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EFFECT OF PHYSICO-CHEMICAL POLLUTION OF RIVER DEORANIA ON THE METABOLIC ACTIVITIES OF PREDATORY FISH, CHANNA PUNCTATUS AT DISTRICT BAREILLY (U.P.) INDIA

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ABSTRACT

The present study was aimed at assessing the value of different physicochemical parameters of two sites (i.e. site A is clear and considered a control site while site B is loaded with heavy pollution so it is considered as experimental site) during December 2005-2006 and 2020-2021 in extreme months of different seasons. The analysis showed that the discharge of a major part of domestic wastes of Bareilly City, city refuge, debris, animal and human excreta and industrial effluents, enhanced the pollution load at site B and thereby enhanced the abnormal metabolic activities of fish. Whereas at clear site A the metabolic activities of fish were normal. In the present study, the following parameters i.e. temperature, colour, transparency, dissolved oxygen (DO), free CO_2, biochemical oxygen demand (BOD), salinity, total dissolved solids (TDS), level of glycogen, reducing sugar level, total protein level, level of amino acids, activity of alkaline phosphatase and acid phosphatase enzymes were analysed.

Keywords: Pollution, industrial effluents, fish, Deorania river, temperature, colour, pH, BOD, TSS, TDS.

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Introduction :

The impact of domestic and industrial pollution on natural bite has been reviewed by *Petrocelli* et. al (1975) and Jarvinen et al. (1978). Depending on the composition and concentration, industrial effluents alter the rates of feeding and digestion of fishes (Webb and Brett, 1972) and indirectly influence enzyme activity by varying the substrate availability (Lehninger, 1982). Aquatic resources of not only this district but

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also this state are still inadequately and largely unassisted (Singh et al., 1994; Jhingaran, 1991). Seasonal and geographic changes affect water quality in rivers and lakes (Chitmanat and Traichaiyaporn, 2010). Less than 1% of the world's freshwater is found in rivers, which are essential components of the biosphere. Due to rivers' higher ecological and social significance, pollution from indiscriminate sewage disposal, industrial waste disposal, and excessive human activity is harming aquatic organisms and changing their physicochemical characteristics (Murhekar, 2011; Annalakshmi and Amsath, 2012).

The city Bareilly is a part of Rohilkhand division which lies in the north-west of Uttar Pradesh.

It is located approximately between latitudes $28^0$55'N to $79^0$60'E. This district occupies a sound position among the industrial cities of Uttar Pradesh. About 90 big industries and 1094 small-scale industries are operating in the district. Out of these main important industries whose effluents discharges either directly or indirectly into experimental water bodies viz. Deorania river. It is a main tributary of river Ram Ganga which is major tributory of holy river Ganga; Bareilly is situated at distance of a 8 Km from the Western bank of river Ram Ganga, is 4 Km. from the South-West bank of river Nakatia while the river Deorania passes about 8 Km. from the north west then west-south through the thickly populated area of Bareilly city (Mazhar and Kapoor, 1992) and joins river Ram Ganga near Unchagaon and thus pours tons of organic and inorganic wastes into this river. Besides rivers, several ponds and vast areas under irrigation considerably contribute to the high moisture content in the study area.

Freshwaters are one of the main resources of food for the rapidly increasing human population, since there is greater awareness to utilize every possible kind of food but the overactivity of human beings is deteriorating the water quality at a fast pace and studies directed in this direction are urgently required. Keeping these objectives in view, the present research work was designed to observe the effect of sewage and industrial effluents on the biota of river Deorania at Bareilly (U.P.)

The river Deorania forming the experimental set-up of this work represents a special type of habitat as this river is situated in the open countryside and is associated with the cultivation of fishery crops and other minor occupations of the people.

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Materials and methods :

For the study the samples from clear site A and polluted sites B and C were collected in sterilized plastic containers and already sterilized broad mouthed laboratory bottles for the analysis of pollution to assess the physicochemical characterisation of the river Deorania in extreme months of different seasons at three different sites in summer, winter and rainy seasons for investigation of physical parameters that is temperature, colour, total suspended solids (TSS), transparency and chemical parameter that is pH, dissolved oxygen (DO), free CO_2, BOD, COD, salinity and total dissolved solids were carried out.

