their use has been associated with environmental pollution, food chain contamination, food poisoning, and human health issues. According to a joint report by the Food and Agricultural Organization (FAO) and World Health Organization (WHO), approximately three million individuals experienced pesticide poisoning worldwide in 1990, out of which 220,000 cases resulted in death annually.[5] Therefore, many pesticides (especially organochlorines) have been banned or severely restricted by the United States Environmental Protection Agency (USEPA), European Union (EU), and some other regulatory bodies.[6-8]

Organochlorines are synthetic organic pesticides that are primarily composed of carbon, hydrogen, chlorine, and occasionally oxygen and sulphur. These pesticides are also known as chlorinated hydrocarbons, chlorinated organics, chlorinated insecticides, and chlorinated synthetics.[9,10] Although organochlorines are potent and effective pesticides, their use has been banned or highly restricted in many countries due to their toxicity, low water solubility, and high chemical stability, which cause their bioaccumulation in food chains.[3,10,11]

Vegetables are a food group required in balanced human diets as the major sources of essential minerals and vitamins. Vegetables could be consumed as the main food, or added to complementary diets.[12] Vegetables improve bowel movement owing to their high composition of fibers. In Nigeria, leafy and non-leafy vegetables are consistently in high demand. Therefore, vegetable farming is a thriving business and good source of income for many citizens in this country. Among several vegetables that are commercially cultivated in farms in Lagos, Nigeria are *Lactuca sativa* (lettuce), *Allium fistulosum* (spring onion), and *Spinacia oleracea* (spinach). Lettuce is a leafy, herbaceous annual or biennial plant, which is grown for its leaves that are primarily consumed raw as in green salad. Spring onion is a clumping, slowly-spreading, evergreen, perennial onion, which is primarily grown and harvested for its tasty onion-flavored leaves. Spinach is a leafy, herbaceous, annual plant, which is grown for its leaves that are consumed cooked as a vegetable. Spinach is an abundant source of iron, calcium, and other essential vitamins and minerals. Similar to most crops, lettuce, spring onion, and spinach are often attacked by pests.

In their attempts to ward off pests and maximize production, many vegetable farmers in Nigeria are in the habit of directly applying pesticides to their growing crops, especially in cities such as Lagos. Although, organochlorine pesticides have been banned in Nigeria, they are still widely used by farmers and food stuff merchants partly due to their low cost and ease of access.[8] Such unregulated use of pesticides potentially exposes consumers to pesticide toxicity through residual contamination.

The present study aimed to evaluate the concentrations of organochlorine pesticide residues in the salad vegetables (lettuce, spring onions, and spinach) and soil samples collected from three farms in Lagos, Nigeria. The potential human health risks associated with the consumption of these vegetables were also assessed.

Materials and Methods

Sample collection

Lactuca sativa (lettuce), *Allium fistulosum* (spring onion), *Spinacia oleracea* (spinach), and soil samples were collected from farmlands located in Alapere, Idi-Araba, and Tejuosho in Lagos (Fig. 1). The vegetable crop samples (lettuce, spring onions, and spinach) were carefully pulled from the soil, wrapped in aluminium foil, and placed in large, brown envelopes. The soil samples were collected at the depth of 15 cm using a soil hand trowel and placed in black polythene bags. The plant and soil samples collected from each site were carefully labelled to avoid mix-up. The samples were immediately transferred to the laboratory for analysis.

