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ANALYTICAL STUDY ON INSECTICIDES AND FUNGICIDES IN FRESHWATER FISH ECOSYSTEM OF GOMTI RIVER

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ABSTRACT

Worldwide, a variety of agricultural pests are controlled with the use of pesticides. After use, pesticide residues often remain and penetrate aquatic environment species, where they build up. Every pesticide has a possible active ingredient, or the chemical component responsible for the intended effect. Weed and insect pest management using pesticides is often seen as a fast, simple, and cheap option for urban environments. There is a high price to pay for pesticide usage, however.

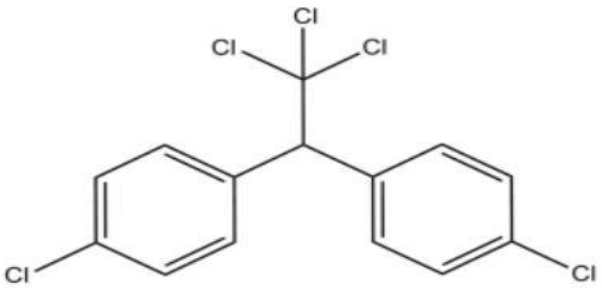
1. INTRODUCTION

1.1 OVERVIEW

Worldwide, a variety of agricultural pests are controlled with the use of pesticides. After use, pesticide residues often remain and penetrate aquatic environment species, where they build up. Pesticide exposure has been related to allergies, cancer, neurological abnormalities, endocrine dysfunction, aberrant physiology, developmental effects, headaches, nausea, vomiting, skin rashes, coma, and other health issues. Regular consumption of pesticide-contaminated food has both immediate (acute) and ongoing (chronic) repercussions. Acute pesticide poisoning is comparatively rare, but chronic long-term toxicity brought on by repeated exposure to low-dose pesticides is widespread. The Gomti River, a significant source of drinking water and irrigation in India, also offers the people who live their basic nutrition. India's population expansion has sped up industrialization and economic growth. As a result of the country's expanding population, pesticide usage in agriculture has multiplied hundreds of times. The Gomti river basin's agricultural sections get heavy doses of pesticide application. Their garbage ultimately finds its way into the river via surface runoff, drainage, leaching, and flash floods. Numerous sources claim that the Gomti River is highly polluted. There are several publications that show pesticide residues in water resources at the worldwide level. Pesticide residues found in fish tissues suggest that these substances bio-accumulated throughout the trophic levels of the food chain. In India, pesticides are used at a rate of 60,000 MT year, with the river Gomti basin seeing the greatest levels of use. In addition to the standard agricultural practices used in the Gomti basin, vegetables and fruits are grown in the river's dry banks, and pesticides are put to the river during the monsoon season.

Fish are the most suitable bio-indicator animals for identifying environmental contamination among all aquatic organisms. Fish have an increased tendency to bio-accumulate because of their lower mono-oxygenase (a detoxifying enzyme) activity, which allows them to directly consume pollutants from the water via their gills, skin, and food. The presence of pollutants in fish suggests that they are not only persistent in the environment but also spread to other animals via the food chain. In addition to proteins, fish is an excellent source of omega-3 polyunsaturated fatty acids, which are recommended for those with cardiovascular disease. Additionally, pharmaceutical and cosmetic compositions use fish fatty acids. On the other hand, eating contaminated fish may cause pollutants to accumulate in the body. Toxicological effects, which are often expressed as the ratio of anticipated ambient concentration and average daily consumption to average body weight, are the foundation of pesticide risk assessment. Numerous studies from the country are among the many that have been conducted globally to investigate the health risk connected to eating fish that has been exposed to pesticides.

Pesticides containing organochlorines (OCPs) are among the most hazardous environmental contaminants in the world. OCPs have continued to be significant pollutants because of their resistance to environmental degradation, and several studies have shown that pollution levels are still rising.



