

Levels of endocrine disrupting compounds in wastewater from Ubakala Abattoir, Abia State, Nigeria

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ABSTRACT

The study examined the presence of endocrine disrupting compounds in abattoir wastewater in Ubakala, located in Abia State, Nigeria. The samples of abattoir wastewater were collected from different points at the Ubakala abattoir in contaminant-free containers and preserved according to standard procedures before transporting samples to the laboratory for analysis. The endocrine disrupting compounds analysed for were Polychlorinated Biphenyls (PCB), Dichloro Diphenyl Trichloroethane (DDT), Dioxins, Nonylphenol (NP) and Organotins using Gas chromatography (GC) coupled to an electron capture detector (ECD) analysis techniques. The data collected were analyzed using descriptive and inferential statistics. Analysis of Variance was used to separate the means. The coefficient of correlation between samples was determined using Pearson Correlation techniques. The study revealed that endocrine disrupting compounds present in the samples ranged from Polychlorinated Biphenyls (PCB) (24.33 ng/L to 5.70 ng/L), Dichloro Diphenyl Trichloro ethane (DDT) (17.95 ng/L to 2.71 ng/L), Dioxins (4.21 ng/L to 0.73 ng/L), Nonylphenol (NP) (0.07 ng/L to 0.01 ng/L) and Organotins (3.86 ng/L to 1.23 ng/L). The presence of these endocrine disrupting compounds in abattoir wastewater is of great concern for both food safety and human health because of their harmful nature at relatively minute concentrations. The study recommends the need to create awareness in various abattoirs and butches in the State and to sensitize the public on health implication of these emerging contaminants in abattoir wastewater. Thus, abattoirs should operate on a closed water circuit with appropriate methods of waste disposal to reduce any risk to humans and animals via the food chain.

Keywords: Wastewater, abattoirs, endocrine disruptors, public health, environmental exposure

INTRODUCTION

An abattoir is a facility where animals are slaughtered, most often (though not always) to provide food for humans (Canencia *et al.*, 2016). Abattoir supply meat, which then becomes the responsibility of a packaging facility. It has also been reported that animals which graze on contaminated plants and drink from polluted waters, as well as marine lives that breed in heavy metal polluted waters also accumulate such metals in their tissues and milk if lactating (Guillette *et al.*, 2000). When

such animals are killed, these metals are released in the soil as natural sink but subsequently leached out into nearby streams or water bodies (Coker, 2001; Omole and Longe, 2008). According to Kolpin *et al.* (2002), abattoir wastes usually are multi-dimensional, mainly organics containing fat, grease, hair, feathers, grit, flesh, manure, and undigested feed, blood, bones and process water (Nafarnda *et al.*, 2006). Endocrine disrupting compounds (EDCs) are chemicals that interfere with the normal function of the

endocrine system in wildlife and humans (China, 2019). Studies in the United Kingdom have shown that wild fish exhibit reproductive abnormalities linked with exposure to EDCs from treated sewage discharges. Several hundreds of chemicals may have endocrine disrupting properties (Birkett and Lester, 2003). More than 100 substances are categorized as potential endocrine disruptors such as: carbon disulfide, ophenylphenol, tetrabrominated diphenyl ether, 4-chloro-3-methylphenol, 2,4-dichlorophenol, resorcinol, 4-nitrotoluene, 2,2'-bis(4-(2,3-epoxypropoxy) phenyl) propane, 4-octylphenol, estrone (E1), 17 α -ethinylestradiol (EE2), and 17 β -estradiol (β E2) (Andersen *et al.*, 2004; Dudgeon *et al.*, 2006). EDCs are a global and ubiquitous problem. Exposure occurs at home, in the office, on the farm, in the air we breathe, the food we eat, and the water we drink (Birkett and Lester, 2003). Of the hundreds of thousands of manufactured chemicals, it is estimated that about 1000 may have endocrine-acting properties. Biomonitoring (measurement of chemicals in body fluids and tissues) show nearly 100% of humans have a chemical body burden. In addition to the known EDCs, there are countless suspected EDCs or chemicals that have never been tested (Lim *et al.*, 2000).

