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Original Research Article

Health Risk Assessment of Organochlorine Pesticide Residues in Yam Samples in Ibaji Local Government of Kogi State, Nigeria

***[1,2]Ekwoba, Lucky, [1]Ajai, Alexander I., [1]Fadipe, Labake A. and [1]Olusanya, Jacob J.**

[1]Department of Chemistry, Federal University of Technology Minna, Niger State, Nigeria.
[2]Department of Chemistry, Prince Abubakar Audu University Anyigba, Kogi State, Nigeria.

*Corresponding Author's email: ekwoba.l@ksu.edu.ng   Phone: +2348034141267

KEYWORDS

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Dietary intake,
Hazard index,
Organochlorine pesticides (OCPs),
Residue contamination.

ABSTRACT

Organochorine pesticide residues remain a global public health concern due to their presence, bioaccumulation, and long-term toxicity in food chain. This study evaluates the human health risks associated with organochlorine pesticides (OCPs) residues detected in yam (Dioscorea spp.) samples collected from selected agricultural sites over two consecutive years. Residue extraction was performed using the QuEChERS method, and quantification was achieved through gas chromatography-mass spectroscopy (GC-MS). The targeted OCPs included alpha-BHC, beta-BHC, gamma-BHC, endosulfan sulfate, and gamma-chlordane. Concentrations were assessed against international regulatory standards and acceptable daily daily intake (ADI) thresholds. Results revealed vary levels of contamination, with some residues, particularly Aldrin and heptachlor epoxide, exceeding permissible risk level. Estimated cancer risk (CR) values for both adults and children indicated significant potential for chronic health impacts, especially due to Aldrin (CR-Children: $3.64 \times 10^{-3} – 5.12 \times 10^{-4}$; CR-adult: $1.01 \times 10^{-3} – 1.43 \times 10^{-4}$) and heptachlor epoxide (CR-Children: $9.95 \times 10^{-4} – 3.66 \times 10^{-4}$; CR-adult: $2.77 \times 10^{-4} – 1.02 \times 10^{-4}$). Even at lower concentrations, residues such as p,p'-DDT and gamma-BHC contributed to the cumulative risks burden. The findings highlight the urgent need for continuous environmental monitoring of pesticides residues in food crops. Strengthening regulatory enforcement and promoting sustainable agricultural practices are critical steps toward minimizing long-term dietary exposure and safeguarding public health.

CITATION

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INTRODUCTION

Pesticides broadly refer to agrochemicals used to control or eliminate pests that threaten agricultural productivity (Jalal and Bondarenko, 2025). They include bactericides, fungicides, herbicides, insecticides, and rodenticides, each formulated to suppress organisms capable of damaging crops or transmitting diseases. In addition to synthetic compounds, pesticides also encompass biological agents such as selected viruses and bacteria that target pests with high specificity (Hezekiel *et al.*, 2024). Pesticides are further grouped into distinct chemical families, including organochlorine, organophosphates, organofluorines, carbamate, poyrethroids, bipyridyl herbicides, triazines, triazoles and chloroacetanilides, each with unique structural characteristics, mechanisms of action, and environmental implications (Hezekiel *et al*.,2024).

Global pesticides consumption is estimated at approximately 4.2 million tons per year, reflecting their indispensable role in modern agricultural production (BRIEF, 2022). China remains the leading producer, followed by the United State and Argentina, which are also among the largest consumers (Zuo *et al*., 2023). However, the increasing reliance on pesticides to meet rising food demands has heightened concerns regarding environmental contamination, residue accumulation, and associated health risks (Beyuo *et al*., 2024). According to the World Health Organization (WHO), nearly 3 million agricultural worker in developing countries experiences severe pesticides poisoning annually, with approximately 18,000 fatalities (WHO, 2022). These statistics highlight the occupational hazards linked to pesticides handling, particularly in the regions with inadequate safety regulations and limited access to protective equipment.

Beyond agricultural fields, pesticides are widely used in commercial, industrial, and household settings (Zhou *et al*., 2024). Yet their long-term toxicological effects on humans, wildlife, and ecosystems remain insufficiently characterized. Exposure risk varies with chemical persistence, environmental mobility, and concentration levels (Brown and Green, 2020). Farmworkers, factory employees, and domestic users often face acute exposure risks, while the general population is widely exposed to low-level residues through contaminated air, water, soil, dust, and food (Zuo *et al*., 2023). Overtime, bioaccumulation of persistent compounds has been associated with cancers, endocrine disruption, reproductive dysfunction, and immune system impairment.

Numerous studies have documented pesticide contamination in ecosystems, indicating that pesticides pollution is an escalating environmental concern across various geographic regions (Tang *et al*., 2021; Zhou *et al.,* 2024; Iqba *et al*., 2025). Residues originating from agricultural runoff, industrial waste, and domestic activities frequently enter rivers and lakes used for irrigation activities, posing threats to aquatic ecosystems and public health. Although indirect exposure typically involves low concentrations, chronic exposure, even at trace levels, may contribute to neurological disorders, hormonal imbalance, and immune suppression (Soni *et al*., 2025). This risk is particularly elevated among populations residing near treated farmland or individuals frequently handling pesticides without proper protective gear.

Significant gaps remains in understanding the extent of environmental contamination, especially in developing regions where monitoring systems are limited. The persistence, dispersion patterns, and cumulative risks associated with chronic, low-level pesticides exposure are still poorly characterized, creating substantial uncertainties in environmental and public health protection. Rigorous, location-specific studies to assess pesticides residues in environmental matrices, evaluate potential exposure pathways, and characterized associated ecological and human health risks, such data are critical for strengthening regulatory frameworks, informing safer agricultural practices, guiding public health interventions, and promoting sustainable pesticides management.

MATERIALS AND METHOD

Chemicals

A standard mixture of organochlorine pesticides with twenty components: Aldrin, alpha-HCH, Beta-HCH, Delta-BHC, Gamma-HCH (Lidane), P, P^{I}-DDD, P, P^{I}-DDE, P, P^{I}-DDT, Dieldrine. Endosulfan-alpha, Endosulfan-beta, Endosulfan-total, Endrin, Endrine aldehyde. Endrin Keton, Heptachlor, Heptachlor epoxide, Methoxychlor, Cis-Chlordane, Trans-chlordane in n-Hexane: Toluene (1:1). The HPLC grade n-Hexane, acetonitrile, dichloromethane, Sodium citrate tribasic, sodium citrate dibasic, sodium chloride, sodium sulfate were obtained from Sigma Aldrich. All glass items; beakers, centrifuge tubes, measuring cylinders, and columns, were washed with detergents and rinsed with acetonitrile before being dried in an oven at 150 ^{0}C (Man *et al.*, 2011).Vials were washed with detergent and rinsed with acetone: hexane mixture and dried in an oven at 150 ^{0}C.

