

Abstract

A rapid increase in the use of pesticides has led to the indiscriminate discharge of these pesticides into the aquatic environment, and this has, in turn, created adverse effects on the aquatic organisms. Contaminants such as tobacco leaf dust released from agricultural farm lands into the water bodies induce changes in the hormonal levels in fish. The toxic effect of Tobacco leaf dust and the ameliorative properties of pawpaw leaf were therefore investigated. Juveniles of *Heteroclaris* were exposed to lethal concentrations (0.00 mg/L, 10.00 mg/L, 15.00 mg/L, 20.00 mg/L and 25.00 mg/L) of tobacco effluent under static renewal bioassay with continuous aeration for 96 hours. The 96-hour LC50 value was determined as 23.05 mg/L. The fish were fed on a diet with varying percentage inclusion of pawpaw leaf (0.0%, 10.0% and 20.0%) for the period of 28 days to ameliorate the toxicity. After the experiment, the fish were sacrificed to collect blood and brain for hormonal assay. There was a significant ($P < 0.05$) reduction in the growth and reproductive hormones in both the blood and brain of fish exposed to both acute and chronic concentrations of Tobacco leaf dust. The group fed on a diet supplemented with 20% pawpaw leaf recorded an increase ($p < 0.05$) in the hormones. This result indicated that 20% pawpaw leaf is capable of neutralising the toxic effect of Tobacco leaf dust on growth and reproductive hormones in *Heteroclaris*.

Introduction

Fish is one of the most important vertebrates serving as food to man. Fish is among the healthiest foods on the planet. It is loaded with very high nutrients, including high-quality proteins, iodine and various vitamins and minerals. It is also said to be the cheapest source of protein for man. Water-soluble toxicants from industrial and municipal wastes leached into soils, and the atmosphere have rapidly transferred into water bodies. Uptake of such toxicants by aquatic organisms like fish may be followed by metabolism of the toxicants into more toxic derivatives. They thus act as toxicant amplifiers, making the toxicants available to predators at dangerously high costs.

Several cases of pollution in fish and fish consumers have been reported. The term pollution broadly refers to any undesirable change in the natural quality of the environment brought about by physical, chemical or biological factors. Pollution of aquatic systems by large amounts of waste material that negatively modify the water is termed aquatic pollution. This type of ecological deprivation occurs when harmful pollutants are directly or indirectly discharged into aquatic systems without removal of harmful substances. Aquatic pollution leads to the suffering of organisms and vegetation that survive in water, including fish and amphibians. The main sources of aquatic pollution include industrial wastes, mining activities, sewage and wastewater, marine dumping, burning of fossil fuels, accidental oil leakage, global warming, atmospheric deposition, pesticide application during agricultural activities and urban development.

Fish are intimately associated with the aqueous environment; physical and chemical changes in the environment are rapidly reflected as measurable physiological changes in fish (Omoriege, 1999). Fish species serve as a major test organism in ecotoxicological assessment because of their major link to humans in the food chain. The African catfish *Clarias gariepinus* is one of the commercially important species of fish for rapid aquaculture expansion in Nigeria and elsewhere in the developing world. African catfish grow quickly, are omnivores, and are desirable as food; they are a valuable species worldwide. They possess accessory air-breathing organs, which enable them to tolerate adverse aquatic conditions where other cultivable fish species cannot survive (Olatunde, 1983). It is widely cultivated and used as an experimental fish. Often, ponds in which *Clarias gariepinus* is cultivated are infested with aquatic molluscs. Plant extracts are useful for the control of water molluscs responsible for the transmission of water-borne disease (Kela et al., 1989). Hybrid catfish is a hybrid of the African catfish *Clarias gariepinus* and *Heterobranchius bidorsalis*. The success of *Heteroclarias* is attributed to its hybrid vigour, ability to colonise the variety of habitats created by the formation of the lake (Olatunde, 1989). They are omnivores which are desirable as food, thus are valuable species worldwide. They are one of the commercially important species for rapid aquaculture expansion in Nigeria and elsewhere in the developing world.

Pesticides are compounds which have biocide properties and are applied in order to kill or control certain organisms and many others. Few are absolutely specific to their target organisms, and many other species, including fish, may therefore be at risk because even sub-lethal concentrations may significantly affect the physiological behaviours, nutrition and reproductive function.

Botanicals are natural biocides (Burdhill, 1985) and their contamination of natural waters has become inevitable in Nigeria because of the recent wide use of piscicidal plants like *Blighia sapida*, *Kigelia africana*, *Tetrapleura tetraptera*, *Raphia vinifera*, *Parkia biglobosa* and *Tephrosia vogelii* are frequently in use by the fisher folks because they are highly potent (Fafioeye, 2001). The presence of these botanicals in high concentrations may have adverse effects on aquatic organisms.

Water pollutants cause toxic effects that range from biochemical alterations in a single cell to changes in organs and even the whole population of aquatic organisms (Bernet et al., 1999). As the fish are considered as one of the bio-indicators of water contamination, the extent and effect of pollution in them can be monitored by examining the sublethal indices or biomarkers.

