Study of the physico-chemical parameters of Harsul Dam, Aurangabad (M.S.)

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Introduction :

The Physico- chemical characteristics of a water body exert a great effect on biota present in water body of Harsul dam. The physico-chemical parameters and biotic communities of lentic and lotic water bodies have been already reported in detail by Yousaf (1989), Pandey *et al.;* Sugunan (1995), Kaur *et al.;* (1997), Gopal and Zutshi (1998), Esmaeili and Johal(2005), Negi *et al.;* (2006). Harsul Dam is an important dam constructed on the river Kham in the year 1952. The basic purpose of this dam is to supply water in nearby locality for domestic use. This lake has vast potential of fishery; hence physico-chemical characteristics of this reservoir have been taken for present study.

Material and methods

In the present study an attempt was made to assess degradation of the water of Harsul Dam for checking the pollution status. The basic aim of this Harsul lake is to supply water to nearby locality for domestic use. During the present study, water samples were collected two sampling point's i.e. Upstream: - the point where the principle feeder opens into the Harsul dam.Midstream: - the point that gives the general water quality of the Dam.

Grab sampling was done at the upstream and midstream, the samples were collected, in a sampling bottle, to assess their physical and chemical qualities at weekly intervals. The samples were collected in thoroughly cleamed 2.5 liter inert plastic containers, which were rinsed with distilled water before collection. Water samples then were taken in a sampling bottle avoiding floating materials. The stoppers of the sample containers were closed properly to present contamination from outside. The containers were labeled description the name of the water body, date, time sampling –point and conditions under which they were collected as samples.

In the present investigation, the water chemistry of Harsul dam has been studied for a period of one year i.e. from January 2009 to Dec 2009 and analyzed important chemical parameters. All the parameters like pH, Temperature, Turbidity, TDS, Hardness, Chloride, Sulphates, Phosphates, DO, COD, BOD, were analyzed according to the standard methods (APHA 1998 and Trivedi and Goel 1986).

Result and discussion

Physico-Chemical Parameters of Harsul water Dam:

pH: potentia Hydrogen expressed in terms of pH depends upon the amount of carbonates and free carbonate tension in the water. This is an index of acidic, alkaline and neutral nature of water. It is important parameters to analyzed various metabolic activities and interaction of biological communities in the aquatic systems. In the present investigation the maximum values 8.16 and 8.10 were recorded in the month of December 2009 at both sites i.e. Upstream and Downstream 2009(Table -1). This was due to the absence of free carbon dioxide as it was utilized in photosynthesis. Manian *et al.;* (1992) established a positive correlation between pH of the water with that of productivity status. Mitra (1995) recorded the pH range of 8.5 to 9.0 in the polluted rivers and observed the effect of pH on the Phytoplankton abundance. Lower values of pH were reported during rainy season owing to addition of rainwater leads to its low value. This could be attributed to the fact that in the absence of free carbon dioxide, the carbon dioxide, from the carbonate cannot be utilized; hence there was increase in carbon dioxide and carbonate ions. The present findings are supported by Esmaeili and Johal (2005), Negi *et al.;* (2006).

Temperature: Temperature in the water is important for its effects on the chemistry and biochemical reaction in the organisms. It is essential factor in the aerobic environments of aquatic system, as it determines the succession of predominant species of algae, bacteria and other aquatic organisms.

Monthly water samples were collected for one year (i.e. from January 2009 to December 2009) the water temperature fluctuated according to atmospheric temperature ranging from 21^{oc} (January 2009 and December 2009) to 32^{oc} in the month of May 2009. Water depth was less in the month of May and highest in the month of September.

From table 1, it is evident that the temperature showed fluctuation between 19^{oc} to 33^{oc} during January to December 2009. As expected, summer months such as March, April and May recorded. High temperature and winter with low temperature detectable changes were also noted during the observation. Similarly Subramanyam *et al.;* (1976), Krishnamurthy and Bharti (1996), Swarnlatha

and Narsing Rao (1991), Borse and Bhave (2000) and Anvar (2000), Shinde (2006) also noted that the temperature fluctuated between 19.0°C and 33.0°C in the year 2003 and 21.0°Cand 32.0°C in the year 2004.

