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Human Health Risk Assessment of Organochlorine Pesticide Residues in Selected Portable Drinking Water Produce and Sold in Ilaro, Ogun State

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Abstract

The importance of safe drinking water cannot be over-emphasized. The lack of safe drinking water by the government led to a paradigm shift to dependent on potable water as a safe haven for good drinking water. This study aimed at assessing the health risk of organochlorine pesticide (OCP) in potable water produced and sold in Ilaro. Ten water samples from five major water factories were collected. The liquid-liquid extraction of the samples was carried out using dichloromethane (DCM). The OCP was analyzed quantitatively using electron-captured detector Gas chromatography and the human health risk was obtained using the Hazard index(HI) model. The result obtained revealed the presence of endosulfan ether, dieldrin and mitotane in TT water samples with mean concentration values of 6.34 µg/l, 0.218 µg/l and 12.12 µg/l respectively, which are all higher than the WHO maximum residue limit (MRL) of 0.1 µg/l for drinking water. Endosulfan ether and dieldrin showed a hazard index HI>1 which is an indication of Oncogenic health risk to both adults and children, except mitotane with HI<1. FC water samples revealed five residues with mean values higher than the recommended WHO limits for drinking water, except mitotane. Only endosulfan ether and dieldrin have HI>1 in both adults and children implying Oncogenic health risk, while endosulfan had HI>1 in only children and less than 1 in adults. Federal Polytechnic Ilaro (FPI) water samples had only two residues namely endosulfan ether and dieldrin with 1.31 µg/l and 0.073 µg/l respectively, higher than the recommended limit; both also have HI>1 for both adults and children. This shows Oncogenic health risks. Alpha-Lindane, dieldrin, endosulfan ether and mitotane were present in EL water samples with mean values 0.15 µg/l, 0.724, 0.78 and 0.01 µg/l higher than the WHO limit, except mitotane which is lower. All except mitotane had HI>1, posing an Oncogenic health risk to the consumers. In VP water samples, five residues endosulfan ether 28.43 µg/l, dieldrin 0.615 µg/l, mitotane 0.03 µg/l, Isodrin 0.576 µg/l and Endrin 0.011µg/l; higher than the WHO limit. The HI>1 for endosulfan, dieldrin and endrin in both adults and children, while mitotane is H<1. The result of this study implies that virtually all the water samples from the five major factories in Ilaro are contaminated with a high concentration of OCP higher than the WHO recommended boundary for drinking water and are of anthropological Oncogenic health risk to the consumers of the potable water both the children and adult, especially after long term ingestion as indicated using Hazard Index Model.

Key Words: Contamination, health risk, organochlorine, pesticides, potable water.

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Introduction

Organochlorine pesticide is a chlorinated organic compound regarded as a persistent organic pollutant (POP) by the World Health Organization (WHO), due to its ability to remain at the place of application for a long time, lack of degradation to non-toxic substances, bio-accumulative nature and also its potentials of causing chronic and acute toxicity resulting to ill health conditions or even death of the exposed living organism in the environment (Sosan, et al., 2008), Researches have shown that organochlorine resides are chemicals of public health risks and ecological concern, especially at very concentrations.

Organochlorine has been associated with various health conditions notably among these is breast cancer. He, Zuo, Wang and Zhao (2017) reported a possible link between breast cancer risk with the presence of organochlorine. The mechanism of its action is linked with its hormone-disrupting ability which is related to estrogen: a female hormone involved in the increase of breast cancer risk. Wolff, et al., (2000) also reported a possible risk factor or organochlorine for breast cancer having detected its presence in the blood serum of the patient; these include Lindane, Dieldrin, DDT (Dichlorodiphenyltrichloroethane) among others. The ability of this organochlorine to disrupt the structure of DNA in unborn children is also evidence of the public health risk of the compound to the populace (Ennaceur, Gandoura & Driss, 2017). Organochlorine effect on the Cortical Neurons (CN) by initiating proliferation in the human breast cancer–driven cells has also been demonstrated (Briz, et al., 2011); hence, its effect on nerve and brain cell damage especially in children leading to retard learning (Ennaceur, Gandoura & Driss, 2017). A worldwide estimate of 220,000 cases of pesticide poisoning was reported by WHO (Adeniyi & Okocha, 2012). The wide range of the effect of this compound on the ecosystem and public health risks led to the banning of the compound in developed countries; but still found its flow into developing countries like Nigeria due to poor or lack of internal regulation and control by the government (Okoya, Ogunfowokan, Osubiodo & Torto, 2017).

