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Article Review: Heavy Metals and Pesticides in Aquaculture: Health Problems

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Abstract: Heavy metals and pesticides have begun to raise a public attention in water and aquaculture ecosystems, contribute to the larger problem of aquatic pollution, which can seriously damage the marine environment and cause health hazards to people in some areas. Moreover, increasing pollution of groundwater and surface water from a wide variety of industrial, municipal, and agricultural sources has additionally seriously tainted water quality in these sources, effectively reducing the supply of freshwater for human use. Owing to their toxicity persistence and tendency to accumulate in water and sediment, heavy metals, metalloids and pesticides when occurring in higher concentrations, become severe poisons for all living organisms.
In this review we try to draw a spot light on the severe damage caused by heavy metals and pesticides in water and aquaculture ecosystems and also, the potential suggestions to reduce their pollution for sustainability and water conservation.

Keywords: Accumulation; Environmental damage; Heavy metals; Pesticides.

1. Introduction

The contamination of fresh waters with a wide range of pollutants has become a matter of concern over the last few decades [1]. The natural aquatic systems may extensively be contaminated with heavy metals released from domestic, industrial and other man-made activities [2].
Aquatic systems are considered as suitable sites for disposal of and recycling the sewage and toxic wastes and drain off the excess to the sea. Thus, the dual stress exerted on the water courses are ultimately faced by the biological communities inhabiting them, of this fish is the most important aquatic community concerning the man.
Heavy metals have a great ecological consideration due to their toxicity and accumulation. Fish may accumulate significant concentrations of metals in water in which those metals are below the limit of detection in routine water samples [3,4].
Non-essential metals are usually potent toxins and their bioaccumulation in tissues lead to intoxication, decreased fertility, tissue damage and dysfunction of a variety of organs [5,6].
Heavy metals are non-biodegradable and once discharged into water bodies, they can either be adsorbed on sediment particles or accumulated in aquatic organisms. Fish may absorb dissolved elements and heavy metals from surrounding water and food, which may accumulate in various tissues in significant amounts and are eliciting toxicological effects at critical targets. Also, fish may accumulate significant concentrations of metals even in waters in which those metals are below the limit of detection in routine water [7], therefore, fish might prove a better material for detecting metals contaminating the freshwater ecosystems.
Organometallic compounds (tributyltin) have been used extensively as antifouling agents and are now banned in many countries because of its effect known as *imposex*. Imposex refers to a change of sexual characteristics in invertebrates, female gastropods growing a penis, for instance.
In common, persistent organic compounds (POCs) all have the following characteristics: they are stable and toxic, and share a similar structure. It has emerged that some highly stable organic compounds - chiefly halogenated hydrocarbons - can have serious environmental effects in the sea. Such substances have in common the presence of a halogen in their molecule (chlorine, iodine, fluorine, astatine), have a low polarity and low water solubility. Aromatic compounds are more reactive and susceptible to chemical and biochemical transformation and include pesticides (chlorinated such as DDT – DDE, Polycyclic

Aromatic Hydrocarbons, Hexa Cyclo Hexan, and Organometallics such as tributyltin). The use of PCBs has been prohibited for a long time, emissions from unidentified sites still occur. For example, re-circulated waste paper used as raw material for new pulp was discovered downstream from a paper mill. PCBs, for instance, are frequently found in fish liver, seal blubber, bird eggs, and human fat.

Organochlorines have been associated with impaired reproductive ability in seals and whales. For instance, octachlorostyrene (OCSs) have been found in benthic organisms. OCS concentrations can be taken as an indication of incomplete combustion resulting in the accumulation of chlorinated hydrocarbons in marine organisms.

2. Methodology

Problem of heavy metals and pesticides

In recent years, the problem of marine environmental pollution with heavy metals and pesticides has begun to raise a public attention especially in coastal areas. Dumping wastes into marine environments contribute to the larger problem of aquatic pollution, which can seriously damage the marine environment and cause health hazards to people in some areas. Although several adverse health effects of heavy metals and pesticides have been known for a long time, the exposure to these elements continues; moreover, it is even increasing in some parts of world, in particular in the less developed countries, though emissions have declined in most developed countries over the last 100 years [8]. Owing to their toxicity persistence and tendency to accumulate in water and sediment, heavy metals, metalloids and pesticides when occurring in higher concentrations, become severe poisons for all living organisms.

