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Organochlorine Pesticides Contamination of Some Rivers in Abia State- Nigeria

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ABSTRACT

The use of pesticides by most Nigerian farmers to control pests and increase crop yield has been severally reported by many agricultural scientists in Nigeria. Hence this study is aimed at evaluating the level of pesticide contamination of some selected river waters in Abia State, Nigeria. The contamination of organochlorine pesticides (OCPs) from nine selected rivers in Abia State Nigeria was investigated to estimate the current level of pollution in these rivers. The Iyi Achi river in Ndielu-Ugwueke, Iyi Oba river in Okanu Ohafia and Iyi Ivere Atani in Arochukwu were selected from the North Senatorial zone. While Iyi Ocha river in Umukabia-Umuahia, Iyi Okwuta river in Okwuta Ibeku- Umuahia and Iyi Ogba Lelu river in Old Umuahia were selected from the Central Senatorial zone. For the South Senatorial zone, Ojii river in Ihie Ngwa, Azumini blue river in Azumini Ndoki and the Asa river in Ohambele- Ndoki were selected for this study. The total pesticides concentration was in the range of 0.039 – 0.192 mg/L in the rivers water. The common OCPs detected in these river water were α-BHC, β – BHC, Dieldrin and endrin. Iyi-Ocha river had the highest concentration of total OCPs (0.192 mg/L), followed by Azumini river 0.126 mg/L, Ojii river 0.120 mg/L, Iyi Okwuta 0.113 mg/L, Iyi Ogba Lelu 0.104 mg/L. While Iyi Ivere Atani in Arochukwu and Iyi Oba river had 0.067 mg//L and 0.039 mg/L respectively. α - BHC, β – BHC, Dieldrin and endrin were the most common OCPs detected. Various concentration patterns between the selected river waters were observed. Iyi Ocha river, Iyi Okwuta river and Ogba Lelu river were contaminated with α-BHC, β – BHC, and endrin. Ojii river and Azumini river were contaminated with α-BHC and β – BHC only, while Iyi Achi, Iyi Oba, Iyi Ivere Atani in Arochukwu and Iyi Asa river is contaminated with α-BHC, β – BHC, Dieldrin and endrin. The OCPs levels in all the rivers sampled were generally below the WHO standard levels.

1. Introduction

Organochlorine pesticides (OCPs) contamination of the environment has been a matter of great concern. Organochlorine pesticides (OCPs) has been noted for their persistence, bioaccumulative and toxic characteristics in the environment [1,2]. These compounds have been used and continued to be used in large quantities. Although the use of pesticides have resulted in a wide range of benefits: to control weeds, insects and pests, including increase in food production and reduction of insect-borne diseases, their use also raises questions about their possible effects in the environment including water quality [3,4]. Organochlorine pesticides (OCPs) residues reach the aquatic environment through direct run-off, leaching, equipment washing and careless disposal of empty containers etc., [5,6]. Organochlorine pesticides (OCPs) include the group of DDT (dichloro-phenyl-trichloroethane), isomers of BHC (hexachlorobenzene), aldrin, dieldrin, endrin, chlordane, toxaphene, endrin heptachlor, heptachlor epoxide, methoxychlor and HCH (hexacyclochlorobenzene) [7,8].

Due to the low cost versatility in industry, agriculture and public health of chlorinated pesticides some third world countries including Nigeria still make use of them [9-11]. Recent studies in Taiwan have shown that there still exist a variety of OCPs residues in the rivers which DDT and HCHs were the dominant OCPs compounds [12]. Some developed countries including Germany, the prohibition of OCPs was effective 35 years ago, but DDTs were still detected in canal waters [13]. In some countries like USA, Germany, Russia, Egypt China and Nigeria the presence of OCPs in surface waters, sediments, biota and vegetations have been investigated in detail [14-18]. Although the use of OCPs has been prohibited in developed countries, their use in Nigeria still persists [19].

The rivers in Abia state are polluted from various sources. The rivers studied are surrounded by agricultural farmlands which are extensively cultivated and pesticides are also used by the farmers to control pests. Most of these rivers provide habitat for native fishes such as catfish and tilapia fish which are significantly reducing due to various pollutants. These rivers also serve as source for domestic activities and other uses for the inhabitants.