However, Organochlorine has its benefits in agriculture which are primarily to improve crop yields as herbicides or insecticides (Fosu-Mensah, et al., 2016). The frequent usage and indiscriminate disposal of the containment of the compound have been one of the most common factors that have been of great concern. The anthropogenic activities of the populace especially the farmers who make regular use of these chemicals contaminate the environmental compartment such as the air, water and soil (Fosu-Mensah, et al., 2016). Both surface and underground water bodies are contaminated by this organochlorine-containing pesticide even after several of its application. This contamination goes through a chain reaction or a food web to become a public health challenge or risk to the populace (Danko et al., 2008).

The global challenge of lack or inadequate safe drinking water supply to the exponentially growing population especially in the urban areas and the corresponding anthropogenic activities of this growing populace have increased incidences of environmental compartment contamination, particularly the water bodies. This has led to total dependence on portable water (generally known as pure water, sachet water or bottled water) as a key source of safe drinking water for the populace. Of course, the importance of safe drinking water or clean water cannot be overemphasized owing to the global statistics of water-related disease cases; in the US, CDC (Centre for Disease Control) reported that each year 1 in every 44 persons get sick from water-borne illnesses. It was also stated with the 2014 statistics of 7.15 million illnesses, 118,000 hospitalizations and 6,630 deaths (CDCP, 2020) globally. It has also been reported that 2.1 billion people lack access to benign drinking water, 3.4 million persons die each year from scarce and dirtied water sources and nearly 6000 progenies die of water-related disease cases each day (WHOlives, 2022).

However, the major challenge of depending on portable water as safe drinking water is its source and treatment before production into portable water and the inadequate monitoring and regulation of the use of potential pollutants like pesticides in the country and their usage in the environment and also the processing or treatment standards which must be followed. These factors informed this investigation of the presence and the possible health risk of organochlorine pesticides in the portable drinking water produced and sold in Ilaro, Ogun State, Nigeria.

Materials and Methods

The study area

The study area, Ilaro which is the study area is an ancient town and also the headquarters of Yewa South Local Government Area in Ogun state, Southwest Nigeria. Being a semi-urban town, its food supply is known to be dependent on the hinterland surrounding it. It also lies between latitudes 6.894°′N and 30126°E longitudes and boasts a population of 301,952. The most popular occupational activities include trading and farming. Ilaro is a host community to tertiary institution campuses such as The Federal Polytechnic, Ilaro and the National Open University of Nigeria, among others and their students.

Materials

Reagents and Chemicals

It was ensured that the reagents and chemicals made use of in the course of this research were of high analytical grade and purity standard. These include the silica gel (60–200 mesh size), anhydrous Na_2SO_4 having a percentage purity of 99.5%, typical OCPs, dichloromethane (DCM), n-hexane and acetone. The distillation of dichloromethane and n-hexane was executed three times before being used.

Methodology

Sample assemblage, stowage and pre-therapy

The APHA 2005 water and wastewater examination sampling method was utilized as a guide for the sampling employed in this study. was implemented in accordance with APHA (2005) standard approaches for scrutiny of water and wastewater. Potable drinking water samples were collected from five (5) different pure water factories in Ilaro such as (vessel of praise, Tailor-Tailor, Fepil, Fadcol, Eleyele) in triplicate and stored in clean amber tinted Winchester flagons (2.5 L capacity) after being laved with clarified water and the water matrice. The collected samples were warehoused at 4^{o}C pending further analytical procedures.