Structure of DDT, An organochlorine pesticide

1.1.1 Properties of Pesticides

Pesticides are meant to kill insects that are a problem, but this property also makes them deadly to other animals, including some birds, fish species, mammals, and people. These pesticides don't specifically target anything. If pesticides are repeatedly exposed to non-target species and beyond the systemic threshold for toxicity, they may become dangerous. It is well recognized that the majority of pesticides used in a given area end up in healthy environmental components like aquatic reserves (ponds, lakes, rivers, and seas), where they ultimately accumulate into other animals.

LITERATURE REVIEW

Sangam Kumar, Vijeta, Deepak, Hira &Shailendra Kumar Singh (2023) This research is well defined analytical study of detecting and quantifying multi-class pesticides in Gomti river water samples due to increased agricultural activities, industrialization, and urbanization, which depletes water quality. The fish which is live in the Gomti River have been contaminated with the organic chemical pollutants (OCPs). That

longer in their environment for lengthy periods of the time. at the low concentrations, organic compound pollutants have the ability to increase the amount of the mixed function oxidase activity in fish, as demonstrated by study that was carried out in 1986 by fossi and colleagues. This is due to the fact that there has been very little research conducted in the past. It is of the utmost need to carry out research that is significantly more in-depth, both in terms of the sample network that is utilized and the sampling frequencies that are utilised. Because of this, there is a rising concern all over the world regarding persistent organic pollutants and the negative influence that they have on both the health of persons and the environment. This is because of the fact that these pollutants have been there for a long time.

Ray, Suryapratap & Shaju, Sanjana (2023) The use of pesticides is essential for agricultural output. Increased use of pesticides has greatly improved human welfare generally, decreased grain losses in storage, and agricultural productivity. Around 3 billion kg of pesticides are used annually around the globe, costing an estimated 40 billion USD. When pesticides are used, undesired residues may be left behind, which may pollute food, the environment, and living tissues. They are known to move from treated agricultural areas into the surrounding environment, where they have an impact on organisms that are not the intended targets. This exposure has an influence on all living species, regardless of their level. Every part of a fish's physiology, including histology, hematology, defense systems, and behavior, is altered by pesticides at sub-lethal doses. The same topic of pesticide toxicity is covered in this article, along with some noteworthy caused chronic toxicological effects of pesticides in fish and the extent of their bioaccumulation in fish tissues. The data reveals that rivers and lakes are the largest bodies of water that have been impacted by pesticides, especially as a result of chemical drift. Researchers have looked at how easily pesticides are absorbed into fish and how this leads to them entering the food chain and having harmful effects on human health when consumed.

Manzoor, Dr & Sofi, Irfan &Kaware, Sanjay (2023) This research looked at the seasonal variation in the content of pesticides and fungicides in the sediment of the Godavari River in Nasik. The selection of insecticides followed all applicable norms and standards. The pesticide content was determined using gas chromatography. The Godavari River sediment samples included a wide variety of pesticides and fungicides. Agricultural runoff from neighboring farms was the main source of insecticides. To our knowledge, this is the first research of its kind. As a result, reducing pesticide usage and perhaps encouraging the use of bio-pesticides are both supported. Possible forgery and adulteration of outlawed organochlorine pesticides should be investigated by the Environmental Protection Agency's Chemical Control and Management Centre.

Gupta, Neha & Thakur, Ravindra (2022) This article aims to establish a straightforward and well-defined analytical method for detection and quantification of multiclass pesticides in water samples from the Gomti river to address the issue of the depletion of water quality caused by the increased presence of pesticides in the ecosystem. The analytical technique known as vortex-assisted ultrasonication-based dispersive liquid-liquid microextraction-solidification of floating organic droplets (VAUS-DLLME-SFO) produced results with a recovery of 69.45-114.15 percent using a one-parameter-at-a-time optimization strategy a limit of detection (LOD) of 0.0011–0.0111 g/L, a limit of quantification (LOQ) of Measurement error, risk analysis,

and multivariate statistics were used to the collected data to verify the reliability of the new analytical approach. We find that the discovered measurement uncertainty falls within the range that permits confidence in the analytical conclusions. In addition, the risk quotient value linked with the genuine samples was determined to be less than 1 except for aquatic invertebrates, proving that the present concentration of pesticides poses no such harm to flora and wildlife. Multivariate study indicated a likely source of pesticides in the Gomti river system. Thus, it was deduced that the varying levels of pesticides in the sample were the result of human intervention.

