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Mini Review

PRESENCE OF ENDOCRINE DISRUPTING CHEMICALS IN THE CITY OF KARACHI

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INTRODUCTION

Xenobiotics are the harmful chemical substances foreign to the body of living organisms. They can enter in the living body from sources like environmental contaminants, domestic waste, sewerage waste and industrial effluents. These compounds have the ability to disturb the natural physiological mechanisms of the body by disturbing the naturally occurring hormonal system. Therefore, these compounds (or chemicals)are termed as Endocrine Disturbing Chemicals (EDCs).There are about 85,000 chemical products present in the environment, while about 1,000 are declared as EDCs (Street *et al*., 2018). Many plastic making companies use phthalates, bisphenol A and Plasticizers in manufacturing their products. Many other chemicals such as flameretardants, industrial chemicals, alkylphenols, metals and dioxins are also added to the environment from different sources (Street *et al*., 2018). Table 1 Lists of 45 EDCs that have been published by United Nations. The list includes phthalates, bisphenols and parabens.

Table 1. List of 45 Endocrine Disrupting Chemicals (EDCs). (Source: chemicalwatch.com; WHO, 2012).

4-Nonylphenol, branched and linear	Carbon disulphide
4-Nonylphenol, branched and linear, ethoxylated	Metam-sodium
4-(1,1,3,3-tetramethylbutyl)phenol	Zineb
4-(1,1,3,3-tetramethylbutyl)phenol, ethoxylated	Ziram
4-Heptylphenol, branched and linear	Thiram
p-(1,1-dimethylpropyl) phenol	Tert-butyl methyl ether; MTBE; 2-methoxy-2-methylpropane
Bis(2-ethylhexyl) phthalate; DEHP	Methyl4paraben
Diisobutyl phthalate; DIBP	Ethylparaben
Dibutyl phthalate; DBP	Propylparaben; propyl 4-hydroxybenzoate
Benzyl butyl phthalate; BBP	Butylparaben; butyl 4-hydroxybenzoate
Resbenzophenone	4-nitrophenol
Benzophenone-2; 2,2',4,4'- tetrahydroxybenzophenone	2,4,6-tribromophenol
Benzophenone-3; Oxybenzone	Resorcinol
4,4'-dihydroxybenzophenone	Pentachlorophenol (PCP)

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3-Benzylidene camphor (3-BC); 1,7,7- trimethyl-3-(phenylmethylene)bicyclo[2.2.1]heptan-2- one	Tebuconazole
3-(4-Methylbenzylidene) camphor; 1,7,7- trimethyl-3-[(4-methylphenyl) methylene]bicyclo[2.2.1] heptan-2-one	Triclosan
2-ethylhexyl 4-methoxycinnamate	Diethyl phthalate (DEP)
Bisphenol F	Dihexyl phthalate (DHP)
Bisphenol S	Dicyclohexyl phthalate (DCHP)
Butylated hydroxytoluene	Dioctyl phthalate (DOP)
Tert.-Butylhydroxyanisole (BHA); tertbutyl-4-methoxyphenol	Diisodecyl phthalate (DiDP)
Quadrosilan; 2,6-cisDiphenylhexamethylcyclotetrasiloxane	Diundecyl phthalate (DuDP), branched and linear
	Triphenyl phosphate

A report published by World Health Organization and Endocrine Society mentions the undesirable effects of Endocrine Disturbing Chemicals on human health (WHO, 2018; Diamanti-Kandarakis *et al*., 2009; Gore *et al*., 2015). Severe physiological disorders are found in people inhabiting areas with high concentrations of EDCs. EDCs bring about changes in the functions of endocrine systems that can directly impact the hormonal secretions and ultimately human health. These compounds can cause abnormal developmental processes, irregularities in the reproductive cycles, neuro endocrinological disorders, impaired growth, thyroid problems and irregular metabolic activities. This can even lead to cancer due to hormonal imbalance. Therefore, it is imperative that the levels of EDCs in environment are regulated (Duk-Hee Lee, 2018).

According to Khan *et al*. (2017) EDCs alter hormonal functions by affect in gendogenous hormonal mechanism of secretion, binding and transportation. EDCs enter the environment from the use of pesticides, detergents, medicinal waste, sewerage waste, municipal effluents and agricultural waste. They impact the aquatic environment which becomes unsuitable for the survival of different species inhabiting it. Anthropogenic activities cause accumulation of these EDCs in the aquatic environment (Maha, 2016).

Following researcher have reported on the adverse effects of EDCs on human health and different species in wildlife: Moccia *et al*. (1981, 1986), Reijnders (1986), Colborn *et al*. (1993), Ankley and Giesy (1998), Tyler *et al*. (1998), Van Der Kraak (1998), deFur *et al*. (1999), IPCS (2002), Jobling and Tyler (2003), Matthiessen (2003), Canesi *et al*. (2004), Myers *et al*. (2004), Zala and Penn, (2004), Mills and Chichester (2005), Waring and Harris (2005), Porte *et al*. (2006), Bergman *et al*. (2012), Hunter *et al*. (2012), Kortenkamp *et al*. (2012), Heindel *et al*. (2015), Khan *et al*. (2017), Peter *et al*. (2018) and Street *et al*. (2018). The effects of EDCs on wildlife has been reviewed in this paper with specific reference to the environment of Karachi city.

The effects of EDCs were observed in fishes and birds as most of the aquatic species are effected due to direct exposure of chemical effluents. The abnormality in thyroid secretions also leads to the infertility. Egg laying ability and fecundity level also decrease. Studies have revealed that in turtles, fishes, and birds the embryonic development is also effected by EDCs (Colborn *et al*., 1993). According to Myers *et al*. (2004) presence of EDCs in the environment has adverse health effects in inhabitants of that environment.