Extraction of OCPs and Cleaning

One litre (1 dm^3) of each potable drinking water sample was poured in a two litre (2 dm^3) sized partitioning conduit and then liquid-liquid abstraction method was employed for its extraction and this was also done in triumvirate using 10 mL of doubly purified dichloromethane (DCM) individually for each batch extracted. The extracted batches were rigorous shaken for about 30 minutes after discharging periodically the built-up pressure. The organic phase were collected and placed in 50 cm^3 amber-tinted vials after each extraction. The three sets of the abstraction were collected and the volume of the unsheathe was abridged to approximately 5 mL under a torrent of air. For the clean-up research, a column of about 1 cm (internal diameter) x 15 cm (length) was plugged padding it up with glass wool at the lowermost end and then supported using about 7 g activated silica gel which was carefully prepared in the laboratory using a slurry form in DCM. Then, 2 g of anhydrous sodium sulfate was used to absorb up any water or solvent by placing it at the top of the column. To prevent the possible cracking of the crammed silica gel surface-assimilative, the pre-elution was prepared with 15 cm^3 DCM while ensuring there was no exposure of the sodium sulfate layer to the air. The reduced extracts were allowed to sink through and below the sodium sulfate coating as they were run through the column. 10 x 3 cm^3 portions of DCM was also used to prepare the Elution. Then, under a stream of pure nitrogen, the collected eluents and its complementary solvent was then volatize to dryness.

Quantitative Guesstimate of the Organochlorine Pesticides

The Gas Chromatography method was employed for the analyses of the extracted OCPs from the portable drinking water samples. The analyzing system used is located at the Nigeria Institute of Oceanography and Marine Research (NIOMR) Test centre, VI, Lagos and it is made up of a Gas Chromatograph coupled to an Electron Capture Detector (GC-ECD). 1 mL n-hexane was used to reconstitute the dried and cleanup up eluent samples. The partitioning was accomplished on a fused silica duct column of specification DB-17, 30 m long x 0.25 mm internal diameter with lm thinness of 0.25 µm). Nitrogen-mixed Helium was used as the carrier gas. Through a micro plunger, the injection of purified eluents to the tune of 1 µL was executed in an undivided injection mode on the injection port at a low degree of 2 mL/minute within the 21.667 min run time. The recorded temperature of the plunger was 250 °C and that of the detector was 290 °C. Oven temperatures along the whole process started from 150 °C and amplified to 280 °C at 6 °C per minute.

Vetting

Vetting was carried out in accordance with technique 8000B (USEPA, 2007). After the calibration, gadget voids were executed and for each batch, research laboratory abstraction blanks were also examined. It was observed that the blank samples were free of any hydrocarbon-containing residue. For each GC run, four calibration standards were used and calibration curves of the correlation coefficients were obtained in duplicates.

Human Risk Assessment

Exposure Assessment

The area of environmental and occupational hygiene focused on the processes of measuring, computing, characterizing and modelling the frequency, duration and magnitude of an interface between a contaminating agent and the size of the exposed population are known as Exposure Assessment.

The estimated daily intake (EDI) is calculated as;

$$EDI = \frac{C \times W_F}{W_{AB}}$$

Where C = contaminant concentration in water (µg g−1), WF=daily average water ingestion assuming 7.5 L day^{-1} person^{-1}, and WAB=average body weight (70 kg for adults).

