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REVIEW ARTICLE **OPEN ACCESS**

A review on genotoxic potential of insecticides on fresh water fish

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ABSTRACT
Insecticides are widely used for pest control in agriculture and forestry, leading to their accumulation in aquatic ecosystems. Freshwater fish are exposed to these insecticides either directly or through their prey, leading to genotoxic effects that can have significant ecological and health consequences. This review summarizes the current knowledge on the genotoxic potential of insecticides on freshwater fish, highlighting the mechanisms of genotoxicity, factors influencing their toxicity, and methods of assessing genotoxicity. The review also discusses the potential implications of genotoxic effects of insecticides on fish populations and the environment, as well as possible strategies for minimizing their impact.
Keywords: *insecticides, genotoxicity, freshwater fish, ecological consequences, health implications, toxicity mechanisms, environmental impact..*

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INTRODUCTION

Pesticides are frequently employed in agricultural practises to manage pests, and they are well known to be hazardous to aquatic creatures. Freshwater fish are highly susceptible to the damaging effects of pesticides and serve as crucial indicators of the health of aquatic ecosystems. Genotoxicity is among the various harmful consequences and is of particular concern since it may cause heritable DNA changes in exposed species and result in the onset of cancer or other disorders.A chemical's capacity to harm DNA and cause mutations, chromosomal abnormalities, and other genetic modifications is known as its genotoxicity.

Pesticides' genotoxic effects on freshwater fish have significant effects on the ecosystem and human health. In addition to the possibility of causing genetic harm to fish populations, eating contaminated fish may put human health at risk from exposure to it. To safeguard the wellbeing of freshwater fish populations as well as human populations, it is essential to restrict the use of pesticides and keep an eye on their effects on aquatic ecosystems.

Top of Form

Since they have been used so much more frequently throughout time, pesticides have largely contaminated the environment. Insecticides are used to lessen the harm that insects do to crops, but there have been concerns raised about how they may affect fish and other non-target species. Due to their close proximity to agricultural regions where the chemicals are administered, freshwater fish are particularly susceptible to insecticide exposure. Insecticides' potential to be genotoxic to freshwater fish is being evaluated in this review.

METHODS

A literature search was conducted using electronic databases, including PubMed and Google Scholar. Keywords such as "insecticides," "freshwater fish," "genotoxicity," and "DNA damage" were used to identify relevant articles. Articles published between 2000 and 2022 were considered.

RESULTS

The genotoxic potential of insecticides on freshwater fish has been a topic of interest in the scientific community for several decades. The use of insecticides in agricultural and urban areas has led to the contamination of water bodies, causing adverse effects on aquatic organisms, including fish.

Numerous studies have reported the genotoxic effects of insecticides on fish. A study by Khatri et al. (2018) evaluated the genotoxic potential of two insecticides, cypermethrin and chlorpyrifos, on the freshwater fish *Channa punctatus*. The results showed a significant increase in DNA damage in fish exposed to both insecticides.[1]

Another study by Kumar and Sharma (2019) investigated the genotoxic effects of imidacloprid, a neonicotinoid insecticide, on the freshwater fish *Labeo rohita*. The study demonstrated that exposure to imidacloprid caused DNA damage in the fish, indicating its genotoxic potential.[2]

Similarly, a study by Saha et al. (2016) evaluated the genotoxic potential of three commonly used insecticides, chlorpyrifos, endosulfan, and cypermethrin, on the freshwater fish *Catla catla*. The results showed that all three insecticides caused significant DNA damage in the fish.[3]

A review article by Gokulakrishnan et al. (2021) summarized the available literature on the genotoxic potential of insecticides on freshwater fish. The review highlighted that exposure to insecticides such as chlorpyrifos, cypermethrin, and imidacloprid can cause DNA damage, chromosomal aberrations, and micronucleus formation in freshwater fish.[4]

One study by Sharma and colleagues (2017) investigated the genotoxic effects of an insecticide called chlorpyrifos on the freshwater fish, *Channa punctatus*. The researchers found that exposure to chlorpyrifos resulted in significant DNA damage in the fish, as evidenced by the presence of micronuclei and other DNA lesions. The study concluded that chlorpyrifos has genotoxic potential and can cause DNA damage in aquatic organisms.[5]

Similarly, a study by Khan and colleagues (2018) examined the genotoxic effects of another insecticide, deltamethrin, on the freshwater fish, *Oreochromis niloticus*. The researchers found that exposure to deltamethrin resulted in a significant increase in DNA damage in the fish, as measured by the comet assay. The study concluded that deltamethrin has genotoxic potential and can cause DNA damage in freshwater fish.[6]

In another study, Singh and colleagues (2019) investigated the genotoxic effects of a commonly used insecticide, malathion, on the freshwater fish, *Labeo rohita*. The researchers found that exposure to malathion resulted in significant DNA damage in the fish, as evidenced by the presence of micronuclei and other DNA lesions. The study concluded that malathion has genotoxic potential and can cause DNA damage in aquatic organisms.[7]

Another study by Islam and colleagues (2020) examined the genotoxic effects of an insecticide, cypermethrin, on the freshwater fish, *Puntius ticto*. The researchers found that exposure to cypermethrin resulted in a significant increase in DNA damage in the fish, as measured by the comet assay. The study concluded that cypermethrin has genotoxic potential and can cause DNA damage in freshwater fish.[8]

One study by Rodríguez-Fuentes et al. (2016) investigated the genotoxic effects of two commonly used insecticides, chlorpyrifos and cypermethrin, on the freshwater fish species *Astyanax mexicanus*The researchers found that exposure to both insecticides resulted in DNA damage and chromosome aberrations in the fish. .[9] Another study by Sharma et al. (2017) examined the genotoxic potential of the insecticide imidacloprid on the freshwater fish *Channa punctatus.*[10] The results of this study showed that imidacloprid caused DNA damage and chromosomal aberrations in the fish.

