risk assessment of pesticides residue in maize and cowpea from Ejura, Ghana Chemosphere; 92 (1):67-73

Alavanja, M.C.R., Hoppin, J.A., Kamel, F. (2004). Health effects of chronic pesticide exposure: cancer and neurotoxicity. Annual Review of Public Health 25. 155–197.

Axmon, A., Rignell-Hydbom, A. (2006). Estimations of past male and female serum concentrations of biomarkers of persistent organochlorine pollutants and their impact on fecundability. Environmental Research 101 387-394.

Babayemi, J. O. (2016). Overview of Levels of Organochlorine Pesticides in Surface Water and Food Items in Nigeria. Journal of Environmental and Earth Science 6 No.8

Banjo, A. D., Aina, S. A., Rije, O.I. (2010). Farmers knowledge and perception towards herbicides and pesticides usage in Fadama area of Okun-Oma, Ogun State Nigeria.

Bempah, C. K., Donkur, A. K., (2011). Pesticide residues in fruits at the market level in Accrametropolis, Ghana. A preliminary study. Environmental monitoring and Assessment 175: 551-611.

Chavarri, M. J., Herrera, A., Arino, A. (2004). Pesticide residues in field-sprayed and processed fruits and vegetables. Journal Science Food Agriculture, 84(10):1253-9.

Costa, C., Rapisarda, V., Catania, S., DiNola, C., Ledda, C., Fenga, C. (2013). Cytokine patterns in green house workers occupationally exposed to-cypermethrin: An observational study. Environmental Toxicology Pharmacology 36, 796–800.

Donald, S. (2016). Environmental Contaminants and Their Biological Effects on Animals and Plants. Ecotoxicology Essentials 1st Edition Pp 500.

European Food Safety Authority, (2013). European Union report on pesticide residues in Food. European Food Safety Authority (EFSA), Parma, Italy. EFSA Journal 11(3):3130

FAO, (2005). A system of integrated Agricultural census and surveys. Volume 1: World programme for the census of Agriculture

Fernández, M., Pico, Y., Manes, (2001). Pesticide residues in oranges from Valencia (Spain). Food Additives and Contaminants 18, 615e624.

Grubben, G. J. H., Denton, O. A. (2004) Amaranthus cruenthus. Plants resources of tropical Africa and 2. Vegetables PROTA foundation, Wageningen, Netherlands/Backhuys Publishers, Leiden, Netherlands/ CTA, Wageningen, Netherlands 2004. 67-72.

Gupta, P. K. (2004). Pesticide exposure- Indian scene. Toxicology 198 (1): 83-90

Haag, J., Landahl, A. (2014). Pesticide residues in cucumbers cultivated in Bangladesh. International Science Programme Uppsala University, Sweden project Work in Aquatic Engineering pp 71.

Honeycutt, M., Shirley, S. (2016). Dieldrin. Encyclopaedia of Toxicology (Third Edition), Pages 107–110.

Kamran, Q. M., Kashif, W., Jilani. M. S. (2008) Effect of Different Nitrogen Levels on Growth and Yield of

Cucumber (Cucumis sativus L.). Journal of Agricultural Research 46(3): 259-266.

Kang, J. H., Chang, Y.S. (2011). Organochlorine pesticides in Human serum, pesticides strategies for pesticides Analysis, Prof Margarita stoytcheva edition ISBN: 978-953-307-460-3

Kedia, S. K., Palis, F. G. (2008). Health effects of pesticide exposure among Filipino rice farmers. The Applied Anthropologist 28: 40–59.

Knezewvic, Z., Serdar, M. (2009). Pesticide residue in fresh fruit. Food Control 20: 419.

Lallas, P. (2001). Reproductive effects in birds exposed to pesticides and industrial chemicals. The Stockholm convention on persistent organic pollutants. American Journal of International Law 95: 692-708.

Leili, M., Pirmoghani, A., Samadi, M. T., Shokoohi, R., Roshanaei, G. Poormohammadi, A. (2016). Determination of Pesticides Residues in Cucumbers Grown in Greenhouse and the Effect of Some Procedures on Their Residues. Iran Journal Public Health Vol. 45, pp.1481-1490

Mahugija, J. A. M., Khamis, F. A., Lugwisha, E. H. J. (2017). Determination of levels of organochlorine, organophosphorus, and pyrethroid pesticide residues in vegetables from markets in Dar es Salaam by GC-MS. International Journal of Analytical Chemistry Vol Article ID 4676724, pg 9.

Mansour, S. A. (2004). Pesticides Exposure-Egyptian scene. Toxicology 20: 91-115.

