P: ISSN No. 2231-0045 RNI No. UPBIL/2012/55438 VOL. -V, ISSUE-II, November-2016
E: ISSN No. 2349-9435 Periodic Research

# Effect of Chronic Exposure of Fenvalerate on Oxygen Consumption of Fresh Water Fish, Heteropneustes Fossilis

**Ayesha Siddiqua**
Assistant Professor,
Deptt.of Zoology,
Mata Gujri Mahila Mahavidyalaya,
Jabalpur

**Manjusha Pouranik**
Assistant Professor,
Deptt.of Zoology,
Mata Gujri Mahila Mahavidyalaya,
Jabalpur

**Sangeeta Sarkhel**
Assistant Professor,
Deptt.of Zoology,
Mata Gujri Mahila Mahavidyalaya,
Jabalpur

**Abstract**

Oxygen consumption is very important short term indicator of general health conditions of a fish and is often measured routinely during pollution toxicity stress. The present study describes the possible effects of commonly used pesticide Fenvalerate, a synthetic Pyrethroid on the rate of oxygen consumption of a teleost fish, *Heteropneustes fossilis* (Bl.). The fish were subjected to sub-lethal concentrations (0.00070, 0.00046 & 0.00035 ppm) i.e. $1/10^{th}$, $1/15^{th}$ & $1/20^{th}$ of 96 hrs LC 50 values of fenvalerate, chronically for the period of eight weeks and the rate of oxygen consumption recorded at the interval of seven days. The experiment repeated twice and results averaged. The fish revealed zigzag pattern for oxygen consumption, recording increased rate during midterm phase of chronic exposure period as compared to the control.

**Keywords:** Heteropneustes fossilis, Fenvalerate, Oxygen-Consumption, Sub-lethal concentration.

**Introduction**

Pollution of water bodies due to industrial and agricultural effluents has exposed its biota to an unlimited extent of danger. Transport of pollutants from industrial and agricultural areas into the rivers and streams leads to its contamination and chronically affects the flora and fauna. The aquatic animals are particularly susceptible to the toxic substances, since their habitat is strictly confined to water bodies. They are exposed to the toxic compounds that are dissolved in large quantities in polluted water. Increasing regulatory restrictions on organophosphate pesticides, pyrethroid pesticides have replaced organophosphates for many residential and agricultural uses. These pesticides bring about a series of change in the organism. The synthetic pyrethroids are commonly used because of their rapid biodegradability and non-persistent nature. Pyrethroids are used preferably over organochlorine, organophosphorus due to their high effectiveness and low toxicity to birds and mammals and easy biodegradability (Kale. et al. 1999). Fish sensitivity to pyrethroids may be explained by their relatively slow metabolism and elimination of these compounds (David et al. 2003).

**Aim of the Study**

The current study is aimed to analyze the possible effect of, Fanevalerate a commonly used pesticide (synthetic pyrethroid) on the oxygen consumption of a fresh water teleost fish, *Heteropneustes fossilis.*

**Review of Literature**

The organic pollutants decrease the level of dissolved oxygen in the water bodies. It leads to many changes in organism physiology (Rajkumar & Manohar. 1998). In general one of the symptoms of pesticide toxicity is respiratory distress (O' Brien 1967). The rate of respiration is indicative of the physiological state of organism and any major change in respiration shows the environmental stress. Respiration in animals is the mostly used test for understanding the physiological action of the toxicants.

Gills are the major respiratory organs and all metabolic pathways depend upon the efficiency of the gills as they reflect the metabolic state of fish through respiratory activities, Gills are subjected to greater risk as they are exposed to attacks of bacteria, fungi and other toxicants/pollutants present in water. The respiratory potential of an animal is an important physiological parameter to assess the toxic stress, because it is a valuable