Other studies have also found evidence of genotoxicity in freshwater fish exposed to insecticides. For example, a study by Venkataramana et al. (2019) investigated the genotoxic potential of the insecticide endosulfan on the freshwater fish *Labeo rohita.* The researchers found that exposure to endosulfan resulted in DNA damage and chromosomal aberrations in the fish.[11] Similarly, a study by Mohapatra et al. (2018) investigated the genotoxic potential of the insecticide thiamethoxam on the freshwater fish *Cirrhinus mrigala*. The results of this study showed that thiamethoxam caused DNA damage and chromosomal aberrations in the fish.[12] A study conducted by Panda and Ray (2013) investigated the genotoxic effects of chlorpyrifos, an organophosphorus insecticide, on the Indian catfish (*Heteropneustes fossilis*). The study found that the insecticide induced DNA damage and chromosomal aberrations in the fish.[13]

Similarly, a study by Akcha and Hispard (2004) examined the genotoxic potential of deltamethrin, a pyrethroid insecticide, on the European eel (*Anguilla anguilla*). The study found that the insecticide induced DNA damage and caused chromosomal aberrations in the fish.[14]

Another study by Soloneski et al. (2015) investigated the genotoxic potential of fipronil, a phenylpyrazole insecticide, on the freshwater *fish Jenynsia multidentata.* The study found that the insecticide induced DNA damage and caused chromosomal aberrations in the fish.[15]

Additionally, a study by Milinkovitch et al. (2004) investigated the genotoxic potential of endosulfan, an organochlorine insecticide, on the fish *Oreochromis niloticus*. The study found that the insecticide induced DNA damage and caused chromosomal aberrations in the fish.[16]

One study conducted by Singh *et al.* (2020) investigated the genotoxic potential of imidacloprid, a commonly used neonicotinoid insecticide, on the freshwater fish, *Channa punctatus*. The study reported that imidacloprid induced DNA damage in the fish, as evidenced by the increased frequency of micronuclei in erythrocytes. The study concluded that imidacloprid had a genotoxic potential on the fish, and its use should be regulated to minimize the adverse effects on non-target organisms.[17]

Another study by Islam *et al*. (2021) evaluated the genotoxic potential of cypermethrin, a pyrethroid insecticide, on the freshwater fish*, Labeo rohita*. The study reported that cypermethrin induced DNA damage in the fish, as evidenced by the increased frequency of micronuclei and nuclear abnormalities in erythrocytes. The study concluded that cypermethrin had a genotoxic potential on the fish and recommended that its use be regulated to minimize its adverse effects on non-target organisms.[18]

A review by Sánchez-Bayo and Goka (2014) analyzed the genotoxic potential of various insecticides on fish, including organophosphates, carbamates, pyrethroids, and neonicotinoids. The review reported that several insecticides had genotoxic effects on fish, including the induction of DNA damage and chromosomal aberrations. The review also highlighted the need for more research on the genotoxic potential of insecticides on non-target organisms, especially in aquatic ecosystems.[19]Diaz et al. (2017) investigated the genotoxicity of the insecticide methomyl on the freshwater fish Piaractus mesopotamicus. The study found that methomyl caused DNA damage and chromosomal aberrations in the fish, indicating its genotoxic potential.[20] Similarly, Kumar and Sharma (2017) reported DNA damage in the freshwater fish Cirrhinus mrigala exposed to the insecticide imidacloprid. [21]Amaral et al. (2018) found that the insecticide fipronil caused oxidative stress and DNA damage in the freshwater fish Prochilodus lineatus[22]. Batista et al. (2018) investigated the genotoxic potential of a mixture of insecticides (chlorpyrifos, cypermethrin, and imidacloprid) on the fish Oreochromis niloticus. [23]The study found that the mixture caused DNA damage and chromosomal aberrations in the fish. Jagyanseni et.al (2022) reported that Acephate is causing serious problems in fish as per genotoxicity study of acephate on Clarias batrachus.[24].

CONCLUSION

The contamination of water bodies due to the use of insecticides in agricultural and urban areas has led to adverse effects on aquatic organisms, including freshwater fish. Numerous studies have reported the genotoxic effects of insecticides such as cypermethrin, chlorpyrifos, imidacloprid, endosulfan, and deltamethrin on freshwater fish. Exposure to these insecticides can cause DNA damage, chromosomal aberrations, and micronucleus formation in freshwater fish. Several studies have also demonstrated the genotoxic effects of insecticides on specific species of freshwater fish. These studies emphasize the importance of regulating the use of insecticides to prevent adverse effects on the aquatic environment.

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