

Pesticides Toxicity in Fish with Particular Reference to Insecticides

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ABSTRACT

The present study has been carried out to study the toxic effects of pesticides as well as insecticides on fish. The use of pesticides in agriculture is recognized as a worldwide practice. Unfortunately, the environment and non-target creatures, especially aquatic life, may suffer if these pesticides are used carelessly in an attempt to increase agricultural productivity and output. The World Health Organization reports that there are more than 3 million cases of pesticide poisoning worldwide year, resulting in 220,000 deaths. Mutations are caused by several of these drugs.

KEYWORDS: *productivity, Chemicals, agriculture, worldwide, Health, Environment.*

Introduction: Pesticide usage is acknowledged as a component of agricultural operations globally. Regrettably, “the careless use of these pesticides to enhance agricultural output and productivity may have an adverse effect on non-target organisms, particularly aquatic life and the environment. According to the World Health Organization, there are over 3 million instances of pesticide poisoning globally each year, which leads to 220,000 fatalities”¹. Many of these chemicals are mutagenic², “linked to the development of cancers or may lead to the developmental deficits. Worldwide pesticide usage has increased dramatically during the past two decades, coinciding with changes in farming practices and increasingly intensive agriculture. Environmental pollution caused by pesticides, especially in aquatic ecosystems, has become a serious problem. Contamination of water by pesticides, either directly or indirectly, can lead to fish kills, reduced fish productivity, or elevated concentrations of undesirable chemicals in edible fish tissue which can affect the health of humans consuming these fish”.

Concern about the potential health risks that exposure to pesticides and their metabolites may bring to humans has grown as residual levels of these chemicals have been discovered in foods and drinking water. “Surface water contamination has a long history and is a serious problem on a local, regional, national, and international scale³. Chemicals from agricultural practices often accumulate in soft-bottom sediments and aquatic species after entering the aquatic environment by air deposition, surface runoff, or leaching. Pesticides have been discovered in aquatic ecosystems all around the globe, yet often there is little information available on how these pesticides harm the creatures that live there”.(WHO,1992)

Statement of the Problem: Aquatic creatures' ability to develop, survive, and reproduce is known to be negatively impacted by pesticide pollution of surface waters. “Many forms of waste water include varying quantities of pesticides, which have been shown in multiple studies to be hazardous to aquatic life, particularly fish species. Many different kinds of chemicals are known to be very

¹ WHO, 1992. Our planet our Health: Report of the WHO Commission on the Health and Environment, World Health Organization, Geneva.

² Garaj-Vrhovac, V., D. Zeljezic, 2000. Evaluation of DNA damage in workers occupationally exposed to pesticides using single cell gel electrophoresis (SCGE) assay. *Mutat Res.*, 469: 277-285.

³ “Cerejeira, M.J., P. Viana, S. Batista, T. Pereira, E. Silva, M.J. Valerio, A. Silva, M. Ferreira, A.M. Silva-Fernandes, 2003. Pesticides in Portuguese surface and ground waters. *Water Research*, 37(5): 1055-1063, ISSN 0043- 1354”

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harmful to fish, and those in charge of regulating pollution in rivers have identified certain as being especially hazardous to fisheries. Examples of these include ammonia, phenols, cyanide, and the salts of various metals. Prior to 1940, the majority of chemicals used as pesticides, including lead arsenate, copper sulphate, sodium arsenite, sodium cyanide, and phenolic combinations, were based on these same hazardous groups. In addition to these, pyrethrum, derris, and nicotine—all naturally occurring chemical compounds derived from plants—were often utilized as insecticides⁴. The long-term health risk to the population is fish exposed to chemicals, particularly insecticides. The human population is thus much at danger from consuming these toxic fish. Reducing the harm that pesticides and other pollutants do to the marine ecology has been shown to depend heavily on the rationalization of pesticide usage. Therefore, the rest has an effect, at least in marine animals⁵.

Objectives: The present study has been carried out with the following objectives-

- ✓ To study the different types of pesticides.
- ✓ To discuss about the toxic effects of Pesticides as well as insecticides in Fish.