indicator of energy expenditure in particular and metabolism in general. This also helps for making valid inferences on its environmental requirements. Hence, studies on oxygen comsumption have gained a lot of importance. Oxygen consumption in *Mystus vittatus* on exposure to aldrex and nuvan have been studied by Arasta T. (1993). Effect on oxygen consumption of rainbow trout in response to1, 2, 4, 5-tetra-chlorobenzene exposure have been observed by Brauner et.al. (1994). Reddy & Bashamohideen (1995) studied oxygen consumption in *Cyprunus carpio* on exposure to cypermethrin. Yang and Randall (1997) observed effect of tetra-chlorobenzene & tetrachloroguaiacol on oxygen consumption of rainbow trout. Wagh & Jagtap (1997) have reported significant changes in *Cyprinus carpio* regarding oxygen consumption rate on exposure to thiodon. Toxic effect of dimethoate has been studied by Kalavathy et. al. (2001) on the fish *Sarotherodon mossambicus*.. Similar effect of pesticide on oxygen consumption & haematology of fish have been studied by Magare & Patil (2000). Various works of the scientists have revealed that the effect of pesticides, block the respiratory centers of brain leading to condition similar to asphyxia. In order to specify the effect of pollutant, the present study was undertaken to determine the possible effect of chronic exposure of fenvalerate (a synthetic pyrethroid) on the rate of oxygen consumption of a teleost fish, *Heteropneustes fossilis* (Bloch).

**Material & Method**

**Fish**

Adult, fresh water fish *Heteropneustes fossilis* were collected from (Sagar Lake) and other local riverine sources. The fish were acclimatized to laboratory conditions for 15 days, in large glass aquaria containing filtered de-chlorinated water. The water was renewed every day and average 10-12 hours of photoperiod was maintained daily. The fishes were fed with dry fish food and live earthworms every alternate days.

**Pesticide**

Fanvalerate 20% EC manufactured by Rallis India Limited was obtained from market. Solution was prepared by dissolving in distilled water

**Chronic exposure**

Healthy acclimated fish of similar weight (18-20 cm) & length (15-17 cms) were subjected to three sub lethal concentrations of the pesticide fenvalerate, being 1/10, 1/15 & 1/20 of 96 hours LC50 values). The concentration were 0.00070, 0.00046 & 0.00035 ppm, & the exposure period was of eight weeks.

**Oxygen Consumption**

The amount of oxygen consumed by a group of fish was determined according to Wrinkler's Iodometry Method as described by Strickland and Pearsons (1968). Observation on oxygen consumption was recorded at the interval of seven days for eight weeks. Feeding was stopped prior to the experiment. A group of fish was maintained simultaneously as control without the pesticide in the medium. The quantity of oxygen consumed by both the experimental & control groups were calculated in relation to unit wet weight of the fish. The difference in oxygen content of the initial & final samples was taken as the amount of oxygen consumed in µ gm $O_2$ consumed/h/gm wt/litre. Difference in the values of oxygen consumed by experimental and control fishes was taken as the measure of toxic effect of the pesticides. Significance of the data obtained was analyzed statistically using students't' test. The experiments were repeated twice and the results were averaged.

**Results and Discussion**

The effect of prolonged exposure of the test fish to three sub-lethal concentrations of pesticide fenvalerate is tabulated in the table (1) and represented in the graph A and B

The test fish does not show much variation in the pattern of oxygen consumption (uptake) under the effect of sub lethal concentrations of the pesticide viz 0.0007, 0.00046 & 0.00035 ppm. Increase in oxygen uptake in I week was followed by decrease upto IV week. Whereas V, VI & VII week period recorded significant increase, thereafter declining in the VIII week of the experiment. Fishes revealed a zig-zag pattern for oxygen consumption. Initial increase in rate of oxygen consumption showed a compensatory phase to enhance the physical activity followed by decrease, which can be an immediate response to the toxic environment. Continuous decrease in later period may be attributed to the failure of respiratory mechanism. Initial increase and then gradual decline in oxygen consumption indicated that the pesticide acted as an uncoupler.

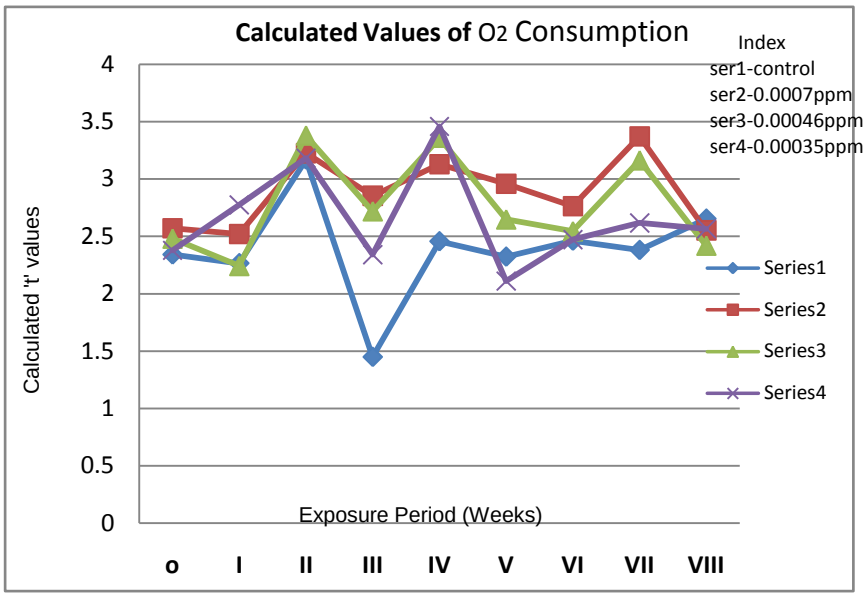
P: ISSN No. 2231-0045 RNI No. UPBIL/2012/55438 VOL. -V, ISSUE-II, November-2016