Study Sites Description

Ibaji LGA is located in the southern part of Kogi State, Nigeria, with its administrative headquarters in Onyedega. It spans about 1,377 square kilometers and lies between latitudes 6°52'N to 6°87'N and longitudes 6°48'E to 6°80'E. The area is bordered by the Niger River to the west, separating it from Edo State, while it shares eastern boundaries with Enugu and Anambra States, and the southern boundary with Delta State (Ekwoba *et al.,* 2023). As of the 2006 census, Ibaji had a population of approximately 128,129 people. By 2022, this number was projected to rise to about 171,900. The population is predominantly Igala, with a notable Igbo minority making up about 15% (Abdulsamad, 2018). Ibaji is a major agricultural zone in Kogi State. The residents are primarily subsistence farmers who cultivate yam, cassava, rice, maize, beans, and various vegetables. The proximity to the Niger River also supports widespread fishing activities. However, poor infrastructure has limited the area's potential to distribute agricultural produce efficiently (Olubiyo *et al.*, 2020). The area experiences a tropical climate with an average annual rainfall of approximately 1,450 mm. Temperatures average around 29 °C, with humidity levels near 53 %. The rainy season runs from April to October, while the dry season spans from November to March (Ajodo and Olawepo, 2021). The position of the local government had also made the Ibaji to be prone to annual flooding from river Niger.

The specific study areas were Odogwu, Ejule, Onyedega, and Ogaine farming points defined as Y1 to Y4 respectively as shown in Figure 1

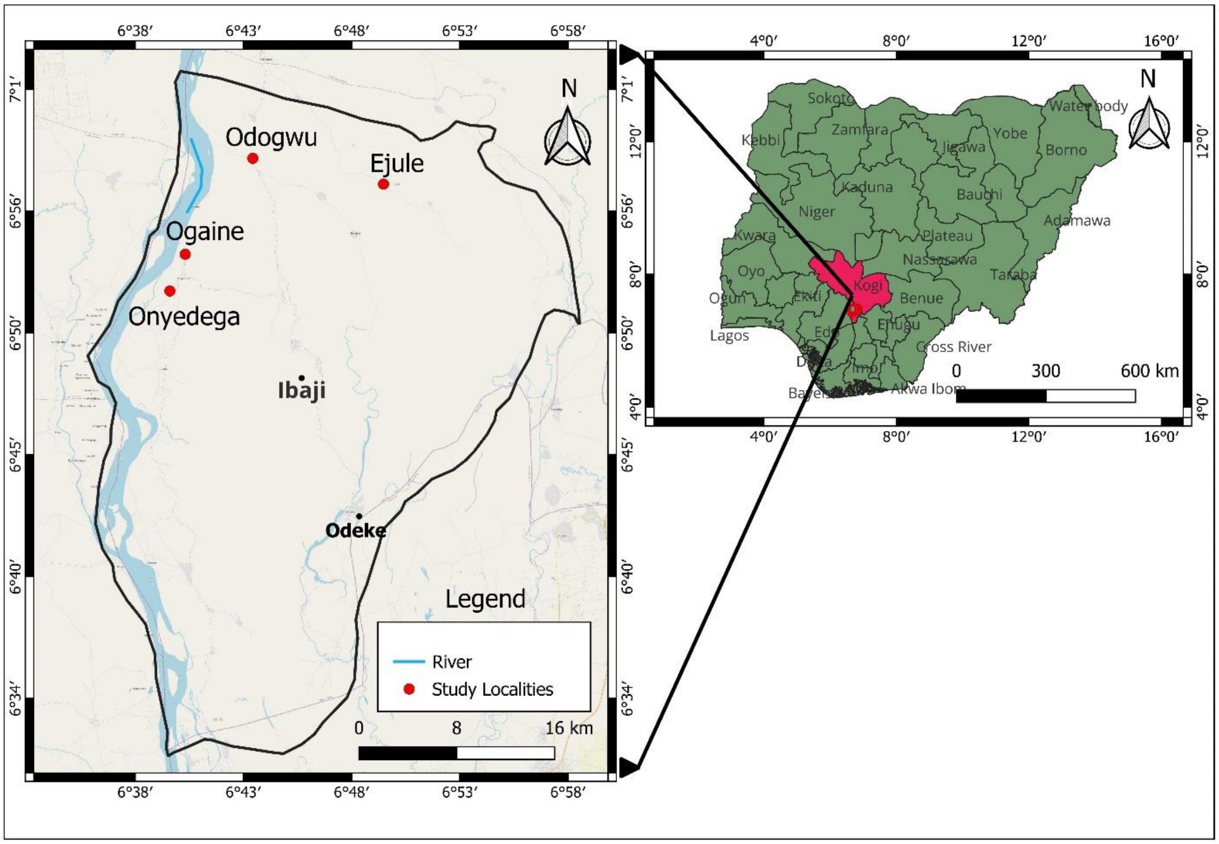

Figure 1: Map of the study area

Sampling and OCP Extraction Technique

Total of 24 yam samples were collected from four different farms that were chosen based on their history of pesticide use and farming methods. Three random sampling locations were selected at each farm to obtain composite matrices. Representativeness was ensured by collecting about 1 kilogram of yam tubers per point. To avoid deterioration and contamination, samples were kept in a plastic bags and transferred under carefully monitored circumstances to the laboratory for further pretreatment and analysis. Deionized water was used to wash the yam tubers in order to get rid of any remaining soil. A stainless-steel knife was used for peeling to remove surface impurities. After being peeled, the yams were sliced into tiny pieces and homogenized until they were smooth.

Sample preparation was carried out using the QuERCHER methods

Table 1: Procedures and corresponding activities

Procedure	Activities
Weighing	5 g of homogenized yam sample was placed in a 50 mL centrifuge tube
Extraction	10 mL of acetonitrile was added, followed by vigorous shaking for 1 minute
Salting Out	4 g MgSO4,1 g NaCl,0.5g disodium hydrogen citrate sesquihydrate, and 1g trisodium citrate dehydrate were added to facilitate phase separation. sonicated for 5min
Centrifugation	The sample was centrifuged at 4000 rpm for 5 minutes
Clean-up	1 mL of the acetonitrile extract was transferred to a dSPE tube containing PSA, C18, and MgSO4
Final Centrifugation	The sample was centrifuged again at 4000 rpm for 5 minutes
Filtration	The supernatant was filtered and stored in vials for GC-MS or LC-MS analysis

Instrumentation

Organochlorine pesticides concentrations in ppb (OCPs) concentrations in the sample extracts were determined by gas chromatography-mass spectrometry with an Agilent 6890A gas chromatograph (GC) interfaced with an Agilent 5973 mass selective detector (Agilent Technologies, Santa Clara, USA). A DB-5 capillary column (30 m length ×0.25 µm film thickness × 0.25 mm i.d.) was used for separation, and pure helium gas at a flow velocity of 1mL/min was used as the carrier gas. The gas chromatographic column had an initial temperature of 80 °C, which was held for 2 min, and was then increased at 25 °C min-1 to 150 °C; it was further raised to 200 °C at 3 °C min-1, and finally increased to 300 °C at 2 °C min-1. The temperature of the injection port, ion source, and quadrupole and transfer line were 250, 230, 150 and 280 °C respectively. The sample was injected into the GC via a pulsed split less mode with an injection volume of 1μL. A procedural blank was included for every sample in order to estimate interference and cross-contamination between samples (Yun *et al.*, 2014). No organochlorine pesticide residue was found in the blank samples (Chandra *et al.*, 2021a).