DISCUSSION:

Pesticide Toxicity:

The pesticides were used before 2000 BC, in order to protect the agricultural crop from dangerous insects and pests. Elemental Sulphur, is the first known pesticide which was used about 4500 years ago, for the protection of crops. In earlier times, different poisonous plants were used as pesticide, to control the pest activity in the crops, as described in Rig Veda. Toxic heavy metals were also used as pesticide, around the 15th century. Different forms of pesticides were used from the beginning of the 17th century, such as nicotine sulphate, pyrethrum etc. In the mid 19th century, arsenic based pesticides were mainly used in agricultural practices. Pesticides are a mixture of chemical substances which are used to repel or kill crop eating insects and pests, which affect crop production and health of humans. Pesticides are a class of biocide which acts as a protective agent for the crop against pests. Biocides are the chemicals which kill harmful insects. The pests cause deterioration of the crop noticeable as premature fall of the fruit, thinning of fruit, desiccation of plants, defoliation etc. Thus, pesticides are used for controlling the pest activities in agricultural fields, gardens, houses etc. Pesticide is a broad category which includes herbicides, rodenticides, fungicides, insecticides, termiticides, molluscicides, bactericides, piscicides etc. The pesticides provide great advantage in agriculture as a pest control aid, but on the other hand, it has many downsides to non-targeted beings. The pesticides pollute the water bodies and environment by various ways such as, agricultural runoff, direct discharge, direct spraying, industrial discharge etc⁶.

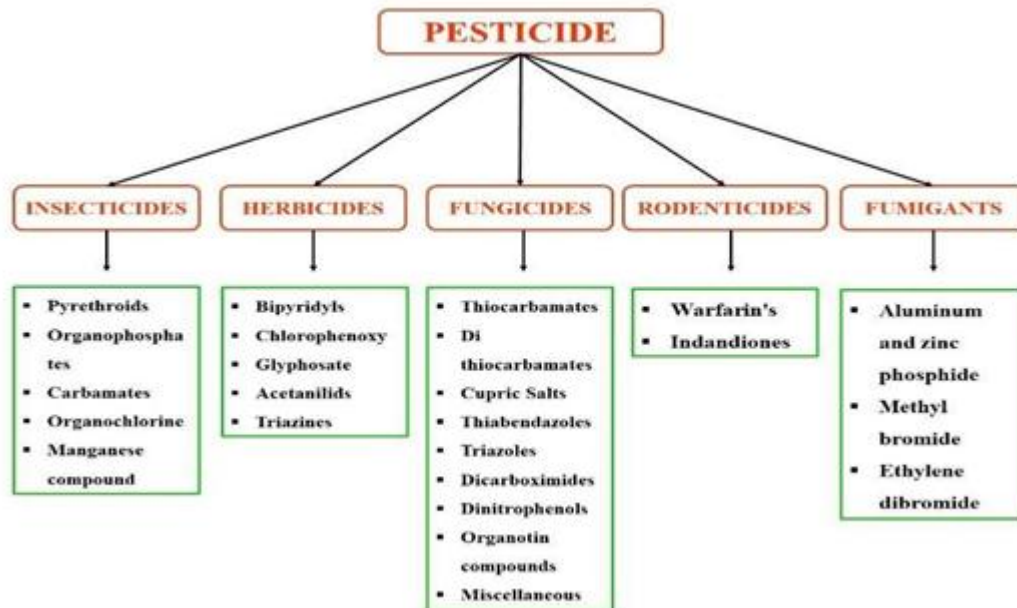
TYPES OF PESTICIDES: Pesticides are categorized into three groups: 'Inorganic', 'Natural Organic' and 'Synthetic Organic'. Mercurial, fluorides, and borates are inorganic pesticides, nicotine, rotenone and pyrethrum are included in natural pesticides, organophosphates, carbamates, and chlorinated hydrocarbons are included under synthetic organic pesticides. There are different categories of pesticides such as, fumigants, herbicides, rodenticides, algacides, fungicides, insecticides, etc.

⁴ "N. Sangeeta Rani, 2020. Effect of Pesticide Application on Aquatic Environments and Fish Diversity in Indian Scenario, ISSN-2349-5162"

⁵ "Dr. Kalawati Kumari, 2020. Pesticides toxicity in fishes: A review, E-ISSN: 2320-7078 P-ISSN: 2349-6800"

⁶ "Neha Jain Et Al 2021. Toxic Effects Of Agricultural Pesticides In Fishes, ISSN: 0973-7219, Volume 18, Issue 1".

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Effects of Insecticides on Fish: Alterations in blood biochemical parameters: The results of a blood biochemistry test show what's going on in fish exposed to pesticides. Certain enzymes are released into plasma by wounded cells in various organs, and we may identify aberrant amounts of these enzymes in blood. Certain fish exposed to pesticides may have lower blood levels of certain biochemical components as follows because of the severity of the tissue damage, especially liver damage, which may cause a considerable reduction in the production of several biochemical parameters in cells: Exposure of *Cyprinus carpio* to diazinon⁷, *Oreochromis niloticus* exposed to Carbaryl, and *Oreochromis niloticus* exposed to Bifenthrin⁸.

