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Assessment of Toxicity in Fresh Water Fish Labeo Rohita Treated

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Abstract - The term "toxicity" is used to describe the potential for a material to harm or kill living organisms. Acute toxicity tests are used to determine if a substance or effluent, in specific quantities, is harmful to a group of test organisms under controlled conditions of exposure for a relatively brief period of time. Population increase, rapid urbanisation, rapid industrialization, and rapid agricultural development have all had a major impact on water quality and availability in India. Human actions including oxygen depletion, increasing BOD & COD loads, and alterations in water clarity, pH, phosphate, and nitrate levels are to blame for eutrophication and the degradation of water quality. Aquatic organisms are particularly vulnerable to environmental pollution. Ecological exploitation has put aquatic ecosystems including plankton, fish, and invertebrates under tremendous pressure. Here, fish bioassays might prove to be a useful tool for assessing the state of water that has been polluted with a wide variety of potentially hazardous substances. Fish bioassays have revealed a wide variety of pathological effects, including stunted development, in polluted river water. Both generalizable and target-specific effects can be investigated through bioassay research. An organism is able to successfully deal with the challenge of survival in a changing environment because of its behavior, which allows it to adapt to both external and internal inputs.

Keywords - Toxicity, Fresh Water, Fish Labeo, Population.

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INTRODUCTION

Water is one of the most significant and extensively distributed resources on the planet, and life cannot exist without it. The estimated amount of freshwater on the earth is just 3%; saltwater makes up the vast bulk. These freshwaters were much further covered by glaciers and polar ice caps. Because of this, surface and land water sources are among the world's most threatened infrastructure and are thus of utmost importance. This implies that both the amount and consistency of these services must be appropriately controlled. Water safety is a big worry due to the ever-increasing pollution loads in today's globe. The consistency of surface waterways is deteriorating as a result of the careless dumping of industrial effluents, agricultural runoff, waste, and other residential contaminants. Both of which have a significant impact on non-target creatures and water use. [1]

Toxic effects are those that a chemical is likely to have on living organisms. Acute toxicity studies are performed to ascertain whether or not a certain dose of research material or effluent negatively affects a population of test species during a regulated short-term exposure. The quantity and quality of water in India have been significantly affected by the country's rapidly growing population, expanding urban and industrial infrastructure, and increasing agricultural production. The loss of oxygen, rising BOD and COD loads, and rising clarity, pH, phosphate, and nitrate levels caused by human activities are major contributors to eutrophication and water quality decline. Pollutants in the environment have been found to have negative effects on marine life. A variety of aquatic organisms are in danger as a result of human activity, including plankton, insects, and invertebrates. Testing the stability of water contaminated with complex radioactive chemical mixes may be extremely helpful with fish bioassays. Some clinical signs in polluted river water may be detected using bioassays on fish. Bioassay studies may be conducted to investigate either broad or narrow effects.[2]

ECOLOGY AND ENVIRONMENTAL ASPECTS

Ecology is the study of how different types of living things interact with their surroundings. The Greek words "oikos" and "logos," which translate to "house" and "place to live in, respectively," are the roots of the English word "ecology." German scientist Ernst Haeckel first used the word ecology in 1869. It concerns with how living things are distributed, abundant, and interact both globally and at the level of communities, populations, and ecosystems. Ecosystems are composed of these interactions between people, groups, and communities and their environment.

An ecosystem is a group of living things that interacts as a system, including nearby nonliving elements of the environment. It is the structural and functional unit of ecology. It is made up of biotic and abiotic elements that are connected by energy and nutrition cycles. Ecosystems are dynamic systems that are controlled by both internal and external causes and are periodically disturbed. An ecosystem has two main components that are always communicating with one another. [3]

WATER – AN INDISPENSABLE RESOURCE

Water is the "Pillar of our Civilization" since it is the most valuable, necessary, and renewable natural resource. It's an essential resource for all forms of life on Earth and one of the most precious. Nearly three-quarters of Earth's surface is covered by water, making aquatic ecosystems crucial to our planet's health. Water is found in the seas as salt water, on land as surface water in lakes and rivers, underground as ground water, in the atmosphere as water vapour, in the form of solid ice, and in municipal water distribution systems.[4]

There is just around 3% freshwater on Earth, with the rest being salty. Seventy percent of the world's freshwater is found in glaciers, twenty-nine percent in subterranean water, and one percent in rivers and lakes More quickly and widely than at any other similar moment in human history, people have altered ecosystems during the last several decades, mostly to fulfil the world's expanding needs for food, fresh water, lumber, fibre, and fuel. This has led to a significant and essentially irreversible decline in the diversity of life on Earth. The changes made to ecosystems have resulted in significant net improvements in human well-being and economic growth, but these improvements have come at an increasing price in the form of the loss of many ecosystem services, increased risks from nonlinear changes, and the aggravation of poverty for some groups of people. [5]