Recent research indicates that several sewage treatment plant effluents and rivers in the Nigeria comprise sufficient quantities of estrogenic compounds to induce harmful effects on aquatic species (Bergman *et al.*, 2012). A wide range of substances, both natural and man-made, are thought to cause endocrine disruption, including pharmaceuticals, dioxin and dioxin-like compounds, polychlorinated biphenyls, DDT and other pesticides, and plasticizers such as bisphenol A (Gore *et al.*, 2011). Endocrine disruptors may be found in many everyday products— including plastic bottles, metal food cans, detergents, flame retardants, food, toys, cosmetics, and pesticides. Endocrine disrupting compounds (EDCs) have gained significant interest in recent decades in the academic press because of the many, serious diseases related to them. Exposure to EDCs is interlinked with decreased fertility, changed sexual behaviour,

and amplification of abnormalities and cancers in humans and laboratory animals (Raghupathi and Soto, 2014). These compounds have become one of the significant concerns for wastewater treatment in recent decades. China (2019) highlights that despite the relative efficacy of existing chemical and physical methods for removing certain EDCs from wastewater, there is emerging evidence supporting the need for more widespread application of nature-based and biological approaches, particularly the use of biofilms. This study aims to examine the presence of endocrine disrupting compounds in abattoir wastewater in Ubakala, Nigeria and to proffer solutions that will inform the public about emerging contaminants in the study area.

MATERIALS AND METHODS

The study was conducted in the Abattoir located in Ubakala, Umuahia, Abia State. Ubakala is a large town in Umuahia South Local Government Area (LGA) of Abia State, Nigeria. It is one of the five ancient clans of Umuahia. A popular market for which it is known, is the Apumiri Market in Apumiri where Umuahia South Local Government Area Headquarters is situated as well. They have common boundaries with Isiala-Ngwa LGA. Ubakala people are generally modest, religious, and industrious.

Prior to sample collection, meat inspection and recording of all cases of activities in the abattoir was carried out for a period of two (2) months. Samples were collected from the abattoir wastewater at different points/locations labelled as (I, 2, 3 to 4) and a control point located at varying distance to the abattoir, using a clean-free brown glass bottles and stored at 4°C in the dark box until laboratory analysis was carried out. Ten grams of each sample of abattoir wastewater from the sampling points as contained in a conical flask was digested with 5ml of phosphoric acid, heated on the heating mantle for about an hour, until heated to dryness. 100ml of distilled water were added and thoroughly shaken and filtered into a 100ml standard flask and the filtrate was made up to mark with distilled water (Huet, 2000).

Aliquot were analyzed in the laboratory using Gas chromatography (GC) coupled to an electron capture detector (ECD) analysis technique. Aliquots of abattoir wastewater samples were analyzed for the presence and concentrations of endocrine disrupting compounds (EDCs) (such as Polychlorinated biphenyls (PCB), Dichloro diphenyl trichloroethane (DDT), Dioxins, Nonylphenol (NP) and Organotins). Certified standard solutions of the elements (1000 µg/g) under investigation were used for the preparation of the elements working standard solutions. The data were analyzed using one-way analysis of variance to find out the statistical difference among the mean values of EDCs

concentrations in abattoir wastewater using SPSS 22.0 package. This was expressed as mean \pm standard deviation. The coefficient of correlation between some EDCs concentrations was calculated by Pearson correlation test. Statistical significance was set at $P < 0.05$.

RESULTS

The result of the study from samples collected from the different points in the abattoir wastewater are presented in Table 1. The results showed that concentration levels were from 24.33 ng/L for PCB which was the highest to 0.01ng/L for nonylphenol, which was the lowest EDC.

Table 1: Endocrine disrupting compounds in Abattoir wastewater

Samples	PCB (ng/L)	Dioxins (ng/L)	Nonylphenol (ng/L)	DDT (ng/L)	Organotins (ng/L)
Point 1	22.37 ^b \pm 0.62	4.21 ^a \pm 0.00	0.07 ^a \pm 0.01	17.78 ^b \pm 0.48	3.86 ^a \pm 0.00
Point 2	21.87 ^c \pm 0.13	2.71 ^b \pm 0.00	0.04 ^a \pm 0.01	17.95 ^b \pm 0.08	2.90 ^c \pm 0.00
Point 3	22.18 ^b \pm 0.17	3.12 ^c \pm 0.00	0.05 ^a \pm 0.01	21.75 ^a \pm 0.25	3.18 ^b \pm 0.00
Point 4	24.33 ^a \pm 0.35	1.15 ^d \pm 0.00	0.04 ^a \pm 0.01	12.55 ^c \pm 0.05	2.53 ^d \pm 0.01
Control	5.70 ^d \pm 0.76	0.73 ^e \pm 0.00	0.01 ^b \pm 0.00	2.71 ^d \pm 0.31	1.23 ^e \pm 0.00