Tissue and Organ damage: We may learn about the condition and operation of organs via histology. Organ tissue damage and injury may lead to decreased development, survival, and fitness, poor reproductive outcomes, or increased vulnerability to pathological alterations. The duration of the fish's exposure to the poisons and the pesticide concentrations determine the frequency and severity of tissue lesions. Numerous pesticides result in either targeted or non-targeted histopathological damage⁹.

4.1.8.3. Reproductive Dysfunction, Changes in the physiological or environmental characteristics of fish may have an impact on their ability to reproduce. Fish may have problems during their normal reproductive process as a result of exposure to environmental contaminants such as pesticides, herbicides, heavy metals, and xenobiotics. Recent studies have shown that fish exposed to pesticides have malfunctioning reproductive systems. Fish reproductive biology is negatively impacted by insecticides in a variety of ways, including lower fertility and histological damage to the testicles and ovaries¹⁰, impairment of the vitellogenesis process, disturbance of the steroid genesis process,

⁷ "Banaee M, Mirvagefei A, Rafei GR, Majazi AB, "Effects of sublethal Diazinon concentrations on blood plasma", *Biochemistry, Int. J. Environ. res.*, 2(2): 189-198, 2008"

⁸ "Agrahari S, Kashev C. Pandey, Krishna Gopal, " Biochemical alteration induced by monocrotophos in the blood plasma of fish, *Channa punctatus* (Bloch) ", *Biochemistry and Physiology* 88: 268–272, 2007. & Velisek J, Svobadova Z, Machova J, "Effects of bifenthrin on some hematological and histopathological parameters of common carp (*Cyprinus carpio* L) ", *Fish Physiology and Biochemistry*, 35,583-590, 2008".

⁹ "Fanta E, Sant,Anna R, Romao F, Vianna ACC, Freiberger S, "Histopathology of the fish *corydoras paleatus* contaminated with sublethal levels of organ phosphorus in water and food", *Ecotoxicology and Environmental Safety*, 54:119-130, 2003".

¹⁰ "Banaee M, Mirvagefei A, Rafei GR, Majazi AB, "Effects of sub lethal Diazinon concentrations on blood plasma", *Biochemistry, Int. J. Environ. res.*, 2(2): 189-198, 2008"

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postponement of gonad maturation, modification of the reproductive and parental behaviour, impairment of the olfactory response, disorder in reproductive migrations, and interference with the timing of spawning and courtship behaviour of male and female fish¹¹. Certain pesticides are classified as endocrine disruptive substances because they may affect fish's endocrine system's regular operation. Insecticide side effects on the hypothalamus-pituitary gonad axis may also be a major factor in fish reproductive failure. Insecticides that cause milt were also exposed to fish eggs, resulting in decreased rates of fertilisation, hatching, and larval survival. Fish exposed to pesticide residues have reduced reproductive capacity owing to energy loss¹².

Development Disorders: The focus of research on insecticide-induced developmental problems is on the connections between toxin concentrations and abnormalities in normal development, from the embryonic to the puberty stages. Fish with impaired normal development and growth have a lower probability of surviving. In viviparous fish, pesticides may reach embryos and larvae directly, via the yolk, or through the parental¹³. "Spinal deformity, mostly scoliosis, lordosis, and morphological abnormalities were also estimated. Alterations in the embryo of fish are edema of yolk sac and crooked body of larvae"¹⁴. "Decreased fish growth consists of disorder in feeding behaviors, decrease in feeding rate, dysfunction in metabolism process and waste of energy to overcome the stress caused by insecticides exposure. Disorder in the metabolism of carbohydrates, proteins and lipids were recorded"¹⁵.

Behavioral alterations: Fish subjected to various pesticides exhibited alterations in their swimming patterns, eating behaviours, predation, competitiveness, reproduction, and social interactions between species, including hostility. The fish may become less mobile as a result of certain pesticides' effects on ACHE activity¹⁶.

Genotoxicity: Insecticides and other geotaxis compounds have physical and chemical characteristics that allow them to interact with genetic materials (damage or DNA inactivation). A mutation is a heritable alteration in the genotype of a cell that may arise from the interaction of a chemical with genetic material. As a consequence, the mistake can be passed on to the daughter cell or the next generation. Fish exposed to pesticides may also develop cancer or develop tumours in various tissues due to the geotaxis properties of these xenobiotics. Fish eggs and larvae exposed to varying concentrations of pesticides also exhibit chromosomal damage. Certain pesticides act like genes, causing abnormal plasma steroid hormone concentrations, immunosuppressive or reproductive problems, or both¹⁷.

