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Assessment of Toxicity in Fresh Water Fish Labeo Rohita Treated

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Abstract: A substance's ability to inflict damage or death on living beings is quantified by its "toxicity" degree. Researchers conduct controlled, short-term studies of acute toxicity to find out whether a drug or effluent is harmful to a range of species at certain quantities. There has been a dramatic decline in the quantity and quality of water in India as a result of the country's fast population increase, industrialisation, and agricultural expansion. Oxygen depletion, elevated biochemical and chemical oxygen demand loads, changes to phosphate, nitrate, and pH levels, and changes to water clarity are only a few ways in which human activities contribute to eutrophication and the deterioration of water quality. Pollution poses a significant threat to aquatic life. Invertebrates, plankton, and fish are in a particularly vulnerable situation due to the ecological exploitation of aquatic habitats. To evaluate the condition of water that has been contaminated with various potentially harmful compounds, fish bioassays may prove to be an effective technique. Bioassays on fish have shown stunted growth, which is only one of the several negative impacts of dirty river water. The use of bioassays allows for the investigation of effects on both specific targets and larger populations. By changing reactions to both internal and external signals, behavioural adaptations assist animals in coping with the difficulty of living in surroundings that are always changing.

Keywords: Fish Labeo, Fresh Water, Toxicity, Population

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INTRODUCTION

One of the most varied and plentiful resources on our planet, water is necessary for all life. Only around 3% of the water on Earth is freshwater, whereas the great majority is salty. The freshwaters were mostly surrounded by polar ice caps and glaciers. The vulnerability of surface and land water sources highlights their criticality as one of the planet's most vulnerable infrastructures. Therefore, it is critical to have tight control over the frequency and quantity of these services. A water safety crisis has emerged due to the increasing levels of pollution throughout the world. The lack of consistency in surface streams is being worsened by the negligent release of various residential pollutants, agricultural runoff, industrial effluents, and garbage. Neither of those things helps save water or harms unintended wildlife. [1]

Any material with the potential to harm living things is considered toxic. The goal of acute toxicity studies is to identify any potential harmful effects of a study chemical or effluent at a certain dosage on a group of experimental animals during a specific time period. Rapid population growth, rising urbanisation and industrialisation, and higher agricultural output have all contributed to a precipitous drop in India's water supply, both in terms of quantity and quality. Anthropogenic factors that contribute to water pollution include oxygen depletion, increased biochemical oxygen demand (BOD and COD loads), changes in pH, phosphate, nitrate, and clarity. The effects of pollution on marine life are catastrophic, according to research. Insects, plankton, snails, and many other aquatic creatures are in risk of extinction due to human interference. The stability of water polluted with complicated mixtures of radioactive chemicals may be better understood via the use of bioassays on fish. Fish bioassays may be able to identify certain clinical signs in polluted river water. Bioassay research allows for the investigation of both general and targeted effects.[2]

ECOLOGY AND ENVIRONMENTAL ASPECTS

Ecology studies ecosystems and the relationships between various forms of life. In Greek, "oikos" means "house" and "logos" means "place to live in." The English term "ecology" is derived from these two ideas. Ernst Haeckel, a German biologist, coined the term "ecology" in 1869. Global ecosystems, populations, and communities of living organisms, including their distribution, interactions, and amount, are the focus of ecosystem research. Interdependence between humans and their natural surroundings forms intricate webs known as ecosystems.

All the living and nonliving creatures in a certain area form an interconnected web called an ecosystem. As a fundamental part of ecosystems, it is essential. Energy and nutrition cycles connect biotic and abiotic components. Ecosystems are subject to periodic shocks and are constantly changing due to the influence of several internal and external factors. The two primary parts of every ecosystem are always influencing one another. [3]

WATER – AN INDISPENSABLE RESOURCE

Because of its boundless worth, energy, and ability to regenerate, water is revered as the "Pillar of our Civilisation" by humans. Since it is essential to the survival of every single living thing on Earth, it is rightfully considered a rare resource. Since water makes up almost three quarters of Earth's surface, aquatic ecosystems are vital to the planet's survival. There are many different places and kinds of water. Some examples include surface water (found in bodies of water like lakes and rivers), groundwater, air (by condensation and solid ice), and municipal water systems. For example, saltwater is considered surface water.[4]