Turbidity: It is the reduction of clarity in the water due to the presence of suspended or colloidal particles. Turbidity is measured by the amount of light reflected by the particles. It is an indicator for the general condition of the water. Turbidity to water is caused by suspended matter viz. clay, Silt, and organic matter and by plankton and other microorganisms that interfere with the passage of light through the water (APHA). Turbidity closely related to suspended solids (TSS), but also includes plankton and other organisms. The turbidity interferes with disinfection and provides a medium for microbial growth. TSS, organic matters also contribute to turbidity. Soil erosion, urban runoff, decaying plants and animals, Bottom-feeding fish, Algal blooms, flooding contribute to turbidity.

In the present investigation maximum values of turbidity (12.20, 12.90, 14.20 NTU) were recorded in June, August and September 2009 in upstream site where as 13.70, 14.20, and 15.00 NTU was reported in July, August, and September 2009 with Midstream site(Table-1). The higher Turbidity affects Photosynthesis rate of Phytoplankton's due to constant hindrance in transmitting the light.

Verma *et al*.;(1978), reported that the turbidity depleted the rate of primary production and checking the phytoplankton growth. Saxena *et al.;* (1966), reported highest value of turbidity in river Ganga at Kanpur during rainy season due to surface run-off. Sharme *et al.;* (1981) reported maximum turbidity 1702 NTU in river Yamuna at Agra. In present investigation the lowest value of turbidity was reported in pre-monsoon months and highest in Monsoon months

Months	Sites	pH	Temp °c	Turb. NTU	TDS Mg/L	Hardness Mg/L	Cl Mg/L	SO4 Mg/L	PO4 Mg/L	DO Mg/L	COD Mg/L	BOD Mg/L
Jan-09	Upstream	7.70	22.40	11.00	262	100.00	39.05	6.5	1.86	4.6	16.0	8.4
	Midstream	7.82	21.00	9.00	288	92.00	42.60	5	0.94	5.6	8.6	7.3
Feb-09	Upstream	7.79	24.60	8.15	278	120.00	46.15	6.4	1.76	4.2	20.0	5.7
	Midstream	7.70	23.00	4.60	260	100.00	46.20	4.9	1.01	5.4	8.0	12.0
Mar-09	Upstream	7.65	27.20	6.60	316	98.00	39.05	5.2	1.90	4.8	16.0	6.0
	Midstream	7.71	25.00	5.10	262	110.00	24.90	5	1.20	5.2	12.0	5.3
Apr-09	Upstream	7.60	29.00	9.30	324	89.00	35.50	4.1	1.88	4.1	8.0	7.0
	Midstream	7.63	26.00	7.60	290	100.00	32.00	5.1	1.45	4.3	8.0	4.2
May-09	Upstream	**7.57**	32.00	6.20	346	84.00	42.60	3.5	1.90	4.4	12.0	6.4
	Midstream	7.60	29.00	9.00	300	110.00	35.50	5	1.20	4.1	8.0	5.7
Jun-09	Upstream	7.60	28.00	12.20	298	80.00	35.50	3.6	0.96	5.6	8.0	8.8
	Midstream	7.64	29.00	6.20	332	80.00	46.20	4.7	1.41	3.6	16.0	9.6
Jul-09	Upstream	7.65	25.00	10.30	156	70.00	24.85	4.6	0.99	5.7	8.0	11.0
	Midstream	7.70	27.00	13.70	298	100.00	39.10	4.2	1.45	3.5	20.0	9.0
Aug-09	Upstream	7.69	24.60	12.90	188	88.00	24.85	4.6	1.10	5.4	4.0	11.2
	Midstream	7.68	26.30	14.20	252	50.00	35.50	4.9	1.28	4	16.0	9.6
Sep-09	Upstream	7.80	23.30	14.20	146	40.00	24.85	4.5	1.06	4.8	16.0	12.0
	Midstream	7.82	24.70	15.00	208	94.00	32.00	4.2	1.21	4.4	12.0	9.0
Oct-09	Upstream	7.98	24.20	7.20	200	110.00	28.40	6	1.32	4.6	12.0	5.6
	Midstream	7.90	23.80	4.20	200	90.00	24.00	5.6	0.96	4.9	8.0	4.3
Nov-09	Upstream	8.06	23.00	11.40	236	120.00	31.95	6.3	1.45	4.5	20.0	8.4
	Midstream	8.00	22.10	3.40	202	110.00	28.40	5.4	1.03	5	8.0	5.0
Dec-09	Upstream	**8.16**	24.00	9.20	240	106.00	35.50	6.8	1.89	5	8.0	9.2
	Midstream	**8.10**	21.00	4.56	214	98.00	32.00	6	0.99	4.8	8.0	5.6

