Acute Toxicity of Urea Fertilizer to *Tilapia zilli* Fingerlings

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Abstract

The fingerlings of Tilapia zilli (mean weight 7.95 ± 0.33g) were exposed in glass aquaria to acute concentration of urea fertilizer for a period of 96 hours. The 96hr LC_{50} of the exposed fish was determined to be 15.85 gl^{-1} with lower and upper confidence limits being 8.85 and 28.46 gl^{-1} respectively. During the exposure period, the fish stood in upright position with their snouts above the water surface gasping for air. Other behavioural reactions of the exposed fish observed before death were uncoordinated swimming, restlessness, frequent attempts at jumping out of the tank and quietness. Water quality examination showed a decrease in the dissolved oxygen content and increase in total dissolved solute, conductivity, alkalinity and free carbon dioxide as the concentration of the fertilizer was increased. The toxicological implications of these findings in relation to environmental pollution are discussed.

Keywords: Urea fertilizer, Acute toxicity, *Tilapia zilli*

Introduction

The use of fertilizers in agriculture has increased greatly over the years as a result of the need to meet the ever-increasing food demand of the growing population of the world. Fertilizers are used in fishponds as they indirectly increase productivity by the increase in the abundance of natural food in water (Bardack *et al*., 1972; Brown, 1977; Ita, 1980). Fertilizer in fish fry ponds thus stimulates the production of organisms that may serve as the first food for many species of fish and increase fry survival growth (Ludwig *et al*., 1998). There are few data on the direct toxicity of inorganic fertilizers to freshwater fishes. Oti and Chude (1997) states that $Ca(OH)_2$ was the most toxic of the four fertilizers tested with 96hr LC_{50} to *Heterobranchus bidorsalis* being 44.60 $mg.l^{-1}$. Ufodike and Onusiriuka (1990) reported a 96-hr LC_{50} of 33.9 $mg.l^{-1}$ for $Ca(OH)_2$ to 1258.9 $mg.l^{-1}$ for $NaNO_3$ for *Clarias gariepinus* exposed to the fertilizers.

Ufodike and Onusiriuka (1992) observed depression in erythrocyte sedimentation rate (ESR), and the gills of the exposed fish damaged at 20 $mg.l^{-1}$ of NPK. NPK caused the greatest upset of the water and blood chemistry and also most pronounced gill damage. The toxicity of ammonium, a common constituent of some fertilizers to fish has also been reported (Robinson-Wilson and Sein, 1975; Thurston and Russon, 1983).

Indiscriminate use of fertilizers such as urea however can contribute greatly to the change in pH and other physioco-chemical parameters of the water thus affecting fish production (Hunt and Boyd, 1981). Nigerian fresh water bodies receive effluents from different Agro-allied farms, industries and fertilizer plants including urea plants. They are thus subject to high concentrations of urea. The present study was conducted thus to evaluate the toxicity effect of urea fertilizer to the fingerlings of *T. zilli*, a common commercial cichlid popularly used in Aquaculture in tropical freshwater ecosystems.

Materials and Methods

Fingerlings of the *Tilapia zillii* with mean weight (7.95 ± 0.33g) were collected from PHENOMA fish farm, Ngwo, Enugu State and transported to the Department of Applied Biology, Ebonyi State University in aerated plastic containers. The fish were stocked in 12 glass aquaria (50 x 30 x 30 cm^3) with well aerated, dechlorinated municipal tap water. The fish were acclimated to laboratory conditions for 14 days during which period they were fed twice daily (0800 h and 1400 h) at five percent body weight with 40% crude protein pelleted feed. During this period, dead and abnormal individuals were removed. The purpose of the acclimation was to enable them recover from collection and transportation stresses and stabilized to the experimental environment. Mortality during the acclimation period was less than two percent. Different weights of urea fertilizer were dissolved in 10 litres of water and used for preliminary runs until suitable concentration that would result in 100 % mortality within 72 hrs was derived and this was used as the stock solution. From this, the following concentrations were prepared using serial dilution method of Warner (1962) 50.00, 25.00, 12.50, 6.25 and 3.13 gl^{-1}. Dechlorinated municipal water without fertilizer (0.00 gl^{-1}) serves as the control. Ten fish were exposed to each of the six concentrations with every concentration having a replicate. The exposure period lasted 96 hours. Water was changed daily to discard faecal material and left over food. They were not feed for 48 hours prior to and during the exposure period. Water physico-chemical parameters were monitored every 24 hours using method described by APHA *et al.,* (1985). The effect of the acute concentrations of urea fertilizer on opercula ventilation, tail beat rate and other behavioural characteristics were also investigated. Fish mortality was recorded every 24 hrs though the aquaria were inspected every four hours for dead fish which were removed