E: ISSN No. 2349-9435 Periodic Research

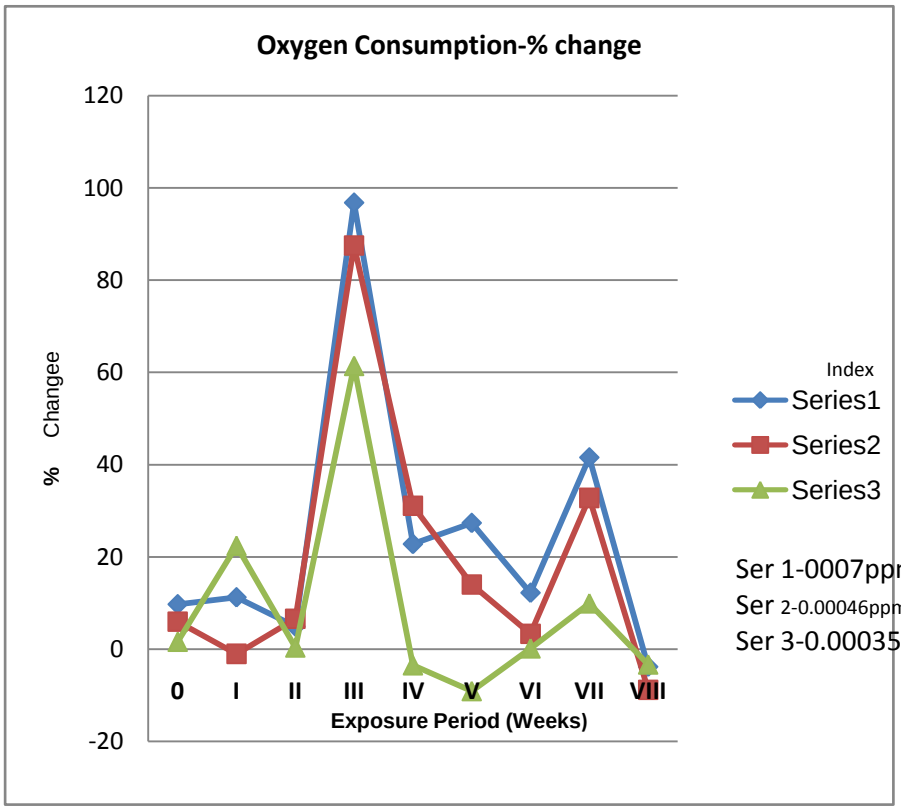
| S. No | Control | | | | | Fenvalerate Concentration (ppm) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0.0007 | | | | | 0.00046 | | | | | 0.00035 | | | | |
| | DF and Exposure period in weeks | Calculated 't' | Tabulated 't' | Probability level | Significance level | Calculated 't' | Tabulated 't' | % Change | Probability level | Significance level | Calculated 't' | Tabulated 't' | % Change | Probability level | Significance level | Calculated 't' | Tabulated 't' | % Change Probability level | | Significance level |
| 1 | 8, 0 week | 2.342 | 2.306 | 0.05 | * | 2.570 | 2.306 | 9.74 | 0.05 | * | 2.481 | 2.306 | 5.94 | 0.05 | * | 2.379 | 2.306 | 1.58 | 0.05 | * |
| 2 | 8I week | 2.266 | 2.306 | 0.05 | NS | 2.521 | 2.306 | 11.25 | 0.05 | * | 2.243 | 2.306 | -1.02 | 0.05 | NS | 2.774 | 2.306 | 22.42 | 0.05 | * |
| 3 | 8 II week | 3.169 | 3.355 | 0.01 | NS | 3.225 | 3.355 | 4.92 | 0.01 | NS | 3.378 | 3.355 | 6.59 | 0.01 | ** | 3.181 | 3.355 | 0.38 | 0.01 | NS |
| 4 | 8 III week | 1.450 | 2.306 | 0.05 | NS | 2.854 | 2.306 | 96.83 | 0.05 | * | 2.719 | 2.306 | 87.52 | 0.05 | * | 2.341 | 2.306 | 61.45 | 0.05 | * |
| 5 | 8 IV week | 2.457 | 2.306 | 0.05 | * | 3.128 | 3.355 | 22.81 | 0.01 | NS | 3.359 | 3.355 | 31.09 | 0.01 | ** | 3.457 | 2.306 | -3.53 | 0.05 | * |
| 6 | 8 V week | 2.323 | 2.306 | 0.05 | * | 2.959 | 2.306 | 27.38 | 0.05 | * | 2.648 | 2.306 | 13.99 | 0.05 | * | 2.111 | 2.306 | -9.13 | 0.05 | NS |
| 7 | 8 VI week | 2.462 | 2.306 | 0.05 | * | 2.763 | 2.306 | 12.23 | 0.05 | * | 2.545 | 2.306 | 3.34 | 0.05 | * | 2.472 | 2.306 | 0.41 | 0.05 | * |
| 8 | 8 VII week | 2.381 | 3.355 | 0.01 | NS | 3.371 | 3.355 | 41.58 | 0.01 | ** | 3.162 | 3.355 | 32.80 | 0.01 | NS | 2.617 | 2.306 | 9.91 | 0.05 | * |
| 9 | 8 VIIIweek | 2.654 | 2.306 | 0.05 | * | 2.553 | 2.306 | -3.81 | 0.05 | * | 2.420 | 2.306 | -8.82 | 0.05 | * | 2.565 | 2.306 | -3.35 | 0.05 | * |

