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Impact of Atrazine induced Changes in few Cat-fish

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Abstract

This paper is in continuity of my Ph.D. work on 'Studies on Atrazine induced changes in some Cat fishes.' After my research work, I am continuously work on this issue and trying to understand more about the impact of Atrazine induced changes in few Cat-fishes and the present paper is also one more step to learn more about the impact of Atrazine induced changes in few catfishes.

This is very alarming that there is a significant reduction in Erythrocyte and Leukocyte counts of Hemoglobin content and blood indices due to the effect of Atrazine exposure. The findings of this paper establish that Atrazine herbicide may substantially led to alterations on behavioral, hematological and biochemical parameters of C. gariepenus. Hence, firmsafeguardsmust be followed during Atrazine application to avoid environmental pollution. This will help in protecting fishes from the toxic effects of Atrazine. The paper also elaborates about such issues.

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Keywords: Atrazine, Herbicide Toxicity, Fresh water fish, Heteroponeustes fossils, LD50, haematological parameters

Introduction

Chemical Control of weeds by herbicides and weedicides are in common use thought the world. It cannot be stopped because it's use is very easy as well as economical too, but at the same time, it's bad effects are also faced by agriculture and piscicultunats. Herbicides have been proved successful in the control of herbs in terrestrial agriculture system. Residual mass of herbicides flows down the aquatic body and ultimately causes unprecedented ecological damage is mainly through their effects on the non-target organism including fish.

Herbicides make up about 40% of the production of pesticides in the world. They have been shown to cause deleterious effects on fish health (Banhawy et al 1996). Synthetic herbicides are commonly used by farmers to control weeds and nuisance aquatic vegetationsaround rivers, lakes, reservoirs and other water bodies.However, these pesticides ultimately find then way to these water bodies inducing adverse impact on fishes living therein (Rsuda et al 1995).

The widespread use of herbicides have resulted in a steady increase in water pollution, evoking considerable damage of phytoplankton and zooplankton, thus depleting essential source of the food chain of fish (Monotonous et al 1995). Atrazine an organic compound consisting of an S-triazine-ring is a widely used herbicide. Its use is controversial due to its effects on-target species such as amphibians. Its use is banned in the European Union but is still one of the most values herbicides in US and Asian countries.The half-life of atrazine in soil is 13 to 261 days.Its endocrine effects, possible carcinogenic effects and epidemiological connection to lower sperm levels in men has led several researchers to call for banning it in the US.

About Atrazine

1. IUPAC Name – 2 – Chloro – 4 (ethylamine) – 6 – (Isoproyl amine) – S – triazine.
2. Molecular formula – $CH_8H_{14}ClN_5$
3. Molecular Mass – 215.68 gm mol^{-1}
4. Density – 1.187 g/cm^2
5. Melting Point – 175^0C
6. Boiling point – 200^0C
7. Appearance – Colorless Solid
8. Solubility in water 0.007 gm/100ml

According to Extension Toxicology Network the oral LD_{50} for atrazine are as follows:

1. In Rats : 3090 mg/kg
2. In mice : 1750 mg/kg
3. In Rabit : 750 mg/kg
4. In Hamsters : 100 mg/kg

Since its introduction in 1958,atrazine has become widely used herbicide in the US.It is the top selling product for Syngenta, the largest chemical corporation in the world.Atrazine has become the most frequently detected contaminant of ground surface and drinking water in the mid-western United States and is one of the most controversial crop protectors in the market.Used initially to control the growth of an annual broadleaf weeds on such raw crops as corn and sugarcane.Atrazine is now applied to Commercial golf courses, industrial centers, lawns and along roadsides. According to the Environmental Protection Agency (EPA) over 76 million pounds of atrazine are applied to crops each a year.Despite its widespread use in the United States the European Union bannedatrazine in 2003, citing it as a major contaminator to water contamination.Besides this banned in US and its controversial nature atrazine is frequently used in Asian continent and presently contaminating the water bodies where pisciculture in practice.

Objectives of the Study

The main objective behind the present work is to unveil the adverse effects on aquatic organism specially the fish including its palatable condition, nutritional value, physio-biochemical condition, growth and productivity.