Quality Assurance

For the sample set, the procedural blank and method detection limit were evaluated. The analytes present in the procedural blanks made it possible to identify the target compounds in the samples on the bases of their retention durations that matched those of reference standards within a preset range of 2 to 10 ng/kg. The method detection limits, or MDLs, are defined as the mean concentration of the blank plus three times the standard deviation. During data processing, values below 0.01 μg/kg were identified as below-detection-limit. OCP concentrations were expressed in μg/kg. Similarly, three separate analyses of the samples were performed, and the findings are displayed as mean and standard deviation values.

Risk Assessment

Estimation of Dietary Exposure.

The estimated daily intake (EDI) for the OCPs residue detected in the various yam sample was calculated for each age category using the equation below.

$$EDI = \frac{C \times IG}{B_w} \quad (1)$$

Where EDI is the estimated daily intake ($mgkg^{-1}d^{-1}$), C is the mean concentration of the pesticides residue, IG is the ingestion rate (kgd^{-1}) and Bw is the average body weight (kg). The average body weight for children ≤ 6 years and adult ≥70 *years* were estimated as 16.7 and 60 respectively and the ingestion rate (IG) was estimated as 0.166kg/day (Fitzpatrick *et al.*, 2017)

Human Health Risk

In this research, non-cancer and cancer health risk assessments were carried out on the basis of the pesticide residues in the yam samples. The evaluation of pesticides residue health risks from dietary intake followed the USEPA (2005) guideline. This involved comparing the estimated daily intake (EDI) with the acceptable daily intake (ADI) (Sosan *et al.*, 2015). The health risk index was calculated for potential health risks using the equation below.

$$HR = \frac{EDI}{RfD} \quad (2)$$

When HI is less than 1.0, it can be concluded with certainty that there is essentially no probability of population level effect. However, if the ration exceeds 1.0 then there is a potential for adverse effect of non-carcinogenic risk. The carcinogenic risk was computed using equation (3)

$$CR = EDI \times SF \quad (3)$$

Where, estimated daily intake (EDI) was calculated as $mg^{-1}kg^{-1}day^{-1}$, RfD represents oral reference dose ($mg^{-1}kg^{-1}day^{-1}$) of OCPs and SF signifies cancer slope factor ($mg^{-1}kg^{-1}day^{-1}$).

The CR has been divided into five levels by some other studies: very low risk is indicated by values less than 1.0×10^{-6}; values between 1.0×10^{-6} and 1.0×10^{-4} indicate low risk; moderate risk is indicated by values between 1.0×10^{-4} and 1.0×10^{-3}; high risk is represented by values between 1.0×10^{-3} and 1.0×10^{-1}; and very high risk is indicated by values greater than 1.0×10^{-1}(Chen *et al.*, 2020).

Statistical Analysis

The SPSS software was used to analyze the data. Standard deviation (SD) and mean values were obtained after the data were run through a one-way analysis of variance (ANOVA) with a significant difference of 0.05.

RESULTS AND DISCUSSION

OCPs Profile

Yam samples obtained from four farming locations (Y1, Y2, Y3, Y4) in Ibaji Local Government Area, Nigeria, spanning two consecutive farming years, were analyzed for residues of 20 different types of OCPs comprising (alpha-BHC, beta-BHC, gamma-BHC, Heptachlor, delta-BHC, Aldrin, Heptachlor Epoxide, gamma-Chlordane, alpha-Chlordane, Endosulfan I, P,P-DDE, Dieldrin, Endrin, P,P-DDD, Endosulfan II, P,P-DDT, Endrin aldehyde, Endosulfan Sulfate, Methoxychlor, Endrin Ketone). The results in Table 2 showed that the Yam samples analyzed from the four different locations were contaminated with OCPs. However, the quantities differed greatly by location and year. Almost all OCP concentrations were significantly higher in Year 1 than in Year 2, which may indicate a shift in pesticide administration methods or environmental deterioration over time. Aldrin levels, for instance, varied between 3.030 and 21.540 μg/kg in Year 1 but sharply decreased to as low as 0.059 μg/kg in Year 2.

Yam samples from location Y3 frequently has the greatest levels of pesticide residues for a number of contaminants (such as DDT, endosulfan II, and alpha+chlordane), suggesting a possible hotspot for pesticide usage or buildup. The amounts were generally lower in location Y4, indicating that local farming practices or environmental factors may vary. Y3 had the largest cumulative pesticide load (the total of OCP concentrations) in Year 1 was 336.690 μg/kg, whereas location Y4 had the lowest, at 77.890 μg/kg.

The residue levels for several pesticides (notably Aldrin and endrin) exceeded WHO/FAO Maximum Residue Limits (MRLs) as shown in table 2, raising serious concerns about food safety and public health. While individual concentrations were much lower in Year 2, the total still showed significant levels, with location Y4 having the highest concentration of 14.274 µg/kg and Y1 the lowest (5.876 µg/kg). The majority of concentrations showed significant differences across studied locations ($p < 0.01$), confirming the spatial variability in pesticide residue levels. These findings align with the findings of Olufade *et al.*, (2014) who reported similar result on dried yam chips obtained from Osun state, with significant levels of heptachlor (0.264 ± 0.038 µg/kg) and aldrin (1.050 ± 0.908 µg/kg), with 75 % to 95 % of samples studied being above the Maximum Residue Limits (MRLs) set by the European Union.

Table 2: Concentrations (µg/kg) of OCPs in Yam Samples from Four Locations in Ibaji Local Government Area in Two Consecutive Years