Table 1- Oxygen Consumption of *H.fossilis* Chronically Exposed to Three Sub-Lethal Concentrations of Fenvalerate.
NS= Not Significant, *=Significant at P<0.05, **=Significant at P<0.01 DF= Degree of Freedom (8)

P: ISSN No. 2231-0045 RNI No. UPBIL/2012/55438 VOL. -V, ISSUE-II, November-2016
E: ISSN No. 2349-9435 Periodic Research




**A: Oxygen Consumption of *H.fossilis* Chronically Exposed to Three Sub-Lethal Concentrations of Fenvalerate**




**B : % Change in Oxygen Consumption of H.fossilis Chronically Exposed to Three Sub-Lethal Concentrations of Fenvalerate**

**Discussion**

Increased oxygen consumption of the test fish, *Heteropneustes fossils* was observed in the present study. The test fish when exposed chronically to sub-lethal concentrations of the pesticide showed increased oxygen consumption during mid-term phase of chronic exposure periods. But the increased concentration of the pesticides adversely affected the respiratory mechanism & the fish revealed decreased oxygen consumption which might be considered as a compensatory adaptation for successful survival of the fish in toxic medium. Similar effects of pesticide toxicity have been reported in the studies of other authors, Arasta (1993), Brauner et. al. (1994), Reddy & Bashamohideen (1995), Yang and Randall (1997) while working on *Mystus vittatus*, *Cyprinus carpio*, and Onchorynchus mykiss exposed to aldrin cypermethrin and tetra-chlorobenzene & tetrachloroguaiacol respectively and this change in rate of oxygen consumption was attributed to inhibition of oxidative enzymes during pesticide stress. Slight progressive increase in oxygen uptake initially and thereafter decrease followed by a slow and steady increase at the termination of the experiment has also been reported in the works of Wagh & Jagtap (1997) and Kalavathy et. al. (2001).

Gills the major respiratory organs were subjected to damage due to pesticide toxicity, and causing chain of destructive events, which ultimately lead to respiratory distress (Magare and Patil 2000). Secretion of mucus over the gills in response to pesticidal toxicity may curtail the diffusion of oxygen (David et. al. 2002), which ultimately reduce the oxygen uptake by the animal. Dharmalata and Joshi (2002) reported that the rate of oxygen consumption controls the metabolic activities. Decreased oxygen consumption in *Heteropreustes fossilis* in the present study might be considered as a compensatory adaptation for successful survival of the fish, in toxic medium. Malthivanan, (2004) also observed gradual decrease with increasing exposure periods in *Oreochromes mossambicus* under the effect of sublethal concentrations of quionolphos.