The temperature was measured by the mercury thermometer, and colour was observed as per Forel Ule colour scale method. The transparency of water was measured according to the method A. Secchi (1865). In chemical parameters pH was measured by using digital portable pH meter. For estimation of DO and BOD the water samples were collected in 300ml sterile BOD bottles at the sampling sites and estimated by Winkler's method according to Trivedi and Goel (1986). Salinity and total dissolved solids (TDS) were estimated according to APHA AWWA and WPCT (1995).

In biochemical parameters analysis under carbohydrate metabolism glycogen level in the liver and muscle tissue of *Channa punctatus* estimated by the Anthrone method of Van der Vries (1954), reducing sugar level estimated by the method of Folin and Wu (1920). Under protein metabolism total protein level and the level of amino acids analysed in blood by the method of Lowry et al. (1951) and Spices (1957) respectively.

Collection and storage of experimental animals

For carrying out experiments the fish *Channa punctatus* were collected using the net with the help of local fisherman from site A of river water Deorania at regular intervals every fortnightly during different seasons of the year 2005-2006 and 2020-2021. They were brought in plastic bags containing river water to the laboratory and maintained in a glass aquarium containing dechlorinated tap water for acclimatization at room temperature for one week. For this experimental estimation required a number of fishes of average size (10.50 $\pm$ 0.50cm in total length, 10.0 $\pm$ 0.30gm in weight) were collected and transferred into separate control (A) and experimental (B)

aquaria. Each aquarium has 10 fish. In the control aquarium fishes were exposed to clear river water brought from site A while in the experimental aquarium they were exposed to polluted water brought from site B of river Deorania. The aquarium water was aerated continuously and food was provided in the form of dried, powdered small prawn etc., water was changed at every 24 hours. The fishes were exposed to natural photoperiodism, and the dead animal (if any) was removed as soon as possible from the test container to prevent water fouling.

Results and discussion:

The study was conducted for extreme months of winter, summer and rainy seasons during the year 2020-2021. The average values of different physico-chemical parameters of river water Deorania at sites A and B are given in Tables I and II. The biochemical parameters regarding the level of glycogen in liver and muscle tissues, the level of reducing sugar in blood, the level of total protein in liver and muscles level of amino acids in blood and the activity of enzymes, alkaline and acid phosphatases of fish (*Channa punctatus*) were given in table III and IV. The results of this study clearly indicated that there is heavy load of pollution at experimental site B as compared to control site A.

Major part of its domestic wastes, city sewage debris, animal and human excreta and industrial effluents with other wastes are discharged in river Deorania before about 50 meters away from site B.

Metcalf and Eddy (1916) and Herbert and Merkens (1961) have found that when the concentration of the effluent was high the survival time of fish was reduced. In the present study biochemical data shows that significant behavioural changes in fish *Channa punctatus*. These pollutants cause more menace to aquatics including fish and ultimately to man through food chain due to the drainage of non-biodegradable and persistent in nature (Konar, 1991, Srivastava, 2001). Pollutants cause not only adverse effects on fish metabolism but fish food organisms also. High organic constituents are responsible for a significant portion of oxygen demand (Babu et al. 1997). The organic matter supports good microbial growth, the microorganisms utilize the oxygen which leads to high values of BOD, COD and low values of DO. The initial increase in opercular movement can be taken as an index of the stress felt by the fish exposed to polluted water media. Fishes of the control group are free from

any such type of behavioural changes so it is clear that only pollutants present in water were responsible for the changed behaviour and mortality. Animal behaviour is a neurotropically regulated phenomenon which is mediated by neurotransmitter substances (Samba Siva Rao, 1999). The property of salinity & alkalinity of natural water is usually imparted by the presence of bicarbonate, carbonate, hydroxide, phosphate, silicate and borate.