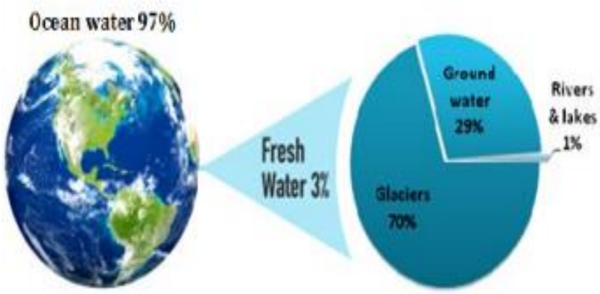

Figure 1: Water resources on earth

A self-inflicted burden on humanity is pollution

The introduction of pollutants that have a negative impact on the environment is referred to as pollution. Water pollution has been increasing at a shocking pace among other sorts of contamination as a result of the world's fast industrialization, civilization, and green revolution. Surface and groundwater sources are being contaminated by industrial wastes that are regularly dumped into water basins. Water contamination has many different causes and sources, and it is widely categorised on a number of criteria Water contamination is thus the cost of progress brought forth by technical advancements that enhance human lifestyle. Simply put, it is an adverse anthropogenic influence on natural water bodies caused by advanced technology for human wellbeing.

Over five million chemical compounds have already been created by humans, and chemical firms produce over 150 million tonnes of synthetic chemicals each year. Every year, massive amounts of oil are hidden by mining activities and other geophysical changes. From their natural deposits, significant amounts of organic and inorganic materials have been discovered. During manufacture, storage, transit, use, or final disposal, these activities cause the release of chemicals and waste products into the environment, which participate in natural cycles and reactions and subsequently disrupt the ecosystems. These chemicals and waste materials mostly end up in the aquatic environment. Natural water body contamination is becoming a widespread issue in emerging nations. Numerous synthetic organic compounds that have the potential to damage the aquatic environment are among the countless chemicals that are utilised commercially. The by-products of industrial and urban activity are other water pollutants. For instance, the manufacture of chlorophenoxy herbicides and chlorophenols produces chlorinated dibenzo-p-dioxins as a byproduct, as does the burning of organic waste.[6]

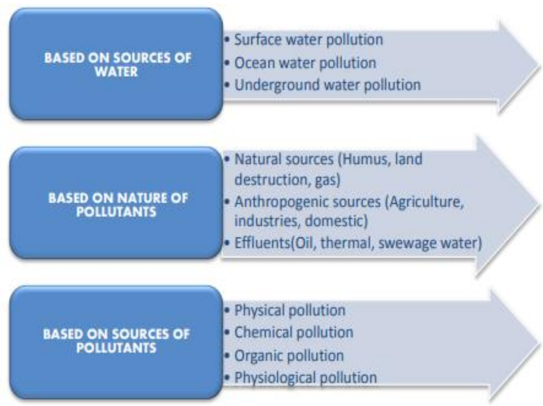

Figure 1.2: Classification of water pollution based on different criteria.

Water body pollution has become a global issue for both emerging and developed countries as a result of rapid urbanisation and industrialisation. The main water resources are harmed by the principal sources which include industrial effluents, drainage, household waste, agricultural waste, and discharges from sewage treatment facilities. As a result, water's capacity to support its biotic communities goes through a noticeable change. The indiscriminate usage of harmful substances is causing grave worry around the globe. Understanding the harmful effects of the contaminants that pose a significant danger to aquatic life has therefore become necessary.

Over the past few decades, the threat to public water supplies as well as the harm done to aquatic life have made the contamination of freshwater with a wide variety of pollutants a source of great concern. Surface water quality in a region is largely influenced by anthropogenic activities like urban, industrial, and agricultural influence and increasing water resource exploitation, as well as natural processes like precipitation rate, weathering, and soil erosion. Surface run-off is a seasonal occurrence, whereas wastewater discharge is a continuous polluting source.[7]

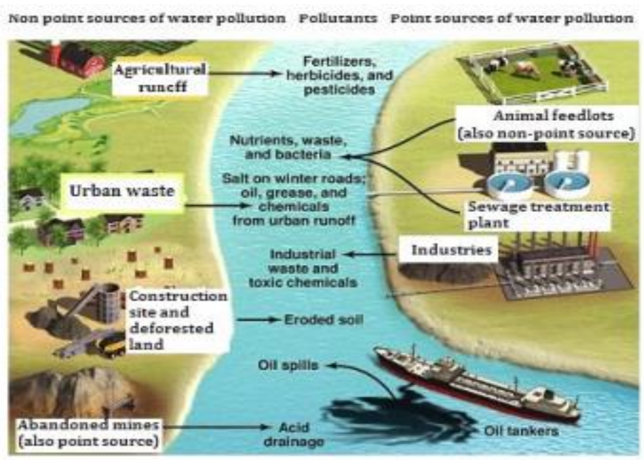

Figure 1.3: Different sources (point and non-point) of water pollution.