The presence of tobacco leaf dust affects water quality parameters. Water quality parameters such as temperature, dissolved oxygen, free carbon (IV) oxide, pH, alkalinity and conductivity are parameters that are paramount to the many factors that affect fish health, growth and reproduction (Camus et al., 1998 and Hill, 1955). Decreased temperature, CO₂, pH, and dissolved oxygen, as well as increased alkalinity and conductivity, occur as a result of the presence of tobacco leaf dust in the aquatic environment, and this results in acidic conditions as well as hypoxia-induced stress in the fish.

Hormones are chemicals synthesised and produced by the specialised glands to control and regulate the activity of certain cells and organs. These specialised glands are known as endocrine glands. These hormones are critical towards maintaining proper physiological functions. These hormones include Follicle Stimulating hormone (FSH), Luteinizing hormone (LH) and Prolactin (PRL), which are important pituitary hormones required for reproductive processes in both males and females.

Carica papaya belongs to the family Caricaceae. It has been identified as a natural antioxidant, and pawpaw leaves have been tested and found to contain essential ingredients capable of enhancing feed intake, feed utilisation and suppression of pathogens' growth.

Methodology

Experimental Setup

The test on the toxicity of tobacco leaf dust was performed on *Heteroclarias* from a commercial fish farm. The fish were transported in a well-aerated plastic jerry can to the Department of Zoology, University of Ilorin. They were acclimatised for 14 days in a plastic aquarium of 50-litre capacity containing chlorine-free water. The water was changed every 24 hours, and the fish were fed with standard feed daily.

Preparation of Stock Solution

Tobacco leaves were collected from a farm, sun-dried for 24 hours, and pounded into fine powder. The stock solution was prepared by dissolving 2 kg of the powder in 10 litres of water, left for 24 hours, and sieved to obtain a concentrated solution.

Water Quality Parameters

Biological oxygen demand, pH, temperature, conductivity, chemical oxygen demand, dissolved oxygen, and turbidity were measured using standard equipment.

Ameliorative Agent

Pawpaw leaves were collected, washed, shade-dried, and ground into powder for incorporation into fish feed.

Fish Feed Supplementation

Experimental diets were formulated using fish meal, toasted soya, maize, groundnut cake, vegetable oil, DCP, vitamin C, salt, methionine, lysine, bone meal, and pawpaw leaf. Pawpaw leaf was included at 0%, 10%, and 20%.

Acute Test

Six concentrations of tobacco dust (0–30 mg/L) were prepared for the 96-hour acute toxicity test. Behaviour and mortality were observed, and hormones were later assayed.

Chronic Test

Fish were exposed to a 1/10 LC50 concentration for 28 days and fed diets with varying pawpaw leaf levels. Water and toxicants were renewed daily.

Hormonal Assay

Blood samples were collected and analysed for LH, FSH, progesterone, and prolactin using EIA methods.

Data Analysis

Data were analysed using ANOVA followed by Duncan multiple range test with SPSS.

Conclusion

The study revealed significant reductions in growth and reproductive hormones in both blood and brain of *Heteroclaris* exposed to tobacco leaf dust under acute and chronic conditions. Supplementation with 20% pawpaw leaf meal ameliorated these toxic effects significantly, improving hormonal levels. These findings show that pawpaw leaf possesses strong ameliorative potential against the toxic effects of tobacco leaf dust on hybrid catfish.

References

- Abdalla, C. W., Roach, B. A., & Epp, D. J. (2012). Valuing environmental quality changes using averting expenditures: An application to groundwater contamination. *Land Economics*, 68, 163–169.
- Adamu, K. M. (2009). Sub lethal effects of tobacco (***Nicotiana tobacum***) leaf dust on enzymatic activities of ***Heteroclaris*** (a hybrid of ***Heterobranchus bidorsalis*** and ***Clarias gariepinus***). *Jordan Journal of Biological Sciences*, 2, 151–158.
- Adetuyi, F. O., Akinadewo, L. T., Omosuli, S. V., & Lola, A. (2008). Anti-nutrient and antioxidant quality of waxed and unwaxed ***Carica papaya*** fruit stored at different temperatures. *African Journal of Biotechnology*, 7, 2920–2924.
- Agbon, A. O., Omoniyi, I. T., & Teko, A. A. (2002). Acute toxicity of tobacco (*Nicotiana tobacum*) leaf dust on ***Oreochromis niloticus*** and haematological changes resulting from sub-lethal exposure. *Journal of Aquatic Sciences*, 17(1), 5–8.

APHA. (1998). *Standard methods for the examination of water and wastewater* (20th ed.). American Public Health Association.

Bahmani, M., Farkhondeh, T., & Sadighara, P. (2012). The anti-parasitic effects of **Nicotina tobacum** on leeches. *Comparative Clinical Pathology*, 21, 357–359.