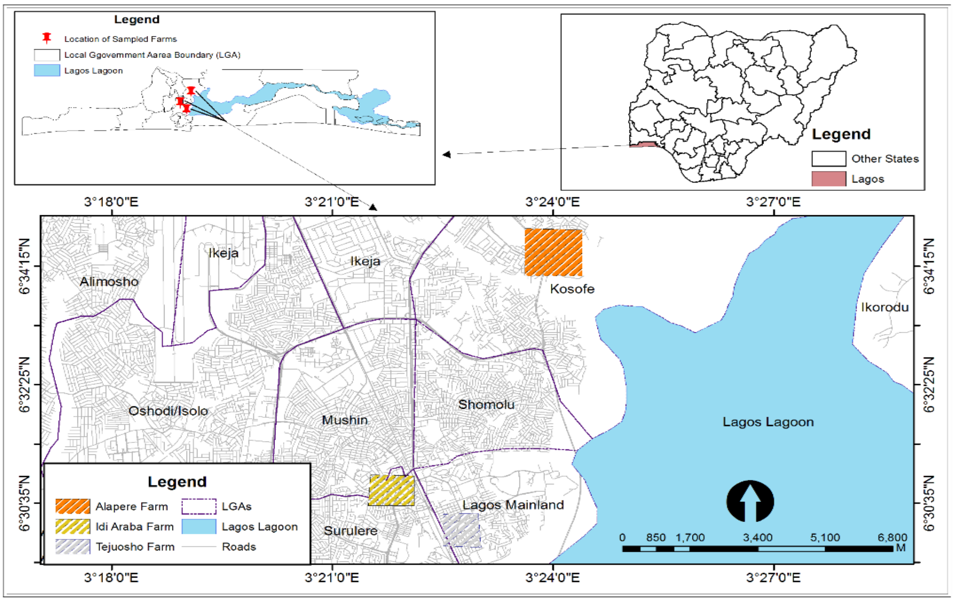

Fig. 1. Map of Nigeria (top right) showing Lagos State (top left) and sampling locations (bottom)

Sample extraction and analysis

The vegetable and soil samples were subjected to extraction prior to the gas chromatographic (GC) analysis using the combined maceration and solid-phase extraction (SPE) method. Maceration was carried out by weighing 10 grams of the samples (soil or plant) and 10 grams of anhydrous Na_2SO_4 into a 50-milliliter amber glass bottle. Afterwards, 40 mL of the extraction solvent mixture (hexane-to-acetone ratio: 1:1 v/v) was added and agitated for 20 min on a mechanical shaker. The covered glass amber bottle was properly sealed and sonicated for 20 min, and the combined aliquot was collected in a 250-milliliter beaker.

Solid-phase extraction (SPE) was then used for the clean-up of the extract. In the clean-up procedure, the solvent used for extraction was initially eluted through the cartridge to condition and equilibrate the cartridge. Following that, the extract was eluted through the cartridge and collected into another small beaker. The residues (impurities) were retained on the stationary phase, which was composed of glass wool combined with aluminum oxide (Al_2O_3) and anhydrous Na_2SO_4 (2:3 wt/wt). The cleaned extract was evaporated to the volume of two milliliters using a nitrogen concentrator to the final volume. The cleaned, concentrated sample extracts were subjected to gas chromatography-mass spectrometry (GC-MS) analysis. The constituents of the organochlorine pesticides were identified by comparing the mass spectra with a known standard.

The programming of GC-MS

Agilent Technologies GC (Model: 7890A) interfaced with a mass selective detector (MSD; model: 5975C) was the main instrument. Column specification was HP-5 (30 mm X 0.25 mm X 0.320 µm). The column oven temperature was set at 80-280 °C with the hold time of 1-2 min, flow rate of 10 °C for 1 min, final temperature of 280 °C. Time was 6 min, and flow rate was 11 °C at 1 min. The column phase included the mobile phase with helium gas (99.9% purity; 0.5 mL per minute), in addition to the stationary phase (30 mm X 0.25 mm X 0.320 µm) with the carrier gas of helium (99.9% purity). Electron Ionization (70 v) was performed at the temperature of 250 °C using an MSD detector operated at the ion-source temperature of 250 °C, while the injector was operated at the temperature of 250 °C. Finally, the injection mode was splitless with the injection volume of 1 µ/L.