Immuno-suppression: Insecticides modify the immune system's function, leading to immunological depression, unchecked cell division, and changes in the host's defence systems, such as acquired and innate immunity against infections. Fish immune systems are crucial for defence against a wide

¹¹ "Jaensson AS, Moore AP, Kylin AH, Olsen KH, "Effects of a pyrethroid pesticide on endocrine responses to female odours and reproductive behavior in male parr of Brown trout (*Salmo trutta* L)", *Aquatic toxicology*. 81:1-9, 2007"

¹² "Moore A, Waring CP, "The effects of synthetic parathyroid pesticide on some aspects of reproductive in Atlantic salmon (*Salmo Salar* L)", *Aquatic Toxicology*, 52 : 1-12, 2001".

¹³ "Viant MR, Christopher AP, Ronald ST, "Metabolic effects of dinoseb, diazinon and esfenvalerate in eyed eggs and alevins of Chinook salmon (*Oncorhynchus tshawytscha*) determined by 1H NMR metabolomics", *Aquatic Toxicology* 77: 359-371, 2006"

¹⁴ "Xu CTW, Lou CH, Zaho M, "Enantioo-selective separation and Zebra fish embryo toxicity of insecticides beta-cypermethrin", *J. Environ. Sci.*, 22(5):738-742, 2010"

¹⁵ "Begum G, "Carbofuran insecticides induced biochemical alterations in liver and muscle tissues of the fish *Clarias batrachus* (Linin) and recovery response", *Aquatic Toxicology*, 66:83-92, 2004"

¹⁶ "Bretaud S, Toutant JP, Saglio P, "Effects of carbofuran, diuron and nicosulfuran on acetylcholinesterase activity on gold fish (*Carassius auratus*)", *Ecotoxicol. Environ. Safe.* 47: 117-124, 2000"

¹⁷ "Jin XY, Chen RJ, Liu WP, Fu ZW, "Effects of endocrine disrupting chemicals on the transcription of genes related to the innate immune system in the early developmental stage of Zebra fish (*Danio rerio*)", *Fish Shellfish, Immunol.* 28:854-61, 2010".

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range of infections. It has been shown that some pesticides at sublethal concentrations harm fish by suppressing their immune systems. Because of the immune-depressing effects of pesticide exposure at sub-lethal doses, fish are likely more susceptible to infectious illnesses¹⁸.

Public Health Implication: The more poisonous the chemical is, and the longer and more intense the exposure, the more detrimental the impacts of pesticides are to human health. Man is known to be poisonous to pesticides. Pesticide poisoning may cause a number of symptoms, such as irritability, vertigo, tremor, tonic, and persistent convulsions. A person may have moderate skin irritation, birth deformities, tumours, genetic alterations, blood and nerve diseases, endocrine disruption, unconsciousness, or even death as a result of pesticide exposure¹⁹. Pesticides have been linked to developmental impacts. Recent increases in juvenile cancer cases throughout North America, including leukaemia, might be caused by somatic cell mutations resulting from exposure to both genotoxic and nongenotoxic chemicals. Because the neurological systems of mammals and insects are fundamentally similar, insecticides designed to disturb insects may have detrimental effects on mammalian nervous systems. Exposure has been associated with both acute and chronic changes in individuals affected. Pesticides may cause hormone imbalances and contribute to the growth and development of cancer. Despite being banned, DDT and its breakdown product DDE are known to disrupt estrogenic action and may even cause breast cancer. Levels of DDT and DDE are still prevalent in the environment. It has been shown that male penis in animals exposed to pesticides, such as DDT, during the foetal stage will grow substantially smaller than usual and will produce undecided testicles. Pesticide exposure may happen in pregnancy, during the postnatal early developmental phases, or even if one or both parents were exposed before to conception. Reproductive disruption may happen as a result of systemic structural alterations or chemical reactivity²⁰.

Conclusion: We may thus draw the conclusion that regularly monitoring the levels of pesticide residues in food materials and individuals in a manner that gauges the residents' exposure to the pesticides is a matter of great public health concern. To determine the quantity and duration of exposure to these pesticides, as well as to cause notable fatal and non-lethal effects on the organism, further research has to be done.

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