immediately to avoid fouling the test media. The 96 hour LC_{50} was determined using probit analysis. The lower and upper confidence limits of the LC_{50} were determined as described by UNEP (1989). Data collected were subjected to analysis of variance with Duncan's new multiple range post hoc-test of significance difference ($P < 0.05$) between various non fertilizer and fertilizer concentrations.

Results

The 96 hr LC_{50} for *Tilapia zilli* exposed to urea fertilizer was 15.85 gl^{-1} (probit Y = -2.85 + 6.67 x) with lower and upper confidence limits of 8.83 and 28.46 gl^{-1}respectively (Fig 1). A positive correlation indicated by the linear relationship in the graph of logarithmic fertilizer concentration versus probit mortality indicated that as concentration of toxicant increased, mortality rate increased. At concentrations of 50.00 gl^{-1}, 100% mortality was recorded within the first 24 hours of exposure. At concentrations of 25.00, 12.50 and 6.25 gl^{-1}, the mortality recorded were 90, 10 and 10 % respectively. No mortalities were recorded at 3.13 and 0.00 gl^{-1}concentrations (Table 1). The results of the water physico-chemical parameters of the experimental media (Table 2) showed a decrease in the dissolved oxygen content but the values of total dissolved solute, conductivity, alkalinity and free carbon dioxide increased as the urea concentrations increased compared ($P < 0.05$). There were however no significant difference between the various values of temperature and pH ($P > 0.05$).

The test fish exhibited different behavioural patterns during the exposure period. These include restlessness, erratic swimming, frequent attempts at jumping out of the tank, air gulping and loss of balance.

Discussion

Results obtained from this research revealed that the 96 h LC_{50} value of urea fertilizer for *T. zilli* (7.95 ± 0.33 g) was 15.85 gl^{-1} with lower and upper confidence limits of 8.83 and 28.46 gl^{-1} respectively. The result obtained was at variance with the 96 h LC_{50} of 4.79 reported by Palanisamy and Kalaiselvi (1992) when *Labeo rohita* was exposed to acute concentration of urera fertilizer. The difference may be due to difference in fish species and environmental conditions. The results also showed that concentration from 25.00 gl^{-1} and above were lethally to the test fish within 96 hours. This is because 90 % mortality was recorded in the tank with concentration 25.00 gl^{-1}. In this investigation, the least mortality (10 %) was recorded in the tank with concentration 6.25 gl^{-1}. All other subsequent concentrations did not show mortalities. Our study thus indicated that the percentage mortalities increase with increase in concentration of the toxicants. This could be understandable because urea is known to hydrolyze easily in water to give ammonium carbonate, which is volatile and thus releases ammonia (Onusiriuka and Ufodike, 1992).