Hazards Assessment

The target hazard quotients (THQs),

$$THQ = \frac{(E_F \times E_D \times R_{IR} \times C)}{(F_{RD} \times W_{AB} \times T_A) \times 10^{-3}}$$

A health peril appraisal model acquired from USEPA (IRIS, 2005) was used for the approximation of the oncogenic and non-oncogenic risk individuals are exposed to through the use of potable drinking water. Oncogenic risk (CR) was calculated from the relations

Oncogenic risk

$$\boldsymbol{C = \frac{(E_F \times E_D \times W_{IR} \times SF \times C)}{(W_{AB} \times T_A) \times 10^{-3}}}$$

Where: RFD = oral reference dose (mg/kg/day (BW)), EF = frequency of exposure (350 days per annum); WIR = water ingestion rate (g per person per day), SF=oral cancer slope factor (mg kg^{-1} day^{-1}) $^{-1}$ TA=average exposure time (365 days year^{-1} × lifetime, presuming 70 years), and ED = duration of exposure (70 years). In this present study, concentrations used in risk computations are all based on a wet weight base. Hazard-based concentration data will be used in the study to examine the RFD and SF values (WHO, 2002)

The hazard index (HI) represents the precis of the computed non-oncogenic risks, and RT refers to the total oncogenic risks. HI and RT were computed using the expression below (Yu *et al*. 2014).

$$\boldsymbol{HI = \sum THQ_i}$$

$$\boldsymbol{RT = \sum R_I}$$

Results

Table 1: The concentrations (µg/L) of organochlorine residues in the analyzed portable water Sample from Tailor-Tailor water factory (TT).

Residues	**TTA(µg/l)**	**TTB(µg/l)**	**Mean**	**HI**		**EDI**		**CR**	
				AD	**CN**	**AD**	**CN**	**AD**	**CN**
Endosulfan ether	6.343	0.534	6.344 ± 2.9045	90.66	45.166	0.544	0.271	------	------
Dieldrin	0.218	0.325	0.218 ± 0.0535	374	186	0.019	0.009	0.299	0.149
Mitotane	12.125	12.125	12.125 ± 0	0.28	0.318	0.104	0.519	-------	
Delta-lindane	0.042	------	0.042 ± 0	9.944	2.777	0.004	0.001	0.0001	0.00005

• EDI = estimated daily intake, HI = hazard index, and CR = Oncogenic risk, NA= Not available

The concentrations of organochlorine residue investigated in Tailor-tailor potable water matrice assembled from Ilaro are conferred in Table 1. Four organochlorine compounds were detected. These are endosulfan ether, dieldrin, mitotane and delta-lindane. The table above also shows the appraised daily intake (EDI), hazard index and Oncogenic risk of both children (CN) and adult (AD).Endosulfan ether, dieldrin, mitotane and delta-lindanehave mean concentrations and standard deviation of 6.344±0µg/l, 0.218±0 µg/l, 12.125±0 µg/l and 0.042±0 µg/l respectively. The profile of organochlorine pesticides residues in this potable drinking water showed that the mean concentrations of mitotane (12.125±0 µg/l) were high and alpha-lindane has the lowest concentration of 0.042±0 µg/l.

Table 2: The Concentrations (µg/L) of organochlorine deposits in the analyzed portable water Sample (Fadcol water) from Fadcol water factory.

Residues	**FA(µg/l)**	**FB(µg/l)**	**Mean**	**HI**		**EDI**		**CR**	
				AD	**CN**	**AD**	**CN**	**AD**	**CN**
Endosulfan ether	8.139	0.78	4.459 ± 3.6798	63.833	31.833	0.383	0.191	**---**	**----**
Dieldrin	0.316	0.29	0.301 ± 0.013	516	24	0.0258	0.0012	0.413	0.019
Endosulfan	0.071	-----	0.075 ± 0	0.213	1.066	0.00064	0.0032	0.0010	0.005
Mitotane	-----	0.29	0.29 ± 0	0.0048	0.0248	0.0024	0.0124	---	**----**