Values are mean \pm standard deviation of 3 replicates

^{abc} Means in a column with different superscripts are significantly different ($P < 0.05$)

The result in Table 2 shows the relationship between the endocrine disrupting compounds in abattoir wastewater in Ubakala Abattoir. There was significant correlation between PCB and nonylphenol (0.988) and DDT (0.752) which was significant at 0.01 level of

significance. Dioxins significantly correlated with nonylphenol (0.633, $P < 0.05$) and DDT (0.621, $P < 0.01$). There was also a negative significant correlation between nonylphenol and DDT (0.897) at 0.01 level of significance.

Table 2: Pearson correlation coefficient showing the relationship between endocrine disrupting compounds in abattoir wastewater at Ubakala

	PCB	Dioxins	Nonylphenol	DDT	Organotins
PCB	1				
Dioxins	.988**	1			
Nonylphenol	.605	.633*	1		
DDT	.752**	.621**	-.897*	1	
Organotins	.508	-.431	-.376	.478	1

*. Correlation is significant at the 0.05 level ($P < 0.05$).

**. Correlation is significant at the 0.01 level ($P < 0.01$)

The results of wastewater at the different point for PCB are shown in Figure 1. Values obtained for all the wastewater showed that contaminants were high in concentration level at point 4 while the lowest value obtained was recorded at the control point (5.70ng/L).

The polychlorinated biphenyls (PCB) content in the abattoir wastewater ranged from 5.70 ng/L – 24.33 ng/L. There was significant difference ($P < 0.05$) in the polychlorinated biphenyls (PCB) content of abattoir wastewater.

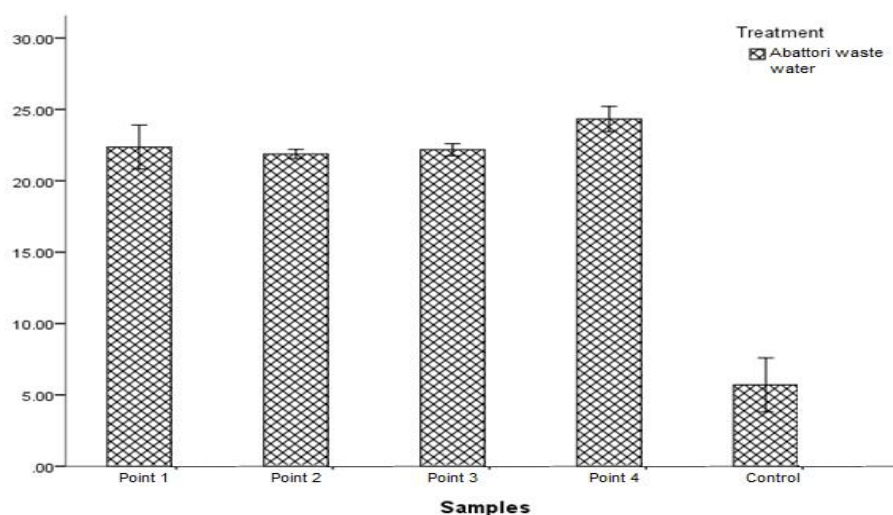


Fig. 1. PCB in Abattoir wastewater across sampling points in ng/L

Figure 2 shows the concentration of the pollutants in the wastewater for Dioxins. The dioxins content in the abattoir wastewater ranged from 0.73 ng/L – 4.21 ng/L. Values obtained showed a peak at point 1 (4.21ng/L)

and a corresponding increase at point 3 (3.12 ng/L). The change in the trend for results obtained was totally different from what was seen in the results for PCB values.