The bioaccumulation of heavy metals and some pesticides in the different fish tissues has been studied by several investigators. Bioaccumulation of metals may lead to high mortality rate or cause many biochemical and histological alterations in the survived fish [9].

The bioaccumulation factor (BAF) is the ratio between the accumulated concentration of a given pollutant in any organ and its dissolved concentration in water:

$$\text{Bioaccumulation factor (BAF)} = \frac{\text{pollutant concentration in fish organ (mg/kg)}}{\text{pollutantin water (mg/l)}}$$

A. Sources of metals and pesticides contamination

Significant amounts of heavy metals and pesticides are eventually carried intofres, marine, estuarine and coastal water systems. The biota concentrates many heavy metals and pesticides relative to their environment. The invertebrates appear to have a particularly high capacity for concentrating metals from the environment when they filter plankton during feeding. Because of the ability of many metals to form complexes with organic substances, there is a tendency for them to be fixed in the tissue and not to be excreted and they may be passed up the food chain to higher organisms including man.

They enter aquatic systems via natural and anthropogenic sources, including industrial, agricultural, and mining activities. The aquatic environment is more susceptible to the harmful effects of heavy metal pollution because aquatic organisms are in close and prolonged contact with the soluble metals. What's more, unlike toxic organic compounds, metals cannot be degraded but undergo bioaccumulation through the food chain [10,11].

Human activities can increase metal concentrations to higher than background levels. Anthropogenic sources of metals include industrial and municipal waste products, urban and agricultural runoff, fine sediments eroded from catchments, atmospheric deposition, CCA treated wood walkways [12] antifouling paints from ships (mainly tin and copper), metals from pipes in sewage treatment plants and drainage from acid sulfate soils and mine sites. Mine drainage, in particular, can significantly increase the concentrations of some metals. Metal contamination tends to be localized to areas situated in close proximity to mine sites, industrial installations and large cities [13].

Agricultural use of pesticides is a subset of the larger spectrum of industrial chemicals used in modern society. The American Chemical Society database indicates that there were some 13 million chemicals identified in 1993 with some 500 000 new compounds being added annually.

Because the environmental burden of toxic chemicals includes both agriculture and non-agricultural compounds, it is difficult to separate the ecological and human health effects of pesticides from those of industrial compounds that are intentionally or accidentally released into the environment. However, there is overwhelming evidence that agricultural use of pesticides has a major impact on water quality and leads to serious environmental consequences.

B. Environmental significance and the ecological effects

Metals tend to accumulate in animals and plants including mangrove vegetation [14] and sea grasses. They enter aquatic organisms through body and respiratory surfaces, and by ingestion of particulate matter and water. Toxicity manifests as impairment of metabolic function, with possible changes to the distribution and abundance of populations [15]. Sublethal effects may include changes in morphology, physiology, biochemistry, behavior and reproduction [16]. Massive fish kills can occur when aluminum and iron are mobilised with drainage from acid sulfate soils [17]. The extent of metal uptake, toxicity and bioaccumulation varies depending on the organism, and can be modified by temperature, pH, turbidity, dissolved oxygen and the concentrations of other metals in solution. Accumulation of metals by aquatic organisms *e.g.* bivalves and crabs [18] can be a useful indicator of the presence of metals in biologically available forms. If metal levels in organisms are too high for human consumption, shell fishing waters are closed.

Ecological effects of pesticides extend beyond individual organisms and can extend to ecosystems. Swedish work indicates that application of pesticides is thought to be one of the most significant factors affecting biodiversity [19]. Pesticides are included in a broad range of organic micro pollutants that have ecological impacts. Different categories of pesticides have different types of effects on living organisms, therefore generalization is difficult. Although terrestrial impacts by pesticides do occur, the principal pathway that causes ecological impacts is that of water contaminated by pesticide runoff. The two principal mechanisms are bioconcentration and biomagnification.