Congener	Year	Y1 (ODOGWU)	Y2 (EJULE)	Y3 (ONYEDEGA)	Y4 (OGAINE)	WHO/FAO, 2023
Aldrin	1	21.54 ± 0.45[a]	20.10 ± 0.46[b]	17.68 ±0.31[c]	3.03 ± 0.12[d]	
	2	0.08 ± 0.00[c]	0.06 ± 0.00[d]	0.10 ± 0.00[b]	0.13 ± 0.01[a]	20
	Sig.	**	**	**	**	
Alpha+BHC	1	4.19± 0.09[c]	2.16 ± 0.05[d]	5.92 ± 0.10b	6.71 ± 0.27[a]	
	2	ND	0.130 ± 0.01	ND	ND	500
	Sig.	-	**	-	-	
Alpha+Chlordane	1	40.15 ± 0.84[b]	19.58 ± 0.45[c]	56.22± 0.98[a]	8.45 ± 0.34[d]	
	2	0.21 ± 0.01[c]	0.15 ± 0.01[c]	3.83 ± 0.17[b]	4.44 ± 0.19[a]	NA
	Sig.	**	**	**	**	
Beta+BHC	1	9.02 ± 0.19[b]	3.27 ± 0.08[d]	10.07 ±0.17[a]	7.93 ± 0.32[c]	
	2	0.86 ± 0.04[b]	0.29 ± 0.01[c]	1.45 ± 0.06[a]	0.92 ± 0.04[b]	500
	Sig.	**	**	**	**	
Delta+BHC	1	28.57 ± 0.60[a]	15.33 ± 0.35[c]	21.81 ± 0.38[b]	6.97 ± 0.28[d]	
	2	0.51 ± 0.03[c]	0.31± 0.01[d]	1.56 ± 0.07[a]	1.38 ± 0.07[b]	500
	Sig.	**	**	**	**	
Dieldrin	1	1.51 ± 0.03[b]	1.50 ± 0.04[b]	2.09 ± 0.04[a]	0.86 ± 0.04[c]	
	2	0.06 ± 0.00[a]	0.05 ± 0.00[b]	0.06 ± 0.00[a]	0.06 ± 0.00[a]	20
	Sig.	**	**	**	**	
Endosulfan I	1	19.25 ± 0.40[c]	24.24 ± 0.56[b]	35.39 ± 0.61[a]	2.34 ± 0.09[d]	
	2	0.22 ± 0.01[b]	0.28 ± 0.01[a]	0.15 ± 0.01[c]	0.25 ± 0.01[ab]	100
	Sig.	**	**	**	**	
Endosulfan Sulfate	1	14.04 ± 0.29[a]	5.41 ± 0.13[c]	6.97 ± 0.12[b]	0.65 ± 0.03[d]	
	2	0.03 ± 0.00[c]	0.03 ± 0.00[c]	0.06 ± 0.00[a]	0.04 ± 0.00[b]	100
	Sig.	**	**	**	**	
Endrin	1	26.13 ± 0.54[b]	38.07 ± 0.88[a]	25.72 ± 0.45[b]	3.63 ± 0.14[c]	
	2	0.56 ± 0.03[b]	0.53 ± 0.02[bc]	0.68 ± 0.03[a]	0.46 ± 0.02[c]	20
	Sig.	**	**	**	**	
Endrin aldedyde	1	6.51 ± 0.13[b]	5.72 ± 0.13[c]	6.05 ± 0.10[bc]	7.34 ± 0.29[a]	
	2	0.40 ± 0.02[c]	0.28 ± 0.01[d]	0.50 ± 0.02[b]	1.03 ± 0.04[a]	20
	Sig.	**	**	**	**	
Endrin ketone	1	10.45 ± 0.22[c]	19.43 ± 0.45[a]	17.23 ± 0.30[b]	3.60 ± 0.14[d]	
	2	0.45 ± 0.02[d]	0.84 ± 0.03[b]	0.65 ± 0.03[c]	0.94 ± 0.04[a]	20
	Sig.	**	**	**	**	
Endsulfan II	1	19.20 ± 0.40[c]	38.11 ± 0.88[b]	60.46 ± 1.05[a]	4.17 ± 0.17[d]	
	2	1.53 ± 0.08[a]	1.29 ± 0.04[b]	0.87 ± 0.04[c]	1.42 ± 0.06[ab]	100
	Sig.	**	**	**	**	
Gamma+ Chlordane	1	10.77 ± 0.23[a]	3.45 ± 0.08[c]	8.36 ± 0.14[b]	2.62 ± 0.10[d]	
	2	0.10 ± 0.01[c]	0.10 ± 0.00[c]	0.25 ± 0.01[a]	0.18 ± 0.01[b]	NA
	Sig.	**	**	**	**	
Gamma+BHC	1	1.57 ± 0.04[c]	4.95 ± 0.12[a]	3.45 ± 0.06[b]	1.25 ± 0.05[d]	500
	2	ND	ND	ND	ND	
	Sig.	-	-	-	-	

Congener	Year	Y1 (ODOGWU)	Y2 (EJULE)	Y3 (ONYEDEGA)	Y4 (OGAINE)	WHO/FAO, 2023
Heptachlor	1	1.91 ± 0.04[b]	4.81 ± 0.11[a]	1.86 ± 0.04[b]	0.88 ± 0.04[c]	20
	2	ND	ND	ND	ND	
	Sig.	-	-	-	-	
Heptachlor Epoxide	1	11.06 ±0.23[c]	24.42 ± 0.57[a]	20.91 ± 0.36[b]	4.05 ± 0.16[d]	20
	2	0.21 ± 0.01[d]	0.64 ± 0.02[b]	0.36 ± 0.02[c]	0.87 ± 0.04[a]	
	Sig.	**	**	**	**	
Methoxychlor	1	17.42 ±0.36[b]	28.22 ± 0.65[a]	6.64 ± 0.12[c]	1.52 ± 0.06[d]	NA
	2	0.18 ± 0.01[b]	0.17 ± 0.01[b]	0.161 ± 0.01[b]	0.30 ± 0.01[a]	
	Sig.	**	**	**	**	
P,P'+DDD	1	3.48 ± 0.08[b]	4.12 ± 0.09[a]	3.07 ± 0.05[c]	0.33 ± 0.01[d]	NA
	2	0.07 ± 0.00[b]	0.08 ± 0.00[b]	0.08 ± 0.00[b]	0.21 ± 0.01[a]	
	Sig.	**	**	**	**	
P,p'+DDE	1	1.07 ± 0.02[d]	1.57 ± 0.04[c]	7.44 ± 0.13[a]	3.19 ± 0.13[b]	NA
	2	0.14 ± 0.01[b]	0.15 ± 0.01[b]	0.14 ± 0.01[b]	1.23 ± 0.05[a]	
	Sig.	**	**	**	**	
P,P'+DDT	1	13.22 ±0.28[b]	13.37 ± 0.31[b]	19.35 ± 0.34[a]	8.37 ± 0.34[c]	100
	2	0.24 ± 0.01[c]	0.27 ± 0.01[c]	0.52 ± 0.02[a]	0.40 ± 0.02[b]	
	Sig.	**	**	**	**	
TOTAL	1	261.06 ± 5.43[b]	277.83 ± 6.41[b]	336.69 ± 5.83[a]	77.89 ± 3.15[c]	
	2	5.88 ± 0.32[c]	5.63 ± 0.18[c]	11.43 ± 0.49[b]	14.27 ± 0.60[a]	
	Sig.	**	**	**	**	

Results are presented as Means ± standard errors. Samples on the same row with different superscripts are significantly different ($p < 0.05$); ND: Not detected; NA: Not available; Sig.: Significance
**Significantly different ($p < 0.01$)

Estimated Daily Intake (EDI) and Health Risk Assessment (HRI)

The EDI values for OCPs were evaluated in yam samples obtained from four different locations and presented as Y1-Y4 (Table 3), which represents Odogwu, Ejule ojebe, Onyedega and Itoduma farming sites, over two years (1 and 2), and categorized for both children and adults. Health risk index (HRI) was obtained by the ratio of EDI to RfD (estimated daily intake to oral reference dosage) and the EDI was computed as described by equation (1). These values were compared to the Acceptable Daily intake (ADI) limits set by the WHO/FAO (2023) as presented in table 3 and 4. Notably, EDIs for certain OCPs such as alpha-BHC and Heptachlor were not detected (Nd) or below detectable limit in year 2, indicating either absence or concentrations below the quantification limit.