Table-1.Reveals Monthly mean Values of Some Physico- Chemical Parameters

From Harsul Dam Water During Jan 2009 to Dec 2009

Maximum value of turbidity was only because of surface run-off water with soil in rainy season, domestic waste, cattle washing, bathing activity etc.

Similar observations were also reported by earlier works such as Ajmal and Raziuddin (1985), Ghose and Sharma (1988), Mathew *et al.;* (1992), Gaikwad (2003) and Shinde (2006).

Total Dissolved Solids:(TDS) Total dissolved solids denotes mainly the various kinds of minerals present in the water "Dissolved Solids" refers to any mineral salts, metals, cations or anions dissolved in water. Dissolved solids are important parameters in drinking water. Portability of water depends much on the dissolved solids. Higher concentration produces distress in cattle and plants which are also adversely affected. It leads to increase the salinity of the soil and creates problems in industrial applications.

Concentration of TDS, from natural sources have been found to vary from less than 30 mg/ lit. To as much as 6000 mg/lit depending upon the solubility of minerals in different geographical regions. A sudden or extreme change in TDS could kill aquatic life (Sivakumar *et al.;* 2000), Gaikwad (2003).

In the present investigation, minimum TDS value 146 mg/l in the month of September 2009 and maximum 346 mg/l in 346 mg/l in May 2009 were recorded with upstream site and minimum 200 mg/l in October 2009 and maximum 332 mg/l in the month of June were recorded with midstream. In the present investigation, the TDS values minimum were recorded during rainy season because of the rains, an additional water in it, while maximum values in summer season owing to high temperature and high rate of evaporation. Trivedi and Goel (1986) stated that in the polluted water the concentration of other substances increases depending upon the type of pollution. Similar findings were also reported by Shinde (2006) and Negi *et al.;* (2006).

Hardness: Hardness of water depends on the amount of Calcium and Magnesium salts dissolved in the water. Crompton (1985) and Roy (1996) analyzed the loads of inorganic and organic pollutants in stagnant and flowing water and concluded that the calcium, magnesium related compound play an important role in the growth and occurrence of aquatic micro and microorganisms.

In the present investigation minimum value of hardness 40 mg/l in September and maximum value 120 mg/l was recorded in February and November 2009 were reported with the upstream site, whereas minimum value 110 mg/l in the month of March, May and November were reported. So maximum values on an average were recorded in winter and minimum in monsoon. Obtained result is in conformity to findings of Sugunon(1995), Esmaeili and Johal (2005), Sharma(1986), Kaitha *et al.;* (2000),Negi *et al.;* (2006).

Chlorides :- Chlorides is one of the major inorganic anions in water and waste water. Chlorides are not utilized directly and indirectly for aquatic plants growth and hence its existence in the aquatic systems is responsible for a large amount of organic matter, which in turn causes eutrophication.

In present investigation, minimum value of chlorides 24.85 mg/l in July and August 2009 and maximum 46.15 mg/l and 42.6 mg/l in June respectively was reported in upstream site and minimum value 24.9 mg/l in March and October 2009 and maximum values 42.6 mg/l and 46.2 mg/l in January and February 2009 respectively in midstream site of Harsul dam (Table-1). Concentration of chloride was decreased from June to October in upstream and from September to December 2009 in midstream site of Harsul dam. The rise of chloride was obtained due to dumping effluents of corporation, fluctuations in temperature and surface evaporation. This could be explained by the fact that the presence chloride salts may interfere with other nutrients which are being utilized in the process of photosynthesis. In monsoon the chloride were recorded. Similar results were observed and recorded by Sharma *et al.;* (1978), Mukharjee *et al.;* (1991), Thresh *et al.;* (1944), Vass (1980), Shinde (2006), and Negi *et al.;* (2006). Padhi(1995) and Rana *et al* (1995) reported that the enrichment of chloride in the aquatic bodies is due to rainfall and substances carried from the catchments.