Bioconcentration is the movement of a chemical from the surrounding medium into an organism. The primary "sink" for some pesticides is fatty tissue (lipids). Some pesticides, such as DDT, are "lipophilic", meaning that they are soluble in, and accumulate in, fatty tissue such as edible fish tissue and human fatty tissue. Other pesticides such as glyphosate are metabolized and excreted.

Biomagnification is describes the increasing concentration of a chemical as food energy is transformed within the food chain. As smaller organisms are eaten by larger organisms, the concentration of pesticides and other chemicals are increasingly magnified in tissue and other organs. Very high concentrations can be observed in top predators, including man.

Persistent Organic Pollutants (POPs) and Organochlorine pesticides (OCPs) are capable of persisting in the environment, transporting between phase media and accumulating to high levels, implying that they could pose a risk of causing adverse effects to human health and the environment. Consequently, most OCPs are designated as persistent organic pollutants (POPs) and even as endocrine disrupting chemicals (EDCs). POPs, including aldrin, chlordane, chlordecone, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, α/β-hexachlorocyclohexanes, lindane, mirex, pentachlorobenzene, and toxaphene.

The ecological effects of pesticides (and other organic contaminants) are varied and are often inter-related. Effects at the organism or ecological level are usually considered to be an early warning indicator of potential human health impacts.

3. Results and Discussion

Effect of heavy metals and pesticides on fish

Heavy metals

Heavy metals, such as cadmium , lead, arsenic , chromium, mercury and copper, are among the most dangerous and abundant inorganic environmental pollutants, arising from industrial discharges and mining practices [20].

When fish are exposed to elevated levels of metals in a polluted aquatic ecosystem, they tend to take these metals up from their direct environment. Heavy metal contamination may have devastating effects on the ecological balance of the recipient environment and the diversity of aquatic organisms [21]. Transport of metals in fish occurs through the blood where the ions are usually bound to proteins. The metals are brought into contact with the organs and tissues of the fish and consequently accumulate to a different extent in different organs and tissues of the fish [22]. Heavy metals are non-biodegradable and once they enter the environment, bioconcentration occurs in the fish tissue in the case of aquatic environment, by means of metabolic and biosorption processes [23]. The presence of heavy metals has been associated with decreased fertility and other reproductive abnormalities in birds, fish, shellfish and mammals, as well as altered immune function [24]. Heavy metals like mercury and cadmium are known to accumulate in marine organisms, and cause rapid genetic changes [25,26]. It is also possible that may increase the susceptibility of aquatic animals to various diseases by interfering with the normal functioning of their immune, reproductive and developmental processes [27].

Prolonged exposure to water pollutants even in very low concentrations have been reported to induce morphological, histological and biochemical alterations in the tissues which may critically influence fish quality [28,29]. It was reported that aquatic organisms showed high capability to accumulate heavy metals.

Cadmium (Cd) has been reported to exert deleterious effects in terms of nephrotoxic, cytotoxic, genotoxic, immunotoxic and carcinogenic [30]. Long exposure of cadmium produces a wide variety of acute and chronic effects in aquatic animals. Its prime site is kidney (kidney damage: renal tubular damage). Cd may exert immunosuppressive effects in both fishes and crustaceans [31]. Recent reports suggest that cell mediated immunity is most affected and phagocytosis, natural killer cell activity and host resistance towards experimental infections are markedly impaired in cadmium toxicity [32]. Cadmium in high doses induce structural and function alterations in various vital organs including liver, kidney, gill and intestine of fishes. Cd accumulates in liver of fishes in high concentrations [33,29]. It also induces various pathological changes in liver tissues including engorgement of blood vessels, congestion, vacuolar degeneration of hepatocytes, necrosis of pancreatic cells and fatty changes in the peripancreatic hepatocytes. Gills are also reported to act as storehouse of cadmium in experimental studies [34, 35, 36, 37].

Gills of Tilapia, Oreochromis *mossambicus*,have morphological and biochemical changes after experimental Cd exposure. In scanning electron microscopic studies, observed an augmentation of microbridges in pavement cells and an increase in the apical membrane of chloride cells.