In year 1, aldrin: Y1 (2.14×10^{-4}), heptachlor: Y2 (2.43×10^{-4}), alpha-BHC: Y4 (6.67×10^{-5}), gamma-BHC: Y3 (3.43×10^{-5}), heptachlor: Y2 (4.78×10^{-5}), alpha-Chlordane: Y3 (5.59×10^{-4}), and P, P-DDT: Y4 (8.56×10^{-4}) — all exceeded their respective ADI limits of 0.0001 to 0.002 µg/kg bw/day. There are serious concerns about their dangers to human health, especially for children, based on the estimated daily intake (EDI) of organochlorine pesticides (OCPs) in yam samples from four locations (Y1–Y4) over a two-year period. The Acceptable Daily Intake (ADI) limitations set by the Joint FAO/WHO (2017) Meeting on Pesticide Residues (JMPR) were surpassed by the EDI values for a number of OCPs, including aldrin, endrin, heptachlor epoxide, and alpha-chlordane. For example, children at location Y1 had an EDI for aldrin of 2.14×10^{-4} µg/kg body weight/day, which is higher than the ADI of 0.0001 µg/kg bw/day. In a similar vein, Year 1 at Y2 endrin levels (3.78×10^{-4} µg/kg/day) was higher than the ADI of 0.0002 µg/kg/day, suggesting possible exposure risks.

Considerable food safety concerns are raised by the evaluation of the Health Risk Index (HRI) for organochlorine pesticides (OCPs) in yam samples obtained from the four locations (Y1–Y4) over two years in a row, especially in the first year as shown in Table 4. The data show that a number of OCPs, particularly for children, reported HRI values significantly higher than the suggested safety threshold of 1.0. These includes Dieldrin, Endrin, Heptachlor, Heptachlor Epoxide, and Aldrin.

Adults' HRI values were below or near the threshold concentrations in children's in Year 1 and surpassed the safe limit of 1. For instance: Heptachlor Epoxide in Children in Y1 was 7.29; Adults, 2.03; while Heptachlor at Y2 was 3.19 in Children and 8.87×10^{-01} in Adults. Endrin Ketone at Y2 in Children was 4.83 $\times10^{-01}$; and 1.34 $\times10^{-01}$ in Adults. Aldrin at Y1 in Children was 7.14 and Adults, 1.99 respectively.

These numbers show that in almost every case, children's exposure levels when adjusted for their body weight and consumption rate pose a much higher risk than those of adults.

Children's HRI values remained consistently higher than adults' in Year 2, despite a large decline for both age groups—likely as a result of improved pesticide management or environmental degradation of OCPs. For instance, Y4's heptachlor epoxide concentration of 5.77 $\times 10^{-01}$ was obtained for children and 1.62 $\times 10^{-01}$ for adults. Aldrin Aldehyde at Y4, has a concentration of 3.42 $\times 10^{-02}$ for Children and 9.50 $\times 10^{-03}$ for Adults. Despite the fact that most values from the present study fall under the threshold of concern, the relative disparity in risk remains stark.

According to the statistical analysis from both years, children are three to eight times more likely than adults to be at risk for health problems due to pesticide residues in yams. To ensure safer food systems, particularly for the younger and most vulnerable members of society, these increased hazards necessitate proactive regulatory, agricultural, and public health responses.

Cancer Risk Analysis

In year one, TLCR (total cancer risk) values for both children and adults across the four locations are in the high-risk category (between 10^{-3} and 10^{-1}). These elevated levels suggest substantial and concerning exposure to OCPs such as Aldrin, Dieldrin, and Heptachlor epoxide, which are recognized carcinogens. The highest TLCR for children was recorded in Y3 (5.911×10^{-3}), and the lowest for adults in Y4 (4.659×10^{-4}), though still within the high-risk range.

The second year revealed a discernible drop in cancer risk scores. All adults' TLCR values ($< 10^{-4}$) are considered low-risk, and children's TLCR levels at Y1 and Y2 are similarly in this range. Children in Y3 (1.02×10^{-4}) and Y4 (1.49×10^{-4}) continue to be at moderate risk, which are issues of concern about persistent residue levels in the area.

Children's TLCR ratings are consistently greater than adults' across all years and regions. Children are biologically more susceptible to the carcinogenic consequences of pesticide exposure because of their heightened sensitivity, smaller body mass, higher food consumption per unit weight, and growing immune and detoxifying systems.

This result is consistent with findings from similar studies across West Africa

In Nigerian cassava and maize, Oyinloye *et al.*, (2021) found TLCRs in children that were greater than 10^{-3}, suggesting a substantial lifelong cancer risk as a result of Aldrin and Heptachlor epoxide contamination.

OCPs in local foods in Nigeria have been linked to increased cancer risks, particularly for children, according to Onwujiogu *et al,* (2022). TLCRs frequently beyond USEPA standards, highlights the crucial route of exposure via tainted staple foods.

The present study's decrease in risk between Years 1 and 2 reflects similar findings in Ghana, possibly as a result of improved agronomic practices, stricter regulations, or greater awareness. Ogbeide *et al*. (2021) found OCPs like Dieldrin and Aldrin in yams at levels with low to moderate TLCRs, with children facing more pronounced risks.

Table 3: Estimated Daily Intake ($mg^{-1}kg^{-1}day^{-1}$) of the OCPs from Different Locations

