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ANALYSIS OF POLYCHLORINATED BIPHENYLS CONTENT OF SURFACE WATER, PLANT AND SOIL IN AGBANI COMMUNITY IN NKANU WEST LOCAL GOVERNMENT AREA, ENUGU STATE

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Abstract: Contamination of surface water, Plants and soil with polychlorinated biphenyls (PCBs)) is an issue of current global concern. Polychlorinated biphenyls (PCBs) is originated from commercial, incineration and industrial sources. Hence, there is a need for monitoring their occurrence and distribution in the environment. This study assessed the occurrence, distribution and composition profiles of PCBs in Agbani Village in Enugu State. Samples such as surface water, soil and plants were collected randomly in Section (A, B and C) which represents the four cardinal points of the community. The levels of polychlorinated biphenyls were analyzed using an Agilent 7890A Gas chromatograph coupled to an Agilent 5975C mass selective detector. The following poly chlorinated biphenyls compounds (Lindane, Endosulfan, Emamectin, Dichlovos, Isopropyl amine, Aldrin, Nonachlor, Chlordane and Heptachlor) were detected. The level of poly chlorinated biphenyl found in Section (A, B and C) for surface water is as follows: (4.02356 mg/ml), (2.65755 mg/ml) and (2.82669 mg/ml), Soil: (7.9749 mg/g), (6.8343 mg/g) and (3.6558), Plant: (0.005 mg/g), (0.01256mg/g) and (0.00465 mg/g) respectively. The level of polychlorinated biphenyls found in Section A was relatively higher than other values obtained in Section C and B. Moreover, human, Agricultural and industrial activities has led to increase of polychlorinated biphenyls within the study area. Therefore, Government should deem it necessary to regulate or monitor industrial activities within the study area. Finally, Surface water located within these areas should not be used for any form of domestic activities hence, should be treated before consumption.

Key words: Polychlorinated biphenyl, soil, water and Plant

Introduction

Polychlorinated biphenyls (PCBs) can be defined as group of toxic, long-lasting substances that have a high tendency to accumulate in the environment as organic pollutants which can cause latent risk to the environment (Adeogun et al., 2016).Polychlorinated biphenyls (PCBs) are synthetic chemicals which can be used as coolants and lubricants in transformers, generators, and electrical capacitors because of their electrical insulating properties, low burning capacity and chemical inertness (Necibi and Mzoughi, 2017). They were also used in the production of plasticizers in rubber and polyvinyl chloride plastics (Erickson and Kaley, 2011). Some Countries like United State of America and Europe were the major producer of Polychlorinated biphenyls (Gioia et al., 2013).on before now, So many efforts have been made in order to reduce the emissions of PCBs from their sources, however, high concentrations of these chemicals have been found in non-producing regions such as Africa (Alkhatib et al., 2002). According to Adeyemi et al., (2009) high levels of Polychlorinated biphenyls can be attributed to the atmospheric deposition of PCBs. However, Importation of fairly used and old electrical equipment from developed countries has also contributed to the increasing levels of the chemicals in the regions (Amiard et al., 2015). The high demand for electronic equipment and disposal of these products as e-wastes are regarded as important sources of PCBs in aquatic environments in Nigeria (Obaje, 2013). Aquatic ecosystems are usually the final destination of wastes products contaminated with polychlorinated biphenyls (Barakat et al., 2013). Polychlorinated biphenyls has been characterized with some common features such as persistency in nature or the ability to bio accumulate for a period of time (Okoh, 2015). For instance the levels of PCBs along with the food chain ultimately increases as the levels of exposure increases (Mackay and Fraser, 2000). Dietary exposure of PCBs to humans has been noted as an important route of exposure (Moon and Ok, 2006). Enormous amounts of chemical pollutants are currently being discovered in air, soil, and water of our planet; all, resulting chiefly from anthropogenic means (Khan, 1983). This mammoth level of environmental contamination occasioned by these chemical agents call for an evaluation of their consequences to the web of life. The contaminants that potentially result in adverse biological effects – whether at individual, population, community or ecosystem level – poly chlorinated biphenyl, are of major concern especially in agricultural practices (Pimentel, 2005). Indeed, poly chlorinated biphenyl constitute one of the main drivers of population decline in some wildlife species (Carvalho and Fernando, 2006). Therefore, proper evaluations of the risk that poly chlorinated biphenyl compounds pose to organisms and ecosystems should be conducted in a scientific manner.