Determination of residual organochlorine pesticides in the test samples

The residual pesticide concentration in the test samples was determined using Eqs, 1 and 2:

$$Actual\ Peak\ Area\ =\ Sum\ of\ Peak\ Area - Solvent\ Peak\ Area \quad (1)$$

$$General\ Concentration\ of\ Pesticide = \frac{Actual\ Peak\ Area\ \times\ Standard\ Concentration}{Standard\ Peak\ Area} \quad (2)$$

The health risk assessment of the consumption of the sampled vegetables

The health risks assessment of the consumption of the test vegetables was performed through the comparison of the pesticide residues in the salad vegetables to the established acceptable daily intake (ADI) or acute references doses (ARfD) values as specified by the EU Commission Database.[13] The ADI value was estimated at 0.5 mg/day, and the ARfD value was estimated at 0.5 mg/day. The estimated daily intake (EDI) of the pesticide residues was calculated using Eq. 3:

$$Estimated\ Daily\ Intake\ (EDI) = \frac{Food\ consumption\ data\ (vegetable) \times\ Residue\ level}{Mean\ Body\ Weight} \quad (3)$$

where the mean body weight (Africa)[14] is 60.7 kg, and the food consumption data (vegetable)[15] was calculated to be 0.4 kg/day.

The long-term risk assessment of the intake of the test vegetables was compared to the toxicological data of the pesticides by calculating the hazard quotient (HQ) using Eq. 4:[16]

$$Hazard\ Quotient = \frac{Estimated\ daily\ intake\ (EDI)}{Acceptable\ daily\ intake\ (ADI)} \quad (4)$$

The hazard index of the consumption of the salad vegetables collected from the farmlands was calculated as the sum of the HQ of the vegetables using Eq. 5:[16]

$$Hazard\ Index\ =\ \sum HQ \quad (5)$$

where, *HQ* represents the hazard quotient.

Statistical analysis

Data analysis was performed with SPSS version 25.0 and GraphPad Prism version 7.0 using the analysis of variance (ANOVA) and t-test. The mean differences between the variables were considered significant at the P-value of less than 0.05.

Results and Discussion

Residual organochlorine concentrations in the shoots of the sampled salad vegetables

As indicated in Table 1, 18 organochlorine pesticides were detected at varied concentrations in the shoots of the salad vegetables (lettuce, spring onions, and spinach) in the present study. The detected pesticides were hexachlorocyclohexane alpha isomer (α-BHC), hexachlorocyclohexane beta isomer (β-BHC), lindane (γ-BHC), chlorothalonil, hexachlorocyclohexane delta isomer (δ-BHC), heptachlor epoxide, aldrin, heptachlorepoxide, 1-chloro-2-[2,2-dichloro-1-(4-chlorophenyl) ethenylbenzene [4, 4'-DDE (O.P.)], Endosulfan I, 1-chloro-4-[2,2-dichloro-1-(4-chlorophenyl) ethenylbenzene (P,P-DDE), dieldrin, endrin, Endosulfan II, 2,2'-4,4',5,5'-hexachlorobiphenyl (PCB-153), PF-38; 1,1'-(2,2,2-Trichloro-1,1-ethanediyl) bis (4-chlorobenzene) (P.P DDT), and lambda-cyhalothrin (L-cyhalothrin).

Table 1. Residual organochlorine concentrations in shoots of sampled salad vegetables

