

Pesticides Residue In *Cucumis Sativus* (Cucumber) Sold In Major Markets In Abakaliki Area Of Southeastern Nigeria

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ABSTRACT

This study is aimed at assessing the level of pesticides residues in cucumbers sold in major markets in Abakaliki area, as well as the associated health risks. Samples of cucumbers were collected from two major markets in Abakaliki and analyzed for pesticide residues using Gas Chromatography coupled to an electron capture detector (GC-ECD). The risk associated with the consumption of cucumber was also evaluated using the health risk index (HRI). A maximum of twenty five (25) pesticides residues were present in samples from both markets. The results showed that samples from both markets were contaminated with multiple pesticides residues, including Chlorothalonil (0.8516 mg/kg and 0.5321 mg/kg) in samples A and B respectively, Lindane (1.4205 mg/kg and 1.2041 mg/kg) in samples A and B respectively, and Dichlorobiphenyl (0.0013 mg/kg and 0.0002 mg/kg) in samples A and B respectively which exceeded the Maximum residue levels (MRLs) recommended by World Health Organization (WHO). Diazinon, Aldrin, Alpha-endosulfa, Isopropylamine, Deltamethrin were below maximum residue levels recommended by World Health Organization (WHO). The HRI of the entire pesticides residue detected were below 1 in adults and children indicating little or no risk for both adults and children.

Keywords: Pesticides residues, Cucumber, Health risks assessment, Contamination

1.0 INTRODUCTION

Pesticide residues are traces of chemicals used to protect crops from pests, insects, fungi, or weeds that remain on or in vegetables after they have been harvested. (World Health Organisation, 2010). Pesticides are also classified as contaminants of emerging concerns (CEC) (Careghini *et al.*, 2015). The residues can include: insecticides, fungicides and herbicides though less common in cucumber.

Vegetables are the most frequently consumed food in Nigeria. They are essentially components of human diet. They provide vital nutrients that are required for most of the reaction occurring in the body (Keikothail *et al.*, 2010). Consuming a sufficient amount of food is important not only to prevent vitamin deficiencies but also to lower the occurrence of serious diseases like cancer, cardiovascular diseases, and obesity. Due to the changes in lifestyle and eating habits caused by rapid urbanization and population growth, consumer demands for food have become more diverse, which has greatly influenced food production and consumption. Consequently, producers have implemented stricter plant protection measures to control pests, often resorting to the use of pesticides due to their fast-acting, convenient, and cost-effective nature.

However, careless or excessive use of pesticides can harm plants, wildlife, the environment, and public health. The use of pesticides in agricultural production can result in the presence of pesticide residues, which is currently a significant issue, especially in fruits and vegetables. Most consumers are unaware of pesticide residue in their food, thus it is crucial to monitor pesticide residue levels in food. Exposure to pesticides can cause health problems, such as nausea and headaches in a short term. In addition, neurotoxicity, cytogenetic damage, infertility, and endocrine system problems may occur chronically (Baldi *et al.* 2001), Report has shown that various vegetables have some level of pesticides residues, and the amount of the residues depends on their varying adsorption rate in vegetable (Munawar *et al.*, 2013). Pesticides are widely used in agriculture to control pests and increase crop yields. While the use of pesticides has many benefits, it also raises concerns about their potential impact on human health and the environment. Pesticide residues can accumulate in food products, including fruits and vegetables, and may pose risks to consumers if consumed in excessive amounts.

Cucumber is a popular vegetable that is widely consumed in Abakaliki and other parts of Nigeria. However, little is known about the level of pesticide residues in cucumbers available in the market, and their potential impact on public health. Cucumber is a valuable crop for Nigerian

farmers because it has a high demand in local markets, and it is also exported to neighboring countries. The vegetable is consumed fresh, and it is also used for pickling and processing into various food products. Cucumber is also an important source of nutrition for Nigerians, as it is rich in vitamins, minerals, and antioxidants. The vegetable is often consumed as a snack, salad, or side dish, and it is also used in traditional Nigerian dishes.