Therefore, the monitoring of PCBs levels in surface water, soil and plant is very importance because of the several effects of PCBs that have been observed over the years. The biological effects include carcinogenicity, immune suppression, neurobehavioural effects, hypothyroidism, infertility and reproductive system disorders, cardiovascular disease and elevated serum lipids, hypertension, diabetes, liver disease, asthma, arthritis, and low birth weight (Breivik et al., 2007). Therefore, human, Agricultural and industrial activities are the major sources of Polychlorinated biphenyl. It is high time we began to monitor any activities that will encourage the rapid increase of polychlorinated biphenyl in our environment.

Materials and Methods

Sample collection: Surface water were collected randomly within the four cardinal points of the community respectively. Water samples were collected using a 2.5 L amber glass bottle. Before analysis, samples were filtered through 0.45µm fiberglass filters to remove sand and debris.

Analytical Procedure for Polychlorinated Biphenyls

Extraction and quantification: The extraction of the water samples was done according to the method of USEPA (2006a.) Briefly, 40 ml of dichloromethane (DCM) was used to extract 200 ml of the water sample twice. The extract was filtered through a funnel containing glass wool and 1 g of anhydrous Na_2SO_4

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into an Erlenmeyer flask and then washed with 10 ml of DCM. The combined sample extracts were concentrated to about 5 ml using a rotary evaporator. The concentrated extract was dissolved in 40 ml of n-hexane and further concentrated to 1 ml.

The extract was solvent exchanged to n-hexane. The extract was transferred into a Florisil column twice pre-washed with 20 ml of n-hexane. Elution was done with 50 ml of DCM/hexane (vol/vol ratio). The eluate was concentrated on a rotary evaporator until the volume reached 3 ml and then further reduced to 1 ml under a stream of nitrogen and solvent exchanged to n-hexane.

Extraction of soil and Plants

Extraction of soil and plants samples were done in accordance with the methods described by Adeogun et al., (2016). Analyses were performed using a gas chromatograph (Agilent 7890A, Agilent Technologies, Palo Alto, CA, USA) with electron capture detection (ECD), and the results were confirmed by GC/MS (mass spectrometry) analysis.

The GC-ECD column was an HP-5 fused silica column of 30 m length, 0.32 mm inner diameter and 0.25 µm film thickness. Nitrogen was used as the carrier gas. The injector temperature was set at 280 and 320°C for the detector, the oven temperature was set at 70°C for a minute and increased to 170 ^{o}C at 40 ^{o}C/min, increasing at 3 ^{o}C/min to 195 ^{o}C (holding this temperature for 3 min), increasing 0.5 ^{o}C/min to 210 oC (holding for 5 min) and increasing 20 ^{o}C/min to 300 ^{o}C with a final hold time of 10 min (Combi et al., 2013). A procedural blank was included with each set of samples. The recoveries for the compounds ranged from 80 to110 %.

Results and Discussion

The concentration of polychlorinated biphenyls (PCBs) present in surface water, soil and plants are presented in table 4.1, 4.1.2 and 4.1.3 respectively.

Table 4.1: Results of Polychlorinated biphenyl (PCBs) concentrations detected in surface water(mg/ml)

Poly chlorinated biphenyls compounds detecte	Study Area			Mean	Minimum	Maximum	EU Maximum Residual Limits (mg/kg)
	Section A	Section B	Section C				
Lindane	0.004	0.0568	0.16568	0.07549		0.16568	0.01
Dichlovos	0.94	0.0087	0.4326	0.46043	0.16568	0.94	0.01
Endosulfan	1.1718	0.0771	0.6420	0.6303	0.94	1.1718	0.05
Emamectin	1.0932	0.98	0.3422	0.8051	1.1718	1.0932	0.01
Nonachlor	0.0075	0.0014	0.2367	0.081867	1.0932	0.2367	0.01
Isopropylamin	0.00056	0.0084	0.0013	0.00342	0.2367	0.0084	0.5
Aldrin	0.0065	0.0028	0.0012	0.0035	0.0084	0.0065	0.01
g-chlordane	0.500	0.868	0.0045	0.4575	0.0065	0.500	0.01