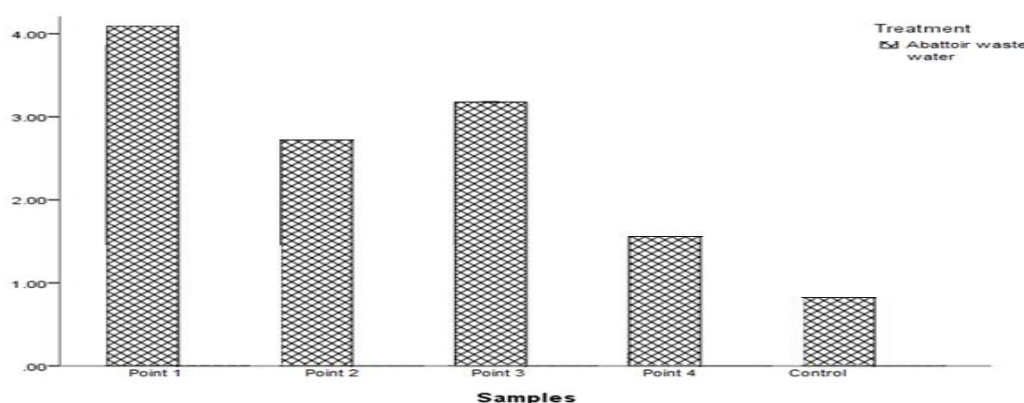


Fig. 2. Dioxins in Abattoir wastewater across sampling points in ng/L

The results for nonlphenol from the abattoir wastewater (Figure 3) showed an increase at point 1 (0.07ng/L) as compared to values obtained at the different points. Although, control had the lowest value which was at (0.01ng/L) of the pollutant. . The nonylphenol

content in the abattoir wastewater ranged from 0.01 ng/L – 0.07ng/L. The control was significantly different ($P < 0.05$) from the four (4) Points in the nonylphenol content in the abattoir wastewater.

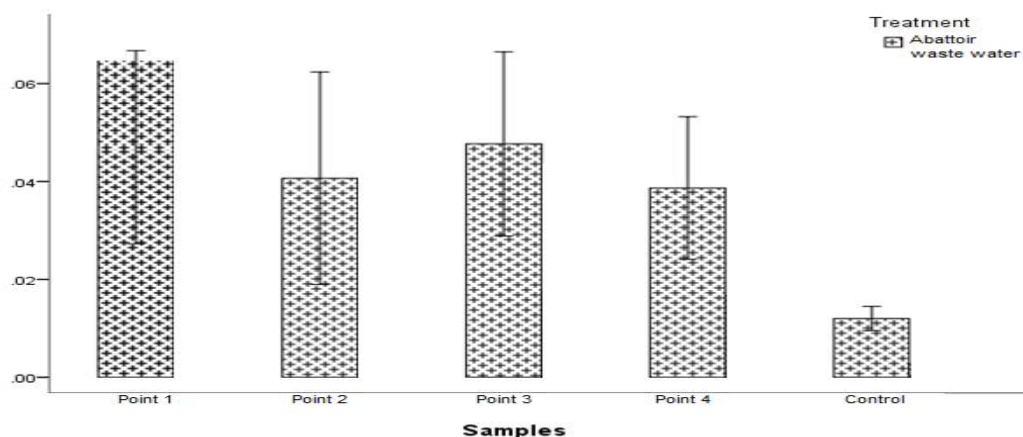


Figure 3: Nonylphenol in Abattoir wastewater across sampling points in ng/L

For DDT, results (Figure 4) showed that point 4 had the highest value which was a similar trend with PCB. Although lower values were recorded at point 3 and the control. The dichloro diphenyl trichloroethane (DDT)

content in the abattoir wastewater ranged from 2.71 ng/L – 21.75 ng/L. There was significant difference ($P < 0.05$) in the dichloro diphenyl trichloroethane (DDT) content in the abattoir wastewater.