SOURCES OF WASTEWATER

The amount of water used in this business varies drastically from mill to mill, process to process, tool to tool, and product to product. Many gallons of water are used in the manufacturing of textiles, and most of that water is wasted as wastewater. The pretreatment, dyeing, printing, and finishing of textiles are major sources of contamination. Desizing is the main cause of pollution in this area. Throughout desizing, all of the sizes that were used during the weaving process are taken out of the cloth and flushed down the toilet. Cleaning a fabric made of natural fibres with scouring removes contaminants and discards them in a wastewater stream. During wet processing, desizing and scouring are often performed together, and together they may be responsible for as much as 50% of the BOD in the wastewater. The environmental damage caused by peroxide bleaching is minimal.[8]

Dyeing creates a large quantity of wastewater, which makes up the bulk of the effluent. Preparation of the dye, cleaning the used dye bath, and washing all result in wastewater production. Dyes produce a rainbow of colours in the wastewater they are dumped into, but also a lot of salt. Resins, softeners, and other auxiliaries, together with other organic pollutants, are left behind throughout the finishing process. In a nutshell, starches, dextrin, gums, glucose, waxes, pectin, alcohol, fatty acids, acetic acid, soap, detergents, sodium hydroxide, carbonates, sulphides, sulfites, chlorides, dyes, pigments, carboxymethyl cellulose, gelatin, peroxides, silicones, fluorocarbons, and resins are all present in the composite wastewater from an integrated textile plant.

Wastewater Characteristics

The volume of process wastewater generated by each unit activity in a textile mill is dwarfed by the volume generated by the size and desizing operation, which follows after the bleaching, dying, and printing phases. Indian textile factories use around 61-646 L/kg of fabric in raw water, generating an average of 35 L/m of fabric, or 86-247 L altogether, in effluent. Water utilised in wet processes typically makes up between 58 and 81% of total water usage, therefore this percentage also applies to wastewater.

Each step in the process of making textiles results in the discharge of wastewater. The amount and composition of these wastewaters change with a variety of factors, such as the kind of material, manufacturing method, and chemicals used. Many harmful substances are released by the textile and dyeing industries. Even though effluent qualities may vary widely across operations, it is possible to make generalisations. Based on the descriptions provided, it was determined that all of the effluents were highly polluted with various organics, colours, and metals.[9]

Treatment of wastewater

All people have a right to a healthy environment, thus we must make every effort to reduce pollution if we want to leave the future generation with a clean environment. There are still numerous companies that dilutionally release their wastewater into streams or waste disposal areas. However, all companies are now developing their own treatment facilities as a result of the Water (Prevention and Control of Pollution) Act of 1974, with the majority of these facilities being situated in the South Gujarat area. Industrial wastewater treatment is difficult because of a number of inorganic and synthetic organic pollutants, many of which are not readily susceptible to biodegradation. Without access to more advanced technology than we now have, it will be difficult to identify and get rid of solvents, oils, polymers, metallic wastes, suspended particles, phenols, and many other chemical industrial process byproducts. It is regrettable but true that additional strategies must be employed to minimise the trash to space ratio when there is a lack of room and diluting the rubbish is not an option. In certain natural situations, a lot of habitat helps to reduce waste issues.[10]

The techniques used might be a mix of physical, chemical, and biological techniques. In most cases, just the following techniques are employed to separate the particles from the liquid:

- The use of coagulants, precipitants, screening, and sedimentation may all improve the removal of soluble and suspended particles.
- Biological processes are used to oxidise organic molecules. When volatile compounds are present, aeration alone may be useful, but it is seldom enough or productive.
- Acidic waste in large quantities has to be neutralised. For economy and control, equalisation is often necessary before neutralisation using sodium hydroxide, lime, sodium carbonate, or mixtures of these popular neutralisation agents.
- Depending on the kind and quantity of hazardous material present, the elimination of poisonous substances necessitates a particular technique of treatment. Industrial waste processing produces residue that might be anything from watery slurries to solid precipitates.