This condition is particularly true in surface water where algae is flourishing. The algae remove free CO_2, free and combined to such an extent that pH value of 9 to 10 are often obtained (Kohli, 1994). The total suspended and dissolved solids are undesirable in water, as it interferes with aeration and photosynthetic activity. Transparency of water supports good growth of fish fauna while in the present study low value of transparency was noted which represents an alarming situation.

At site B there is discharge of effluents, animal excreta soaps, detergent, dyes etc. in river water. The phosphate present in these are an important nutrient for the growth of microorganisms, excessive amount of phosphate leads to extrophication resulting in the depletion of O_2 level of water (Sharma et al., 1978). Although detergents are not highly toxic to fish, they do cause damage to gills, skins and intestine. In the present study the level of glycogen in liver and muscles represent reduction in the experimental group comparatively control group due to its more utilization under stress. The level of reducing sugar in blood represent incensement in experimental group comparatively control group due to reduced glycogen synthesis and increased glycogenolysis. Carbohydrates are the primary and immediate source of energy. In stress condition, carbohydrate reserve depleted to meet energy demand. In present study a significant reduction in protein level was observed in liver and muscles on 7^{th} day after exposure of fishes to polluted water. This changes in protein level can partially be attributed to inhibition of enzyme alkaline phosphatases and on account of pollutants creating stress conditions. The level of total protein in liver and muscles represent also reduction in experimental group comparatively control group.

During stress condition fishes need more energy to detoxify the toxicants to overcome stress. Since the amount of carbohydrate is very less in fishes, the next alternative source of energy in protein to meet the increased energy demand. This changes in protein level can partially be attributed to inhibition of enzyme alkaline

phosphatases and on account of pollutants creating stress conditions. The depletion of protein during stress in experimental fishes in liver and muscles may have been due to their degradation and possible utilization of degraded products for metabolic purposes increase in free aminoacids in protein synthesis (Singh et.al.). In present investigations decrease in total protein level and increase in total free aminoacids in liver and muscles suggest the high protein hydrolytic activity due to elevation of protease activity. Aminoacids are building block of protein. Any change in its concentration in blood is indicative of change in protein metabolism. In the present study the level of free aminoacids in blood represent increasement in experiment group comparatively control group. The changes may be due to decrease in protein synthesis because of inhibition of alkaline phosphatases or protein catabolism due to increase in lysosomal activity. Alkaline phosphatases are the enzymes showing activity in range of pH. They have been found associated with active transport of chemicals across cell mombrance (Vorbrodt, 1959; Hugon and Borgers, 1966). Protein synthesis (Pilo et al., 1972), digestive enzyme synthesis (Sumner, 1965; Timmermans, 1969; Walker, 1970; Ibrahim et al., 1974), spermatogensis (Pavlikova and Repas, 1975). In present study activity of these enzymes has been found to reduce significantly in experimental group. Since these enzymes are vital for life, their reduced levels produce wide range of effects over the metabolism of *Channa punctatus.* This can be substantiated with the observed decrease in protein level in the liver and muscles. Acid phosphatases belongs to the group of lysosomal hydrolytic enzymes. They are proteolytic in action (Bell et al., 1970; Moczon, 1976) and thus play a significant role in catabolism, autolysis and phagocytosis (Abou-Donia, 1978). In present study activity of acid phosphates represent increasement in experimental group comparatively control group which caused enhanced catabolism in the blood tissues. This becomes clear from our present findings in which the decrease in the protein concentration and resultant increase in free aminoacids were observed. Similar increase in its activity is associated with degeneratives changes in human testis (Pavlikova and Repas, 1975). The increase in its activity is associated with degenerative changes by significant decrease in the concentration of the level of total proteins, activity of alkaline phosphatase and the level of glycogen. Beside this, increase in the total free aminoacids and reducing sugar level has also been observed.

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These changes were linked directly to altered behaviour and mortality of *Channa punctatus* in river water Deorania.

Table 1: Average values of different physico-chemical parameters of river Deorania at site A and B in different extreme months of winter, summer and rainy seasons during the year 2005-2006.