Only around 3% of the water on Earth is fresh; the rest is saltwater. An incredible 70% of the freshwater on Earth is stored in glaciers, while 29% is in underground water and 1% is in bodies of water like lakes and rivers. The ever-increasing global need for food, water, wood, fibre, and fuel has caused extensive and fast environmental change over this period of human history. This is the primary cause of the precipitous and likely ongoing decrease in Earth's biodiversity. Ecosystem services have been lost, nonlinear change dangers have grown, and poverty has been worsened for certain groups of people, despite the fact that ecological changes have boosted human well-being and economic wealth. [5]

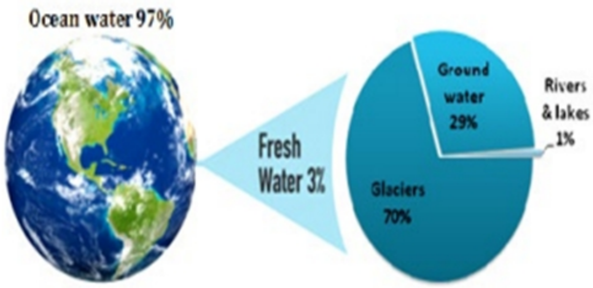

Figure 1: Water resources on earth

A self-inflicted burden on humanity is pollution

When we add contaminants into an ecosystem, we erode its natural components. This process is called pollution. Along with rapid industrialisation, urbanisation, and the green revolution, there has been a concerning increase in water pollution and other forms of contamination on a worldwide scale. Discharging industrial waste into water basins is a common practice that pollutes both surface and subsurface water sources. There is no universally accepted way to classify water pollution, yet there is no shortage of potential sources. As a consequence, technological advancements that improve human existence also cause water pollution. To rephrase, it's the harm that natural water bodies endure due to technological advancements that people have caused.

Chemical industries produce around 150 million metric tonnes of synthetic chemicals annually, and humans have synthesised over five million chemical substances. Large amounts of oil are buried annually as a result of mining and other geophysical processes. Their natural deposits include a wide variety of organic and inorganic components. Chemicals and waste are released into the environment during all of these processes, beginning with the extraction of basic materials and ending with disposal. Subsequently, these pollutants disrupt ecosystems by their interactions in natural cycles and reactions. The majority of these pollutants and garbage end up in aquatic habitats. The issue of contamination of natural bodies of water is becoming more pressing for developing nations. Many synthetic organic compounds have the potential to damage aquatic environments, and among the many chemicals utilised in industry is an overwhelming number of these molecules. Urban and industrial runoff is another source of water contamination. Multiple activities release chlorinated dibenzo-p-dioxins into the environment. These include burning organic waste, making chlorophenoxy herbicides and chlorophenols, and many more.

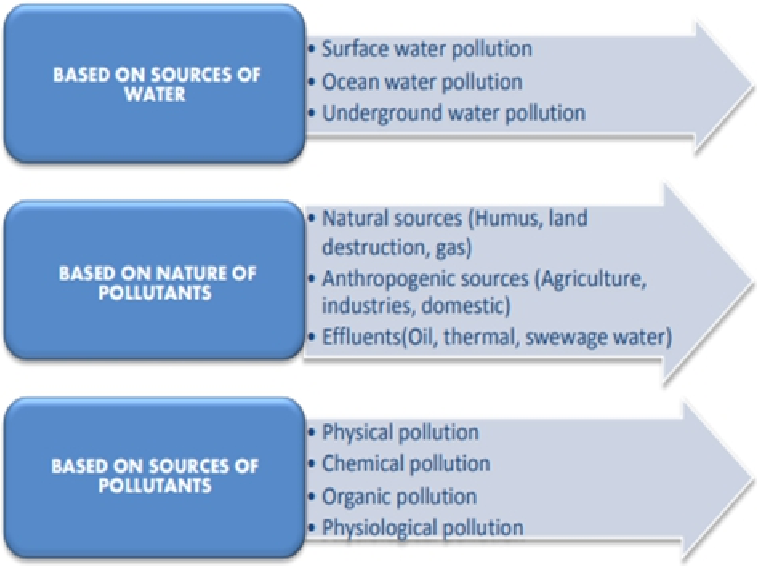

Figure 2: Water pollution Classification based on different criteria.