Lead (Pb) is not necessary for the biological functions of animals even at low concentrations. It is being discharged to aquatic systems mainly from petroleum, chemistry, dye and mining industries, which has toxic effects and can cause mortality to aquatic animals [38]. Chronic lead poisoning has similar toxic effects in fish as in mammals. These include hematological and neural disorders and tetanic spasms together with some morphological changes such as darkening in caudal fin, deformation of vertebrate, anomalies in pigment formation and covering of the gills by a mucus layer [39] .The main mechanisms of lead toxicity are the activation of cellular functions due to this metal's calcium mimicking effect, and the inhibition of the activity of different proteins through its binding to sulfhydryl groups. Lead has high affinity for sulfhydryl groups and can inactivate enzymes, especially those involved in heme synthesis, such as _-aminolevulinic acid dehydratsase and ferrochelatase [40]. On the other hand, lead has a higher affinity than calcium for calmodulin and can activate some calmodulin-dependent processes, inhibit the calcium bombs (calcium–ATPase, sodium–potassium) and channels and replace calcium in several of its receptors [41]. This interaction between lead and calcium has been identified in numerous papers, which show that lead absorption is inversely related to dietary calcium; thus it seems that a low dietary intake of calcium can lead to higher levels of lead in blood.

Arsenicals. Recently, the anthropogenic activities such as treatment of agricultural land with arsenical pesticides, treating of wood using chromated copper arsenate, burning of coal in thermal plants power stations and the operations of gold-mining have increased the environmental pervasiveness of arsenic and its rate of discharge into freshwater habitat [42] . Furthermore, arsenic is used broadly as sodium arsenite to control submerged aquatic vegetation in freshwater ponds and lakes [43]. According to [44], 1.5-3.8 mg arsenite /L is effective and considered safe for fish. Many species of fish that live in arsenic polluted water contain arsenic between 1 - 10 g/g. At the bottom, arsenic levels in fish are reported to be higher than 100 μg/g [45]. The liver cells were found to lose their regular shape due to partial precipitation of both cytoplasmic and nuclear material, resulting shape deformation, vacuolization, necrosis and even cell damage. Also, the gill hyperplasia was found the most induced branchial changes due to arsenic exposure (The DTC values recorded for the liver of arsenic exposed fish were significantly higher than those recorded for the control group, mg/L) than those subjected to arsenate only 56 mg/L.

Chromium. Acute exposure to hexavalent chromium proved to be highly toxic to *Labeo rohita* and induced cumulative deleterious effects at various vital functional sites like metabolic rate, hematological indices and biochemical profiles. The metal induced decrease in the total protein content could possibly affect the enzyme mediated bio-defense mechanisms of the fish, which pose a serious threat to human beings by secondary poisoning through food chain. Three-week exposure of rainbow trout to 2.0 mg/l of hexavalent chromium increased the levels of haemoglobin and haematocrit in their blood [46]. Long-term exposure (30 days) to low concentrations of chromium (1.9 and 2.9 mg/L) increased the erythrocyte count, concentration of haemoglobin, and per cent of haematocrit in the blood of freshwater barbus [47] , and rainbow trout, *Salmo gairdneri*. An increase in these indices was observed in the blood of various fish species after 15-day exposure to 10 mg/L of hexavalent chromium [48]. Earlier works reported a fall in RBC count, hemoglobin percent and packed cell volume and decrease in MCH, MCHC and MCV in freshwater fishes exposed to cadmium, zinc and nickel indicating anemia, erythropenia and leucopoiesis [18,17]. The TEC, hemoglobin per cent and mean cell hemoglobin (MCH) were appreciably declined in *Labeo rohita* exposed to chromium reflecting the anemic state of the fish which could be possibly due to iron deficiency and its consequent decreased utilization for hemoglobin synthesis. Anemia in fish is an early manifestation of acute and chronic intoxication of chromium.