Extreme months parameters	Site-A						Site-B					
	Winter		Summer		Rainy		Winter		Summer		Rainy	
	Dec	Jan	May	June	July	Aug	Dec	Jan	May	June	July	Aug
Temperature (^{0}C)	10.50	10.20	32.20	32.40	29.20	29.00	17.50	16.80	33.10	34.20	29.70	29.20
Colour (Forel-ule Colour scale)	Greenish blue	Greenish blue	Bluesh green	Bluesh green	Greenish yellow	Greenish yellow	Brown	Brown	Brown	Brown	Brownish yellow	Brownish yellow
pH	8.40	8.50	7.50	7.50	7.80	7.80	9.20	9.20	7.10	7.20	9.10	9.10
Transparancy (cm)	47.00	47.50	43.50	43.50	41.00	41.00	29.00	29.00	28.50	28.50	25.00	25.50
TDS (mg/l)	220.00	221.00	255.00	256.00	295.500	299.00	714.50	720.50	830.20	828.20	784.50	780.00
DO (ppm)	6.20	6.10	7.70	7.80	7.20	7.30	0.90	0.90	1.60	1.50	1.80	1.90
BOD (mg/l)	4.10	4.10	4.80	4.90	3.80	4.80	14.70	14.80	28.50	28.90	20.50	20.80
Free CO_2 (mg/l)	1.02	1.05	1.25	1.30	1.40	1.50	2.80	2.70	3.00	3.10	3.20	3.10
Salinity (ppm)	Nill	Nill	0.10	0.10	0.10	0.11	0.30	0.30	0.32	0.31	0.25	0.25

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Table 2: Average values of different physico-chemical parameters of river Deorania at site A and B in different extreme months of winter, summer and rainy season during the year 2020-2021.

Extreme months parameters	Site-A						Site-B					
	Winter		Summer		Rainy		Winter		Summer		Rainy	
	Dec	Jan	May	June	July	Aug	Dec	Jan	May	June	July	Aug
Temperature (^{0}C)	10.80	10.50	32.80	33.20	30.10	30.00	18.10	17.70	33.30	33.90	30.50	30.40
Colour (Forel-ule Colour scale)	Greenish blue	Greenish blue	Blue green	Blue green	Greenish yellow	Greenish yellow	Brown	Brown	Brownish black	Brownish black	Brown	Brown
pH	8.30	8.40	7.40	7.40	7.80	7.80	9.10	9.10	7.10	7.00	8.80	8.80
Transparancy (cm)	46.50	47.00	43.00	42.50	40.50	40.50	28.50	28.50	27.00	27.00	24.50	25.00
TDS (mg/l)	230.00	235.00	258.00	262.00	310.50	312.50	725.50	726.50	850.10	860.00	790.50	795.00
DO (ppm)	6.10	5.80	7.50	7.60	7.40	7.20	0.80	0.80	1.50	1.50	1.70	1.70
BOD (mg/l)	4.20	4.30	5.00	5.20	4.80	4.90	17.20	18.20	32.50	33.00	25.50	24.00
Free CO_2 (mg/l)	1.30	1.40	1.55	1.60	1.70	1.75	3.50	3.20	3.60	3.55	3.70	3.65
Salinity (ppm)	Nill	Nill	0.12	0.13	0.14	0.15	0.37	0.38	0.40	0.38	0.37	0.35

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Table 3: Changes in total protein, total free amino acids, glycogen, reducing sugar, Alkaline phosphatose, Acid phosphatase in different tissues of *C. punctatus* on 7th day after exposure to control and experiemental aquarias in different season during the year 2005-2006.