Sulphate: - Sulphate occur appreciably in all natural water bodies, particularly there with high salt content. Besides, biological oxidation of reduced sulphere species also add to sulphate content and it imports hardness with other cations. During the period of present study, minimum value of sulphate 3.5 mg/l and 3.6 mg/l in May and June 2009 and maximum 5.6 mg/l and 6.4 mg/l in December 2009, January and February 2009 in upstream site respectively and also minimum 5.6 mg/l and 5.4 mg/l in October and November 2009 respectively in midstream of Harsul Dam(Table-1). In present investigation, maximum concentration of sulphate was recorded in summer. This may be well attributed to evaporation of surface water of Harsul dam because of high temperature. Chemically sulphate play an important role in forming salt of Ca and Mg to give permanent hardness to water (Trivedi and Goel 1986), Shinde (2006) also obtained similar results during his research study leading to Ph.D. degree.

Phosphate: Phosphate come in water bodies either directly or indirectly from weathering or phosphoric rocks and are present in the form of dissolved phosphates. Kakati and Bhattacharya (1990) analyzed different aquatic system for Physico-chemical and microbiological characteristics and correlated them with phosphate contents.

In the present investigation, minimum value of phosphate 0.96 mg/l, 0.99 mg/l in june 2009 and maximum value 1.86 mg/l, 1.88 mg/l in the month of January, April and December 2009 was recorded in upstream site of Harsul dams and also minimum value of phosphate 0.94 mg/l and 0.96mg/l in the months of January and October 2009 and maximum 1.45 mg/l in April and July 2009 was reported from midstream of Harsul dam , respectively (Table-1). In deep water of Harsul dam phosphorus precipitates as apatite, a calcium flurophosphate mineral wereobtained with phosphate content in surface water. However, phosphorus is a constituents of some dyes surface active compounds and common detergents. Similar observations were also recorded by Shastree and Malik(1992), Saxena *et al* (1996),Negi *et al* (2006). In the present investigation,the value of phosphate showed great fluctuations. The maximum value from January to April and December and minimum from June to September 2009 in upstream site and in midstream site it was just an arbitrary.

Dissolve Oxygen :-Dissolved Oxygen(DO) is one of the important and critical characteristics of water quality assessment. Its presence is essential to maintain the higher

forms of biota and keep balance of various populations, thus keeping the water body healthy. DO also plays an important role in productivity of aquatic ecosystem. The low oxygen concentration causing a wide array of stress related response (Mathews, 1998). In view of this determination of DO is essential.

In present study,minimum DO values 4.1 mg/l and 4.1 mg/l, 5.7 mg/l and 5.4 mg/l in June, July August 2009 was recorded in upstream site of Harsul dam and also minimum DO value 3.6 mg/l and 3.5 mg/l in June and July 2009 and maximum 5.6 mg/l and 5.4 mg/lit , 5.2 mg/lit in January, February and March 2009 was recorded in midstream of Harsul dam(Table-1).Dissolve Oxygen was generally maximum in winter season . This May be well attributed to low water temperature and minimum DO was recorded in summer. This may be due to higher temperature and decrease in water level on evaporation. The present findings are well in line with findings of earlier workers like Jindal and Vasisht (1985), Singh and Mahajan (1987) and Negi *et al* (2006).

Chemical Oxygen Demand:- Chemical oxygen Demand test determines the oxygen required for the chemical oxidation of organic matter with the help of strong chemical oxidant. In the present investigation, carried out for one year i.e. from January to December 2009, minimum COD value 4 mg/l in August 2009 and maximum 16 mg/l and 20 mg/l in January and February 2009 were recorded at upstream site and also minimum 6 mg/l in April 2009 and maximum 16 mg/l in August 2009 were recorded at Midstream sites respectively (Table-1) . It was clear from the investigations that the COD variations went on changing with seasons and also with release of chemical substances from agriculture wastes and sewage. Rapid agricultural activities in vicinity of the lentic and lotic systems showed their impacts on COD levels. Present work is in conformity with the findings of earlier work such as Raina and Dungrakoti(1975), Naik and Purohit(2001), Salve and Hiware(2006).