PHYSICOCHEMICAL TREATMENTS (ADVANCED TREATMENT)

i. Adsorption

The increase in component concentration at the surface of a two-phase interaction is known as adsorption, a surface phenomenon. Physical adsorption may be replaced with chemisorption, in which a chemical reaction occurs between the sorbent molecule and the adsorbent surface (physisorption). Physical sorption is a general process with no degree of specificity, while chemisorption depends on the reactivity of the adsorbent and adsorptive. The surface reactivity is linked to the chemisorbed molecules, guaranteeing monolayer adsorption. A multilayer structure often experiences significant relative pressures during physisorption. When a molecule is physisorbed, it preserves its original identity and returns to its liquid condition. If a molecule has a reaction or dissociation while being chemisorbed and its original identity cannot be restored by desorption, it will lose its original identity. Chemisorption requires the same amount of energy that a comparable chemical reaction does. In physisorption, exothermic energy is often present, although it seldom exceeds the energy of condensation during the adsorption phase.[11]

ii. Coagulation

The word "coagulation" comes from the Latin verb coagulare, which means to force things together. This method describes what happens when a chemical is added to a colloidal dispersion and the force trying to keep the particles apart results in particle destabilisation. When the right chemical is used, coagulation takes place, causing particles to stick together when they come into contact. The first particles produced are submicroscopic in size, and the whole process occurs in a split second. In order to treat water, coagulation is often brought about by adding salts that hydrolyze in the liquid. Iron salt or aluminium salt are added to muddy water to clarify it. The pH of the water will drop if alum is used for coagulation because there will be an excess of hydrogen ions. Over the last ten years, important advancements in our understanding of the mechanics of coagulation have been made possible by the hydrolysis of metal ions.

iii. Neutralization

Even while it would appear straightforward to combine an acid with a base to neutralise it, there are really a number of challenges that must be solved when handling acid waste. Examples of neutralising agents include limestone, hydrated lime, ammonia, sodium hydroxide, sodium carbonate, and quick lime. Lime and limestone may include dolomitic minerals, or minerals rich in calcium. Although sodium carbonate, sodium hydroxide, and ammonia are all potent neutralising agents, they are seldom utilised because to their high costs. Recombining the waste with metal ions is often required for the treatment of wastes such as metals, oils, and grease in order to neutralise and precipitate the waste. Due to the volume and weight of the created flux, waste is given some time to settle. To neutralise acidic wastes, one option is to mix the waste with lime or dolomite lime slurries, transport the waste via limestone beds, or use strong caustic soda (NaOH) or soda ash (Na_2CO_3).[12]

iv. Remedial measures

Reducing pollution levels must be a top priority. Avoiding pollution may be accomplished by the use of legal, social, economic, and technological measures. Trash-related pollutants damage our air, land, and water in a variety of different ways before entering the ecosystem. Waste items being present in water is particularly alarming since many of them might enter the food chain and becoming harmful due to biochemical reactions. Studying sewage disposal and waste management techniques is crucial. According to the EPA, copper is a "high priority" pollutant.

EFFECT OF WASTES

The repercussions of used dye can be simplified into four categories:

i. Toxicity to fish and fish food

Depending on factors including fish size, age, and sensitivity to chemicals, some of the compounds that may be found in dyeing wastes may be harmful to fish and fish food. Not only should the entering water's pH, temperature, hardness, total alkalinity, oxygen content, and other dissolved components be taken into account, but so should the water's source. It's also important to think about the stream's biota, how much stratification there is, how much oxygen is there, and whether or not there are any compounds that are either synergistic or antagonistic. Streams open to the public that have been polluted with dyes represent a potential threat to humans since aquatic species, especially fish, may absorb the chemicals into their tissues, potentially disrupting the food chain. [13]

ii. Effect on human beings

Human health is at danger due to the toxic nature of the wastewater created by the textile industry. Examples of this kind of trash include:

- Chemicals that irritate or inflame tissues;
- toxins or poisons that have negative effects when inhaled or ingested;
- corrosion agents that damage body tissues
- Substances that are carcinogenic,
- mutagenic, or teratogenic;
- allergenic chemicals;
- combustible mineral oils and organic solvents

In addition, colour is often the first indicator of water pollution. Extensive use of dyes in both the industries that produce and consume dyes results in significant problems, primarily the discharge of coloured wastewater. Some dyes are highly visible at concentrations as low as 1 ppm, which can have an effect on the quality of water bodies. Dyes aren't just bad for the planet; they can also be hazardous to human health. Toxic, mutagenic, and carcinogenic dyes do exist. There is a potential for long-term water supply contamination from industries that release dyes into the environment. Allergies, dermatitis, skin irritability, cancer, and mutations are just some of the negative effects that drinking water contaminated with dyes can have on infants and adults. [14]

iii. Effect on sewers

Corrosive acid wastes from the dyeing process can eat away at concrete and metal structures. The soap in sewage is broken down by acids into fatty acids, which then form a sticky scum that clings to surfaces and makes sludge-dewatering difficult.

iv. Effect on sewage treatment processes

Due to the waste chemicals' harmful reactivity with living things, dyeing wastes have a negative impact on sewage treatment operations.