Alpha lindane	-----	0.01	0.01 ± 0	0.1808	0.0085	0.00085	0.0004	0.0001	5E-4
DPCH	-----	0.12	0.12 ± 0	---	-----	0.010	0.005	-----	----

• **EDI = estimated daily intake, HQ = hazard quotient, and CR = Oncogenic risk, NA= Not available**

The concentrations of organochlorine residue investigated in Fadcol potable water samples collected from Ilaro are conferred in Table 2. 20 organochlorine residues were screened but only six organochlorine compounds were detected. These are endosulfan ether, dieldrin, mitotane, alpha-lindane, endosulfan and Delta-pentachchlorocyclohexane with their mean concentration and standard deviation of 4.45981±3.679µg/l,0.303±0.013µg/l, 0.29±0, 0.01±0µg/l, 0.075±0 and 0.12±0 respectively. The table above also shows the estimated daily intake (EDI), hazard index and Oncogenic risk of both children (CN) and adults (AD). The rundown of organochlorine pesticides in this potable drinking water showed that the mean concentration of endosulfan ether (4.45981±3.67981µg/l) was high and alpha-lindane has the lowest concentration of 0.01±0µg/l.

Table 3: The concentrations (µg/L) of organochlorine residues in the analyzed portable water FPI water factory

Residues	FPILA(µg/l)	FPILB(µg/l)	Mean	HI		EDI		CR	
				AD	CN	AD	CN	AD	CN
Endosulfan ether	1.666	0.966	1.316 ± 0.035	62	9.333	0.113	0.056	-----	
Dieldrin	0.0774	0.0694	0.073 ± 0.04	126	62	0.0063	0.0031	1.008	0.049

• **EDI = estimated daily intake, HI = hazard index, and CR = Oncogenic risk, NA= Not available**

The concentrations of the OCPs detected in potable drinking water samples can be used as pointers to disclose the possible effect such water can cause on the user. Different methods have been implemented in the literature to identify the probable health effects of the scrutinized OCPs in potable drinking water (Zhou et al., 2006). The concentrations of organochlorine residue investigated in FPIL potable water samples collected from Ilaro are presented in Table 3. Two organochlorine compounds were detected. These are endosulfan ether and dieldrin with their mean concentration and standard deviation of 1.316±0.35µg/l and 0.0734 ±0.004 µg/l respectively. The table above also shows the appraised daily intake

(EDI), hazard index and Oncogenic risk of both children (CN) and adults (AD).

Table 4: The concentrations (µg/L) of organochlorine residues in the analyzed portable water Eleyele water factory

Residues	EEA(µg/l)	EEB(µg/l)	Mean	HI		EDI		CR	
				AD	CN	AD	CN	AD	CN
Alpha lindane	0.053	0.260	0.156 ± 0.104	2.014	1.400	0.014	0.007	0.018	0.080
Dieldrin	1.087	0.3600	0.724 ± 0.364	1240	620	0.062	0.031	0.992	0.496
Endosulfan ether	0.783	-----	0.783 ± 0	11.166	5.5	0.067	0.033	------	----
Mitotane	-------	0.01	0.01 ± 0	0.002	0.0008	0.0009	0.0004	-----	-----

• EDI = estimated daily intake, HI= hazard index, and CR = Oncogenic risk, NA= Not available

As is shown in Table 4, four organochlorine pesticides were detected in Eleyele portable water samples. These are alpha-lindane, dieldrin, endosulfan ether and mitotane with their mean concentration and standard deviation of 0.156±0.104µg/l, 0.724±0.364 µg/l, 0.783±0µg/land 0.01±0µg/l respectively. The table above also shows the EDI, hazard index and Oncogenic risk of both children (CN) and adults (AD). The rundown of organochlorine pesticides in this potable drinking water showed that the mean concentration of endosulfan ether (0.783±0µg/l) has the highest concentration and alpha-lindane has the lowest concentration of 0.01±0µg/l in the water sample.