According to Colborn *et al*. (1993) there were many abnormalities found in Bald Eagles who had accumulated EDCs in their tissues. The studies were also carried out in the Salmon fishes belonging to lakes of Canada and USA. It found that Salmon fishes suffered from many physiological disorders included enlargement of thyroid glands, decrease in thyroid secretions, as well as undeveloped or poorly developed eggs. Bergman *et al*. (2012), Kortenkamp *et al*. (2012) and Khan *et al*. (2017) also studied the effects of EDCs in wildlife.

Other researchers including Myers *et al*. (2004) and Heindel *et al*. (2015) also studied the epidemiological effects of EDCs on wildlife and human health. While Moccia *et al*. (1981, 1986), Reijnders (1986) and Colborn *et al*. (1993) discussed the effects of EDCs on the environment as well as their effects on thyroid functions in birds and fishes. Parr and Kidd (2005) studied the effects of estrogen exposure on amphibians in lakes of Canada. It was found that the reproductive capability as

well as metamorphosis in amphibians have been effected. Experiments were performed on Green frogs (*Rana clamitans*) and larvae of Wild mink frog (*Rana septentrionalis*). Tada *et al*. (2007) studied the effects of VTG induction in freshwater turtles (*Chinemys reevesii*) from the ponds with sewage water contamination containing estrogens (E2) of 0.52–1.7 ng/L.

DISCUSSION

Karachi city is the main industrial hub of Pakistan. With a high population of about 30 million, the city produces millions of tons of domestic waste as well as industrial waste. Many industries dump their effluents in Lyari and Malir Rivers. A large quantity of contaminated water with toxic chemicals is released into the Arabian Sea. Many trace elements were found in samples of water from Karachi harbor (WWF-Pakistan, 2007). Karachi's Coastal area is effected with industrial and domestic environmental pollutants.

A research was carried out by Khan *et al*. (2007) to determine the in *vitro* yeast estrogenic screen in wastewater from Karachi. It was found that EDCs level was high in Pak colony area which is located in between industrial area (Table 2).

Table 2. Estrogenic activities of seven different wastewater sites in the Karachi region.

Location, sample name	Predicted estrodial equivalence concentration (M)	Predicted estrodial equivalence concentration (ng/L)
Gulshan-e-Iqbal, site A	5.35E-12	1.46
Shorab Goth, site B	7.88E-12	2.15
Gabol Town North Karachi, site C	2.79E-12	0.76
Pak Colony, site D	2.74E-11	7.47
Lasbella, site E	2.82E-12	0.77
Machar Colony, site F	4.55E-13	0.12
Liaquatabad, site G	7.68E-13	0.21

There are cattle farms in Korangi Creek area who dump their waste including blood and organic waste into the Korangi Creek. Level of contaminants in coastal areas of Karachi were also observed by Shahzad *et al*. (2009) and Saleem and Kazi (1998). According to Siddiqui *et al*. (2017) high levels of toxic chemicals has been found from the Korangi Creek areas (Figs. 1 and 2).

Fig. 1. View of polluted area in Korangi Creek.

Fig. 2. Korangi Creek polluted area.

According to Amjad and Rizvi (2000) 25% of contaminants are dumped into Lyari River while 59% of pollutants are dumped into Malir River from Karachi city. Gharo Creek, Gizri Creek and Korangi Creek are the main channels for discharge of waste. Hunter *et al.* (2012) reported estrogenic activity in soft tissues of mussel from coastal areas of Karachi. Estrogenic activity at Buleji point 1 was 8.91 ±4.77 ng E2 equivalents/g, Paradise point 1 had 1.72 ± 0.81 ng E2 equivalents/ng and Paradise point 2 had 0.61 ± 0.84 ng E2 equivalents/g. Estrogenic compounds were found higher in Korangi Creek as compared to samples from Manora Island.

EDCs also have adverse effects on food chains. It has a disastrous effect on biodiversity, their reproductive patterns and their physiological functions. Khan *et al*. (2017) studied the effects of EDCs in fish (*Engraulis purava*) as well as in mussel (*Mytilus*). High levels of contamination was found inBaba Island where Anchovy had 95.78ng E2 equivalents/g wet weight of fish tissue and in Sandspit (Fig. 3) it was 20.70ng E2/g of fish tissue. Second highest contaminant levels were found in Korangi Creek with average of 77.19ng E2 equivalents/go f fish tissues.

Fig. 3. View of Sandspit beach polluted with plastic and other domestic materials.

Recently, Siddiqi *et al*. (2017) conducted a study on multi-residue screening of endocrine disrupting chemicals (Pesticides and PCBs) in the marine environment of Karachi. Evaluating the bio concentration evidence and preferred sources of these chemicals, theyreported that 12 pesticides and 9PCBs were analyzed in 38 different species of fish, crabs, mollusks, echinoderms and shrimps from six different locations from Karachi coastline. Concentration levels of EDCs at all sampling locations were below the extraneous residue limit and maximum residue limits of codex alimentarious commission of FAO-WHO and US-FDA. But according to the US EPA, screening guidelines, concentration levels of ΣDDTs and ΣPCBs were found higher than their set limits in samples from two locations; Korangi Creek and Fish Harbor (Fig. 4). Based on this study levels of EDCs are still low to the amounts reported from other parts of the world

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Fig. 4. Environmental effluents entering Korangi Creek.

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