Bari, J. M., Hasa, P., Absar, N., Haque, M. E., Khuda, M. I. I. F., Pervin, M. M., Khatun, S., & Hussain, M. I. (2006). Nutritional analysis of two local varieties of papaya (**Carica papaya** L.) at different maturity stages. *Pakistan Journal of Biological Sciences*, 9, 137–140.

Basile, A., Giordano, S., Lopez-Saez, J. A., & Cobianchi, R. C. (1999). [Article title not provided]. *Phytochemistry*, 52, 1479–1482.

Dudgeon, D. (2014). Accept no substitute: Biodiversity matters. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 24, 215–232.

Fagbenro, O., & Akinduyite, I. (2011). Acute toxicity of aqueous *Morinda lucida* leaf extracts to **Oreochromis niloticus**. In L. Liping & K. Fitzsimmons (Eds.), *Proceedings of the 9th International Symposium on Tilapia Aquaculture* (pp. 46–51). Shanghai, China.

FAO. (1996). *Parasites: Infection and disease of fishes in Africa*. CIFA Technical Paper No. 31. FAO.

FAO. (2004). *FAO Fisheries Circular 886*. FAO.

Farombi, E. O., Adelowo, O. A., & Ajimoko, Y. R. (2007). Biomarkers of oxidative stress and heavy metal levels as indicators of environmental pollution in African catfish (**Clarias gariepinus**) from Ogun River, Nigeria. *International Journal of Environmental Research and Public Health*, 4(2), 158–165.

Jhingran, V. G. (1975). *Fish and fisheries in India*. Hindustan Publishing Corporation.

Konar, S. K. (1970). Nicotine as a fish poison. *The Progressive Fish-Culturist*, 32, 103–104.

Kori-Siakpere, O. (1998). Petroleum-induced alterations in the haematological parameters of **Clarias gariepinus**. *Nigerian Journal of Science and Environment*, 1, 87–92.

Kori-Siakpere, O., & Oviroch, E. O. (2011). Acute toxicity of tobacco (*Nicotiana tobaccum*) leaf dust to African catfish (**Clarias gariepinus**). *Archives of Applied Science Research*, 3(2), 1–7.

Krimsky, S. (2001). *An epistemological inquiry into the endocrine disruptor* (Master's thesis).

Musa, S., Aura, C. M., Ogello, E. O., Omondi, R., Charo-Karisa, H., & Munguti, J. M. (2013). Haematological response of African catfish (**Clarias gariepinus**) fingerlings exposed to different concentrations of tobacco (*Nicotina tobaccum*) leaf dust. *ISRN Zoology*, 2013. <https://doi.org/10.1155/2013/492613>

Noga, E. J. (1996). *Fish disease: Diagnosis and treatment*. Mosby-Yearbook.

Davies, O. A., & Jaja, E. (2013). [Article title missing]. *International Letters of Natural Sciences*, 4, 10–25.

Ogueji, E. O., & Auta, J. (2007). Investigation of biochemical effects of acute concentrations of lambda-cyhalothrin on African catfish (**Clarias gariepinus**). *Journal of Fisheries International*, 2(1), 86–90.

Omoniye, I., Agbon, A. O., & Sodunke, S. A. (2002). Effects of lethal and sub-lethal concentrations of tobacco (*Nicotiana tabacum*) leaf dust extract on weight and haematological changes in **Clarias gariepinus**. *Journal of Applied Sciences and Environmental Management*, 6(2), 37–41.

Oyelola, O. (2005). *Evaluation of the hypoglycemic activity of Treculia africana Decne (root) in normal and diabetic rats* (Master's dissertation). University of Ibadan.

Radhaiah, V., Girija, M., & Rao, K. J. (1987). Changes in selected biochemical parameters in the kidney and blood of *Tilapia mossambicus* exposed to heptachlor. *Bulletin of Environmental Contamination and Toxicology*, 39, 1006–1011.

Rand, G. M., Wells, P. G., & McCarthy, L. S. (1995). Introduction to aquatic toxicology. In G. M. Rand (Ed.), *Fundamentals of aquatic toxicology: Effects, environmental fate, and risk assessment* (2nd ed.). Taylor & Francis.

Richards, R. (1977). Diseases of aquarium fish 1. *Veterinary Record*, 101, 166–167.

Tobor, J. G. (1990). *The fishing industry in Nigeria: Status and potential for self-sufficiency in fish production*. NIOMR.

Vogue, E. (1984). *Tobacco encyclopedia*. Tobacco Journal International.

Warne, M. S. J., Petra, R. W., Cole, B., & Lunau, B. (2002). Toxicity and hazard assessment of cigarette butts to aquatic organisms. *Interact 2002 – Programme and Abstract Book*, 1.

Yamano, K. (2005). The role of thyroid hormone in fish development with reference to aquaculture. *Japan Agricultural Research Quarterly*, 39(3), 161–168.

Zoeller, R. T., Tan, S. W., & Tyl, R. W. (2007). General background on the hypothalamic–pituitary–thyroid (HPT) axis. *Critical Reviews in Toxicology*, 37(1–2), 11–53.