Table 5: The concentrations (µg/L) of organochlorine residues in the analyzed portable water Vessel of the praise water factory.

Residues	VPA(µg/l)	VPB(µg/l)	Mean	HI		EDI		CR	
				AD	CN	AD	CN	AD	CN
Endosulfan ether	6.078	50.782	28.43 ± 22.352	406.833	403.333	2.441	1.21	---	-----
Dieldrin	0.565	0.665	0.615 ± 0.05	1056	52	0.053	0.003	0.931	0.042
Mitotane	0.03	-----	0.03 ± 0	0.005	0.002	0.003	0.001	---	------

Isodrin	0.526	0.626	0.576 ± 0.05	---	-----	0.049	------	---	
Endrin	0.011	-----	0.011 ± 0	3.1333	1.333	0.0009	0.0004	---	------

• EDI = estimated daily intake, HI = hazard ind ex, and CR = Oncogenic risk, NA= Not available

The concentrations of organochlorine residue investigated in the Vessel of praise potable water matrices gotten from Ilaro are published in **Table 5**. Five organochlorine compounds were detected. These are endosulfan ether, dieldrin, mitotane Isodrin and Endrin with their mean concentration and standard deviation of 28.43±22.352µg/l, 0.615±0.05 µg/l, 0.03±0 µg/l, 0.576±0.05µg/l and 0.011±0 µg/l respectively. The table above also shows the estimated daily intake (EDI), hazard index and Oncogenic risk of both children (CN) and adults (AD). The result shows that endosulfan ether has the highest residue concentration of 28.43±22.352µg/l while mitotane has the lowest concentration of0.03±0 µg/l.

Discussion

Human Health Risk Assessment

Organochlorine pesticides (OCPs) have been used worldwide, predominantly in Africa for several decades.

Although many are banned, some African countries s till use OCPs exclusively for the forestalling and control of malaria (mosquito). Organochlorine pesticides are pigeonholed by their bioaccumulation in the environment, especially in the food chain, where they find their way into the human body. The organochlorine pesticide deposit was determined. In this investigation, the residual concentrations of different OCPs in five different potable drinking water-producing factories (Eleyele, Tailor-tailor, fadcol, Vessels of Praise and FEPIL) in Ilaro were estimated. The recorded results revealed that delta -lindane, endosulfan ether, dieldrin, mitotane, were present in Tailor-tailor portable drinking water; endosulfan ether, endosulfan, alpha-lindane, mitotane, alpha-lindane and DPCH (Delta-pentachloro cyclohexane) were present in fadcol potable drinking water; endosulfan ether and dieldrin were present in FEPIL portable drinking water; alpha-lindane, dieldrin, endosulfan ether and mitotane were present in Eleyele portable drinking water and endosulfan ether, dieldrin, mitotane, Isodrin and Endrin were present in Vessel of Praise potable drinking water. From the result fadcol potable drinking water sample has the highest number of organochlorine residues (6 residues) and FEPIL potable drinking water has the least organochlorine residues (2 residues) as shown in the tables above.

Concentrations (µg/L) of organochlorine residues in the analyzed portable water Sample from Tailor-Tailor water factory (TT) with their Hazardous index and Oncogenic ratio

The concentrations of organochlorine residue investigated in Tailor-tailor potable water samples collected from Ilaro are presented in Table 4.1. Four organochlorine compounds were detected. These are endosulfan ether, dieldrin, mitotane and delta-lindane with their mean concentration and standard deviation of 6.343±0µg/l, 0.217±0 µg/l, 12.125±0 µg/l and 0.041±0 µg/l respectively.

In another investigation carried out by El Bouraie et al. (2011) on under-groundwater, a lesser concentration of dieldrin and endosulfan which ranged from 0.001 to 0.074 µg/L was observed. Oyekunle et al. (2011) also reported the mean concentration of dieldrin in a study of OCPs levels in drinking underground water in Ile-Ife, an ancient town in Osun state to be 0.014 ± 0.005 µg/L. This is an indication that the present investigation showed a comparatively high concentration of dieldrin in the analyzed potable drinking water sold in Ilaro.