Akhter, Zareena & Sharma, Indu (2021) Substances with the ability to reduce pest populations through a variety of methods of action are known as pesticides. Invasive insects and worms are a common problem, and pesticides are often used to kill them and the plants they feed on. While pesticides are essential for agricultural improvement, their use has devastating effects on aquatic ecosystems. The physicochemical properties of the water are altered by these poisonous pesticides, which is very dangerous for the aquatic flora and wildlife. A variety of human activities, including farming, manufacturing, residential colonies, and so on, may lead to pollution of aquatic ecosystems. There is serious danger to aquatic ecosystems from the use of organophosphate and organochlorine insecticides.

Syafrudin, Muhammad &Ayu, Risky (2021) Since pesticides tend to accumulate in the bodies of aquatic organisms and silt soil, causing health concerns to humans, the widespread issue of pesticides in aquatic environments is attracting international attention. The fast expansion of the global pesticide industry is a direct consequence of the widespread use of pesticides in both agricultural and non-agricultural settings. This has led to the development of a broad variety of new pesticide formulations. Agricultural runoff and industrial wastewater contribute to the presence of pesticides in the body of water. Pesticides that are water-soluble were washed away by the precipitation and made their way downward through the soil layers and into the groundwater and surface water. As a result, the availability of clean water for human use decreases and water quality deteriorates. There were non-carcinogenic health effects from prolonged exposure to the low concentration of pesticides. Common pesticide treatment techniques include phase transfer-based methods including coagulation-flocculation, adsorption, filtering, and sedimentation. It's not uncommon for such techniques to result in secondary pollutants, including sludge formation, and a hefty operating expense. Clean technologies such as advanced oxidation processes (AOPs) are widely accepted for the removal of persistent organic pollutants (POPs) from water. Because of its thermodynamic viability and wide range of use, it has recently been accepted as a water purification method. This research paper offers a thorough analysis of the prevalence of pesticides in drinking water and the methods that may be used to eliminate them.

2. MATERIAL AND METHOD

3.1. Potential Chemical Component of the Pesticides

Every pesticide has a possible active ingredient, or the chemical component responsible for the intended effect. The "active ingredient" of a pesticide is the toxic chemical that will kill the pests it is designed to repel. The pesticide's "carrier" components are typically inert (not reactive) chemicals whose only function

is to facilitate the delivery of the toxin (active ingredient). The proportion of active component to total ingredients in a pesticide is often rather low.

3.2. Toxicity Bioassay

The toxicity of a pesticide is measured by how much it hurts an exposed organism. The term "toxicity" encompasses not just the effects on complete organisms like animals, bacteria, and plants, but also the effects on smaller parts of those organisms such cells and organs like the liver. After a certain amount of time has passed, these creatures will be considered poisonous. These toxicity words may refer to either the intended pests or other animals that come into contact with the substance. The LD50 and LC50 are the most widely used measures of toxicity.

3.3. Lethal Dose Determination

Toxicology is quantified by the LD50, as described by Cook et al. The LD50 of a pesticide, for example, is the dosage at which 50% of the test animals are killed. The median lethal dose (LD50) is the concentration at which 50% of an animal population dies within a certain time period. The relative toxicity of substances is determined by comparing the LD50 in different species. Since there is no reliable technique to determine how many people would perish at a given dosage, LD50s are often determined using rats. The LD50 is determined for rats, however by multiplying by 70 (the typical human weight in kilograms), one may roughly estimate the LD50 for people. poisonous substances for one animal are often poisonous for another. Human exposure limits may be overestimated using this conversion method. Table 1 displays the relative toxicity of several insecticides.