Mercury (Hg) is a highly volatile element with a long atmospheric half-life. As result of these physical properties, it is ubiquitous in the environment and exposure is not an isolated concern but rather a global threat to human health [49]. In recent years, research has revealed that even chronic exposure to very low concentrations of exposure has the ability to cause long-lasting neurological and kidney impairment [50]. Hg is one of the most toxic heavy metals in our environment including the lithosphere, hydrosphere, atmosphere and biosphere.

Mercury's volatile nature and long atmospheric residence time (approximately one year) have resulted in the global cycling of Hg and its deposition in land, marine, freshwater, and wetland ecosystems in regions of the world remote from the source [51,52]. Inorganic mercury deposited from the atmosphere may be converted by microorganisms in aquatic ecosystems into the highly toxic methylmercury (MeHg) which can bioaccumulate within organisms and biomagnify more than a million-fold in aquatic foodwebs. Consequently, current ecosystem and human health concerns stem from the ubiquitous distribution of Hg in the environment and the health effects associated with high concentrations of MeHg in top predators, including humans [53].

Copper (Cu) is an essential trace metal in small concentrations for several fish metabolic functions. Essentiality of copper arises from its specific incorporation into a variety of enzymes which play important roles in physiological processes (e.g. enzymes involved in cellular respiration, free radical defense, neurotransmitter function, connective tissue biosyntheses and other functions), as well as, into some structural proteins [54]. Although the crucial role of Cu in several enzymatic processes [55], this heavy metal can exert adverse toxicological effects, when present in high concentrations in water [56]. In fact, it is potentially toxic when the internal available concentration exceeds the capacity of physiological detoxification processes. Increasing agricultural production has resulted in increasing number of freshwater systems being impacted by the contaminants present in wastewater releases. In Portugal Cu has been used in viticulture to control fungal diseases in vineyard plants. High concentrations of this heavy metal were detected in some aquatic ecosystems collecting vineyard runoff water and it is also highly concentrated in ground water [57,58]. There are also anthropogenic sources of environmental contamination by Cu including mining, smelting, foundries, municipal waste incinerators, burning of coal for power generation and a variety of copper-based products used in building and construction [59]. When exposed to toxic concentrations, organs of aquatic animals may accumulate copper [4]], which can lead to redox reactions generating free radicals and, therefore, may cause biochemical and morphological alterations [60,61]. Gills are the first target of waterborne pollutants due to the constant contact with the external environment, as well as the main place for copper uptake. It is well known that changes in fish gill are among the most commonly recognized responses to environmental pollutants [61]. Copper salts (copper hydroxide, copper carbonate and copper sulphate) are widely used in agriculture as fungicide, algaecide and nutritional supplement in fertilizers. They are also used in veterinary practices and industrial applications. Copper sulphate is released to water as a result of natural weathering of soil and discharge from industries, sewage treatment plants and agricultural runoff. Copper sulphate is also intensively introduced in water reservoirs to kill algae. Thus excessive amount of copper accumulates in water bodies and cause toxicity to aquatic fauna and flora and ultimately to man. Copper and its compounds have been designated as priority pollutants by [62].

Pesticides

Exposure of fish to pesticides-water-pollutants even in very low concentrations has been reported to induce:

Hematological effect. The most common blood parameters monitored include total erythrocyte count, total leucocyte count, and haemoglobin and haematocrit conten. Several workers recorded increased lymphocyte, leucocyte, and erythrocyte counts, packed cell volume, and hemoglobin in several species of fishes challenged with cypermethrin, deltamethrin, and fenvalerate. Jayaprakash and Shettu observed a decrease in hemoglobin content, total erythrocyte count, packed cell volume, mean corpuscular volume, and mean corpuscular hemoglobin concentration and an increase in total leukocyte count, mean corpuscular volume, erythrocyte sedimentation rate, and clotting time values in the snakehead, *Channa punctatus,* exposed to deltamethrin. Other biochemical variables such as total serum protein, albumin, and globulin contents, albumin-globulin ratio, plasma glucose, alanine aminotransferase, and cholinesterase were reduced in fishes exposed to cypermethrin and deltamethrin .

