

ESTROGENIC EFFECTS OF PERSISTENT ORGANIC POLLUTANTS (POPs) ON FISH REPRODUCTION

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ABSTRACT:- The occurrence of persistent organic pollutants (POPs) in the environment can affect organisms inhabiting aquatic systems that are vulnerable to environmental stressors. This review mainly focused on reproductive alteration induced by POPs. These POPs shows their bioaccumulation as Biotic and abiotic samples showed the same POPs distribution pattern: OCPs > PCBs > PBDEs. Organochlorine pesticides (OCPs), polychlorinated dibenzo-p-dioxins (PCDD), polychlorinated dibenzofurans (PCDF) polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs) are most common categories of POPs. Bioaccumulation of POPs in fishes occurs due to the food which is the main cause of biomagnification. POPs act as a potent endocrine disruptor as they modulate thyroid and sex-steroid hormones. Estrogen a sex steroid hormone which play important role in regulation in fish reproductive physiology. POPs mimic the role of ERs and modulate the estrogen receptors followed by altered the reproductive physiology of fishes. Due to their long-lasting nature, they accumulate inside the various fish tissues and further transfer in next trophic level. In conclusion, the simultaneous exposure of fish to multiple environmental pollutants leads to different alterations, so measures should be taken in order to prevent their occurrence and toxic effects.

KEYWORDS: - Organic pollutants (POPs), Fish Reproduction and Toxic effect.

INTRODUCTION:-

Persistent organic pollutants (POPs) are those environmental chemicals which have potentiality of bioaccumulation and biomagnification as well as ability to long range transport. These chemicals have a negative impact on living beings and the ecosystem (1). POPs are divided into several categories such as organochlorine pesticides such as DDT, polychlorinated dibenzo-p-

dioxins (PCDD), polychlorinated biphenyls (PCB) and polychlorinated dibenzofurans (PCDF), such as dioxins (1). Bioaccumulation of POPs in fishes occurs due to the food which is the main cause of biomagnification (2). In the food chain large fishes have a high level of POPs accumulation. In fishes. Some POPs even in less concentration affect badly and cause several animalities such as risk associated growth as well as reproductive performance (3). These effects are due to immunological modulation, impairment in neuromuscular coordination, genotoxicity and endocrine disruption. POPs can have an impact on aquatic creatures, especially those living in shallow water that are more susceptible to environmental stressors. the buildup and reproductive alterations of POPs were explored in this study.

Organochlorine pesticides:-

There is evidence that OCPs bioaccumulate in living things, and this process may entail bioconcentration and biomagnification (4). OCPs are assimilated when they enter the tissues of living things, which is referred to as bioaccumulation (4,5). Due to their lipophilic nature, they may be found in larger quantities in some tissues, like the liver or kidney, than in others, such the muscle; this is called bioconcentration (6). Be aware that the majority of the OCPs were greater in the mussels than in the sediment where the mussels were found (7). The exception to this was -HCH, which has a lesser propensity to be stored in organisms and is more water soluble than the other OCPs. Organochlorine pesticides can also biomagnify, which means that their concentrations rise as you move up the food chain (7,8). For instance, concentrations of DDT, DDE, or other OCPs may be in the parts per billion in water. Animals such as zooplankton assimilate these OCPs (9). Zooplankton are eaten by insects which are consumed by small fish that are ingested by bigger fish, etc. and at each step, the concentrations of OCPs increase through biomagnifications(10). Because the concentrations of

OCPs are very low initially, no negative effects may be seen until the highest trophic levels are reached. At that point concentrations may be 10 million times those in water (11,12).

Organochlorine pesticides (OCPs) are still being found in a number of environmental areas, especially aquatic ecosystems (13-15). As these substances are known to bioaccumulate in fish tissues, they can be used as indicators to gauge the health of the ecosystem and the possibility that contaminants will move up the food chain (16-18). Fish may also operate as a barometer in areas where people consume fish to gauge the effects of pollutants on human health (19,20).

Organochlorine pesticides (OCPs) have great bioaccumulation capability. These are assimilated due to their lipophilic nature. Some tissues such as the kidney and liver other than the muscles(21). Bioaccumulation means that OCPs enter the tissues of organisms; another term for this is that they are assimilated. They may be found in higher concentrations in some tissues, such as liver or kidney, than in others like muscle because of their lipophilic nature; this is bioconcentration. In the aquatic ecosystem, concentration of OCPs is near about 0.00003 ppm in water. As the trophic level increases, OCPs concentration also increases. For instance in planktons it is 0.04, in small fishes 0.5 ppm and in large fishes 2 ppm(21).

While being widely employed in the past, OCPs have recently been outlawed or used much less due to their neurotoxicity and environmental persistence. OCPs primarily affect the neurological system by interfering with various ion channels. DDT and its analogues disrupt sodium channels, having an impact on both the central and peripheral nervous systems (21,22). OCPs can frequently bioaccumulate in the fat tissues of aquatic organisms like fish and crustaceans because they are persistent. Martyniuk et al. (2020) claim that OCPs are endocrine disruptors since they decrease both the male and female reproductive systems and affect immune system function(23). The same study also discussed changes in lipid metabolism brought on by OCP exposure. Furthermore, they also act as potent teratogens (23,24).