Pollution of water bodies is a growing concern in both developed and developing countries due to rapid industrialisation and urbanisation. The major water resources are mostly endangered by discharges from sewage treatment facilities, industrial effluents, drainage, household rubbish, and agricultural waste. As a result, the capacity of water to support its biological populations is changing. Concern about the casual usage of harmful substances is widespread. Understanding the harmful effects of contaminants that threaten aquatic life is crucial.

Freshwater contamination with different pollutants has been a major concern for the last few decades because of the harm it does to aquatic life and the threat it presents to public water supplies. An area's surface water quality is affected by a lot of things, both natural and man-made. These include things like the rate of precipitation, weathering, and soil erosion. Surface run-off is a seasonal phenomenon, as opposed to the year-round pollution caused by wastewater discharge.[7]

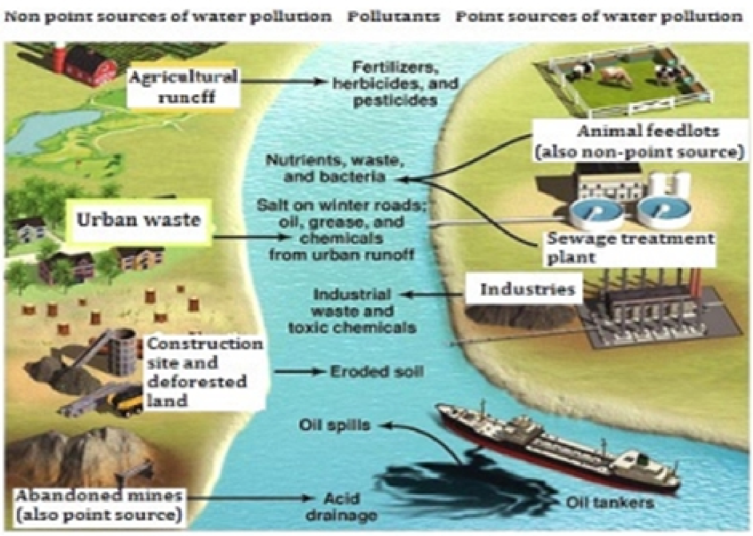

Figure 3: Water pollution Different sources (point and non-point).

WASTEWATER SOURCES

Every mill, process, equipment, and product in this sector uses water in a somewhat different way. The textile business uses a lot of water—many gallons—of which is mostly wastewater. The majority of textile pollutants make their way into the fabric during the pretreatment, dying, printing, and finishing stages. Desizing is a major contributor to the pollution in this area. For textiles, desizing is dumping all the different sizes of fabric that were used in the weaving process down the drain. The process of scouring removes contaminants from textiles made of natural fibres before washing them away in a wastewater stream. Wet processing often involves desizing and scouring, two processes that may add up to half of the biological oxygen demand (BOD) to the effluent. The environmental effect of peroxide bleaching is almost nonexistent.[8]

A large portion of the effluent is wastewater, which is produced during the dyeing process. There are a number of processes that lead to wastewater, including washing, cleaning up the dye bath, and preparing the dye. When thrown in wastewater, dye waste creates a kaleidoscope of colours but also adds a significant amount of salt. While finishing, a lot of auxiliaries, such as resins and softeners, are left behind, along with other organic contaminants. A composite wastewater from an integrated textile plant contains a wide variety of substances, including starches, gums, sugar, waxes, pectin, alcohol, fatty acids, acetic acid, soap, detergents, sodium hydroxide, carbonates, sulfurides, sulfites, chlorides, dyes, pigments, carboxymethyl cellulose, gelatin, peroxides, silicones, fluorocarbons, and resins.

