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ABSTRACT

Pesticide pollution is a serious concern of our life and also for our ecosystem. Because of exponential growth in population and rapid industrialization the contamination of our food, air, water and soil due to extensive use of pesticides and other toxic compounds has become a threat to the continued survival of all living beings. The quality of ground and surface water badly affected by the agricultural run offs as they contain synthetic pesticides and fertilizer residues. When pesticides and chemicals contaminate water that becomes harmful to living beings when it consume or come in contact with fishes and other animals then it increase the incidences of mass mortality and also badly affects the fish survival, physiology, growth, reproduction and overall behaviour. The use of organophosphorus pesticides in agricultural industry cause the environmental issues and the argent demand for different another methods of pest control for minimise such damage, in that spot comprehensive review on pest control with the use of biopesticides. Normally neem oil a biopesticide is considered of low toxicity towards non-target aquatic life comparative to organohosphorus pesticides. Therefore, the use of neem oil in fish farming and agricultural lands should be promoted to its productivity in enhancing immunity against retardation of the development of specific virulent. This article provides the major assessment to know the benefits of bio-pesticide comparative to organophosphorous pesticide nuvan.

Keywords: Nuvan, Neem Oil, Comparative Toxicity, Fresh Water Fishes

INTRODUCTION

Aquaculture is one of the speedy growing zones of food production in world which enlarged from 29.9 million tonnes to 41.9 million tonnes from 2007 to 2012 [1]. Utilization of synthetic pesticides and chemicals for protection from pathogenic agents, conducive to improve whole agricultural output and low labour investment, until now specific result not generated; preferably that has promoted contagious creature appearance which has disease defiant strains [2]. Pesticides are a very effective group of environmental pollutants and reaches in environment through leaching, percolation, spray drift, aerial spray, precipitation or runoff from agricultural fields [3]. It creates negative impacts on our planet. The most commonly used pesticides amongst different pesticides are organophosphorus pesticide in the world because of its quick biodegradability, low persistence so huge quantities find their way into water resources. Unluckily, they are also injurious for non-targeted organisms and can put up dangerous, long term population effects on aquatic and terrestrial species [4]. From the different organophosphorus pesticides, nuvan (2, 2-dichlorovinyl dimethyl phosphate) is used for rice, vegetables, fruits, and

agricultural field as a pre-harvest treatment. It is commonly used on livestock, as anthelmintic pellets for sprays, aerosols and for oral feeding of poultry, pigs and horses. Nuvan is also utilized considerably in storage places, agro-processing units, hospitals, and conveying in aeroplane during flight for disinfection [5]. Nuvan has declared global interest as it increases various remarkable changes in the body of fish out of which difference in biochemical parameters, histopathological changes, chromosomal changes, neurotoxicity, bioaccumulation in tissues, undesired developmental changes and behavioural change etc. are a few in the account of nuvan toxicity [5].

Bio-pesticides are naturally occurring substances that produced by plant originated materials that control pests, microorganisms and pesticide substances. These are mostly useful components of integrated pest management programs and have sustained much practical attention as an alternative to synthetic chemical plant protection products [6]. Biopesticides have also been recognised as easy and viable alternative because it is economical effective, renewable, non-resistant and beneficiary for farmers and eco-friendly. Since ancient time, whereas the use

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of plant originated medicines for therapy and control of human and animal diseases has been started but there is a need to emphasize the importance of biopesticides to protect fish and other aquatic life from the harmful effects of synthetic pesticides so that the entire ecosystem through the food chain will be also protected. Fish is the most valuable organism serving as food for humans and other animals. Fish provides employment for millions of people in whole world. Fishes are important source of protein, vitamins and polyunsaturated fatty acids that protect against cardiovascular diseases. Neem oil plays an important role as biopesticide for fishes and other aquatic animals. One of the most valuable natural compound of neem oil is azadirachtin (AZA) which is originated from the neem tree (*Azadirachta indica*), whose antifungal, antibacterial and antiviral qualities have been well known for many years [7].

More research should be conducted to conclude the mortal and sub-mortal consequences of the organophosphate pesticide nuvan used on the existence and performance of non-targeted invertebrate and vertebrate animals including fish health [8] and beneficial health effects of neem oil on them. Present research article was undertaken to collect information on organophosphorus pesticide pollution on the fish health and comparatively beneficial health effects of neem oil on fish and other aquatic living beings.