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The human health risk assessment of the OCPs in the Tailor-Tailor water samples upon consumption by children and adults is presented in Table 1. The health perils were assessed in terms of non-Oncogenic and Oncogenic health risks. The non-Oncogenic health risks were evaluated by hazard index (HIs) stemming from the consumption of potable drinking water. In adults, HIs greater than 1 are Endosulfan ether (90.66), Dieldrin (374), Delta-lindane (9.944) and mitotane has HIs of 0.2078 which is less than 1 in adult values, while in children Endosulfan ether (45.166), Dieldrin (186), Delta-lindane (2.777) have HIs greater than 1 and mitotane have HIs of 0.318 which is less than 1in children.

A hazard index (HI) beyond the unit value of 1 is a pointer that there are Oncogenic health risks linked with the ingestion of the potable drinking water sample of the study area (Ilaro). Relatively higher HIs observed in children are the same as in adults, which are consistent with the assertion that both children and adult are a vulnerable population to the analyzed organochlorine residues. Occupational pesticide exposure to mitotane has been delineated to upsurge the peril of Parkinson's disease. Also, endosulfan has been known to act as endocrine disrupting chemicals (EDCs) thereby affecting the endocrine system by interference with molecular circuitry (Oyekunle et al., 2011).

Concentrations (µg/L) of organochlorine residues in the scrutinized portable water Sample Fadcol water factory with their Hazardous index and Oncogenic ratio

The concentrations of organochlorine residue investigated in Falcol potable water samples congregated from Ilaro are presented in Table 2. Twenty (20) organochlorine residues were screened but only six organochlorine compounds were detected. These are endosulfan ether, dieldrin, mitotane, alpha-lindane, endosulfan and Delta-pentachlorocyclohexane with their mean concentration and standard deviation of 4.459 ± 3 µg/l, 0.303 ± 0.013 µg/l, 0.29 ± 0, 0.01 ± 0, 0.075 ± 0 and 0.12 ± 0 respectively.

The human health risk assessment of the OCPs in the Fadcol water samples upon ingestion by children and adults is outlined in Table 4.2. The health risks were evaluated in terms of non-Oncogenic and Oncogenic health risks. The Oncogenic health risks were evaluated by hazard index (HIs) emanating from the consumption of potable water. In adults, Hls greater than 1 are Endosulfan ether (63.833), Dieldrin (516), and HIs less than 1 are Endosulfan (0.213), Mitotane (0.005) and Alpha lindane (0.181) in adult values. In children, HIs greater than 1 are Endosulfan ether (31.833), Dieldrin (24), and Endosulfan (1.066). HIs less than 1 are Mitotane (0.025) and Alpha lindane (0.009) in children.

A hazard index (HI) greater than 1 posed an Oncogenic health risks probability with the ingestion of the potable water in the study area. Higher HIs observed in children in this study point out the fact that mainly children are more the
vulnerable population to the Endosulfan ether which is (31.833), Dieldrin (24), and Endosulfan (1.066) organochlorine residues. Immunosuppression, congenital birth defect, chromosomal abnormalities and neurological challenges have been implicated in exposure to endosulfan exposure even at relatively low doses (Ms-Marziyen & Ghasem., 2011).