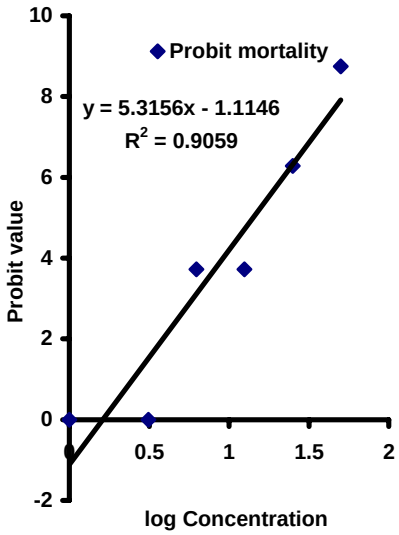

Fig. 1: Graph of 96 hr LC_{50} of urea fertilizer for *Tilapia zilli*

The amount of ammonia present at a particular time would affect the toxicity of urea as reported by Ufodike and Onusiriuka 1990. The restlessness, loss of balance, erratic swimming and respiratory distress reported in this study have earlier been reported (Onusiriuka and Ufodike, 1992; Avoaja and Otti, 1997; Otti, 2002; Omorege *et al*, 2003; Ayuba and Ofojekwu, 2002; Adakole, 2005) when they exposed fish to acute concentrations of different toxicants. Water quality showed some variations during the test period. Though there was a decrease in the dissolved oxygen content and an increase in dissolved solute, conductivity, alkalinity and free carbon dioxide, there were however no significant differences in the mean values of pH and temperature in both treatment and control ($P > 0.05$). The air gulping and the attempt to jump out of the tank observed in the exposed fish is an indication of insufficient amount of dissolved oxygen in the experimental media. Stickney (1979) had reported that insufficient amount of dissolved oxygen is one of the contributing factors to mortality in some fish species.

This study showed clearly that acute concentration of urea fertilizer is harmful to *T. zilli.* It is recommended that application of urea fertilizer into aquatic ecosystems either in ponds, irrigations or farms should be carefully monitored so that concentrations that are lethal to aquatic life do not get into the water.

References

Adakole, J. A. (2005). Acute toxicity of metal-finishing company waste water to *Clarias gariepinus* fingerlings. *Journal of Aquatic Sciences, 20 (2):*69 –73.

APHA, AWWA, WCPF (American Public Health Association, American Water Works Association and Water Control Pollution Federation (1985). Standard methods for examination of water; 15 edition, Washington D.C. USA. 1976 pp.

Table 1: Mortality rate of *T. zilli* exposed to different concentration of urea fertilizer for 96 hours

Concentration g/l	Log conc.	Mortality 24 h	48 h	72 h	96 h	Mortality %	Probit mortality
50.00	1.6990	10 –10	0 –0	0 –0	0 –0	100	8.75
25.00	1.3980	0 –0	9 –0	0 – 0	0 –0	90	6.28
12.50	1.0969	0 –0	0 –0	0 –1	0 –1	10	3.72
6.25	0.7959	0 –0	0 –0	0 –0	1 –1	10	3.72
3.13	0.4955	0 –0	0 –0	0 –0	0 – 0	0	0
0.00	0.0000	0 –0	0 –0	0 –0	0 –0	0	0

Table 2: Mean water quality parameters during 96 hr exposure of *T. zilli* to acute concentration of urea fertilizer

Parameters	Fertilizer concentrations (g/L) 50.00	25.00	12.50	6.25	3.13	0.00
Temperature (^oC)	26.50	26.20	27.00	27.10	27.05	27.00
Alkalinity (mg/L)	23.00	20.40	19.75	18.10	17.80	17.35
Free carbon dioxide (mg/L)	6.50	5.45	3.50	3.50	2.80	2.00
pH	6.30	6.50	6.90	6.00	6.50	7.00
Dissolved oxygen (mg/L)	5.10	5.00	6.70	6.72	7.420	7.20
Total dissolved solute (mg/L)	53.50	49.02	40.10	35.00	29.00	25.00
Conductivity (μ mhos)	95.10	91.00	85.70	79.42	62.50	54.10

Avoaja, D. A. and Otti, E. E. (1997). Effect of sub lethal concentration of pesticide on the growth and survival of the fingerlings of the African freshwater catfish –Heteroclarias (hybrid). *Nigerian Journal of Biotechnology, 8*: 40 – 45.