Review of Literature

One of the crucial problems faced by pisciculturists is the control of aquatic weeds since its profusion causes imbalance in aquatic soluble nutrients and other essentials. Weeds severly restrict plankton production, limits the living spaces of Fish, upset the equilibrium of physico-chemical qualities of water, causes imbalance in dissolve O2budget, promote accumulation of deposit leading to siltation, provide shelter to predatory and weed-fishes, molluscanand aquatic insects and obstruct netting operation (Jhingran, 1983).

The aquatic word problems have been increasing day by day and have attracted the attention of pisciculturists. The extent of this problem can be realized from the fact that water hyacinth (Echornia crassipes) alone accounts for about 0.5 million hectare in India.The area infested withother aquatic weed is estimated to be an additional 3,20,000 hectare, which represents a potential annual loss of fish-crop of 1,60,000 MT per year. Recently another serious weed Salvinia Molesta has been found to be spreading very rapidly and is now considered the second major national weed problem.Among submerged weeds, Hydrilla Verticillatais the most important and difficult to control.Persistent algal-blooms and other blue-green algae seriously affect fish culture in ponds and become even more problematic in intensive culture programs (Ramprabhu and Ramchandran 1984).

Weedicides and herbicides have proved successful in the control of weeds in aquaculture system.However, the production of increasing number of pesticides and herbicides has caused unprecedented ecological damage mainly through their effect of non-target organism including fish. The widespread use of herbicides has resulted in a steady increases in water pollution, evoking considerable damage of phytoplankton and zooplankton, thus depleting essential source of the food chain for fish (Montanes et al 1995).

Atrazine is one of the most commonly used herbicides in the United States.It is widely used in Asian continent and specially the India too. Atrazine is considered as a controversial organic compound due to its bad effects on the non-target organism. Tyrone Hayes a Scientist at UC Berkeley found evidence that it is a teratogen causing demasculinization in male frogs affected by atrazine could reach testosterone levels below females.

Atrazine is used to stop pre and post emergence and broad leaf and grassy weeds in major crops by binding to the plastoquinone binding protein in photosystem II, inhibiting electron transport. Atrazine and its derivatives are also used in many industrial processes, including the production of some dyes and explosives.Atrazine is the most widely used herbicides in conservation tillage system which are designed to prevent soil erosion.

Brief about Atrazine

Atrazine is a selective triazine herbicide used to control broadleaf and grassy weeds in corn,Sogghum, sugarcane, pine apple, Christmas tress and other crops.

It is also used as a non-selective herbicides on non-cropped industrial land and on follow lands. It is available as a dry flowable, flowable liquid, liquid, water dispersible granular and wettable powder formulation (Meister R T (ed) 1992, WSSA Herbicide Hand book 1989).

Regulatory Status & Atrazine

Atrazine has been classified as Restricted Use Pesticides (RUP) due to its potential for groundwater contamination (Food Chemicals News, Washington DC 1990).

Ecological Effects of Atrazine

Atrazine is slightly toxic to birds, fishes and other pond or stream life. In white fish, Atrazine accumulates is the brain, gall bladder, liver and gut (Arch, Hydrobiol Suppl. 59 (2-3) – 252 – 87. 1981). Fish may bio accumulate atrazine to level of 11 times the concentration in surrounding water.

Toxicological Effects

Atrazine is a mild to moderately toxic to human and other animals. It can be absorbed into the blood stream through oral, dermal and inhalation exposure. Symptoms of atrazine poisoning include abdominal pain, diarrhea and vomiting, ey irritation, irritation of mucous membrane and skin reaction. (Hallenbeck, W.H.; K.M. Chunningham – Burns 1985). At very high doses rats showed excitation followed by depression, slowed breathing, in co-ordination, muscle spasm and hypothermia.

After consuming a large oral dose, rats exhibited muscular weakness, hypoactivity, breathing difficult, prostration, convulsion and death. (O-S MSDS for Atrazine 1991).