Exposure to organochlorine pesticides is normally through accidental exposure in an area where they were recently applied. The chemicals can also be ingested in fish, dairy products, and other fatty foods that are contaminated [20-22]. Organochlorine pesticides are very persistent and move long distances in surface runoff or groundwater and accumulate in the environment. Prior to the mid – 1970s, organochlorines resulted in widespread reproductive failure in birds because birds laid eggs with thin shells that cracked before hatching [23, 6, 2].

The effect of short time exposure to organochlorine pesticides may produce convulsions, headaches, dizziness, nausea, vomiting, tremors, confusion, muscle weakness, slurred speech, salivation and sweating. Exposure to organochlorine pesticides over long period may cause damage to the liver, central nervous system, thyroid and bladder. Many of the organochlorines have been implicated in the elevated rates of liver and kidney cancer in animals and humans [24]. Gilden *et al*. [25] reported the hazards concerning pesticide to include reproductive and endocrine disruption, neuro-developmental delays, immune system, cancer and respiratory distress.

It is evident that the inhabitants of these areas are exposed to these organochlorines in various ways since they are used by farmers to protect farmlands from pests and increase crop yield. We thought it quite necessary to determine the contamination level of organochlorine pesticides in these bodies of water and also try to elucidate the contamination status of organochlorines in these rivers.

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2. Experimental Methods

2.1 Sampling Area

Nine rivers were selected for sampling, three each from the three senatorial areas of the state.

Abia North:	Iyi Achi river in Ndielu Ugwueke
	Iyi Oba river in Okanu Ohafia
	Iyi Ivere river in Atani Arochukwu
Abia Central:	Iyi Ocha river, in Umuagu/Umukabia Umuahia
	Iyi Okwuta river, in Okwuta – Ibeku Umuahia
	Iyi Ogba Lelu river, in Old Umuahia
Abia South:	Ojii river, in Ihie Ngwa,
	Azumini blue river, in Azumini Ndoki,
	Asa river in Ohambele Ndoki, Ukwa East

2.2 Sampling Technique

Water samples from each of the selected rivers were collected in eight (8) sampling stations established along each river (upstream and downstream). Four (4) samples were collected from each station. Water samples were collected using 2 L glass bottles. The vials were pre-cleaned with soap, rinsed with ultra-pure water, then with acetone and placed in the oven at 150 °C for 1 and a half hour. Water samples were pre-filtered through 0.45µm fiber glass filters to remove debris and suspended materials. Samples were preserved by adding 5 mL of H_2SO_4 to avoid biological activity and biodegradation [26].

2.3 Sample Extraction

The filtered water samples (1 L) were processed using a Solid Phase Extraction (SPE) technique. Methanol was added to the water sample and shorogate standard (4^1,4^1 - dibromophenyl) (5 µg/L) was added to allow for better extraction [27]. Prior to the extractions, the Agilent SPE cartridges (ENVI- 18) were first conditioned with 5 mL of methanol followed by 5 mL of acetone and 5 mL of Milli Q waters. The water samples (1 L) were passed through the cartridges at a flow rate less than 10 mL/mm. The cartridges were not allowed to become dry as recommended by the Agilent SPE manual. The samples were well mixed and allowed to flow through the cartridge with a flow rate of 60 mL/mm. Following extraction, the cartridges were eluted with 5mL of acetone and 5 mL of Milli Q water and the dried extracts were collected and reduced to a volume of 2 mL under gentle blow of nitrogen.

2.4 Sample Analysis

The organochlorine pesticides were analysed by the Hewlett Packard Gas chromatography 6890 Plus; with a micro-cell electron capture detector (µECD) an autosampler and chem. Station software. A 30 x 0.32 mm id x 0.25 µm film thickness fused silica capillary column HP 1 was used for the chromatographic separation of pesticides. The oven temperature program was programmed from 80 °C to 190 °C at 25 °C/min, 190-280 °C at 25 °C/min, then 280-300 °C at 25 °C/min and held at 300 °C for 2 min. The OCPs compounds were confirmed using GC-MS [28].