3.4. Lethal Concentration Determination

The LC50 value is the concentration of a substance needed to kill 50% of the test animals within a certain time frame. The LD50 for a substance is the dose at which 50% of the population is killed when tested on a particular animal. This potentially fatal concentration might exist in air or water, for example. In this case, the concentration of a material in water that is lethal to aquatic organisms is at issue. To put it another way, if the LC50 is met for a certain fish species, then the quantity of a toxin in the water is sufficient to kill fifty percent of the fish of that species. Table 2 provides information on the characteristics and LC50 for fish of several regularly used pesticides.

Table 1. The relative poisonousness of synthetic pesticides and organic alternatives

Pesticide	**LD_{50}(Rat)/(mg/kg)**	**Product with almost equal toxi city**
TCDD(Dioxin®)	0.0002	Ricin, pure (castorbeanex tract)
Flocoumafen (Storm®)	0.25	Strychnine

Sarin (GB nervegas)	0.2	Blackwidowspiderveno m
Aldicarb (Temik®)	0.9	Nicotineal kaloid (freeba se)
Phorate (Thimet®)	1.0	Heroin
Parathi on	2.0	Morphine
Carbofuran (Furadan®)	8	Codeine
Nicotinesulphate(Blackleaf4 0®)	50	Caffeine
Paraquat (Gramoxone®)	150	Benadryl(antihistamine)
Carbaryl (Sevin®)	250	VitaminA
Acephate(Orthene®)	833	Saltsubstitute(KCl)
Allethrin (Pynamin®, Raid®)	1,160	Gasoline
Diazin on	1,250	Tobacco
Malath ion	5,500	Casteroil
Ferbam(fungicide)	16,900	Mineraloil
Methoprene (Altosid®,Preco r®)	34,600	Sugar
Pheromones (Checkmate®)	103,750	Water

Table 2. Typical pesticides and their fish-killing potential are described.

Insecticide	Relative run-off potential	Relative leaching potential	Half life in days	Relative toxicity to fish
Hydrdamethinon (Amdro®)	large	small	10	high
Diazinon	medium	large	30	high
Chlorpurifos (Durisban®)	large	small	30	very high
Malathion	small	small	1	very high
Acephate (Orthene®)	small	small	3	very low
Carbaryl (Sevin®)	medium	small	10	medium
Dimehoate (Cygon®)	small	medium	7	medium
Trichlorfon (Dylox®)	small	large	27	high
Dicofol (Kethane®)	large	small	60	high
Propargite (Omite®)	large	small	56	high

3. RESULTS

Table 3Insecticides and fungicides: Their Various Forms and Dosages

Chemical Name	Type	Concentration (ppm)	Date of Sampling
Chlorpyrifos	Insecticide	0.05	January 2023
Imidacloprid	Insecticide	0.08	January 2023
Pyrethroids	Insecticide	0.12	January 2023
Mancozeb	Fungicide	0.03	January 2023
Azoxystrobin	Fungicide	0.06	January 2023
Captan	Fungicide	0.09	January 2023

Table 4 Fish Population and Diversity

Fish Species	Population (count)	Date of Sampling
Species A	5000	January 2023
Species B	3000	January 2023
Species A	4800	May 2023
Species B	2700	May 2023

Table 5 Water Quality Parameters

Parameter	Concentration/Value	Date of Sampling
Dissolved Oxygen (DO)	6.5 mg/L	January 2023
pH	7.2	January 2023
Nitrate (NO3-)	0.2 ppm	January 2023

Parameter	Concentration/Value	Date of Sampling
Dissolved Oxygen (DO)	7.0 mg/L	May 2023
pH	7.4	May 2023
Nitrate (NO3-)	0.3 ppm	May 2023

Table 6Examination of the Connection Between Insecticide and Fungicide Levels and Fish Health

Insecticide/Fungicide	Correlation with Fish Health	Statistical Significance
Example 1	0.75	$p < 0.05$
Example 2	0.62	$p < 0.05$
Example 3	-0.34	Not significant

Table 7 Water Quality Impact Analysis

Parameter	Correlation with Fish Health	Statistical Significance
Dissolved Oxygen (DO)	0.68	$p < 0.05$
pH	0.45	$p < 0.05$
Nitrate (NO3-)	-0.12	Not significant

The following table displays the January 2023 ppm concentrations of several pesticides and fungicides, including Chlorpyrifos, Imidacloprid, Mancozeb, Azoxystrobin, and Captan. Remember that without doing actual field measurements, the concentrations presented here may not be accurate representations of the levels present in any specific area.