Several authors (Vutukuru 2005 and Vineeth Kumar & David 2008),studied the effect of hexavalent chromium and malathion respectively on survival, oxygen consumption & biochemical profiles, behavior & respiratory functions of fresh water fish *Labeo rohita*. and reported that the disturbance in oxidative metabolism leads to alteration in oxygen consumption in different fish species exposed to pesticides. Similar effect of chlorpyrifos, and endosulf an on *Oreochromis mossambicus* and *Cyprinus carpio* has been reported (Rao et.al. 2003,Sivakumar and David 2004 ). Shereena et.al.observed initial increase and thereafter decrease in later periods in rate of respiration in *Tilapia mossambica,* when exposed to sub-lethal concentration of pesticide dimethoate. The increase was attributed due to acceleration of oxidative metabolism and with the onset of symptoms of poisoning, the rate decreased in the later periods of exposure probably due to acclimatization to the chemical environment.Marigaudal et.al. (2009) reported variations in oxygen consumption of the fish *Labeo rohita* under lethal and sub-lethal concentrations of cypermethrin. The fish (*Labeo rohita)* depicted increased oxygen consumption on day 1 to day 2 & decreased on day 4 when exposed to lethal concentration. Increased oxygen consumption on days 1, 5, 10 & 15 was observed, as compared to control, when subjected to sub-lethal concentrations. This zig-zag pattern of increase and decrease was in concurrence with the results of the present study. Jothinerendran (2012) while working on oxygen consumption rate of *Channa punctatus* due to dimethoate toxicity reported, that oxygen consumption increased under all exposed concentration, which may be due to internal action of dimethoate.. The metabolic rate in relation to respiration of fish could be increased under chemical stress (Chebbi and David, 2010).Oxygen consumption exhibited decreasing trend in malathion treated group up to 96 hours as compared with control group as reported in the work of Magar and Shaikh (2012). Significant decrease in oxygen consumption of fresh water fish *Oreochromus mossambicus* on exposure to sublethal concentrations of chlorpyrifos has been reported by Padmanabha et.al. (2015). Drop in oxygen uptake of fish indicates the onset of severe hypoxia following pesticides exposure, which triggers on some biochemical changes in different tissues of the fish body. The decrease in oxygen consumption in sub-lethal concentrations possibly implies the adaptive response of the fish exposed to a toxic environment

**Conclusion**

The observations of the present study reveal that initial increase in the rate of oxygen consumption of *Heteropneutes fossilis* in chronic exposure might have been due to increased oxidative metabolism, where as decline in oxygen uptake may be in consonance with the diminished levels of oxidative enzymes. The fluctuated response in respiration may be attributed to respiratory distress as a consequence of the impairment of oxidative metabolism. From the present study it is evident that fanvalerate is a toxic chemical and has a profound impact on oxygen consumption of *Hetreropneustes fossilis* exposed to lethal and sublethal concentrations. Thus the fish oxygen uptake, which is easy to measure and is well documented in the literature may be utilized in modeling oxygen consumption phenomenon The results of the present study are in confirmation with the trend observed in earlier investigations by the above mentioned authors and also established the relationship of the responses in terms of fluctuating oxygen consumption rate of the experimental fish, to the toxic environment.

**References**

1. Arasta, T. (1993): Effects of pesticides on a teleost fish, Mystus vittatus with reference to biochemical studies. Ph.D. Thesis Dr. Hari Singh Gaur University, Sagar.
2. Brauner, C.J.D.J. Randall, J.F. Neuman and R.V.Thurston. (1994): The effect of exposure to 1,2,4,5-Tetrachlorobenzene and the relationship