OCPs	Year	Y1		Y2		Y3		Y4		ADI (WHO/FAO.2023)
		EDI_{child}	EDI_{adult}	EDI_{child}	EDI_{adult}	EDI_{child}	EDI_{adult}	EDI_{child}	EDI_{adult}	
alpha-BHC	1	4.16×10^{-05}	1.16×10^{-05}	2.15×10^{-05}	5.98×10^{-06}	5.88×10^{-05}	1.64×10^{-05}	6.67×10^{-05}	1.86×10^{-05}	NA
	2	NV	NV	NV	NV	NV	NV	NV	NV	
beta-BHC	1	8.97×10^{-05}	2.50×10^{-05}	3.25×10^{-05}	9.05×10^{-06}	1.00×10^{-04}	2.79×10^{-05}	7.87×10^{-05}	2.19×10^{-05}	NA
	2	8.55×10^{-06}	2.38×10^{-06}	2.88×10^{-06}	8.02×10^{-07}	1.44×10^{-05}	4.01×10^{-06}	9.14×10^{-06}	2.55×10^{-06}	
gamma-BHC	1	1.56×10^{-05}	4.34×10^{-05}	4.92×10^{-05}	1.37×10^{-05}	3.43×10^{-05}	9.55×10^{-05}	1.24×10^{-05}	3.46×10^{-06}	0.005
	2	NV	NV	NV	NV	NV	NV	NV	NV	
Heptachlor	1	1.90×10^{-05}	5.28×10^{-06}	4.78×10^{-05}	1.33×10^{-05}	1.85×10^{-05}	5.15×10^{-06}	8.75×10^{-06}	2.43×10^{-06}	0.0005
	2	NV	NV	NV	NV	NV	NV	NV	NV	
delta-BHC	1	2.84×10^{-04}	7.90×10^{-05}	1.52×10^{-04}	4.24×10^{-05}	2.17×10^{-04}	6.03×10^{-05}	6.93×10^{-05}	1.93×10^{-05}	NA
	2	5.05×10^{-06}	1.41×10^{-06}	3.05×10^{-06}	8.49×10^{-07}	1.55×10^{-05}	4.30×10^{-06}	1.37×10^{-05}	3.82×10^{-06}	
Aldrin	1	2.14×10^{-04}	5.96×10^{-05}	1.00×10^{-04}	2.79×10^{-05}	1.76×10^{-04}	4.89×10^{-05}	3.01×10^{-05}	8.38×10^{-06}	0.0001
	2	8.05×10^{-07}	2.24×10^{-07}	5.86×10^{-07}	1.63×10^{-07}	9.94×10^{-07}	2.77×10^{-07}	1.29×10^{-06}	3.60×10^{-07}	
Heptachlor Epoxide	1	1.09×10^{-04}	3.04×10^{-05}	2.43×10^{-04}	6.76×10^{-05}	2.08×10^{-04}	5.79×10^{-05}	4.03×10^{-05}	1.12×10^{-05}	0.001
	2	2.13×10^{-06}	5.92×10^{-07}	6.40×10^{-06}	1.78×10^{-06}	3.59×10^{-06}	9.99×10^{-07}	8.66×10^{-06}	2.41×10^{-06}	
gamma-Chlordane	1	1.07×10^{-04}	2.98×10^{-05}	3.43×10^{-05}	9.55×10^{-06}	8.31×10^{-05}	2.31×10^{-05}	2.60×10^{-05}	7.25×10^{-06}	0.0005
	2	1.01×10^{-06}	2.82×10^{-07}	9.84×10^{-07}	2.74×10^{-07}	2.49×10^{-06}	6.94×10^{-07}	1.79×10^{-06}	4.98×10^{-07}	
alpha-Chlordane	1	3.99×10^{-04}	1.11×10^{-04}	1.95×10^{-04}	5.42×10^{-05}	5.59×10^{-04}	1.56×10^{-04}	8.40×10^{-05}	2.34×10^{-05}	0.001
	2	2.12×10^{-06}	5.92×10^{-07}	1.48×10^{-06}	4.12×10^{-07}	3.86×10^{-05}	1.07×10^{-05}	4.41×10^{-05}	1.23×10^{-05}	
Endosulfan I	1	1.91×10^{-04}	5.33×10^{-05}	2.41×10^{-04}	6.71×10^{-05}	3.52×10^{-04}	9.79×10^{-05}	2.33×10^{-05}	6.47×10^{-06}	0.030
	2	2.23×10^{-06}	6.20×10^{-07}	2.75×10^{-06}	7.66×10^{-07}	1.50×10^{-06}	4.18×10^{-07}	2.49×10^{-06}	6.92×10^{-07}	
P,P-DDE	1	1.06×10^{-05}	2.96×10^{-06}	1.56×10^{-05}	4.34×10^{-06}	7.40×10^{-05}	2.06×10^{-05}	3.17×10^{-05}	8.83×10^{-06}	0.002
	2	1.41×10^{-06}	3.93×10^{-07}	1.48×10^{-06}	4.12×10^{-07}	1.39×10^{-06}	3.87×10^{-07}	1.22×10^{-05}	3.41×10^{-06}	
Dieldrin	1	1.50×10^{-05}	4.18×10^{-06}	1.49×10^{-05}	4.15×10^{-06}	2.08×10^{-05}	5.78×10^{-06}	8.55×10^{-06}	2.38×10^{-06}	0.0005
	2	6.06×10^{-07}	1.69×10^{-07}	4.97×10^{-07}	1.38×10^{-07}	5.96×10^{-07}	1.66×10^{-07}	5.96×10^{-07}	1.66×10^{-07}	
Endrin	1	2.60×10^{-04}	7.23×10^{-05}	3.78×10^{-04}	1.05×10^{-04}	2.56×10^{-04}	7.12×10^{-05}	3.61×10^{-05}	1.00×10^{-05}	0.0002
	2	5.56×10^{-06}	1.55×10^{-06}	5.32×10^{-06}	1.48×10^{-06}	6.78×10^{-06}	1.89×10^{-06}	4.58×10^{-06}	1.28×10^{-06}	
P,P-DDD	1	3.46×10^{-05}	9.63×10^{-06}	4.10×10^{-05}	1.14×10^{-05}	3.05×10^{-05}	8.49×10^{-06}	3.28×10^{-06}	9.13×10^{-07}	0.002
	2	7.06×10^{-07}	1.96×10^{-07}	7.85×10^{-07}	2.19×10^{-07}	7.95×10^{-07}	2.21×10^{-07}	2.09×10^{-06}	5.81×10^{-07}	
Endosulfan II	1	1.91×10^{-04}	5.31×10^{-05}	3.79×10^{-04}	1.05×10^{-04}	1.92×10^{-04}	5.35×10^{-05}	8.32×10^{-05}	2.32×10^{-05}	0.003
	2	1.52×10^{-06}	4.22×10^{-06}	1.28×10^{-05}	3.56×10^{-06}	8.68×10^{-06}	2.42×10^{-06}	1.41×10^{-05}	3.93×10^{-06}	
P,P-DDT	1	1.31×10^{-04}	3.66×10^{-05}	1.33×10^{-04}	3.70×10^{-05}	7.55×10^{-05}	2.10×10^{-05}	8.56×10^{-04}	2.38×10^{-04}	0.002
	2	2.43×10^{-06}	6.75×10^{-07}	2.65×10^{-06}	7.39×10^{-07}	5.19×10^{-06}	1.44×10^{-06}	3.99×10^{-06}	1.11×10^{-06}	
Endrin aldehyde	1	6.47×10^{-05}	1.80×10^{-05}	5.69×10^{-05}	1.58×10^{-05}	6.01×10^{-05}	1.67×10^{-05}	7.30×10^{-05}	2.03×10^{-05}	0.0002
	2	3.95×10^{-06}	1.10×10^{-06}	2.75×10^{-06}	7.66×10^{-07}	4.99×10^{-06}	1.39×10^{-06}	1.03×10^{-05}	2.86×10^{-06}	
Endosulfan Sulfate	1	1.40×10^{-04}	3.88×10^{-05}	5.38×10^{-05}	1.50×10^{-05}	6.93×10^{-05}	1.93×10^{-05}	6.46×10^{-06}	1.80×10^{-06}	0.006
	2	3.08×10^{-07}	8.58×10^{-06}	2.98×10^{-07}	8.3×10^{-08}	5.96×10^{-07}	1.66×10^{-07}	3.98×10^{-07}	1.11×10^{-07}	
Methoxychlor	1	1.73×10^{-04}	4.82×10^{-05}	2.81×10^{-04}	7.81×10^{-05}	6.60×10^{-05}	1.84×10^{-05}	1.51×10^{-05}	4.21×10^{-06}	0.100
	2	1.82×10^{-06}	5.06×10^{-07}	1.67×10^{-06}	4.65×10^{-07}	1.60×10^{-06}	4.45×10^{-07}	2.99×10^{-06}	8.33×10^{-07}	
Endrin Ketone	1	1.04×10^{-04}	2.89×10^{-05}	1.93×10^{-04}	5.38×10^{-05}	1.71×10^{-04}	4.77×10^{-05}	3.58×10^{-05}	9.96×10^{-06}	0.0002
	2	4.44×10^{-06}	1.24×10^{-06}	8.37×10^{-06}	2.33×10^{-06}	6.48×10^{-06}	1.80×10^{-06}	9.36×10^{-06}	2.61×10^{-06}	