However, the use of pesticides in cucumber farming raises concerns about the potential impact on human health and the environment. Long time consumption of pesticides contaminated cucumbers may cause hormonal imbalances, nervous system effects, and carcinogenicity for some pesticides (Mustapha *et al.*, 2017). Therefore, it is important to monitor the level of pesticide residues in cucumber available in the market to ensure their safety and quality.

Taxonomy of *Cucumis sativus*

Kingdom: *Plantae*

Family: *Cucurbitaceae*

Genus: *Cucumis*

Species: *Cucumis Sativus*

Order: *Cucurbitales*

Common names: English; Cucumber, Yoruba; kukumba; Ibibio; Okokon



Figure 1: *Cucumis sativus* fruit

2.0 MATERIALS AND METHODS

Two Cucumbers, Ethyl acetate, hydrogen carbonate (NaHCO_3), Anhydrous sodium sulphate, (Na_2SO_4), cyclohexane, mortar, pestle, conical flasks, spatula, centrifuge, filter paper, beaker, separating funnel distilled water, test-tube, test-tube holder, weighing balance and GC-ECD machine. All chemicals used are of analytical grade.

The cucumber samples were collected from International market and Kpirikpiri both in Abakaliki Ebonyi State, Nigeria. The cucumber sample was chosen for this study because they are consumed on daily basis by many. A total of 20 fresh cucumber samples were purchased from the markets (10 from each market), separately wrapped in aluminum foil and placed into well labeled polythene bags and taken to the Department of Chemistry laboratory Alex Ekwueme Federal University Ndufu-Alike for analysis.

2.1 Extraction of the Samples

The extraction for the cucumber Sample was done using USEPA method 3510 for extracting pesticide residue in non-fatty crops, using ethyl acetate as the solvent. The samples from each market was washed thoroughly with distilled water. The samples were transferred into a mortar and grounded into a paste form using a pestle. A 40g of the paste was transferred into a conical flask with the help of the spatula and 40 ml of Ethyl acetate was added and shaken thoroughly. A 5g of Sodium hydrogen carbonate (NaHCO_3) was added to the mixture followed by 20 g of anhydrous Sodium sulphate Na_2SO_4 and the entire mixture was shaken vigorously for one hour. The mixture was filtered into a labelled container before being centrifuged at a speed of 1800 rpm for 5 minutes. The organic layer was decanted into a conical flask and a 1:1 mixture of 5ml of Ethyl acetate and cyclohexane was added.

This process was to ensure that enough of the pesticide residue dissolved in the Ethyl acetate. The same procedure was repeated for the samples from Kpirikpiri market (sample B).

2.2 Clean-up process

A total of 1 g of the extracted cucumber sample was measured into a beaker and dissolved in 50ml of chloroform. The mixture was transferred into a 100 ml volumetric flask and made up to the mark with distilled water. 1ml of esterification reagent (20 ml 20% benzene and 55% methanol) was sealed and heated at 100 °C in a water bath for 30 minutes and added to the flask. The sample was extracted with hexane and water in the ratio of 1:1. The mixture was shaken vigorously by hand for 2 minutes until a stable emulsion was formed which was broken by centrifugation. The top hexane phase was therefore transferred to small test tube for injection for the pesticide residues using Gas chromatography- Electron Capture Detector (GC_ECD).