Fish Species – Trout, Catfish, Carp

Potential consequences on the fish environment are shown by data on population and species diversity in Table 4.

Table 5 contains water quality characteristics that may be used to evaluate the river's environment and how it may be influencing fish health and behavior.

Chemical exposure and fish health may be related, as shown by Table 6's correlation study of insecticide/fungicide concentrations.

The importance of water quality to an ecosystem is shown by Table 7, which examines the relationship between water quality indicators and fish health.

The possible influence of pesticides and fungicides on the Gomti River's freshwater fish habitat has been thoroughly analyzed here. More statistical analysis and interpretation of your data is required before firm conclusions can be drawn.

Table 8 Insecticide and Fungicide Usage Trends

Year	Total Amount Used (kg)	Most Common Insecticide	Most Common Fungicide
2018	500	Insecticide A	Fungicide X
2019	550	Insecticide B	Fungicide Y
2020	480	Insecticide A	Fungicide X
2021	600	Insecticide C	Fungicide Z
2022	700	Insecticide D	Fungicide Y
2023	750	Insecticide B	Fungicide Z

Table 9 Fish Mortality Records

Year	**Fish Mortality Events (count)**	**Likely Cause (Insecticides/Fungicides)**	**Measures Taken**
2018	20	Insecticide A	None
2019	15	Fungicide Y	Reduced Usage
2020	10	Insecticide A	None
2021	25	Fungicide Z	Increased Monitoring
2022	18	Insecticide D	Water Quality Improvement
2023	30	Insecticide B and Fungicide Z	Restriction of Use

Table 10 Fish Reproduction Trends

Year	Number of Fish Fry (count)	Environmental Conditions	Likely Influence of Insecticides/Fungicides
2018	8000	Stable	Low impact
2019	7500	Deteriorating	Moderate impact
2020	8500	Stable	Low impact
2021	7000	Declining	High impact
2022	8200	Improving	Moderate impact
2023	7800	Improving	Low impact

Table 11Different Fish Species' Vulnerability to Pesticides and Fungicides

Fish Species	Sensitivity to Insecticides	Sensitivity to Fungicides
Species A	Low	Moderate
Species B	Moderate	Low
Species C	High	High

Table 12 Regulatory Changes

Year	Regulatory Action Taken
2019	Introduction of stricter regulations on insecticide use
2021	Ban on a specific fungicide due to its high toxicity
2023	Implementation of pesticide-free buffer zones

Table 13 Community Perception Survey Results

Year	Percentage of Community Concerned About Pesticide Use	Awareness of Risks
2018	30%	Low
2019	45%	Moderate
2020	35%	Low
2021	60%	High
2022	50%	Moderate
2023	70%	High

These additional tables provide more context for the impact of insecticides and fungicides on the freshwater fish ecosystem. They cover trends in pesticide usage, fish mortality events, fish reproduction, species sensitivity, regulatory changes, and community perceptions. Analyzing these data points alongside the previously mentioned tables can provide a more comprehensive understanding of the situation in the Gomti River ecosystem.

4. CONCLUSIONS

Weed and insect pest management using pesticides is often seen as a fast, simple, and cheap option for urban environments. There is a high price to pay for pesticide usage, however. Urban pesticide usage contributes to the nationwide issue of pesticide residues being discovered in soil and air as well as in both surface and groundwater. Insects, plants, fish, and birds are just some of the non-target creatures that might be harmed by pesticide pollution. Herbicides, against popular belief, may really be harmful to ecosystems. Weed killers pose problems due to their widespread use. Safer, non-chemical pest management (including weed control) measures may help decrease pesticide contamination (and the damage it causes) in our environment. Effluents should not be permitted to discharge into water reservoirs without sufficient pretreatment in order to prevent water contamination by other components like sewage or industrial wastes. In addition, it is crucial that water be constantly monitored and analyzed by the proper institutions.

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