Y1= Yam from Odogwu, Y2= Yam from Ejule, Y3= Yam Onyedega, Y4= Yam from Ogaine, Y= Yam sample, EDI= Estimated daily intake, ADI= Allowable daily intake, WHO/FAO = World Health organization/ Food and Agricultural Organization, NA = Not Available, NV = No value

Table 4: Health Risk Index of the OCPs from Different Locations

OCPs	Year	Y1 HI child	Y1 HI adult	Y2 HI child	Y2 HI adult	Y3 HI child	Y3 HI adult	Y4 HI child	Y4 HI adult
alpha-BHC	1	1.39E-01	3.86E-02	7.16E-02	1.99E-02	1.96E-01	5.46E-02	2.22E-01	6.19E-02
	2	NV	NV	NV	NV	NV	NV	NV	NV
beta-BHC	1	2.99E-01	8.32E-02	1.08E-01	3.02E-02	3.34E-01	9.29E-02	2.62E-01	7.30E-02
	2	2.85E-02	7.93E-03	9.61E-03	2.67E-03	4.80E-02	1.34E-02	3.05E-02	8.48E-03
gamma-BHC	1	5.20E-02	1.45E-02	1.64E-01	4.57E-02	1.14E-01	3.18E-02	4.14E-02	1.15E-02
	2	NV	NV	NV	NV	NV	NV	NV	NV
Heptachlor	1	1.27E+00	3.52E-01	3.19E+00	8.87E-01	1.23E+00	3.43E-01	5.83E-01	1.62E-01
	2	NV	NV	NV	NV	NV	NV	NV	NV
Aldrin	1	7.14E+00	1.99E+00	3.35E+00	9.31E-01	5.86E+00	1.63E+00	1.00E+00	2.79E-01
	2	2.68E-02	7.47E-03	1.95E-02	5.44E-03	3.31E-02	9.22E-03	4.31E-02	1.20E-02
Heptachlor Epoxide	1	7.29E+00	2.03E+00	1.62E+01	4.50E+00	1.39E+01	3.86E+00	2.68E+00	7.47E-01
	2	1.42E-01	3.95E-02	4.27E-01	1.19E-01	2.39E-01	6.66E-02	5.77E-01	1.61E-01
gamma-Chlordane	1	2.14E-01	5.96E-02	6.86E-02	1.91E-02	1.66E-01	4.63E-02	5.21E-02	1.45E-02
	2	2.03E-03	5.64E-04	1.97E-03	5.48E-04	4.99E-03	1.39E-03	3.58E-03	9.96E-04
alpha-Chlordane	1	7.98E-01	2.22E-01	3.89E-01	1.08E-01	1.12E+00	3.11E-01	1.68E-01	4.68E-02
	2	4.25E-03	1.18E-03	2.96E-03	8.24E-04	7.72E-02	2.15E-02	8.82E-02	2.46E-02
Endosulfan I	1	3.19E-02	8.88E-03	4.02E-02	1.12E-02	5.86E-02	1.63E-02	3.88E-03	1.08E-03
	2	3.71E-04	1.03E-04	4.59E-04	1.28E-04	2.50E-04	6.96E-05	4.14E-04	1.15E-04
P,P-DDE	1	2.13E-02	5.92E-03	3.12E-02	8.69E-03	1.48E-01	4.12E-02	6.34E-02	1.77E-02
	2	2.82E-03	7.86E-04	2.96E-03	8.24E-04	2.78E-03	7.75E-04	2.45E-02	6.81E-03
Dieldrin	1	3.00E-01	8.36E-02	2.98E-01	8.30E-02	4.15E-01	1.16E-01	1.71E-01	4.76E-02
	2	1.21E-02	3.38E-03	9.94E-03	2.77E-03	1.19E-02	3.32E-03	1.19E-02	3.32E-03
Endrin	1	8.66E-01	2.41E-01	1.26E+00	3.51E-01	8.52E-01	2.37E-01	1.20E-01	3.35E-02
	2	1.85E-02	5.16E-03	1.72E-02	4.93E-03	2.26E-02	6.29E-03	1.53E-02	4.25E-03
P,P-DDD	1	6.92E-02	1.93E-02	8.19E-02	2.28E-02	6.10E-02	1.70E-02	6.56E-03	1.83E-03
	2	1.41E-03	3.93E-04	1.57E-03	4.37E-04	1.59E-03	4.43E-04	4.17E-03	1.16E-03
Endosulfan II	1	3.18E-02	8.85E-03	6.31E-02	1.76E-02	3.21E-02	8.92E-03	1.39E-02	3.86E-03
	2	2.52E-03	7.03E-04	2.13E-03	5.93E-04	1.44E-03	4.03E-04	2.36E-03	6.56E-04
P,P-DDT	1	2.63E-01	7.31E-02	2.66E-01	7.40E-02	1.51E-01	4.21E-02	1.71E+00	4.77E-01
	2	4.85E-03	1.35E-03	5.31E-03	1.48E-03	1.04E-02	2.89E-03	7.97E-03	2.22E-03
Endrin aldehyde	1	2.16E-01	6.00E-02	1.90E-01	5.28E-02	2.00E-01	5.58E-02	2.43E-01	6.77E-02
	2	1.32E-02	3.66E-03	9.18E-03	2.55E-03	1.66E-02	4.63E-03	3.42E-02	9.52E-03
Endosulfan Sulfate	1	2.33E-02	6.47E-03	8.96E-03	2.49E-03	1.15E-02	3.21E-03	1.08E-03	3.00E-04
	2	5.14E-05	1.43E-05	4.97E-05	1.38E-05	9.94E-05	2.77E-05	6.63E-05	1.84E-05
Endrin Ketone	1	2.60E-01	7.23E-02	4.83E-01	1.34E-01	4.28E-01	1.20E-01	8.95E-02	2.49E-02
	2	1.11E-02	3.09E-03	2.09E-02	5.82E-03	1.62E-02	4.51E-03	2.34E-02	6.51E-03