Health Challenges For Aquatic Life

High usage of organophosphate pesticide in aquatic ecosystem, it affects both abiotic and biotic environment. Surface run off from agricultural fields reaches the toxicants into aquatic ecosystem. Bioaccumulation and bio-magnification of nuvan can cause hazardous health effects on non-target organisms. Humans, fishes and other animals also bear a variety of diseases due to vector borne parasites viz. microbes including bacteria, fungi and virus; protozoan and metazoan parasites including helminths, nematodes, arthropods, annelids and molluscs and much more nutritional illness also. That is affected enormous outcome and economic dropping to fish workers, aqua-entrepreneurs and fish farmers. Their income totally depended on aquaculture or related venture. Account for 60% of fish production loss in aquatic ponds by infectious diseases. Hence, it is one of the most important tasks to controlling disease for

aquatic life [9]. In addition, bioaccumulation of organophosphorus pesticide, nuvan in the fish body is also remarked as dangerous problem for a food chain and our environment. .

Different commendation of seafood mostly cultured shrimps sent out from India is now neglected by many countries due to the presence of hazardous pesticide residues. Due to which seafood exporters are facing huge economic losses. Furthermore use of pesticides or other sources of chemotherapy requires a high cost to worker and commonly cost of the drug is mostly higher than the cost of the fish. So prolonged overuse, misuse and continuous use of synthetic pesticides is showing residues of these hazardous chemicals in tissues of edible fishes by studies, which remains a serious problem [1]. Many types of synthetic chemicals and pesticides used to prevent various diseases have not yet yielded good results, but due to their continuous use, the immunity of organisms has been adversely affected. Effectiveness of neem oil greatly depends on elements like methods of preparation, plant role, application of specific analysis and method of implementation, species and age related dosage in aquaculture [2]. Many researches are being done to investigate the effects of plant based biopesticides like neem oil so that the immunity of different species of fish and other aquaculture can be saved and changes in their body can be prevented.

Impact Of Nuvan On Fish Health

Fish have been known for many years as a good indicator of water quality. So any changes of water quality due to exposure of organophosphate pesticide nuvan directly affected the fish health (figure 1, source- Shafat Ali *et al.*, 2020) [10]. Fishes are endangered due to pesticides and chemical contaminants through mouth, direct contact of integuments and by respiration through gills. So any injury to the gills leads not only to disability in gaseous exchange, but also changes in excretion and osmoregulation [11]. Consumption of oxygen is a very sensitive physiological bio-indicator and respiratory changes have been used as stress indicator in animals exposed to nuvan [12]. Nuvan generates significant biochemical changes in fishes and in utmost cases, completely disable them through decreasing acetylcholinesterase enzyme in synapse. Particularly early stages of aquatic animals including

fishes are more sensitive to anxiety and losses.

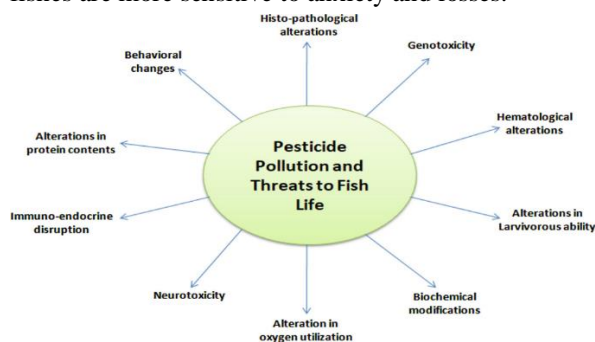


Fig-1. Show effect of pesticide nuvan on fish health

Nuvan an organophosphorus pesticide depict cholinergic quality thus work as neurotoxins to wide ranging of pests. Rahman *et al.*, 2004; Mushigeri and David 2005 [13, 14] observed enzyme inhibition in various tissues of fishes including brain. Accumulation of acetylcholine in the synapse due to inhibition of this enzyme increased neuro-effector activity [3]. The primary and principal sign of nervous system failure is hyperactivity which changes physiological and biochemical activities in fishes [15]. Due to chemical pesticide not only mortality occurs but many behavioural changes also occur in fishes which are considered recently by ecotoxicologists [16, 17]. Behaviour is considered as the physical graphic of the animal's internal metabolic processes, neuronal and endocrine which is essential for life working in combination with both central and peripheral nervous systems [18]. The behavioural patterns widely differ with various fish species and exposure conditions. Rao *et al.*, (2003) and Levin *et al.*, (2003) [19,20] reported that fishes showed abnormal behaviour like loss of equilibrium, erratic swimming and abnormalities to the gill lamellae followed by necrosis were evident after exposure to chlorpyrifos [21,22]. Kumar S. (2014)[23] observed biochemical changed of total protein, lipid profile, and liver glycogen, GPT, GOT, ACP and ALP due to exposure of nuvan on fish *Channa punctatus* (Bloch). Haematological changes like red blood cell (RBC) count, white blood cell (WBC) count and histology of blood cells stimulated by Lethal and sub-lethal concentrations of organophosphorus pesticides [24]. Ahmad S.I. (2020) [25] reported the significant decrease values of TEC as the concentration of Nuvan increases is a sign of severe anaemia caused by pesticide on the exposed fish *Heteropneustes fossilis*. The anaemic condition could be as a result of reduction of erythrocyte production, haemodilution which could be as a result