Wastewater Characteristics

The size and desizing operation generates a disproportionately large quantity of effluent in comparison to the other unit operations in a textile mill's process, after bleaching, dying, and printing. Indian textile mills typically use 61-646 litres of water per kg of fabric for raw materials, and they release 86-247 litres of wastewater, or 35 litres per sq. m., into the environment. Since 58% to 81% of all water usage is attributable to wet processes, wastewater is not dissimilar to the other water sources.

The textile manufacturing process generates wastewater at every step. The amount and composition of these wastewaters are impacted by several factors, such as the kind of material, manufacturing method, and chemicals used. Plenty of toxic chemicals are released into the air by the textile and dying sectors. Although there may be substantial variation in effluent quality among companies, generalisations may still be made. Based on the data provided, it was determined that all of the effluents were highly polluted with various organic compounds, dyes, and metals.[9]

Treatment of wastewater

Everyone has an inherent right to a safe and healthy environment, and it is our responsibility to ensure that future generations continue this tradition. Diluting wastewater before releasing it into landfills or rivers is still a common practice for many firms today. In any case, according to the Water (Prevention and Control of Pollution) Act of 1974, every company is now building their own treatment facilities. These enterprises are mostly located in the South Gujarat region. The treatment procedure is further complicated since many of the inorganic and synthetic organic pollutants included in industrial wastewater are not readily biodegradable. Oils, polymers, solvents, suspended particles, phenols, and metallic wastes are just a few examples of the chemical byproducts that are currently difficult to identify and eradicate due to the limitations of present technology. The need for alternative strategies to decrease the trash-to-space ratio becomes more pressing when room is limited and diluting garbage becomes impractical. In certain natural areas, having a lot of habitat might help reduce waste.

Many other techniques, including physical, chemical, and biological ones, might be considered. The following procedures are often used for particle extraction from liquids:

- Biological activities oxidise organic molecules.
- Clouvants, precipitants, screening, and sedimentation may be used to remove suspended and soluble particles more efficiently.
- When volatile compounds are present, aeration is seldom enough or productive, yet it could work when utilised alone.
- It is critical to neutralise massive amounts of acid waste.
- For economical and controllable reasons, it is frequently necessary to equalise the solution before neutralising it using sodium hydroxide, lime, sodium carbonate, or a combination of these common neutralisation agents.
- The kind and quantity of hazardous material determine the precise treatment method needed for the removal of harmful compounds.
- The end product of processing industrial waste might be anything from a solid precipitate to a watery slurry.

PHYSICOCHEMICAL TREATMENTS (ADVANCED TREATMENT)

i. Adsorption

The process of increasing a component's concentration via what is often referred to as "adsorption" on surfaces is really a two-phase interaction. Chemisorption is an alternative to physical adsorption that involves a chemical interaction between the sorbent molecule and the adsorbent surface. Chemisorption is selective and depends on the reactivity of the adsorbent and adsorptive, while physical sorption does not. Adsorption to a single layer is ensured by surface reactivity in conjunction with the chemisorbed molecules. As a result of physisorption, a multilayer system is often subjected to high relative pressures. While maintaining their molecular structure, physisorbed molecules undergo a phase transition back to a liquid state. It is possible for molecules to lose their original identities when they react or dissociate when chemisorbed and desorption cannot restore them. Equal amounts of energy are required for chemisorption and similar chemical reactions. Although physisorption's exothermic energy is often lower than adsorption's condensation energy, it is nevertheless substantial. [11]

ii. Coagulation

Originating from the Latin word "coagulare," meaning to compel anything to join together, the English term "coagulation" arrives at its root. The method is based on the idea that the addition of a chemical to a colloidal dispersion causes the particles in the solution to become unstable due to the force that is attempting to separate them. Using the correct chemical causes coagulation, which causes particles to adhere to one another upon contact. First of all, creating particles with a size less than a micrometre just takes a nanosecond. Water treatment often involves the use of salts that hydrolyse in water and cause coagulation. Water that is murky may be clarified by adding iron salt or aluminium salt. When alum is employed as a coagulant, the pH of the water is lowered due to the high concentration of hydrogen ions in the water. Hydrolysis of metal ions has recently allowed us to make strides in comprehending the mechanics of coagulation.