Y1= Yam from Odogwu, Y2= Yam from Ejule, Y3= Yam Onyedega, Y4= Yam from Ogaine, Y= Yam sample, HI= Health Risk Index

Table 5: Cancer Risk of the OCPs from Different Locations

		Y1		Y2		Y3		Y4	
OCPs	**Year**	**CR_{child}**	**CR_{adult}**	**CR_{child}**	**CR_{adult}**	**CR_{child}**	**CR_{adult}**	**CR_{child}**	**CR_{adult}**
alpha-BHC	1	7.50×10^{-05}	2.09×10^{-05}	3.86×10^{-05}	1.08×10^{-05}	1.06×10^{-04}	2.95×10^{-05}	1.2×10^{-04}	3.34×10^{-05}
	2	NV	NV	NV	NV	NV	NV	NV	NV
beta-BHC	1	1.61×10^{-04}	4.49×10^{-05}	5.85×10^{-05}	1.63×10^{-05}	1.80×10^{-04}	5.01×10^{-05}	1.42×10^{-04}	3.94×10^{-05}
	2	1.54×10^{-05}	4.28×10^{-06}	5.19×10^{-06}	1.44×10^{-06}	2.59×10^{-05}	7.22×10^{-06}	1.65×10^{-05}	4.58×10^{-06}
gamma-BHC	1	2.03×10^{-05}	5.65×10^{-06}	6.4×10^{-05}	1.78×10^{-05}	4.46×10^{-05}	1.24×10^{-05}	1.62×10^{-05}	4.50×10^{-06}
	2	NV	NV	NV	NV	NV	NV	NV	NV
Heptachlor	1	8.54×10^{-05}	2.38×10^{-05}	2.15×10^{-04}	5.99×10^{-05}	8.32×10^{-05}	2.32×10^{-05}	3.94×10^{-05}	1.10×10^{-05}
	2	NV	NV	NV	NV	NV	NV	NV	NV
Aldrin	1	3.64×10^{-03}	1.01×10^{-03}	1.71×10^{-03}	4.75×10^{-04}	2.99×10^{-03}	8.32×10^{-04}	5.12×10^{-04}	1.43×10^{-04}
	2	1.37×10^{-05}	3.81×10^{-06}	9.97×10^{-06}	2.77×10^{-06}	1.69×10^{-05}	4.70×10^{-06}	2.20×10^{-05}	6.11×10^{-06}
Heptachlor Epoxide	1	9.95×10^{-04}	2.77×10^{-04}	2.21×10^{-03}	6.15×10^{-04}	1.89×10^{-03}	5.26×10^{-04}	3.66×10^{-04}	1.02×10^{-04}
	2	1.94×10^{-05}	5.39×10^{-06}	5.83×10^{-05}	1.62×10^{-05}	3.27×10^{-05}	9.09×10^{-06}	7.88×10^{-05}	2.19×10^{-05}
gamma-Chlordane	1	3.75×10^{-05}	1.04×10^{-05}	1.2×10^{-05}	3.34×10^{-06}	2.91×10^{-05}	8.1×10^{-06}	9.12×10^{-06}	2.54×10^{-06}
	2	3.55×10^{-07}	9.88×10^{-08}	3.44×10^{-07}	9.59×10^{-08}	8.73×10^{-07}	2.43×10^{-07}	6.26×10^{-07}	1.74×10^{-07}
alpha-Chlordane	1	0.00014	3.89×10^{-05}	6.81×10^{-05}	1.90×10^{-05}	1.96×10^{-04}	5.44×10^{-05}	2.94×10^{-05}	8.18×10^{-06}
	2	7.45×10^{-07}	2.07×10^{-07}	5.18×10^{-07}	1.44×10^{-07}	1.35×10^{-05}	3.76×10^{-06}	1.54×10^{-05}	4.30×10^{-06}
P,P-DDE	1	3.62×10^{-06}	1.01×10^{-06}	5.31×10^{-06}	1.48×10^{-06}	2.51×10^{-05}	7.00×10^{-06}	1.08×10^{-05}	3.00×10^{-06}
	2	4.80×10^{-07}	1.34×10^{-07}	5.04×10^{-07}	1.40×10^{-07}	4.73×10^{-07}	1.32×10^{-07}	4.16×10^{-06}	1.16×10^{-06}
Dieldrin	1	2.40×10^{-04}	6.68×10^{-05}	2.39×10^{-04}	6.64×10^{-05}	3.32×10^{-04}	9.25×10^{-05}	1.37×10^{-04}	3.81×10^{-05}
	2	9.70×10^{-06}	2.70×10^{-06}	7.95×10^{-06}	2.21×10^{-06}	9.54×10^{-06}	2.66×10^{-06}	9.54×10^{-06}	2.66×10^{-06}
P,P-DDD	1	1.18×10^{-05}	3.27×10^{-06}	1.39×10^{-05}	3.88×10^{-06}	1.04×10^{-05}	2.89×10^{-06}	1.12×10^{-06}	3.10×10^{-07}
	2	2.4×10^{-07}	6.68×10^{-08}	2.67×10^{-07}	7.43×10^{-08}	2.70×10^{-07}	7.53×10^{-08}	7.10×10^{-07}	1.98×10^{-07}
P,P-DDT	1	4.47×10^{-05}	1.24×10^{-05}	4.52×10^{-05}	1.26×10^{-05}	2.57×10^{-05}	7.15×10^{-06}	2.91×10^{-04}	8.10×10^{-05}
	2	8.25×10^{-07}	2.30×10^{-07}	9.02×10^{-07}	2.51×10^{-07}	1.76×10^{-06}	4.91×10^{-07}	1.36×10^{-06}	3.77×10^{-07}
TOTAL	**1**	**5.45×10^{-03}**	**1.52×10^{-03}**	**4.68×10^{-03}**	**1.30×10^{-03}**	**5.91×10^{-03}**	**1.65×10^{-03}**	**1.67×10^{-03}**	**4.66×10^{-04}**
	2	**6.08×10^{-05}**	**1.69×10^{-05}**	**8.39×10^{-05}**	**2.34×10^{-05}**	**1.02×10^{-04}**	**2.84×10^{-05}**	**1.49×10^{-04}**	**4.15×10^{-05}**

Y1= Yam from Odogwu, Y2= Yam from Ejule, Y3= Yam from Onyedega, Y4= Yam from Ogaine, Y= Yam sample, CR= Cancer Risk, NV= No Value

CONCLUSION

The findings of this study demonstrate that yam samples from the investigated sites contain varying levels of organochlorine pesticide residues, some of which exceed established safety thresholds. Elevated cancer risk values, particularly for aldrin and heptachlor epoxide, highlight serious public health concerns, especially for vulnerable populations such as children. These results emphasize the urgent need for continuous monitoring of pesticide residues in food crops, reinforced regulatory enforcement, and the promotion of sustainable agricultural practices. Long-term risk assessment and dietary exposure studies are essential to protect consumer health and ensure food safety.

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