of the eradication of intestinal cells by the pollutants. Similarly Gautam and Kumar (2008) [26] reported same findings who studied haematology of *Channa punctatus* subjected to Nuvan. Fish requires huge energy to detoxify pollutants during stress conditions so more protein is needed for expand energy requirement to defeat anxiety. So in liver, protein fraction may be inhibited through its degradation and implementation for metabolic purposes. Similarly results are noted by Medda *et al.*, (1992) [27] due to exposer of nuvan on *Labeo rohita* and *Cirrhina mrigala* fingerlings.

Lakshmanan and Rajendran (2013) [28] reported significant decrease in the protein content of liver, kidney and muscle on exposure to dichlorvos in *Oreochromis mossambicus* and suggested that decline in protein content might be on the basis of proteolysis through contributing free amino acids to meet the stress conditions. Same as after acute exposure of nuvan significant decrease in total protein content of *Heteropneustes fossilis* noted by Ahmad and Gautam (2014) [29].

Many researchers were studied on various organs, brain, liver, kidney, gills, muscles, ovary and blood vessels to trace histopathological changes. Histopathological changes are used as biomonitoring tool for fish health in toxicological studies. Furthermore, changes are easier to point out in these organs and are observed as warning signs of destruction in these organs [11]. Kidney not only helps in excretion of wastes but also maintains pH, volume of blood and body fluids. Hence any histological alterations in the kidney induce defence changes harming homeostasis and health of animal. Due to the lethal concentration of rogorin protein, lipid content, carbohydrate decreased and free amino group increased in fish *Clarias batrachus* gill, liver and kidney compare to control noted by Chandra and Sridhar (2015)[30]. Pawar *et al.*, (2021) [11] found the residue of pesticides in liver and muscle of the snake head fish *Channa gachua*. They observed highly significant decrement in total protein, lipid content and glycogen of fishes liver and muscles due to nuvan exposer as compared to control.

Alteration in enzymes activity is mostly related with changes in many other metabolic functions and thus shows over all physiological changes in the organisms. Begum (2005) and Gabriel *et al.* (2012) [31, 32]

reported pesticide exposure caused change in AST and ALT activity [8]. Pesticides can also hinder other hormone related processes in the body such as bone development and thyroid gland functioning [33]. When fishes are exposed to toxicants then level of thyroid hormone has been decline [34]. Nuvan toxicity has been related to change in DNA replication which causes mutation and cellular hyper proliferation hence local mutation [35] all these factors are responsible for hepato carcinogenicity [36]. Apart from this, many other literatures investigate on different changes of numerous fish species which have shown nuvan toxicity.

Impact of Biopesticide, Neem Oil On Fish Health

The demands for using more bio-pesticides from natural sources in agricultural fields are continuously increasing day by day. Due to which, it is necessary for a regular investigation of these biopesticides from the plants for using in the agricultural fields and aquatic ecosystem. The presence of more than a dozen azadirachtin analogs in neem oil makes it very important as azadirachtin contributes significantly to the insecticidal activity. Azadirachtin also significantly improves the antibody response of the organism as needed and there is an inverse relationship between the amount of immunostimulation and the amount of azadirachtin [37, 38]. In fish farm azadirachtin is mainly used to control and prevent from parasites and fish fry predators [39]. The botanical medicines are used for effective health management of fish which are used individually or in combination or in combination with other medicines [7, 9]. Khan and Wassilew (1987); Biswas *et al.* (2002) [40, 41] studied that neem oil, neem leaf extract and seed kernel have been noted more effective in case of certain fungi such as *Trichosporon*, *Geotircum*, *Trichophyton*, *Epidermophyton*, *Micrsporium*, and *Candida*.