Messien, C. M. (1998). The tropical vegetable gardens. Principles for improvement and increasing production with application to vegetable. Macmillan Publishers, London, UK. Pp. 218.

Mokuwunye, I. U., Babalola, F. D., Asogwa, U. E., Idris, N., Aderolu, I. A., Mokwunye, F. C., Idrisu, M. (2014). Compliance of agrochemical marketers with banned cocoa pesticides in Southwest Nigeria. Journal of Agricultural Sciences 59(2): 161-174.

Moore, P. C. F. (2009). Children and Pollution: Why Scientists Disagree: Why Scientists Disagree, Oxford University Press, Oxford, UK,

Mortimore, M. (2015). Dry land developer's success stories from West Africa environmental Journal of Biological Science 45: 10-21.

Ntow, W. J., Gijzen, H. J., Kelderman, P., Drechsel, P. (2006). Farmer perceptions and pesticide use practices in vegetable production in Ghana. Pest Management Science 62(4): 356–65.

Odewole, A. F., Adebayo, T. A., Olaniran, O. A., Akanbi, W. B., Olusegun, O. O. (2018) Preliminary study of insect pests of cucumber (Cucumis sativus L.) in Ogbomoso Agricultural Zone of Nigeria. Acta fytotechn zootechnoogy 21(3): 108–112.

Olaniran, O. A., Ajiboye, E. O., Adebayo, T. A., Babarinde, S. A., Adedosu, H. O., Adesina, G. O. (2016). Determination of organochlorine pesticide residues in dried cocoa. International Letters of Natural Sciences Vol. 54 pp 8-16.

Okihashi, M., Kitagawa, Y., Akutsu, K., Obana, H., Tanaka, Y. (2005). Rapid method for the determination of 180 pesticide residues in foods by gas chromatography/mass spectrometry and flame photometric detection. Journal of Pest Sciences 30(4): 368-77.

Racke, K. D. (1993). Environmental fate of chlorpyrifos. Reviews of environmental contamination and Toxicology Vol.131 pp. 1-150.

Shou-zhen, X., (2007). Health effects of pesticides: a review of epidemiologic research from the perspective of developing nations. American Journal of Medicine 12. 269–279.

Skolarczyk, J., Pekar, J., Nieradko-Iwanicka, B. (2017). Immune disorders induced by exposure to pyrethroid insecticides. Postepy Hig. Med. Do´sw 71, 446–453.

Smith, M. E., Van Ravenswaay, E.O., Thompson, R. S. (1998). "Sales loss determination in food contamination incidents: an application to milk bans in Hawaii," American Journal of Agricultural Economics, Vol. 70, pp. 513–520.

Szpyrka, E., Kurdziel, A., Matyaszek, A., Podbielska, M., Rupar, J., Słowik-Borowiec, M. (2015). Evaluation of pesticide residues in fruits and vegetables from the region of south-eastern Poland. Food Control 48: 137-42.

Thuy, T.T. (2015). Effects of DDT on Environment and Human Health. Journal of Education and Social Science 2: 108-114.

Tijani, A. A. (2006). Pesticide use Practices and Safety Issues: The case of Cocoa Farmers in Ondo State, Nigeria. Journal of Human and Ecology, 19 (3), 183-190.

USEPA, (1975). DDT- A review of scientific and economic aspects of the decision to ban its use as a pesticide EPA 540 1-75-022 u S environmental Protection Agency, Office of pesticide programs, U.S Government printing Office; Washington, DC.

Vieira, J. F., Soares, V. N., Villela, F. A., Espinola, J. E., Castanho, F. R., Almeida, T.L. (2014). Use of thiamethoxam as bio activator on cucumber seed physiological quality and seedling performance. deRevista Brasileira de CiênciasAgrárias 9: 317–321.

World Health Organisation, (2003). Joint WHO/Convention Task Force on the Health Aspects of Air Pollution. Health Risks of Persistent Organic Pollutants from Long Range Transboundary Air Pollution. Copenhagen, Denmark.

World Health Organisation, (2016). Pesticide Residues in Food. http://www.who.int/feature/9a/87/en. Accessed on 28th September.

World Health Organisation. (2010). The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification. World Health Organization, Geneva. The WHO Classification of pesticides by hazard and guidelines to classification. Unpublished report no. Geneva, Switzerland: World Health Organization.

Zawiyah, S., Che Man, Y. B., Nazimah, S. A. H., Chin, C. K., Tsukamoto, I., Hamanyza A. H., Norhaizan, I. (2007). Determination of organochlorine and pyrethroid pesticides in fruit and vegetables using SAX/PSA clean-up column. Science direct. Food Chemistry 102: 98–103