FISH – AN IDEAL BIOMONITOR AIDING IN AQUATIC TOXICITY ASSESSMENT

In environmental research, the use of bioindicators provides important information on toxicological effects on the living ecosystem components that are not identified by chemical approaches. A sensitive and reliable method to gauge the possible impacts of toxic wastes is provided by studies on sentinel species for environmental quality assurance and biomonitoring. The development of ecotoxicity detection methodologies is very necessary due to the rising usage of dangerous chemical contaminants in many industrialised regions of the globe.[15]

Fish are the finest bioindicators of water pollution since they are the dwellers who are most directly affected by its negative effects. Owing to their extensive range of mobility, which enables the assessment of a large-scale geographical impact, and also due to their significance to humans as a source of protein, they are recognised as an essential experimental model for toxicological investigations. Organic substances that are either dissolved in water or ingested by fish come into touch with them. When determining if chemicals in water or food are dangerous to fish, it's vital to take into account how these substances are distributed in the environment, carried within fish, digested, and excreted. It belongs to one of the most significant groups of vertebrates, which has a significant impact on man's way of life. Numerous people have hunger and nutritional deficiencies, which cause them to suffer. The world of today faces several issues, one of which is protein nutrition. Thus, fish, which contains 13–19% of animal protein, is crucial in reversing this nutritional imbalance. Fish play a significant role in the aquatic ecosystem's food chain. It is generally recognised as a model test animal for determining aquatic contaminations since it is a significant part of the aquatic population. Fish are significant in toxicity research due to their capacity to react to contaminants and their function in the trophic web (bioaccumulation and biomagnification). Due to their ecological significance and intimate connection with the aquatic environment, these organisms are well-suited to aquatic bioassay research and the visible behavioural, morphological, and histopathological responses. Water pollution has a negative influence on fish production and health and reduces the variety of fish species. It is clear that fish health reflects and provides a reliable indicator of the condition of a specific aquatic ecosystem.[16]

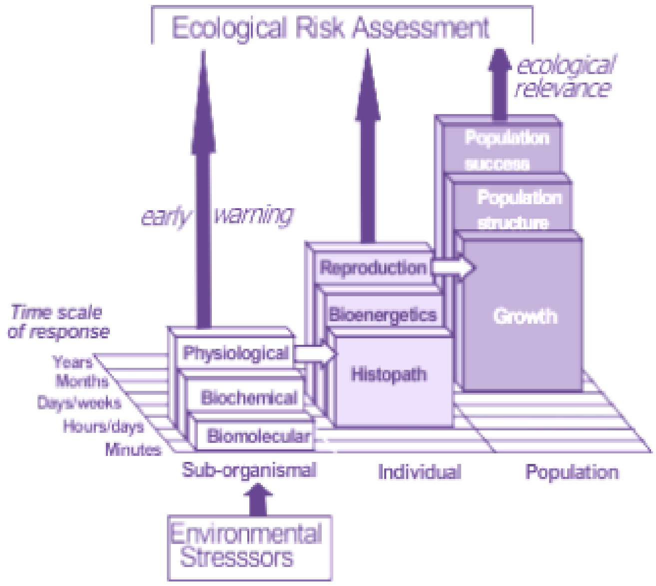

Figure 1.4: Environmental stressors acting on various organizational levels in living organisms

CONCLUSION

Since ever-increasing industrial, agricultural, and other related activities have an influence on water quality, managing water resources is a challenging challenge. Groundwater levels are falling, freshwater sources are becoming more limited, and water quality is deteriorating as a result of urbanisation and population increase. These actions not only put individuals in peril but also severely impact fish species and aquatic ecosystems in general. Based on acute toxicity bio-assays, the 96-hour LC50 value and 95% confidence limits were discovered to be 44.25%. (38.47-50.92). Fish in a poisoned medium had abnormal schooling, erratic and frenetic swimming motions, hyperexcitability, loss of balance, and a vertical posture before they died. Dark body coloration, increased mucus production, loosening and loss of scales, haemorrhages on skin and fins, lateral flexure in the caudal region, and changed pectoral fin position were among the morphological issues.

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