Ayuba, V.O. and Ofojekwu, P. C. (2002). Acute toxicity of the root extract of Jimson's weed *Datura innoxio* to the African catfish *Clarias gariepinus* fingerlings. *Journal of Aquatic Sciences, 17 (2):* 131 –133.

Bardack, J. E., Ryther, J. H., and Mclarney, W. O. (1972). *Agriculture: The farming and Husbandry of Fresh Water and Marine Organisms*. 2nd Edition. Wiley Inter-Science, John Wiley and Sons Inc. New York, USA. 868 pp.

Brown, E. (1977). *World Fish Farming. Cultivation and Economics*. Avi Publsihing Co Westport, USA. 104 pp.

Hunt, D. and Boyd, S. E. (1981). Alkalinity losses from ammonium fertilizer used in fish ponds. *Transactions of American Fisheries Soceity, 110*: 81 –85.

Ita, E. O. (1980). A review of recent advances in warm water aquaculture research and a proposed experimental fish production in Nigeria fishpond. Kainji Lake Research institute, New Bussa, Nigeria. 30 pp.

Ludwig, G. M., Stone, N. M. and Collins "BO". C. (1998). Fertilization of fish fry ponds. Southern Regional Aquaculture Centre, No. 469.

Omorege, E., Ajima, M. N. O. and Keke, I. R. (2003). Effects of sub lethal concentrations of NPK (15: 15: 15) fertilizer on growth and feed utilization by the toothed carp *Aphyosemion gairdneri* under laboratory conditions. *Journal of Aquatic Sciences 18 (2)*: 101 – 104.

Onusiriuka, B. C. and Ufodike, E. B. C. (1992). Acute toxicity of some inorganic fertilizers to *Oreochromis niloticus*. *Journal of Aquatic Sciences 7*: 7 – 11.

Otti, E. E. and Chude, L. A. (1997). Acute toxicity of inorganic fertilizer to African freshwater catfish *Heterobranchus bidorsalis* (Geoffrey) fingerlings. *Niger-Delta Biologia 2 (1)*: 60 –62.

Otti, E. E. (2002). Acute toxicity of cassava mill effluent to the African catfish fingerlings. *Journal of Aquatic Sciences, 17 (1)*: 31 – 34.

Palanisamy, R. and Kalaiselvi, G. (1992). Acute toxicity of agricultural fertilizers to the fish, *Labeo riohita*. *Environmental Ecology, 10 (4):* 869 – 873.

Robinson-Wilson, E. F. and Sein, W. K. (1975). The lethal and sub lethal effects of Zirconium process effluent on juvenile Saknibuds. *American water resources association 2*: 975 – 986.

Stickney, R. R. (1979). Principles of warm water aquaculture. John Wiley and Sons Incorporate USA. 350 pp.

Thurston, R. U. and Russo, R. C. (1983). Acute toxicity of ammonia to rainbow trout. *Transaction of the American Fisheries Society 112:* 092 –704.

Ufodike, E. B. C. and Unusiriuka, B. C. (1990). Acute toxicity of inorganic fertilizer to African catfish *Clarias gariepoinus* (Teugels). *Aquaculture and fisheris management 21*: 181 – 185.

Ufodike, E. B. C. and Onusiriuka, B. C. (1992). Gill damage and Haematology in African catfish exposed to inorganic fertilizers. *Nigerian Journal of Biotechnology 7*: 279 – 282.

UNEP (1989). Estimation of the acute lethal toxicity of pollutants to marine fish and invertebrates. *United Nations Environmental Programmes, Reference Methods for Marine Pollution Studies, No. 43*: 1 – 27.

Warner, R. E. (1962). Research directed towards development of test procedures for evaluating allowable limits of concentrations of toxic substances in the aquatic environment. Final report, US PHS No. 66 – 55, 30, November, 1 –55pp.