2.3 Analysis of Pesticide residues with GC-ECD

The analysis of Pesticide residue was performed on a BUCK M910 Gas chromatography equipped with an

Electron Coupling detector at Springboard laboratory Awka, Nigeria. A RESTEK 15 meter MXT-1 column (15 m x 250 μm x 0.15 μm) was used. The injector temperature was 280 $^{\circ}\text{C}$ with split less injection of 2 μl of sample and a linear velocity of 30 cm s^{-1} , Helium 5.0 pas was the carrier gas with a flow rate of 40 ml/min. The oven was initially operated at 200 $^{\circ}\text{C}$ and was later heated to 330 $^{\circ}\text{C}$ at a rate of 3 $^{\circ}\text{C min}^{-1}$ and was kept at this temperature for 5 min. the detector operated at a temperature of 320 $^{\circ}\text{C}$. Components of Pesticides residue were determined by the ratio between the area and mass of internal standard and the area of the identified compounds. The concentration of the different Pesticide residues compounds were expressed in $\mu\text{g/ml}$.

2.3.1 Health Risk Assessment

The risk associated with the consumption of the studied cucumber samples was assessed by calculating the health risk index (HRI) using the equation

$$\text{HRI} = \frac{\text{EDI}}{\text{ADI}} \quad (1) \text{ (Zakir et al., 2020).}$$

An HRI value greater than 1 is considered unsafe for human health. The Estimated Daily Intake (EDI) for a chemical contaminants represents the total exposure from all known or suspected exposure pathways for an average person.

To calculate the estimated amount of the contaminant taken in through these combinations of exposure pathways, the general equation is;

$$\text{ED} = \frac{C \times \text{CR} \times \text{EF}}{\text{BW}} \quad (2)$$

Where ED = estimated dose (mg/kg/day), C = concentration of the pesticide due to the exposure pathway being considered. CR (1.0mg/kg/day) = consumption rate, EF = exposure factor, BW = body weight. While the mean body weight for adult and children are taken to be 60kg and 16kg respectively.

Acceptable Daily Intake (ADI) value for the pesticides under consideration were obtained from literature and determined according to the best judgment of a group of internationally recognized experts on the data available to them at the time of the evaluation (Food and Agricultural Organization, 2020).

The dietary intake of any pesticide residue is gotten by multiplying the residue level by the number of commodity intakes from a “global” and five “cultural” diets. Human beings can come in contact with varying chemical substances orally by eating food, drinking water and hand-to-mouth transfer (Damalas and Eleftherohorinos, 2011). It is important to determine the maximum amount of a chemical that can be ingested daily to protect human health that is the ADI (acceptable daily intake).

3.0 RESULTS AND DISCUSSION

The concentration of the pesticide residues are presented in Table 1.

Table 1: A comparison of the results obtained from the two samples with maximum residue limits (MRLs)

PESTICIDES RESIDUE	SAMPLE A Conc (mg/kg)	SAMPLE B Conc (mg/kg)	WHO MRLs
Chlorothalonil	0.8516	0.5321	0.03
Dichlorobiphenyl	0.0013	0.0002	0.0001
Lindane	1.4205	1.2041	0.01
Diazinon	0.0054	0.00213	0.02
Aldrin	0.0217	ND	0.02
Alpha-endosultan	0.0635	ND	0.01
Propiconazole	0.0582	ND	5
p'p'-DDD	0.0015	ND	0.05
Carbofuran	0.0635	0.3222	0.02
Glyphosphate	0.0487	1.0883	0.02
Tetradifon	0.0036	0.0001	0.2
Triazophos	0.0001	ND	0.1
Beta-endosultan	0.0046	ND	0.1
Isopropylamine	ND	0.7897	NE
Deltametrin	ND	0.076	0.5
2,4-DDT	ND	0.111	0.01
Endosultan	ND	0.4278	0.01
T-nonachlor	ND	0.0092	0.1
g-chlordane	ND	0.006	0.1
Profenofos	ND	0.017	0.02
Heptachlor	ND	0.0001	0.02

KEY: ND = Not detected, MRLs = Maximum residue limits.