Pesticide Residue (mg/kg)	Mean pesticides concentrations (mg/kg)									MRL
	IDI-ARABA			TEJUOSHO			ALAPERE			
	LETTUCE	SPRING ONION	SPINACH	LETTUCE	SPRING ONION	SPINACH	LETTUCE	SPRING ONION	SPINACH	
α-BHC	0.06±0.07^{Y}	0.01±0.00	0.01±0.00	0.02±0.02^{Y}	0.00±0.01	ND	0.01±0.00	ND	ND	0.01
β-BHC	0.01±0.00	0.02±0.01^{Y}	0.01±0.00	0.01±0.01	0.01±0.01	0.01±0.00	ND	ND	0.01±0.01	0.01
γ-BHC (Lindane)	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.00±0.00	0.01±0.00	ND	0.01±0.00	ND	0.01
Chlorothalonil	0.01±0.02	0.02±0.02^{Y}	0.01±0.01	0.01±0.01	0.00±0.00	0.03±0.01	0.01±0.01	0.02±0.02^{Y}	ND	0.01
δ-BHC	0.01±0.01	0.01±0.01	0.02±0.03^{Y}	0.01±0.00	0.00±0.01	ND	ND	0.01±0.01	ND	0.01
Heptachlor	0.02±0.00^{Y}	0.01±0.00	0.04±0.04^{Y}	0.01±0.00	0.02±0.00^{b}	0.01±0.00	0.02±0.01^{Y}	ND	ND	0.01
Aldrin	0.01±0.01	0.02±0.01^{Y}	ND	0.01±0.01	0.04±0.04^{Y}	0.01±0.00	0.01±0.00	0.02±0.01^{Y}	0.01±0.00	0.01
Heptachlorepoxide	0.01±0.00	0.01±0.00	ND	0.01±0.00	0.00±0.00	ND	ND	ND	ND	0.01
4,4'-DDE(O.P.)	ND	0.01±0.00	0.02±0.02	0.01±0.01	0.00±0.01	ND	0.01±0.01	ND	0.01±0.01	0.05
Endosulfan I	0.04±0.01^{Y}	0.29±0.26^{Y}	0.03±0.00^{Y}	0.04±0.03^{Y}	0.05±0.04^{Y}	0.02±0.00	0.03±0.02^{Y}	ND	0.01±0.01	0.01
P,P-DDE	0.01±0.01	0.02±0.02	0.08±0.03^{Y}	0.08±0.10^{Y}	0.00±0.00	0.03±0.04	ND	ND	ND	0.05
Dieldrin	0.01±0.01	0.02±0.02^{Y}	0.03±0.01^{Y}	0.03±0.02^{Y}	0.01±0.00	ND	ND	0.01±0.00	ND	0.01
Endrin	0.01±0.01	0.02±0.00$^{b\ Y}$	0.02±0.00^{Y}	0.02±0.02^{Y}	0.00±0.01	0.01±0.01	0.01±0.01	0.00±0.01	ND	0.01
Endosulfan II	0.01±0.00	0.05±0.05^{Y}	0.01±0.02	0.00±0.01	0.01±0.01	0.01±0.00	ND	ND	ND	0.01
PCB-153	0.01±0.00	0.01±0.00	0.01±0.01	0.00±0.00	ND	ND	ND	ND	ND	0.01
PF-38	0.02±0.03^{Y}	0.04±0.05^{Y}	0.05±0.07^{Y}	0.05±0.08^{Y}	0.13±0.07^{Y}	ND	ND	0.02±0.03^{Y}	ND	0.01
P.P DDT	0.03±0.00	0.03±0.04	0.05±0.02	0.08±0.07^{Y}	ND	ND	0.02±0.03	ND	ND	0.05
L-Cyhaothrin	ND	0.01±0.02	0.08±0.08^{Y}	0.50±0.71^{Y}	0.01±0.02	0.02±0.03^{Y}	ND	ND	0.04±0.05^{Y}	0.01
Total	0.28±0.17	0.59±0.48	0.51±0.23	0.90±0.93	0.29±0.00	0.16±0.10	0.12±0.06	0.09±0.08	0.09±0.07	

(^{Y}: organochlorine residues higher than MRL value; MRL: maximum residue limits; ND: not detected; b: value significantly higher than concentration values of same pesticide in same crop from one/two farms)

In Idi-Araba farm, α-BHC had the highest concentration (0.06±0.07 mg/kg) in the shoots of lettuce, Endosulfan I had the highest concentration (0.29±0.26 mg/kg) in spring onion, and both P,P-DDE and L-cyhalothrin had the highest concentrations (0.08±0.03 and 0.08±0.08 mg/kg, respectively) in spinach shoots. In Tejuosho farm, L-cyhalothrin, PF-38, and chlorothalonil had the highest concentrations (0.50±0.71, 0.13±0.07, and 0.03±0.01 mg/kg, respectively) in the shoots of lettuce, spring onion, and spinach, respectively. In Alapere farm, Endosulfan I had the highest concentration (0.03±0.02 mg/kg) in the shoots of lettuce, Aldrin had the highest concentration (0.02±0.01 mg/kg) in the shoots of spring onion, and L-cyhalothrin had the highest concentration (0.04±0.05 mg/kg) in the shoots of spinach. The concentrations of these residual pesticides were higher than the maximum residual limit (MRL) prescribed by the EU Commission.[13] The residual concentration of heptachlor epoxide in the spring onion collected from Tejuosho farm was significantly higher ($P<0.05$) compared to the spring onion collected from Idi-Araba and Alapere farms. Similarly, the concentration of endrin was significantly higher in the spring onion obtained from Idi-Araba farm ($P<0.05$) compared to the spring onion obtained from Tejousho and Alapere farms.