Chronic Toxicity of Atrazine

It has been recorded that about 40% of rats receiving oral doses of 20 mg/kg/day for 6 month died with signs of respiratory distress and paralysis of limbs untheological and biochemical changes in he brain, heart, liver, lungs, kidney, ovaries and endocrine organis were observed (USGS 1991). Long-term consumption of high levels of atrazine has caused adverse health effects in animals including Tumer Changes in organs weight and damage to the live and heart (US EPA 1988).

Lethal doses in test animals have caused severe damage in the form of congestion, and / or hemorraging to the lungs, kidney,liver, spleen, brain and heart (US EPA 1968).

Atrazine like other weedicides and herbicides flows down to water bodies on the rain water and with residual effluents of the terrestrial land pieces and contaminate water where cat-fishes also inhabits. It pose some serious problems which are important to analyse in view of the human health care and nourishment.

Due to rapid industrialization, application of synthetic fertilizers and use of various insecticides and pestices, the natural resources are fast degrading in the water quality. Aquatic ecosystems that run through agricultural or industrial arear have highly probability of being contaminated by run off and ground water leaching by a variety of chemicals (Todd and Leuman 2002). Agricultural pesticides are released into the atmosphere by spray, drift, post application, volatilization and wind erosion of soil (Quies et al 2004). Pesticides present in aquatic environment can affect aquatic organisms in different ways (Venteura et al 2008).

In India, were than 70% of the chemical formulation are employed in agricultural practices, and to find their way to freshwater bodies, ultimately affect non-target organization (Bhatnagar et al 1992).

The use of herbicides to control aquatic weeds has applied in fish management where they are used in aquatic habitats, especially rice fields and some fish forms (Wu et al 1980). Atrazine has been one of the most widely and herbicides to control broad leaf weeds in corn or crops, including green veretables (Cue et al 2002). After spraying in crops, it can enter water – sources, because of the highly mobility through soil (warming and Moore 2004). Atrazine reaches aquatic environment due to proximities of the agricultural country sides to the water places, or directly due to the caseless application in such environments. After herbicides are not degraded by microbial or hydrolytic process (Gamble et al 1983). However WHO (1996) reports pointed out that atrazine can be degraded in surface water by photolysis and micro-organisms and the half lives of 20-50 days at 20-25^{0}C have been found under laboratory condition and increasing at lower teleperdure (USEPN-1988).

It has been investigated that atrazine present in natural (Soloman et al 1996, Power et al 1999) and surface waters at concentration exceeding 0.1 gl^{-1} (Environment Agency 1998) also accumulated in a variety of tissues (Du Preez and Vas Vuren 1992). Many authors have reported the impacts of atrazine on the physiology and metabolism of aquatic organisms, particularly fish (Prasad et al 1991, Hussain et al 1996) and metabolism (Grobler et al 1989, Ginivas et al 1991, Prasad et al 1995, Phycia et al 2006).

Fishes are one of most widely distributed organisationa in an aquatic environment and being susceptible to environment contamination may reflect the extent of the biological effect of environmental pollution in water.

Srivasta and Gupta (1981) studied the effect of sodium salt of 2, 4-D on Carbohydrate metabolism in Heteroponeustes fossils . They reported that the fish elicited muscle glycogenolysis and heptic glycogenesis, hyperglycemia hyperlacticaemia and enhanced levels of pyruvate at 3, 6, 12, 48 and 96 hours of treatment to high lethal concentration of the herbicide.

Srivastava and Singh (1981) reported that the exposure of Indian Cat-Fish Heteropneustes fossilis to a high sublethal concentration of 5.6 ppm of Methyl parathion for 3, 6, 12, 48 and 96 hrs affected carbohydrate metabolism, muscle and liver glycogen levels as well as blood glucose level.

Srivastava and Mishra (1983) reported that the exposure of Heteropneustes fossilis to a concentration of 14.625 mg/L of ethion induced muscle and hepatic glycogenolysis with concomitant hyperglycemia at 2, 6, 12 and 48 hrs after treatment.