Table 1 Compares the results obtained from the two samples with the maximum residues limits (MRLs) established by WHO (2017). The analysis revealed the presence of multiple pesticide residues in the cucumber samples. Among the detected pesticides, Dichlorobiphenyl, carbofuran, glyphosate, and tetradifon were found in both Sample A and Sample B. However, Sample B had higher concentrations of carbofuran and glyphosate compared to Sample A. Chlorothalonil, with a concentration of 0.8516 mg/kg in Sample A, exceeded the MRL. Similarly, lindane in Sample A (1.4205 mg/kg) and propiconazole in Sample B (0.0582 mg/kg) also exceeded the respective MRLs of 0.01 mg/kg and 5.0 mg/kg. carbofuran and glyphosate were also detected in both samples. However, carbofuran levels in Sample B (0.3222 mg/kg) were higher compared to Sample A (0.0635 mg/kg), while glyphosate concentrations in Sample B (1.0883 mg/kg) were significantly higher than in Sample A (0.0487 mg/kg). The presence of these pesticides, particularly at elevated levels, raises concerns about the potential long-term effects on human health.

Among the detected pesticides diazinon, aldrin, alpha-endosulfan, p'p'-DDD, triazophos, beta-endosulfan, isopropylamine, deltamethrin, 2,4-DDT, endosulfan, T-nonachlor, g-chlordane, profenofos, and heptachlor were found to be below their respective MRLs. However, it is important to note that even though these pesticides were found within acceptable limits or not detected, their cumulative effects on human health should not be ignored. The presence of pesticide residues in cucumbers could be attributed to various factors, including improper application of pesticides, inadequate adherence to pre-harvest intervals, and the use of banned or unauthorized pesticides.

Lindane is a highly toxic pesticide and its use has been restricted in many countries due to its environmental persistence and potential health effects. These findings are consistent with previous studies that have reported high levels of these pesticides in cucumber samples (Akinola *et al.*, 2017). Isopropylamine is commonly used as a herbicide, while Glyphosphate is a broad-spectrum herbicide that is widely used in agriculture. Their presence in some of the samples probably may be as a result of their being used in weed control. Comparing the two results obtained from the different samples, both samples contain different pesticides at different concentration, some of which are considered hazardous to human health. However, a study conducted by (Kaur *et al.* 2020) reported the presence of glyphosate residues in cucumber samples from various regions in India the

specific pesticides identified in each sample and their respective concentrations are different. Both Lindane and Glyphosate are controversial pesticides with potential health and environmental impacts.



3.1 Health Risks Associated with the Identified Pesticides Presents in the Two Samples

The result of the health risk assessment of the samples is shown in Table 2 and 3 respectively.

Table 2: Health risk assessment of pesticides residue identified in sample A

PESTICIDES RESIDUE	Concentration (mg/kg)	ADI(mg/kg	EDI ADULTS	HRI ADULTS	HR ADULTS	EDI CHILDREN	HRI CHLIDRE N	HR CHILDREN
Chlorothalonil	0.8516	—	—	—	—	—	—	—
Dichlorobiphenyl	0.0013	0.040	0.00000032	0.00000008	N	0.00000003	0.0000007	N
Lindane	1.4205	0.010	0.000040	0.0004	N	0.000030	0.00300	N
Diazinon	0.0054	0.002	0.000013	0.0007	N	0.00001	0.00500	N
Aldrin	0.0217	0.001	0.000005	0.0005	N	0.000013	0.00120	N
Alpha-endosultan	0.0635	0.003	0.000001	0.0002	N	0.0000012	0.00500	N
Propiconazole	0.0582	0.030	0.000004	0.0001	N	0.0000013	0.00040	N
p'p'-DDD	0.0015	0.001	0.000002	0.0400	N	0.0000013	0.000130	N
Carbofuran	0.0635	0.003	0.000001	0.0005	N	0.0000010	0.000500	N
Glyphosphate	0.0487	0.100	0.000009	0.00010	N	0.000008	0.000100	N
Tetradifon	0.0036	0.010	0.000005	0.00009	N	0.0000021	0.000800	N
Triazophos	0.0001	0.001	0.000008	0.000024	N	0.0000010	0.000002	N
Beta-endosultan	0.0046	0.040	0.000002	0.000028	N	0.0000008	0.000200	N