Heptachlor	0.300	0.645	1.00051	0.6485	0.500	1.00051	0.01
total PCBs detected	4.02356	2.65755	2.82669	3.094746	1.00051	5.12279	0.01

Table 4.1.2: Results of Polychlorinated biphenyl (PCBs) concentrations detected in soil (mg/g)

Poly chlorinated biphenyls compounds detected	Study Area			Mean	Minimum	Maximum	
	Section A	Section B	Section C				EU/ Maximum Residual Limits (mg/kg)
Lindane	0.1245	0.652	0.321	0.3658	0.652	0.652	0.01
Dichlovos	1.345	0.9853	0.653	0.9944	1.345	1.345	0.01
Endosulfan	1.4536	0.675	0.873	1.0005	1.4536	1.4536	0.05
Emamectin	1.5678	1.043	0.567	1.059	1.5678	1.5678	0.01
Nonachlor	0.853	0.236	0.452	0.5137	0.853	0.853	0.01
Isopropylamine	0.8532	0.643	0.765	0.7537	0.8532	0.8532	0.5
Aldrin	0.4123	0.752	0.0094	0.3912	0.752	0.752	0.01
g-chlordane	0.642	1.054	0.0098	0.5686	1.054	1.054	0.01
Heptachlor	0.7235	0.794	0.0056	0.5077	0.794	0.794	0.01
total PCBs detected	7.9749	6.8343	3.6558	6.1546	9.3246	9.3246	0.01

Table 4.1.3: Results of Polychlorinated biphenyl (PCBs) concentrations detected in plant(mg/g)

Poly chlorinated biphenyls compounds detected	Study Area			Mean	Minimum	Maximum	
	Section A	Section B	Section C				EU/Maximum Residual Limits (mg/kg)
Lindane	0.00012	0.0124	0.0027	0.00051	0.0124	0.0124	0.01

Dichlovos	0.00034	0.0000	0.0018	0.00071	0.0018	0.0018	0.01
Endosulfan	0.00067	0.0000	0.0000	0.000223	0.00067	0.00067	0.05
Emamectin	0.00087	0.000	0.000	0.00029	0.00087	0.00087	0.01
Nonachlor	0.0013	0.000	0.000	0.00043	0.0013	0.0013	0.01
Isopropylamine	0.00019	ND	0.000	0.000063	0.00019	0.00019	0.5
Aldrin	0.0014	ND	0.000	0.00005	0.0014	0.0014	0.01
g-chlordane	0.00043	0.000	0.0000	0.00014	0.00043	0.00043	0.01
Heptachlor	0.00018	0.00016	0.00015	0.00016	0.00018	0.00018	0.01
total PCBs detected	0.0055	0.01256	0.00465	0.009533	0.01924	0.01924	0.01

Discussion

The results of levels of total polychlorinated biphenyls (PCBs) found in surface Water obtained in Section A, B and C is presented in Table 4.1.

The percentage level of Lindane,Dichlovos,Endosulfan, Emamectin, Nonachlor, Isopropylamine, Adrin, Chlordane and Heptahlor found of surface water obtained in Section A is as follows(0.00034mg/ml), (0.00067 mg/ml), (0.00087 mg/ml), (0.0013 mg/ml), (0.000019 mg/ml),(0.0014 mg/ml), (0.00043 mg/ml) and (0.00018 mg/ml) respectively. Following the outcome of this result, the concentration of Dichlovos, Endosulfan, Emamectin, Nonachlor and Aldrin were found relatively higher than all the values obtained Section B and Section C. Moreover, the level of isopropylamine and chlordane were found relatively high in Section B, whereas the concentration of Lindane and Heptachlor were also found relatively high in Section C.

Prior to the key findings, the levels of polychlorinated biphenyls found in soil samples obtained in Section A, B and C is presented in table 4.1.2.