Kumar *et al.*, (2015) [38] also observed toxicological impacts of a botanical pesticide, azadirachtin on corpuscles of *Stannius* of stinging catfish, *Heteropneustes fossilis*. Neem oil and products derived from different parts of neem have been widely used and promoted in fish-farms to control of fish parasites and fish fry predators as dragon-fly larvae [42]. Thus, it has emerged as an option to reduce the use of toxic pesticide nuvan. Mousa *et al.*, 2008 [43] proved by his own efforts that the aqueous extract of

neem leaves affect the healthy status and survival of Nile tilapia (*Oreochromis niloticus*), African cat fish (*Clarias gariepinus*). Along with this, its ecological changes were also observed on zooplankton community and stated that other products derived from neem also certainly have a less toxic effect on fish health. Winkaler *et al.*, (2007) [39] observed that the concentrations of neem extract when come in contact with fish then it damaged gill and kidney tissue. They also noted that due to the increase in plasma corticosteroid and catecholamine hormones, the level of blood glucose in fish increases, mainly due to the presence of neem leaf extract in water [44].

During acute exposure to sub lethal concentrations of neem leaf extract cause hyperglycemia due to the chemical stress which is more satisfy that increased energy demands and the protein overconsumption don't used as mentioned by Mousa *et al.*, 2008 [43]. Saravanan *et al.*, (2011) [45] observed some biochemical, haematological, enzymological and ionoregulatory indices of Indian Major Carp, *Cirrhinus mrigala* by the presence of products extracted from neem leaf (*Azadirachta india A. Juss*). Medicinal properties and biological activities of Neem (*Azadiracta indica*) noted by Biswas *et al.*, 2002 [41]. Same as different reports have shown that pesticides originated from botanical plants can shows biochemical and histopathological changes in fishes [46]. Ubiogoro, *et al.*, (2017) [2] noted lower levels of conjugate bilirubin, total bilirubin and creatinine in neem leaves aqueous extract fed fish sae as the work of Ogbuewu *et al.*, (2008) [47] suggestive of the fact that Neem has no adverse effect on the kidney (low creatinine) and liver (decrease values of total bilirubin and conjugated bilirubin). They also consider increment in serum protein levels including albumin and globulin in fish as a remark of strong innate immune response. The increment in globulin levels and total protein considered as an outcome of the immune stimulatory effect of neem. Choudhury *et al.*, 2005 [48] reported higher levels of albumin and globulin in fish when treated with immunostimulants.

Future Research Anticipation

Fishes are the natural food items of many animals including human beings. So, it is very essential to safe the health status of fish for protect our ecosystem. It has great industrial, nutritional, medicinal, economic, aesthetic and religious value. In aquatic and terrestrial

ecosystem fish plays an essential role in nutrient cycles through the food chain because they store a major part of nutrients in their tissues and transport these nutrients farther than other animals and release nutrients in dissolved forms which are quickly available to primary producers [8]. Organophosphorus pesticides, on the one hand, increase the mortality rate of fish which can create a large economic loss and on other hand rendering it unfit for human consumption. From a health point of view this work represents that one should respond important preventive consideration when choosing fish. For aquatic life protection hazardous pesticides should be avoided or should be used in little amount or utilized eco-friendly chemicals or biopesticide in agricultural fields which are less toxic or harmless for environment.

Neem oil a biopesticide is essential to produce a unique and effective method to displace poisonous synthetic pesticide. It can be carried out by utilizing the neem phyto-components past knowledge with pesticide poisoning action and joining it with current plans to produce an effective and unique pest control tool. Widespread development of plants can be encouraged by promoting the industry of plant based fertilizers. The main reason for this is that they slow the release of active substances in the soil and also maintain the nutrient quality [49]. Therefore, there is a great need to keep the fishes and their surrounding environment adapted and to protect them from harmful synthetic pesticides so that their life can be saved. Since, neem oil has novel agro-medicinal qualities, hence, its effectiveness act as a bio-pesticide. Parallel to this, it also inactivate wound healing, induces immunity, anti-microbial and anti-cancer properties. Being very beneficial in agriculture as a whole, the various characteristics of neem oil can be combined to cover a multidisciplinary approach. Neem oil also provide multiple benefits in agriculture as well as in biomedicine [50].

CONCLUSION

Current work demonstrates the rejection of chemical pollutants in agricultural practices and the promotion of plant products as biopesticides. Due to industrialization and urbanization, many harmful substances have their toxic effect in our entire ecosystem. Due to which there is a great danger to the aquatic species, fish and other organisms. Therefore, there is a need for mutual efforts to reduce and

eliminate the use of toxic pesticides. Implementing natural remedies using neem oil goes a long way in curbing the pollution caused by toxic synthetic pesticides. It can be said that by using neem oil, all the unwanted organisms in the aquatic ecosystem can be managed with the help of natural or plant derived insecticides instead of harmful pesticides which can also be recognised as an eco-friendly material. Simultaneously, suitable and accurate comprehensive methods should also be prescribed through testing of aquatic animal production facilities in future.

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