Hyperglycemia . Reduction in hepatic glycogen accompanied by a rise in blood glucose is a common reaction of fish against xenobiotic insult. Depletion of hepatic glycogen due to cypermethrin treatment has been observed in *Tilapia mossambica* and *Clarias batrachus*. Glycogen depletion is a regulatory step against xenobiotic insult. It increases intermediary metabolism resulting in the protection of the hepatocytes. Increase in the activity of lactate dehydrogenase (LDH), an enzyme responsible for conversion of pyruvate to lactate in fish exposed to sublethal concentration of cypermethrin and λ-cyhalothrin , is an indication of such metabolism.

Enzymatic effect. The enzymes of energy metabolism have also been found to have the potential to be used as biomarkers of type II pyrethroid toxicity in fish. Total adenosine triphosphatase, sodium-potassium adenosine triphosphatase, and magnesium adenosine triphosphatase activities in the gills of *Catla catla* were significantly reduced when exposed to sublethal concentrations of cypermethrin . Liver alkaline phosphatase is also known to play a role in glycogen metabolism. The enzyme is capable of inactivating phosphorylase enzymes and promotes glycogen synthesis. Inhibition of alkaline phosphatase activity in the liver is thus related to the breakdown of glycogen to meet the energy demand under stress or decrease in the rate of transphosphorylation or uncoupling of oxidative phosphorylation. There are reports that alkaline phosphatase activity of fish increases after exposure to cypermethrin . Higher activities of lactate dehydrogenase (LDH) and acid and alkaline phosphatases were also observed in *Channa punctatus* exposed to cypermethrin and λ-cyhalothrin . Necrosis of liver and subsequent leakage of alkaline phosphatase into blood stream might be responsible for an increase of the enzyme in blood.

Oxidative stress. Lipid peroxidation, induced by reactive oxygen species (ROS), is a common oxidative stress biomarker of toxicants. Lipid peroxides are capable of modifying the properties of biological membranes, eventually resulting in damage of cellular membrane. The most widely used assay for lipid peroxidation is malondialdehyde (MDA), a secondary product of lipid peroxidation caused by free radicals. Fish, like other organisms, have evolved defense systems comprising both enzymatic and non-enzymatic processes to minimize cell damage by lipid peroxides. Catalase (CAT), an enzymatic antioxidant, scavenges ROS and converts them to less reactive species thereby preventing lipid peroxidation. Fish exposed to deltamethrin showed a tendency towards increase in the level of MDA and reduction in the activity of CAT, although cadmium pre-exposure at low concentrations appeared to modulate deltamethrin-induced oxidative stress. *Channa punctatus* exposed to alphamethrin also showed a decrease in the activity of CAT. Enzymes of nitrogen metabolism . Increased activities of enzymes of nitrogen metabolism such as aspartate aminotransferase (AST), alanine aminotransferase (ALT), glutamate dehydrogenase, and glutamine synthetase in response to cypermethrin and λ-cyhalothrin exposure served as useful biomarkers. Increase in the activities of ALT, AST, and transaminases appeared as specific reaction of type II pyrethroids. Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) activities increased in response to cypermethrin in *Orecochromis niloticus* . Marked increase in the activities of transaminases in *Clarias batrachus* and an increase in the activities of aspartate and alanine aminotransferase in *Prochilodus lineatus* have also been reported in response to cypermethrin, a type II pyrethroid .

Acetylcholinesterase (AChE) Activity. AChE activity has been established as a potent biomarker for organophosphorus and carbamate pesticides, while unequivocal evidence is lacking for organochlorines. The activity of the AChE was not inhibited by deltamethrin in three species of fishes. Similarly, esfenvalerate exposure had no effect on AChE activity.

However, the major types of effects of pesticides will vary depending on the organism under investigation and the type of pesticide. Different pesticides have markedly different effects on aquatic life which makes generalization very difficult. The important point is that many of these effects are chronic (not lethal), are often not noticed by casual observers, yet have consequences for the entire food chain:

- Death of the organism.
- Cancers, tumors and lesions on fish and animals.
- Reproductive inhibition or failure.
- Suppression of immune system.
- Disruption of endocrine (hormonal) system.
- Cellular and DNA damage.
- Teratogenic effects (physical deformities).
- Poor fish health marked by low red to white blood cell ratio, excessive slime on fish scales and gills, etc.
- Intergenerational effects (effects are not apparent until subsequent generations of the organism).
- Other physiological effects such as egg shell thinning.