between toxicant and oxygen uptake in rainbow trout Onchorhyncus mykiss during exercise. Environ.Toxicol. and Chem.13:1813-1820.
3. Chebbi, S.B. and David, M.(2010):Respiratory responses and behavioural anomalies of the carp Cyprinus carpio under quinalphos intoxication in sublethal doses. Science Asia, 36: 12-17.
4. David, M., H.B.Shivakumar, R. Shivakumar, S.B. Mushigeri, B. H. Ganti (2003): Toxicity evaluation of cypermethrin and its effect on oxygen consumption of the Fresh water fish, Tilapia mossambica. Indian J.Environ.Toxicol.13,99-102.
5. Dharmalata and Namitha Joshi (2002): Toxicity and respiratory responses of Heteropneustes fossilis exposed to zinc chloride and fly ash leachate. Him. J. Environ. Zool. 16(1); 87-90.
6. Jothinarendiran, N. (2012): Effect of Dimethoate Pesticide on Oxygen Consumption and Gill Histology of the Fish, Channa punctatus. Current Biotica, 5, 500-507.
7. Kalavathy, K., A.A. Sivakumar, R. Chandran (2001): Toxic effects of the pesticide dimethoate on the fish, Sarotherodon mossambicus. J. Ecol. Res. Bio. 2, 27-32
8. Kale, M.N., S John Rathore and D. Bhatnagar (1999): Lipid peroxidative damage on pyrethroids exposure and alternation in antioxidant status in rat erythrocytes:a possible involvement of reactive oxygen species.*Toxicol.Lett.,*105:197-205
9. Magar R.S. and Afsar Shaikh (2012): Effect of malathion on respiratory responses of fresh water fish Channa punctatus. Trends in Fisheries Research Vol. 1 No. 3
10. Magare, S. R. and H. T. Patil (2000): Effect of pesticides on oxygen consumption, red blood cell count and matabolites of a fish, Puntius ticto. Environ. Ecology 18, 891-894.
11. Marigoudar, S. R., R. N. Ahmed, M. David (2009): Cypermethrin induced respiratory and behavioural responses of the freshwater teleost, Labeo rohita Vet.arhiv 79(6) 583-590
12. Mathivanan, R. (2004): Effect of Sublethal Concentration of Quinolphos in Selected Respiratory and Biochemical Parameters in the Freshwater Fish, Oreochromis mossambicus. Journal of Eco Toxicology and Environmental Monitoring, 14, 57-64.
13. O.Brien, R.D. (1967): Insecticide action and metabolism. Academic Press.London. New York.
14. Padmanabha $A_1$, H.R.V.Reddy$_1$, Muttappa Khavi$_1$, Prabhudeva K.N$_2$, Rajanna K.B$_2$ and Chethan N$_2$ (2015): Acute effects of Chlorpyrifos on Oxygen Consumption and food consumption of Freshwater fish, Oreochromus mossambicus (Peters). International Journal of Recent Scientific Research Vol. 6, Issue 4, 3380-3384.
15. Rajmannar, K and Manohar, L. (1992): Pesticide dependent changes in the oxygen consumption of Cirrhinus mrigala. J. Ecol. Biol. 4(4); 287-291.
16. Rao, J.V., Rani, C.H.S., Kavitha,P., Rao, R.N. and Madhavendra, S.S (2003): Toxicity of Chlorpyrifos to the fish, Oreochromis mossambicus. Bull. Environ.Contam.Toxicol. 70; 985-992.
17. Reddy, P. M. and Bashamohideen (1995): Modulations in the levels of respiration and ions in the carp Cyprinus carpio (L) exposed to cypermethrin. Environ. Monito. Assess. 35(3): 221-222.
18. Shereena, K.M., Logaswamy, S and P. Sunitha (2009): Effect of an organophosphorous pesticide (Dimethoate) on oxygen consumption of the fish Tilapia mossambica. Recent Research in Science and Technology 1(1):004–007.
19. Shivakumar, R. and David, M. (2004): Toxicity of endosulfan to the fresh water fish, Cyprinus carpio. Indian J. of Ecology, 31(1); 27-29.
20. Strickland, J.D.H. and T. R. Parsons. (1968): A practical handbook of sea water analysis. Bull. Fish.Res.Board Can., 167: 21-31.
21. Vineethkumar K. Patil and M. David (2008): Behaviour and respiratory Dysfunction as an index of malathion toxicity in the freshwater fish, Labeo rohita (Hamilton), Turkish Journal of Fisheries and Aquatic Sciences, 8: 233-237.
22. Vutukuru, S.S. (2005): Acute effects of Hexavalent chromium on survival, oxygen consumption, Haematological parameters and some biochemical profiles of the Indian major carp, Labeo rohita. Int.J. Environ.Res.Public Health, 2(3), 456-462.
23. Wagh, S.B. and U.L.Jagtap. (1997): Oxygen consumption in Cyprinus carpio (communis) under stress. Environmental Pollution In 21st Century. Narendra Publication. New Delhi.
24. Yang, R. and D.J. Randall. (1997) : Oxygen consumption of juvenile rainbow trout, Onchorynchus mykiss exposed to sub-lethal concentrations of 1,2,4,5- tetrachlorobenzene and tetrachlorguaiacol. Bull.Environ. Contam. Toxicol., 59 :479-485.