Effect of polychlorinated dibenzo-p-dioxins (PCDD):-

Dioxins, often referred to as polychlorinated dibenzo-p-dioxins (PCDDs), are produced as undesired contaminants during the production of pulp and paper made from chlorophenol and its derivatives, as well as during the burning of hazardous, municipal, sewage-sludge, and hospital waste. Although ragworms and lugworms are frequently utilised as a bioindicator for biomarker and bioaccumulation investigations, there are generally very few data available in the literature about the field bioaccumulation of PCDD in polychaetes (25).

A crucial part of the coastal and estuarine food webs is PCDD. According Nunes et al. (2011), the Mondego estuary in Portugal had a concentration of 1.38 pg g⁻¹ ww of PCDD (81.16 pg g⁻¹ lipid) in tissues. These results were lower than the normalized to lipids concentration (269-2,111 pg g⁻¹ lipid) found in both the industrial area and the estuarine sites of the Venice Lagoon in the current study, and they might be explained by the different levels and types of pollution sources affecting the two estuaries (26). The endocrine-disrupting effects of bioaccumulation PCDD are thought to be numerous, and they appear to affect not just the action of steroid hormones but also the function of thyroid hormones (27). The toxicity induced by PCDD also affect the reproductive performance because of their endocrine disruptive action (28).

Polychlorinated dibenzofurans (PCDF):-

In addition to PCDD, another class of almost planar tricyclic aromatic compounds with very comparable chemical characteristics is polychlorinated dibenzofurans (PCDFs) (29). Dibenzofurans (PCDFs) are highly persistent, bioaccumulative, and toxic contaminants found in the environment as a byproduct of chlorine-using chemical processes (such as those used in the wood pulp and magnesium industries), as a result of combustion processes both from natural (forest fires) and anthropogenic sources (fumes from incineration plants, car and boat exhaust fumes), or as impurities in chemicals. They are not intentionally produced but rather occur in the environment as byproducts of (i.e., pesticides and herbicides) (30,31). PCDF shares the same endocrine disruption feature as PCDD. Also, it

altered the way that hormones like thyroxin and estrogen worked. Owing of PCDF's persistence, which manifests changes in reproduction. As a result of PCDF's ability to alter steroid hormone, steroid receptor modulation also occurs. Both types of estrogen receptors are regulated in this modification (31,32).

Effect of polychlorinated biphenyls (PCB):-

Polychlorinated biphenyls, or PCBs, are dangerous industrial substances (31). They present significant health concerns to developing fetuses, infants, and kids, who may experience developmental and neurological issues as a result of prolonged or recurrent exposure to low levels of PCBs (30,31). Even adults can be harmed by these poisons. PCBs are difficult to degrade and can persist in the environment at harmful quantities, despite the fact that their manufacture was outlawed in the United States in 1977(33). Sediments at the bottoms of streams, rivers, lakes, and coastal areas collect PCBs (34). These substances, which can accumulate in the fatty tissues of fish and other animals, represent significant health concerns to those who regularly consume contaminated seafood (34,35). Environmental Defense advises restricting consumption of some fish based on information on PCB amounts in fish that is currently available (36). Due to their advantageous chemical characteristics, PCBs are frequently used in industrial products including carbonless paper, hydraulic fluids, and electrical transformers. Before they were outlawed, PCBs were produced in the United States in excess of 1.5 billion pounds, and some electrical equipment still in use today may contain PCBs (37). PCBs are unfortunately slow to decompose in the environment due to the same characteristics that made them perfect for industrial use (38). The majority of PCBs settle into riverbeds, lake bottoms, and coastal sediments because they do not mix with water (39). Here, they can bioaccumulate in invertebrates, fish, birds, and mammals, including humans, and enter the food chain (39,40).

Effect of polybrominated diphenyl ethers (PBDEs):-

Polybrominated diphenyl ethers (PBDEs), which are used as flame retardants in a wide range of consumer and commercial goods, can save lives. For instance, upholstered furniture made of polyurethane foam, which

is frequently used, is flammable unless treated with the proper flame retardants, such as PBDEs (41). Due to federal and many state requirements requiring the majority of household goods, including beds and electronics, to be flame resistant (42), PBDEs are becoming a crucial commercial chemical. It is not surprising that PBDE use has expanded over time and that yearly sales are currently over 70,000 t (t) metric ton) (43). Commercially, PBDEs are offered in three products, two of which are mixtures of different congeners (44). The so-called penta-product is composed of 2,2',4,4'-tetrabrom odiphenyl ether (BDE-47), 2,2',4,4',5-pentabrom odiphenyl ether (BDE-99), 2,2',4,4',6-pentabrom odiphenyl ether (BDE-100), 2,2',4,4',5,5'(42,45,46). The composition in the following proportions: 9:12: 2:1:1(42). PBDEs also acts as a potent endocrine disruptor as the modulate the function of thyroid as well as estrogen(47). They upregulate the function of estrogen and alters the reproductive physiology of fishes (48).

CONCLUSION:-

It is now obvious that POPs are pervasive environmental contaminants and that their concentrations are rising exponentially in most environmental compartments with doubling durations of roughly 4-6 years. Little is known about the mechanisms by which these compounds leave the products in which they are employed and enter the environment. POPs mimic the role of ERs and modulate the estrogen receptors followed by altered the fish reproduction. Due to their long-lasting nature, they accumulate inside the various fish tissues and further transfer in next trophic level. In conclusion, the simultaneous exposure of fish to multiple environmental pollutants leads to different alterations, so measures should be taken in order to prevent their occurrence and toxic effects.

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