3. Results and Discussion

The results from the GC-MS analysis shows the rivers are contaminated with organochlrorine pesticide residues which ranged from 0.192 mg/L as the highest to 0.039 mg/L as the least as reported in Table 1 below.

Table 1 Total organochlorine pesticide concentration (mg/L)

Senatorial Zone	River	Total pesticide conc. (mg/L)
Abia North	Iyi Achi	0.072
	Iyi Oba	0.039
	Iyi Ivere	0.067
Abia Central	Iyi Ocha	0.192
	Iyi Okwuta	0.113
	Iyi Ogba Lelu	0.104
Abia South	Iyi Ojii	0.120
	Azumiri river	0.126
	Asa river	0.064

The organochlorine pesticides concentrations of the various rivers sampled is reported in Table 1. The result shows that all the rivers sampled is contaminated with organochlorine pesticides of varying concentrations. Organochlorine pesticide concentration in these rivers ranged 0.039 mg/L in Iyi Oba river in Ohafia as the least to 0.192 mg/L in Iyi Ocha river in Umukabia Umuahia as the highest. The common organochlorine pesticides detected in these rivers include α- BHC, β-BHC, Dieldrin and endrin. Various contamination patterns between the selected river water showed that each selected river has its peculiar organochlorine pesticides content. Iyi Ocha, Iyi Okwuta and Iyi Ogba Lelu rivers were contaminated with α-BHC, β-BHC, and endrin. Iyi Ojii and Azumini river were contaminated with α- BHC and β- BHC only. Iyi Achi, Iyi Oba, Iyi Ivere and Iyi Asa were contaminated with α- BHC, β-BHC, Dieldrin and endrin. The organochlorine pesticide levels in these sampled rivers are generally below the WHO standards. [29]. The organochlorine pesticides have been reported to be persistent, bioacumulating and toxic in the environment [2]. Organochlorine pesticides have been reported to be toxic [2, 6, 30, 31].

Several studies have revealed that food, particularly fish products, is the major source for human exposure to organochlorine pesticides (OCPs) [21]. These rivers are surrounded by farm lands where herbicides and pesticides are used to protect plants from pests. Ultimately contamination due to organochlorine pesticide leaching and run –off from these farms pollute the rivers and the aquatic animals are affected. The rivers serve as source for domestic water and fishing actives for the inhabitants of these areas. The ingestion of aquatic animals like fish and long term usage of these waters for domestic purposes may lead to bioaccumulation in tissues of these persons [32]. Varying levels of organochlorine pesticides have been detected in many populations Marin-Morales *et al*. [30-34] had reported on the toxicity of herbicides and its impact on aquatic and soil biota and human health. Dirtu *et al*.; [35] also reported of levels of organochlorine pesticides in general adult population of Iassy, Romania. Organochlorine pesticide residue levels in blood serum of inhabitants from Veracruz, Mexico have also been reported [36]. Brunetto et al. [37] reported the levels of DDT residues in human milk of Venezuelan women from various rural populations. Organochlorine pesticides are carcinogenic [38] and have been reported to have developmental effects on the endocrine system [24].

Though the levels of organochlorine pesticides in these rivers are below the WHO standards [29], there is need to educate the inhabitants of these areas and advice for an alternative source of portable water and the consumption of fish and aquatic animals from these rivers since there could occur bioaccumulation of these organochlorine pesticides and their metabolites in the population and its consequences [39]. The organochlorine pesticides are persistent and therefore remain in the body. The major concern therefore is the toxic effects of these pesticides such as interfering with the reproductive systems and foetal development as well as their capacity to cause cancer and asthma [25].

4. Conclusion

This study has shown that the rivers sampled are contaminated with organochlorine pesticides of varying concentrations and varying patterns of the pesticides. It is possible that most of the rivers in the state that have farmlands in their surroundings may also be contaminated. Alternative portable water sources should be provided by the government for these inhabitants who rely on surface water from these rivers for most of their domestic chores.

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