iii. Neutralization

Although it may seem to be as simple as combining an acid and a base, there are really quite a few obstacles to overcome in order to neutralise acid waste. Acids like ammonia and bases like sodium hydroxide and quick lime and limestone are examples of neutralising agents. Rocks such as dolomite and limestone contain minerals that are rich in calcium. Despite their powerful neutralising capabilities, ammonia, sodium hydroxide, and sodium carbonate are not widely used due to their high price. To neutralise and precipitate waste materials like metals, oils, and grease, it is usually necessary to recombine the waste with metal ions. The generated flux is huge and heavy, therefore the waste takes a long time to settle. Limestone or dolomite slurries, limestone transportation beds, strong caustic soda (NaOH), and soda ash (Na2CO3) are some of the efficient options for neutralising acidic wastes.[12]

iv. Remedial measures

The reduction of pollutant levels must be given top priority. To reduce pollution, it may be necessary to implement policies at the legal, social, economic, and technical levels. Air, land, and water are first victims of waste pollution before it reaches ecosystems. The presence of these waste products in water is particularly worrisome because they may enter the food chain and trigger harmful metabolic processes. Research into sewage and trash management techniques is essential. Among the contaminants that the EPA considers to be of "high priority" is copper.

EFFECT OF WASTES

There are four main categories into which the impacts of used dye fall:

i. Harmful effects on fish and fish meals

Dyeing wastes include compounds that might be harmful to fish and fish food. How much harm comes from these chemicals depends on factors including the fish's age, size, and chemical sensitivity. Factors to examine while analysing incoming water include its oxygen content, total alkalinity, temperature, hardness, and pH, as well as its source. Additional considerations include stratification, oxygen levels, the biota of the stream, and the existence or lack of compounds that work with or against each other. Many fish and other aquatic species absorb these contaminants into their tissues, making them a potential threat to humans if they inhabit streams that are open to the public and have been polluted with dyes. in [13]

ii. Impact on people

Human health is at risk from textile wastewater due to its high toxicity. Examples of this kind of waste include toxins, poisons, inflammation-inducing compounds, corrosion agents, and other substances having negative effects when inhaled or eaten.

Chemicals that cause allergies, combustible mineral oils and organic solvents, chemicals that might cause cancer, mutations, or birth defects are all examples of such substances.

Moreover, changes in colour are often the first signs of water contamination. The emission of coloured wastewater is the most noticeable consequence of dye production and use, both of which are significant causes of significant concerns. Many dyes may have an impact on water quality at concentrations as low as 1 ppm because of how noticeable they are. In addition to damaging the environment, dyes may have negative effects on human health. Toxic effects, cancer, and mutagenesis have been linked to dyes. Companies that release dyes into the environment endanger the sustainability of our water supply. Problems with allergies, dermatitis, skin irritation, cancer, and mutations are just some of the many health issues that may arise from dye pollution in drinking water, which can affect both babies and adults. [14]

iii: Impact on Drains

Metal and concrete are vulnerable to the acidic byproducts of dyeing. A sticky scum forms when sewage acids break down soap into fatty acids; this scum clings to surfaces and makes dewatering sludge more of a challenge.

iv impact on sewage treatment procedures

Problems arise for sewage treatment processes due to the hazardous reactivity of dyeing waste chemicals with living beings.