Although many organochlorine compounds have been used to effectively control pests and diseases in agriculture, they have continued to persist in water, soil, and food environments, thereby becoming contaminants[17] as observed in the present study. The concentrations of the residual pesticides in the vegetables sampled in our research were either higher than or within the threshold of the MRL prescribed by the regulatory authority of the EU Commission.

A similar study was conducted on commercial rice and vegetable farms in Markurdi, Nigeria.[18] In the mentioned study, farmland soil samples and vegetable crops including *Telfairia occidentalis* (fluted pumpkin), *Solanum lycopersicum* (tomatoes), *Amaranthus hybridus* (African spinach), *Solanum macrocarpon* (garden egg) were reported to contain residual pesticides (alpha-HCH, butachlor, aldrin, cypermethrin, dieldrin, pendimethalin, endosulfan, and propanil). However, the pesticide concentrations were within the range of 0.001-1.64 µg/kg in the vegetables, which was lower or within the maximum permissible limits.

The higher residual pesticide concentrations (0.06-0.08 mg/Kg) in the vegetables sampled in this study, compared to the work of Onuwa *et al.*[18], is possibly an indication that farmers in Lagos use excessive amount of pesticides. Lagos is a city with a high population density and a relatively smaller land mass. Consequently, the urge to maximize vegetable production using the small available arable lands could potentially dispose farmers to using higher volumes or amounts of pesticides. During the sampling stage of the present study, we observed that the vegetable farmers concentrated their activities along the patches of river banks and undeveloped wetlands. As such, it is expedient for the Lagos State Government of Nigeria to establish dedicated satellite farm centers or villages where the farmers that are scattered over the state would be brought together, trained on safe farming practices, and made to concentrate their farming activities within the dedicated places.

Residual organochlorine concentrations in the soils of the sampled farms

All the detected organochlorine pesticides (n=18) found in the vegetables were also detected in the soils sampled in the three selected farms. In Idi-Araba farm, L-cyhalothrin was the organochlorine pesticide with the highest mean soil concentration (0.213±0.251 mg/kg), while heptachlorepoxide had the lowest mean concentration (0.007±0.003 mg/L). In the soil sampled in Tejuosho farm, Endosulfan I had the highest concentration (0.110±0.001 mg/kg), while heptachlorepoxide had the lowest concentration (0.004±0.001 mg/L). In the soil of Alapere farm, 4, 4'-DDE (O.P.) had the highest concentration (0.082±0.116 mg/kg), while heptachlorepoxide had the lowest concentration (0.003±0.004 mg/L). The mean concentrations of β-BHC (0.019±0.004 mg/kg), δ-BHC (0.036±0.017 mg/kg), heptachlor epoxide (0.015±0.002 mg/kg), endrin (0.030±0.005 mg/kg), and Endosulfan II (0.048±0.016 mg/kg) in the soil sampled from Idi-Araba farm were significantly higher compared to the mean concentrations of the same pesticides in the soils sampled from Tejuosho and Alapere farms ($P<0.05$). In addition, the total pesticide concentration in the soil of Idi-Araba farmland (0.960±0.258 mg/kg) was significantly higher compared to the soil of Tejuosho and Alapere farms ($P<0.05$) (Table 2).