Trials to solve or ameliorate the problem of heavy metals and pesticides

Global monitoring of heavy metals and pesticides in planet water

1. *Bio-monitoring of water quality*

In an organism, some organes such as the kidneys or the liver are important sites of the accumulation of heavy metals or pesticides in particular fish. Metals entering an organization can be absorbed by metalloproteins that detoxify cellular environnements. They are produced in the presence of contaminants and are the basis of the regulation mechanism. The cellular lysosomes and granules can also be used to sequester these metals. Mechanisms vary bio-indicators and contaminants studied. More recent studies allow to know the subcellular partition of metals in a particular tissue (liver, gills, intestines), much data that provide information on the nature of pollutants from one medium and the duration and degree of exposure these pollutants species in a given ecosystem. The presence of mutations, wounds, parasites or degeneration provide additional information that also interest the toxicologist and the ecologist . Shellfish are also widely used as bioindicators whatsoever for freshwater environments or marine population, their physiology, behavior and accumulation of contaminants in their tissues different levels can give very important information on the state of health of a medium and its level of contamination. They are particularly useful because they are sessile and therefore characteristics of the place where they are found or they are implanted. Among the most popular applications include the imposex or Mussel Watch Program.

2. Water quality indices by the following:

. Bioassay: Usually a scoring system based on the performance of a number of standardized lab assays using pollutant-sensitive species that are indicative of various trophic levels (e.g. bacteria, algae, invertebrates, vertebrates). Bioassay tends to focus on toxicity impacts [63].

. Biotic Indices: There are a variety of standardized biotic indices that are commonly used in Europe for water quality assessment and management. Generally, these indices are developed from benthic assemblages in rivers and streams. The index represents the nature of benthic response, mainly to organic pollution (domestic and municipal wastes). These have not been very successful for toxics assessment. There have been many reviews of biotic indices [64].

Ecosystem indicators: Indicators can include a range of ecological measurements (fish, benthic organisms, habitat, etc.). This technique has proven useful as a means of establishing norms against which managers can measure success of remediation measures. This approach has also been used in the United Kingdom, Canada, and Australia.

. Other Indices: There are a wide range of indices that are used to assess nutrient and/or toxic stress. Many of these use fish as a useful surrogate for impacts on humans. These indices include:

- Measures of fish health using histological (e.g. red/white cell ratio) and pathological measures (size and appearance of organs).
- Presence/absence of contaminant metabolites in fish bile, liver, etc.
- Presence of enzymes as part of detoxification process in organisms (e.g. measures exposure of fish to toxic chemicals).
- Other biochemical indicators:

- Blood Parameters. Compared to fishes of the control group, the RBCs counts, Hb contents and Hct values were significantly reduced due to exposure to both the tested pollutant levels
- Plasma Biochemical Parameters. All the tested plasma biochemical parameters of fishes exposed to pollutant, which include enzymes activities (AST and ALT) and metabolites levels (Total bilirubin, total lipids, glucose and total proteins).
- Carbohydrate Metabolism. The LDH activity in the liver of fishes exposed to pollutant will be significantly higher than normal level. Similarly, the LDH activity in the muscle will be increased due to pollutant exposure.
- Protein Metabolism. Will be significantly privileged in fishes exposed to pollutant.

Removal heavy metals and pesticides in waste water before discharging into water sources or sea

Treatment process - for heavy metals and pesticides before discharging into water sources, sea or using it for irrigation - through the application of the advance technology of waste water treatment.

4. Conclusion

Heavy metals, metalloids and pesticides when occurring in higher concentrations, become severe poisons for all living organisms. Global monitoring of heavy metals and pesticides in planet water should be carried out regularly.

Water treatment is, collectively, the industrial-scale processes that make water more acceptable for an essential contributor in the process of water sustainability and conservation.

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Conflict of interest

The author have declared no conflict of interest.

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