Parameter	Tissues	Control			Experimental		
		Winter	Summer	Rainy	Winter	Summer	Rainy
Glycogen	Liver	2.24±0.05 (100)	2.15±0.06(100)	2.05±0.06(100)	1.50±0.06*(69)	1.23±0.04*(57)	1.15±0.05*(56)
	Muscle	1.85±0.02(100)	1.72±0.01(100)	1.68±0.04(100)	1.37±0.04*(75)	1.18±0.04*(69)	1.09±0.06*(65)
Reducing sugar (µg/ml)	Blood	183.24±1.50(100)	211.85±1.02(100)	275.25±1.62(100)	212.15±1.12*(116)	255.65±1.25*(121)	315.14±1.80*(115)
Protein (µg/ml)	Liver	128.20±1.25(100)	127.90±1.05(100)	131.32±0.55(100)	75.78±1.12*(59)	74.92±0.35*(59)	89.05±1.20*(76)
	Muscle	145.85±1.50 (100)	143.72±0.15(100)	151.88±0.20(100)	98.15±1.08*(68)	95.25±1.20*(66)	107.25±1.25*(70)
Amino acid (µg/ml)	Blood	11.24±0.50 (100)	12.89±0.25 (100)	11.75±0.35(100)	13.75±0.35*(127)	15.02±0.45*(115)	14.05±0.23*(117)
Alkaline phosphatase µ moles/ substrate hydrolized/ µg protein/ 30 minutes	Liver	0.513±0.003 (100)	0.491±0.002 (100)	0.398±0.004(100)	0.465±0.010*(91)	0.425±0.012*(87)	0.352±0.003* (88)
Acid phosphatase µ moles/ substrate hydrolized/ µg protein/ 30 minutes	Liver	0.148±0.002(100)	0.152±0.001(100)	0.51±0.002(100)	0.162±0.003*(109)	0.173±0.002*(114)	0.160±0.001*(107)

- Value are mean ± SE of six replicates.
- Values in parentheses are % change with control taken as 100%
- Data work analysed through student's test.
- Significant ($P<0.05$), when treated groups were compared with controls.

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Table 4: Changes in total protein, total free amino acids, glycogen, reducing sugar, Alkaline phosphatose, Acid phosphatase in different tissues of *C. punctatus* on 7th day after exposure to control and experiemental aquarias in different season during the year 2020-2021.

Parameter	Tissues	Control			Experimental		
		Winter	Summer	Rainy	Winter	Summer	Rainy
Glycogen	Liver	2.20±0.04(100)	2.12±0.05(100)	2.01±0.06(100)	1.46±0.07*(69)	1.22±0.04*(57)	1.15±0.05*(56)
	Muscle	1.82±0.02(100)	1.69±0.02(100)	1.67±0.04(100)	1.36±0.04(76)	1.16±0.05*(69)	1.08±0.06*(65)
Reducing sugar (µg/ml)	Blood	180.24±1.45(100)	213.51±1.00(100)	273.85±1.59(100)	213.11±1.20*(117)	257.50±1.30*(122)	316.13±1.75*(116)
Protein (µg/ml)	Liver	127.80±1.15(100)	126.89±1.06(100)	130.87±0.57(100)	74.52±1.52*(59)	73.85±0.45*(59)	88.08±1.3*(75)
	Muscle	144.89±1.60(100)	143.52±0.45(100)	150.75±0.30(100)	97.25±1.10*(69)	94.82±1.20*(67)	106.85±1.25*(70)
Amino acid (µg/ml)	Blood	11.85±0.40(100)	13.53±0.21(100)	12.12±0.35(100)	14.12±0.25*(128)	15.01±0.85*(116)	14.65±0.22*(118)
Alkaline phosphatase µ moles/ substrate hydrodized/ sig protein/ 30 minutes	Liver	0.510±0.002(100)	0.490±0.004(100)	0.388±0.004(100)	0.455±0.002*(92)	0.415±0.001*(87)	0.350±0.002*(89)
Acid phosphatase µ moles/ substrate hydrodized/ sig protein/ 30 minutes	Liver	0.145±0.002(100)	0.148±0.002(100)	0.151±0.001(100)	0.163±0.003*(110)	0.174±0.002*(115)	0.161±0.001*(107)

- Value are mean ± SE of six replicates.
- Values in parentheses are % change with control taken as 100%
- Data work analysed through student's test.
- Significant ($P<0.05$), when treated groups were compared with controls.

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