Table 2. Residual organochlorine concentrations in soils of sampled farms

Organochlorine pesticides (mg/kg)	Idi-Araba	Tejuosho	Alapere	F
α-BHC	0.023±0.013	0.009±0.001	0.010±0.014	0.957ns
β-BHC	0.019±0.004[a]	0.009±0.003	ND	20.107*
γ-BHC (Lindane)	0.011±0.004	0.006±0.000	0.006±0.000	2.138ns
Chlorothalonil	0.022±0.003	0.011±0.003	0.016±0.015	0.849ns
δ-BHC	0.036±0.017[a]	0.006±0.000	ND	7.394*
Heptachlor	0.015±0.002[a]	0.009±0.001	0.008±0.000	14.993*
Aldrin mg/kg	0.014±0.008	0.011±0.007	0.005±0.000	0.982ns
Heptachlorepoxide	0.007±0.003	0.004±0.001	0.003±0.004	1.169ns
4,4'-DDE(O.P.)	0.028±0.031	0.006±0.002	0.082±0.116	0.637ns
Endosulfan I	0.150±0.172	0.110±0.001	0.008±0.001	0.900ns
P,P-DDE	0.081±0.076	0.011±0.001	0.008±0.001	1.781ns
Dieldrin	0.038±0.026	0.016±0.013	0.003±0.005	2.198ns
Endrin	0.030±0.005[a]	ND	0.007±0.010	10.862*
Endosulfan II	0.048±0.016[a]	0.020±0.004	0.004±0.006	10.185*
PCB-153	0.044±0.055	0.005±0.000	ND	1.126ns
PF-38	0.082±0.097	ND	ND	1.417ns
P.P DDT	0.100±0.065	ND	ND	4.728ns
L-Cyhaothrin	0.213±0.251	ND	ND	1.438ns
TOTAL	0.960±0.258[a]	0.161±0.049	0.172±0.151	13.708*

(ND: not detected; *significant[$P<0.05$]; ns: not significant[$P>0.05$];
a: significantly higher than one/two values in same row [$P<0.05$])

The residual pesticides detected in the soils must have resulted from the non-target depositions that had accumulated through repeated applications. This assumption is premised on the fact that organochlorine pesticides are not natural components of the earth's crust, but are mainly synthetic organic insecticides, which accumulate in the soil environment due to their characteristic properties of high chemical stability and low water solubility.[3,9-11] In addition to contaminating the food chain, the presence of residual pesticides in soil poses a threat to both soil flora and fauna communities.

The health risk (HQ and hazard index) of the consumption of the sampled vegetables

In this current study, hazard quotient (HQ) and hazard index (HI) were used as the parameters to assess the health risks of consumption of the sampled salad vegetables. HQ values of less than 0.2 (HQ<0.2) indicate no risk, while values greater than 0.2 (HQ>0.2) indicate risk in consumption. HI values of less than 1 (HI<1) indicate no risk from consumption, while values greater than 1 (HI>1) indicate risk in consumption.[13]

In Idi-Araba farm, the HQ of all the organochlorine pesticides in lettuce was less than 0.2 (HQ<0.2), while the HQ values of α-BHC (0.432) and Endosulfan I (0.219) of spring onion were more than 0.2. Similarly, the HQ of α-BHC in spinach was more than 0.02 (2.149). In the same farm, the HI calculated for the consumption of spring onion and spinach were 1.151 and 3.332, respectively (HI>1). For lettuce, the HI was less than one (0.382).

In Tejuosho farm, the HQ values of all the pesticides in lettuce, spring onion, and spinach were less than 0.2. However, the HI for the consumption of lettuce was more than one (1.224), but was less than one for the consumption of spring onion (0.453) and spinach (0.462). In Alapere farm, the HQ values for all the organochlorine pesticides in lettuce, spring onion, and spinach were less than 0.2, except for Endosulfan I in lettuce (0.221). The HI calculated for lettuce, spring onion, and spinach in the same farm were less than one (Table 3).