FISH - A PERFECT WATCHDOG FOR AQUATIC POISONING EVALUATIONS

Because they show the toxicological impacts on living ecosystem components, bioindicators aid environmental research in ways that conventional chemical methods can't. Researchers have started using sentinel species for EQA and biomonitoring in order to analyse the potential effects of hazardous wastes in a sensitive and reliable manner. As the usage of harmful chemical pollutants increases in many industrialised countries of the world, there is an increasing demand for enhanced ecotoxicity detection tools.[15]

Because they are the aquatic animals most negatively impacted by water pollution, fish are the best bioindicators of this problem. Their importance as a protein source for humans and their high degree of movement make them an ideal experimental model for toxicological investigations. This allows researchers to examine the effects on a large geographical scale. There are two potential sources of chemicals that fish come into contact with: water and the food they consume. To understand the extent to which chemicals pose a threat to fish, one must consider the many ways in which they enter the body, whether it via food or water. It is a vertebrate that impacts human society in a wide variety of ways. Malnutrition and hunger are major problems that impact a lot of individuals. The modern world is trying to find a solution to the problem of protein nutrition. To compensate for this nutritional deficit, it is essential to eat fish such as salmon, which has a significant amount of animal protein (13% to 19%). Because they are an essential part of the aquatic food chain, fish play an important function in aquatic ecosystems. Its abundance in water makes it a useful model test animal for determining whether contaminants are affecting aquatic ecosystems. Since they are both very susceptible to contaminants and situated high in the food chain, toxicological research including bioaccumulation and biomagnification find fish to be an invaluable subject. In addition, aquatic bioassays are well-suited to examining their behavioural, morphological, and histological responses because of their ecological significance and close association with the aquatic environment. Polluted water lowers fish populations, which in turn lowers fish health and productivity. Indicative of the overall health of an aquatic ecosystem, fish populations provide a clear reflection of its overall condition.[16]

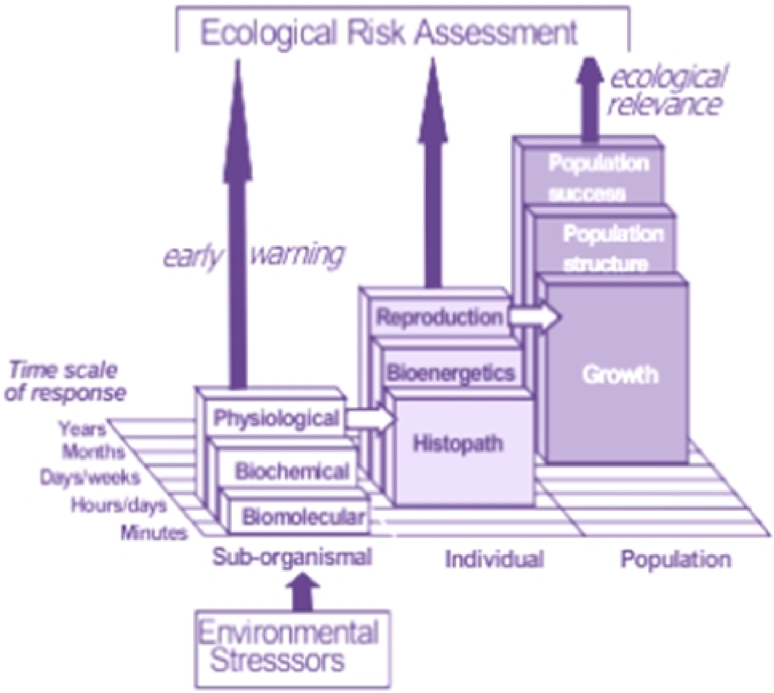

Figure 4: Environmental stressors acting in living organisms on various organizational levels

CONCLUSION

Water resource management is becoming more difficult due to the growing impact of industrial, agricultural, and associated activities on water quality. Groundwater levels are dropping, water quality is becoming worse, and freshwater sources are drying up because of all the people living in cities. These actions endanger not just fish populations but also aquatic ecosystems, which in turn endangers human lives. Acute toxicity bio-assays (sections 38.47-50.92) arrived to a 96-hour LC50 value of 44.25% with 95% confidence limits. Fish exposed to toxic material had dysmorphic traits including an unusual vertical posture, hyperexcitability, imbalance, and improper schooling. Morphological problems included a darker colouration of the body, an increase in mucus production, scale loosening and loss, skin and fin haemorrhages, a lateral flexure in the caudal region, and a shift in the positioning of the pectoral fins.

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