Organochlorine residues concentrations in portable water from FPI water factory with their Hazardous index and Oncogenic ratio

The concentrations value of the OCPs is a marker of the possible effect of the compound on the consumers of potable drinking water. Researchers have adopted different ways of ascertaining the probable health effects of OCPs in drinking water, this includes using different models (Zhou et al., 2006). Table 3 shows the concentrations of organochlorine residues in FEPIL potable water samples analyzed. Two organochlorine compounds were detected. These are endosulfan ether and dieldrin with their mean concentration and standard deviation of 1.316±0.35µg/l and 0.073 ±0.004 µg/l respectively. From Table 3 above, the health risks were assessed in terms of non-Oncogenic and Oncogenic health risks. A high hazard index (HIs) above 1 is evidence of health effects that may result in a long-term injection of the water. In an adult, HIs greater than 1 are Endosulfan ether (62) and Dieldrin (126) and HIs greater than 1 are Endosulfan ether (9.333), Dieldrin (62) in children. Relatively higher HIs observed in bo th children and adults in this study support the argument that both populations are more vulnerable to the health risk of organochlorine pesticides. Dieldrin and endosulfan are tagged agents of neuronal and endocrime system effects (Steenland et al., 2014), and interference with molecular circuitry (Sohail et al., 2004).

Concentrations values in (µg/L) of organochlorine residues in portable water from Eleyele water factory with their Hazardous index and Oncogenic ratio

As is shown in Table 4, four organochlorine pesticides were detected in Eleyele portable water samples. These are alpha-lindane, dieldrin, endosulfan ether and mitotane with their mean concentration and standard deviation of 0.163±0.104µg/l, 0.724±0.364 µg/l, 0.783±0µg/land 0.01±0µg/l respectively. Alpha-lindane, dieldrin, endosulfan ether have HIs > 1 with the corresponding value of 2.014, 1240 and 11.166 respectively, and mitotane (0.0017) HIs <1 for adults. In children, alpha- lindane, dieldrin, endosulfan ether have HIs >1 with the corresponding value of 1.40, 620 and 5.5 respectively and mitotane (0.0008) HIs <1. A hazard indexless than 1 is an indication that there are non-Oncogenic health risks and HIs greater than 1 indicate Oncogenic health risks associated with the consumption of the potable drinking water samples of the study area. Both children and adults are the vulnerable populations to the analyzed organochlorine residues (Alpha- lindane, dieldrin, endosulfan ether) which are Oncogenic. Mitotane has HIs<1 which is non-Oncogenic. Exposure to large alpha-lindane can harm the nervous system, producing a range of symptoms from headache and dizziness to seizure, convulsions and more rarely death.

Concentrations (µg/L) of organochlorine residues in portable water from Vessel of praise water factory with their Hazardous index and Oncogenic ratio

From **table 5** five organochlorine compounds were detected in the water samples. These are endosulfan ether, dieldrin, mitotane, Isodrin and Endrin with their mean concentration and standard deviation of 28.43±22.352µg/l, 0.615±0.05 µg/l, 0.03±0 µg/l, 0.576±0.05µg/l and 0.011±0 µg/l respectively. The hazard index obtained posed a high human Oncogenic and non-Oncogenic health risk in the consumption of potable water by adults and children, especially on a long-term bases. From the result endosulfan ether (406.833), dieldrin (1056) Endrin (3.133) have HIs>1 and mitotane (0.00514) HIs<1 in adults. In children, the result shows that endosulfan ether (403.333), dieldrin (52) Endrin (1.133) have HIs>1 and mitotane (0.002) HIs<1. Therefore, both adults and children are vulnerable to endosulfan ether, dieldrin, Isodrin and Endrin toxicity from the potable drinking water samples. Incoordination and gastrointestinal disturbances have been reported by Steenland et al. (2014) to be associated with occupational exposure to dieldrin.

Conclusion

The investigated potable water as obtained in this study showed that the concentration values of most of the samples are higher than the minimum residue limit (MRL) recommended by the WHO for drinking water. The high hazards index observed from this study indicated Oncogenic and non-Oncogenic health risks in the use of potable water by adults and children. To prevent the exposure of the inhabitants of Ilaro to the detrimental effect of these chemicals, regular monitoring and regulation of the production factories by the regulatory bodies should be maintained and adherence to the standard strictly followed.

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