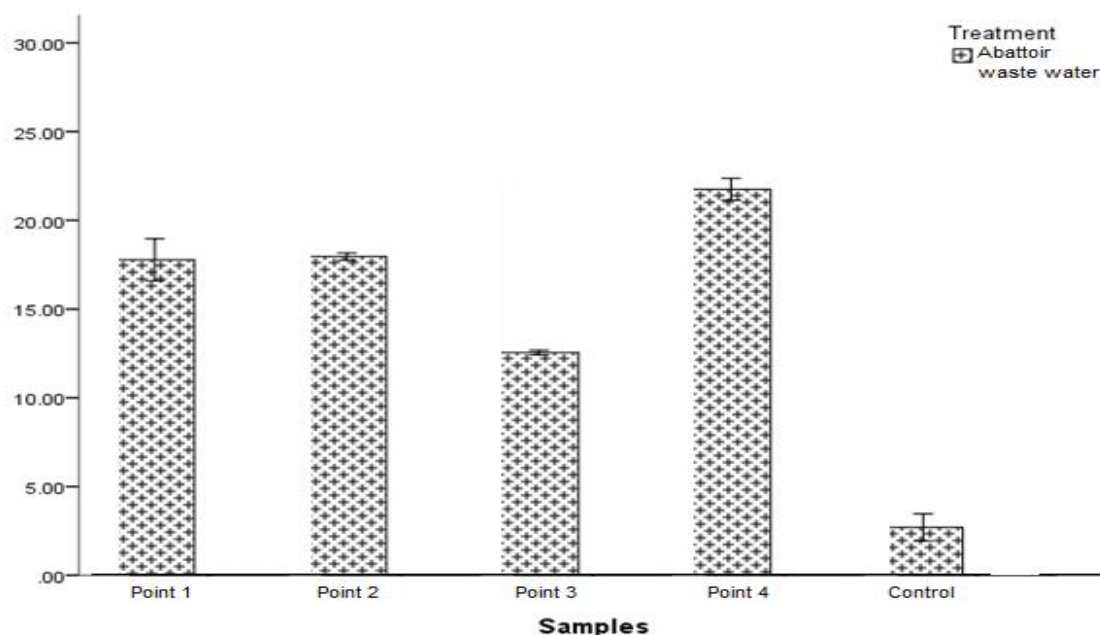


Fig. 4: Dichloro diphenyl trichloroethane (DDT) in abattoir waste across sampling points in ng/L

Results of organotins in abattoir wastewater (Figure 5) showed that point 1 had the highest value of the pollutant concentration

(3.86ng/L) as compared to the control (1.23ng/L) of the pollutants. The organotins content in the abattoir wastewater ranged

from 1.23 ng/L – 3.86ng/L. There was significant difference ($P < 0.05$) in the organotins content in the abattoir wastewater.