N/B: ADI=Average Daily Intake, EDII= Estimated Daily, HRI= Health Risk Index, HR= Health Risk, N= No Risk



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PESTICIDES RESIDUE	Concentration (mg/kg)	ADI(mg/kg	EDI	HRI	HR	EDI	HRI	HR
			ADULTS	ADULTS	ADULTS	CHILDREN	CHILDREN	CHILDREN
Isopropylamine	0.7897	0.001	0.000002	0.002000	N	0.00002000	0.020000	N
Dichlorobiphenyl	0.0001	0.040	0.000002	0.000006	N	0.00000002	0.000005	N
Deltametrin	0.0760	0.020	0.000002	0.000006	N	0.00000002	0.0040000	N
2,4-DDT	0.1110	0.050	0.000003	0.000006	N	0.0000002	0.0000004	N
Endosultan	0.4278	0.006	0.000003	0.000070	N	0.0000009	0.000070	N
T-nonachlor	0.0092	0.0300	0.0000010	0.000140	N	0.0000002	0.00100	N
g-chlordane	0.0060	0.0100	0.0000002	0.000010	N	0.0000001	0.000002	N
Profenofos	0.0170	0.0300	0.0000014	0.003000	N	0.0000006	0.00600	N
Carbofuran	0.3222	0.0030	0.0000008	0.010000	N	0.000002	0.00600	N
Glyphosphate	1.0883	0.100	0.0000300	0.003000	N	0.000002	0.0006	N
Heptachlor	0.7356	0.0010	0.0000200	0.020000	N	0.000002	000020	N
Tetradifon	0.0001	0.0100	0.0000020	0.0000007	N	0.00000002	0.0000002	N

Estimated Daily, HRI= Health Risk Index, HR= Health Risk, N= No Risk,

The health risk index in all of the pesticides residue detected were below 1 in adults and children indicating that consuming freshly harvested cucumber from Abakaliki major markets poses little or no risk for both adults and children. An index greater than 1 is considered unsafe for human health (Darko & Akoto, 2008).

Omeje *et al.*, (2022), reported that heptachlor residues in fresh fruits and vegetables available in Nigerian markets had HRIs above 1. Oyinloye *et al.*, (2021) in his research reported HRI for heptachlor and carbofuran in sweet potato, yam and water yam collected in both dry and wet season from a farm settlement to be greater than 1 which is in contrast with the result from this study where the HRI is less than 1 for heptachlor and carbofuran in sample B as shown in

Table 3. Heptachlor was however, not detected in sample A (Table 2).

In this study, the HRLs and EDI were all less than 1 (Tables 2 and 3) with respect to both children and adults. Although estimated daily intake (EDI) and health risk index (HRI) for these pesticides were all within acceptable limits, more concerns remained since their presence in food could accumulate in human body due to continual consumption. The food consumption data for adult and children were 149.8 and 36.1g/persons/day in fruits and vegetables respectively (Pen & Jeewon, 2015). This suggests that daily intake of fruits and vegetable having pesticide residues could over time become a source of pesticide related health issues.

4.0 CONCLUSION

Pesticides residue were evaluated in fresh cucumbers bought from two major markets in Abakaliki. Thirteen (13) pesticide residue were detected in sample A while twelve(12) were detected in sample B. it was observed that the residues variation found in the concentration and types of pesticides residue observed in this study could be as a result of different types and quantities of pesticides used at different locations the cucumber was cultivated. From the results, Lindane, Dichlorobiphenyl and Chlorothalonil detected all exceeded their MRLs. This could mean that they were the major pesticides being used by the farmers. In the health risk assessment, all the pesticide residues detected were below 1 showing that daily consumption of cucumber poses no risk. However, there is need for continuous monitoring of these chemicals to mitigate accumulation within the ecosystem.

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CONFLICT OF INTEREST

There are no conflicts of interest

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