Table 3. Health risk (HQ and HI) of consumption of sampled vegetables (HQ: hazard quotient; HI: hazard index)

Pesticides	Hazard quotient of pesticides in salad vegetables from the farms								
	Idi-Araba farm			Tejuosho farm			Alapere farm		
	Lettuce	Spring onion	Spinach	Lettuce	Spring onion	Spinach	Lettuce	Spring onion	Spinach
$HQ_{\alpha\text{-BHC}}$	0.041	0.432	2.149	0.021	0.011	0.010	0.010	0.010	0.016
$HQ_{\beta\text{-BHC}}$	0.013	0.014	0.089	0.118	0.014	0.010	0.006	0.009	0.017
$HQ_{\gamma\text{-BHC}}$	0.010	0.011	0.028	0.035	0.006	0.009	0.004	0.007	0.007
$HQ_{\text{Chlorothalonil}}$	0.015	0.084	0.122	0.034	0.011	0.032	0.012	0.019	0.022
$HQ_{\delta\text{-BHC}}$	0.009	0.015	0.090	0.065	0.008	0.013	0.005	0.011	0.060
$HQ_{\text{Heptachlor}}$	0.020	0.013	0.067	0.019	0.019	0.013	0.016	0.019	0.014
HQ_{Aldrin}	0.011	0.014	0.024	0.015	0.027	0.011	0.007	0.048	0.023
$HQ_{\text{Heptachlorepoxide}}$	0.007	0.011	0.011	0.016	0.007	0.004	0.005	0.052	0.020
$HQ_{\text{4,4'-DDE(O.P.)}}$	0.004	0.009	0.018	0.015	0.007	0.010	0.009	0.002	0.011
$HQ_{\text{Endosulfan I}}$	0.127	0.219	0.194	0.138	0.137	0.164	0.221	0.054	0.055
$HQ_{\text{P,P-DDE}}$	0.015	0.021	0.086	0.097	0.011	0.043	0.012	0.011	0.005
HQ_{Dieldrin}	0.013	0.031	0.042	0.034	0.011	0.018	0.010	0.059	0.022
HQ_{Endrin}	0.016	0.019	0.033	0.023	0.007	0.011	0.012	0.010	0.005
$HQ_{\text{Endosulfan II}}$	0.019	0.035	0.041	0.014	0.024	0.030	0.041	0.074	0.010
$HQ_{\text{PCB-153}}$	0.006	0.027	0.022	0.006	0.004	0.005	0.004	0.008	0.019
$HQ_{\text{PF-38}}$	0.016	0.164	0.110	0.104	0.118	0.021	0.032	0.047	0.018
$H_{\text{P.P DDT}}$	0.031	0.026	0.129	0.120	0.009	0.019	0.026	0.190	0.059
$HQ_{\text{L-Cyhaothrin}}$	0.011	0.007	0.077	0.352	0.024	0.040	0.011	0.027	0.026
HI	0.382	1.151	3.332	1.224	0.453	0.462	0.444	0.656	0.409

The potential human health hazard of the consumption of the sampled vegetables in this current research calls for concern. The HI of the consumption of one or more vegetables from two of the three sampled farms was more than one (HI>1), which implies that the consumers of the vegetables that are cultivated in these farms are potentially at the risk of pesticide toxicity and poisoning. This calls for the immediate intervention of the relevant authorities as the consequences of organochlorine pesticide toxicity are severe and cannot be overlooked. Organochlorine toxicity in humans leads to the stimulation of the central nervous system, thereby leading to hyperexcitability, agitation, confusion, and seizures. Furthermore, organochlorines are strongly lipophilic, which makes them prone to accumulating in the brain, liver, and the other body tissues with high lipid content, thereby leading to severe and fatal consequences.[3,19,20]

Conclusion

In this study, a total of 18 organochlorine pesticides were detected at varied concentrations in the sampled vegetables and soil. The calculated HI for the sampled vegetables indicated that the consumption of these salad vegetables could expose the consumers to higher health risks. Since the use of harmful pesticides is not limited to Nigeria, these findings may be a reflection of the situation in some other countries. It is recommended that governments and stakeholders raise awareness to discourage farmers from the use of organochlorine and other harmful pesticides.

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