Srivastava and Mishra (1981) reported that the fish Heteropneustes fossilis when subjected to a high sublethal concentration of 0.2 mg / dm^2 lindane in water, elicited muscle and hepatic glycogenolysis at 2, 6, 12, 48 and 96 hrs of treatment to pesticide. Level of blood glucose significantly decreased at 2, 48 and 96 hrs, but hyperglycemia resulted at 6 and 12 hrs of treatment.

Dabral and Chaturvedi (1983) studied the effect of Folidol at 12.5^{0}C for 15 days on certain hematological parameters of Heteropneustes fossilis. They observed marked and significant fluctuation in the values of TEC, TLC, Hb%, ESR and MCH. They noticed anemia, leukopenia and erythropaenia in the fish.

Srivastava and Singh (1982) studied the effect of propoxur on carbohydrates metabolism in Heteropneustes fossilis and noticed that exposure of the fish to 5.20 ppm propoxur for 3, 6, 12, 48 and 96 hrs showed depletion in muscle glycogen at 12 hrs and hepatic glycogenolysis at 3, 12, 48 and 96 hrs accompanied with hyperglycemia at all time intervals. They explained the effects in terms of acute stress syndrome.

Srivastava and Srivastava (1981) studied histopathological changes in the kidney of Channa punctatus due to exogenous urea at the level of 1800 ppm and noticed severe damage in the renal tubules,

pyknotic and karyorrhectic nuclei in the tubular cells as well as narcosis in the hemopoietic tissues.

Singh and Srivastava (1981) made a study on the effect of a paired mixture of Aldrin and formathion (1:1) for 3, 6, 12, 48 hrs on carbohydrate metabolism in Heteropneustes fossilis. They noticed that muscle – glycogen declined at 3, 6, 12 and 48 hrs, blood glucose levels declined significantly at 3, 12, 48 and 96 hrs, blood lactate levels were elevated and blood pyruvate values was depressed.

Singh and Srivastava (1982) reported the exposure of Indian Cat fish Heteropneustes fossilis to 10.4 ppm formation for 3, 6, 12, 48 and 96 hrs, caused depletion of muscle glycogen and increase in blood lactate and pyruvate concentrations.

Mandal and Kulshrestha (1980) reported that Indian Cat-fish Clarias batrachus subjected to 1 ppm sumithion treatment exhibited histopathological changes in the liver, kidney, intestine, haemopoietic tissue and blood. They observed hepatic necrosis, vacuolation and breaking down of cell boundaries of liver tissues, vacuolation of epithelial cells of uriniferous tubules of kidney, lesion formation in villi of intestine, marked degeneration of haemopoietic tissue and loss of R.B.C.

Inter-parameter related effects of Atrazine Treatment

From the above observations and statistical analysis of datas of different biochemical blood parameters i.e. Estimation of Blood glucose level, Blood urea level, Total Serum Cholesterol Heteropneustes fossilis and Clarias batrachus due to Atrazine treatment at 120 mg/L concentration at different time intervals i.e. 24 hrs, 48 hrs, 72 hrs and 96 hrs of treatments, it appears that the herbicide Atrazine (ATR) causes a general effect on Adrenal gland, pancreatic Endocrine parts – βcells, Hepatic cells, Renal tubules and also at the pituitary gland, which ultimately adversely affects the hormonal balancing and causes hyperactivity of Adrenal gland, producing higher level of Adreno-corticordes secretion, damage of hepatic cells, causing deposting the cholesterol from Liver tissue to Serum ultimately increasing the serum cholesterol level called hyper-cholesterolaemia. At the same time increased Adreno-corticoides activity caused increased protein Catabolism, leading to gluconeogenesis which ultimately caused a rise in the Blood glucose level of the fish. Increase in the Blood Urea level of the fish may be due to the damaging effect of the chemical on the Renal tubules further decrease and againsn increase in the Blood Urea level may be attributed to restoration and ultimately the damaging affect of Renal tubules.

Conclusion

As conclusion of this this research project we can be able to give guidelines to acquaculturists for the proper aquaculture without the bad effects of atrazine and other chemical treatments to the agriculture pests.

Justification

With refence to this research project we can be able to give guidelines to acquaculturists for the proper aquaculture without the bad effects of atrazine and other chemical treatments to the agriculture pests.

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