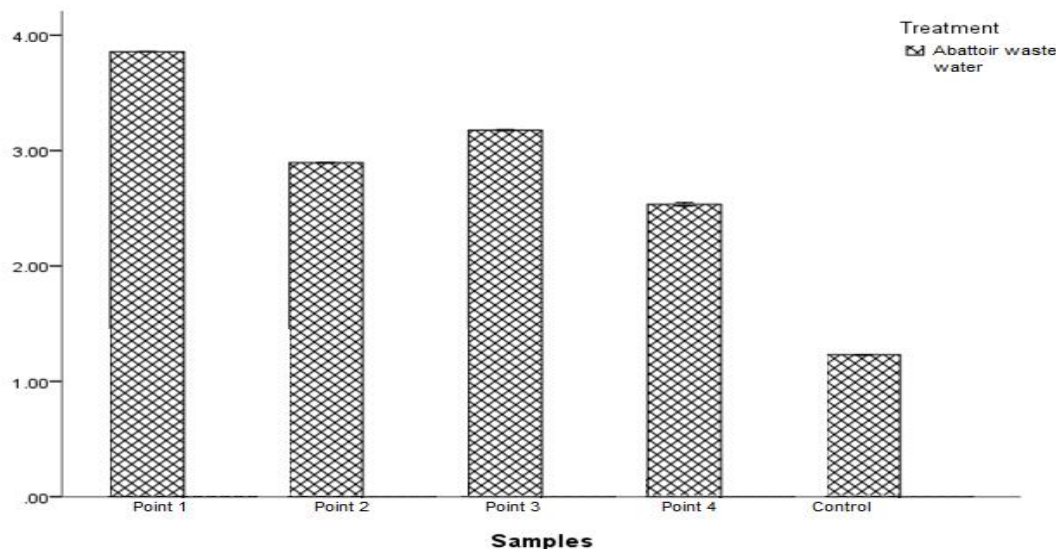


Figure 5: Organotins in Abattoir wastewater across sampling points in ng/L

DISCUSSION

Despite several investigations have been done on endocrine disrupting chemicals in wastewater sources in the world, none of them is from Abia State, Nigeria. Our study focused on the identification and determination of levels of EDCs compounds in wastewater due to its impact on animals and human via the food chain. The concentration of EDCs compounds in wastewater samples showed that all five studied compounds found in abattoir wastewater samples agrees with the findings of Ma *et al.* (2007) that EDCs activity of industrial wastewater are ranged from 0.1 to 13.3 ng/L after treatment. Studies show that wastewater treatment plants appear to be one of the major sources of pollutants because these compounds are not easily degradable by biological treatment. This present data showed that the concentration of Polychlorinated biphenyls (PCB) in the abattoir wastewater from 24.33 to 5.70 ng/L is comparable to the rate of 10.56 mg reported by Macilwain (1998) in USA. But it is greater than that of 4.01 ng/L reported by Korner *et al.* (2001) in India. EDCs are relatively high in contaminated environments in which industrial chemicals leach into soil and water. These compounds are taken up by microorganisms, algae, and plants, and move into the animal kingdom and up the food chain, Gutendorf *et al.* (2001). The dioxins in the abattoir wastewater (0.73 – 4.21 ng/L) also agrees with similar studies of 3.89 ng/L reported by Kookana *et al.* (2002) and

Johnson and Sumpter (2001) in Australia that wastewater generated by abattoirs contain high levels of pollutants such as dioxins which affects the tissues of top predators including humans. The nonylphenol in the abattoir wastewater (0.01 – 0.07 ng/L) recorded was less than the rate reported by Vandenberg *et al.* (2014). This compound might enter the cow meat through animal pens; bleeding / stunning, carcass processing/cleaning, offal processing, and by-products processing; and affect the endocrine of the body system. The dichloro diphenyl trichloroethane (DDT) in the abattoir wastewater within the range of 2.71 – 21.75 ng/L recorded in this study was greater than the rate of 1.09 ng/L reported by Birkett and Lester (2003). This might be as a result of its high concentrations in the environment, although comparable to that of 0.09 ng/L as reported by Bergman *et al.* (2012) in Northern Spain. Human diseases and disorders are attributable to environmental factors which are caused by DDT, which have been seen to cause several deadly diseases, including cancer and respiratory and cardiovascular diseases (Bola *et al.*, 2011). The organotins in the abattoir wastewater (1.23 – 3.86 ng/L) recorded was less than the rate of 4.74 ng/L reported by Matheyarasu *et al.*, 2012 and that of 7.92 ng/L reported by Omole and Longe, 2008 in Northern Spain.

Environmental exposures to compounds such as organotins are recognized to contribute to endocrine-related disorders.

The study revealed that there was significant correlation between PCB between nonylphenol and DDT. Dioxins significantly correlated with nonylphenol and DDT. This study agrees with the finding of Huet (2000) and that of Gutendorf and Westendorf (2001) that showed a negative significant correlation between nonylphenol and DDT. Results compared to other authors showed that PCBs and DDT were higher than the findings of Peng et al., 2008, which means that the treatment of effluents from abattoir wastewater is very paramount in reducing the contaminants from the environment before discharging into any receiving aquatic body.

CONCLUSION

The study gave useful insight about the presence and concentrations of some endocrine disrupting compounds (polychlorinated biphenyls (PCB), dichloro diphenyl trichloroethane (DDT), dioxins, nonylphenol (NP) and organotins) in the abattoir wastewater in Ubakala Abattoir, Abia State. The presence of these endocrine disrupting compounds in abattoir wastewater is of great concern for both food safety and human health because of their harmful nature at relatively minute concentrations. From the results of the study, it can be concluded that the abattoir wastewater in Ubakala Abattoir contains endocrine disrupting compounds. It is therefore recommended that; butchers in various abattoir should be sensitized on the health implication of these endocrine disrupting compounds in abattoir wastewater.

RECOMMENDATION

The study recommends that abattoirs operate on a closed water circuit. Mines and industries producing these compounds must practice safe processing procedures and be equipped with appropriate methods of waste disposal to decrease risk of human and animal exposure to endocrine disrupting compounds.

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