The concentration of Dichlovos (1.345 mg/g), Endosulfan (1.4536 mg/g), Emamectin (1.5678 mg/g),Nonachlor (0.853 mg/g), Isopropylamine (0.8532 mg/g), Chordane (0.642 mg/g) and Heptachlor(0.7235 mg/g) were found relatively high in Section A. Moreover, the concentration of Lindane (0.652 mg/g) and Aldrin (0.765 mg/g) were found relatively high in Section B. However, is only Section C that the level of Chlordane (0.0098 mg/g) were found relatively high

The results of total polychlorinated biphenyls present in all the plant samples collected in Section A, B and C is presented in table 4.1.3.

The concentration of Endosulfan (0.00067 mg/ml), Emamectin (0.00087 mg/ml), Nonachlor (0.0013 mg/ml), Isopropylamine (0.00019 mg/ml), Aldrin (0.0014 mg/ml), Chordane (0.0043 mg/ml) and Heptachlor (0.0055 mg/ml) were found relatively high in Section A. Isopropylamine and Aldrin were not detected in Section B, but were found present in all the plant samples collected in Section A and Section C.

This also implies that total level of Polychlorinated biphenyl found in all the plant samples collected within the study area were found relatively low and below maximum residual limits.

The results obtained in the present study was similar with the values obtained by Kampire et al., (2017) (1.60 to 3.06 ng g-1; South Africa), Verhaert et al., (2013) (<50–1400 pg g-1 dw; Congo), Barakat et al., (2013) (1480–137,200 pg g^{-1}; Egypt), de Souza et al., (2008) (18–184 pg g-1 dw; Brazil), Tombesi et al., (2017) (0.61 to 17.6 ng g− 1; Argentina) Odabasi et al., (2017) (2.7–2450 μg kg−1dw; Turkey), Li et al., (2007) (0.03 – 13.99 ng/g; China), and Kim et al., (2018) (18.1– 136.8 μg/kg; USA). These differences could lie on the specific industrial activities and sources of PCBs that release the chemicals into the various water bodies. Although the concentrations of PCBs in plant in the present study were relatively low, Obanya et al., (2018)..

Organic contaminants are spread in the environment through water and air, however, they are expected to move from the soil to the soil because organic contaminants are hydrophobic (Beyer and Biziuk, 2009). Similar studies in Nigeria (Ethiope, Benin and Warri Rivers (Ezemonye, 2005a; 2005b); Choba River (Archibong et al., 2017). The values obtained in Section A were lower than the USEPA PCBs limits. During rainy season, the heavy rains tend to flush in more effluents from different sources into water bodies thus, the increase in the levels of various contaminants in water (Gao et al., 2013). Several studies have shown that PCBs in aquatic environments are toxic to inhabiting organisms at significant levels. The swimming velocity of Japanese medaka (Oryzias Latipes) exposed to 1-25 μg/g of PCBs decreased in a dose-dependent manner (Nakayama et al.., 2005).

Lerner et al., (2007) reported that juvenile Atlantic salmon (Salmo salar) exposed to 1 and 10 μg/L of PCBs during smolting exhibited a dose-dependent reduction in preference for seawater. They also found that 10 μg/L of PCBs exposed juvenile S. salar exhibited a 50% decrease in gill Na+,K+-ATPase activity and a 10% decrease in plasma chloride levels in freshwater. Plasma triiodothyronine was significantly reduced in S. salar exposed to PCBs at 1 and 10 μg/L (Lerner et al., 2007). Gonzalez et al., (2016) observed that larval zebrafish (Danio rerio) treated with 2-10 ppm exhibited enhanced thigmotaxis.

Conclusion:

Polychlorinated biphenyls (PCBs) are persistent organochlorine chemicals that are toxic to aquatic
Organisms and humans. Which can be used as a coolants and lubricants in transformers, generators, and electrical capacitors because of their electrical insulating properties, low burning capacity and chemical inertness.

Therefore, the present study assess the levels of poly chlorinated biphenyl compounds contaminated with soil, plants and surface water within Agbani Community in Nkanu West Local Government Area in Enugu State.

Data from this study suggested that the level of poly chlorinated biphenyls found in the soil, water and plants collected in Section A, B and C is within permissible limits. Although the levels of PCBs that were found in the soil was higher than all values obtained in the surface water and plants. Finally, surface water within the study area should be treated before consumption. Moreover, food crops planted within these areas, should be well processed to avoid bio accumulation of polychlorinated biphenyls in the system.

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