Biochemical Oxygen Demand:- Biochemical oxygen Demand is an indicator parameter to know the presence of biodegradable matter in the waste and express degree of contamination. In the present investigation the values of BOD were observed at two sites first. upstream site and second Midstream site during January to December 2009. Minimum BOD value 5.7 mg/l and 5.6 mg/l in the months of February and October 2009 and maximum value 11.00 mg/l and 11.2 mg/l in the month of July and August 2009 were recorded at upstream site and also minimum BOD value 4.2 mg/l and 4.3 mg/l in the month of April and October 2009 and Maximum value 9.6 mg/l and 9.6 mg/l in the months of June and August 2009 at midstream were observed respectively (Table-1). The BOD attended its high peak during monsoon and low peak in winter at both sampling stations.

Similar type of observations were made by the earlier workers such as Mathur *et al* (1991), Patki (2002), Salve and Hiware(2006). Thorat and Sultana (2001) reported higher values of BOD 140 -180 mg/l indicating organic pollution.

The present investigation concludes that the Harsul dam water was non polluted. All results are within permissible limit when compared with WHO and ISI. The water from Harsul dam is good for drinking after normal processing.Harsul dam may be in danger in year to come due to excessive exploitation of water for irrigation and other purposes. Biota in this Harsul dam may loose their natural home therefore; survival is the major problem for Harsul dam.

References

Ajmal,M., Raziuddin and Khan A V., (1985), Physicochemical aspects of Pollution in Kali Nadi.TAPC Tech.Annual.12:106-144

Anvar Bstcha,S M., (2000), Studies on surface and bottom water temperature –distribution of a tropical estuary during different seasonal periods J.Env.Poll.7: 143-148.

APHA. (1998), In Standard methods for the examination of water and waste lands. 20th edition, Washington, D.C. American Public Health Association.

Borse, S.K. and Bhave P V., (2000), Seasonal temperature variation and their influence on the level of dissolved carbondioxide and pH in Anar river water, Jalgaon (Maharashtra). Asian J.Microbiol. Biotech. and Env.Sci. Vol. 2,159-163

Crompton T R., (1985), Determination of Organic substances in water. John.Wiley and Sons,New York.

Esmaeili,H. and Johal M S (2005), Proc National Seminar-New Trends in Fishery development in India, Punjab University, Chandigarh,173.

Gaikwad L B., (2003), Hydrobiological study of Nandrabad dam". Ph.D. thesis. Dr.Babasaheb Ambedkar Marathwada University, Aurangabad.

Ghose and Sharma C.R., (1988), The effect of drain water on the Physico- Chemical and bacteriological characteristics of river Ganga at Patana, Bihar. Ecology and pollution of India river (Ed.BYR.K.Trivedi) Asian Publishing House, New Delhi, pp 225-263.

Gopal, B. and Zutshi, D., (1998), Hydrobiologia pp 384 : 267

Jindal,R. aand Vashisht H S., (1985)., Zoologica Orientalis, Vol. 12(182), 74

Kaitha P K., Seth R N and Tewari S C., (2000), In cold water aquaculture and fisheries, H.R.Singh and W.S.Lakra (Ed) Narendra Publishing House New Delhi.

Kakati G N and Bhattacharya K G., (1990), Physico-Chemical characteristics of the Municipal waste water of Gauhati, Ind.J.Env.prot., Vol. 10, 690-644

Kaur H., Dhillon S S., Bath K S and Mander G (1997), Interrelationship between Physico- Chemical factors at Harike wetland (Punjab- India) J.Env.Poll., Vol. 4, 237-240

Krishna Murthy S R., and Bharti S G., (1996), A study on distribution of diatoms in the river Kali around Dandeli, (NKanara Dist) Karnataka, India, Poll.Res., Vol. 15, 321-324.

Manion S., Udaiyan K and Rathinasami., (1992), Pollution studies in river Bhavani .plankton population and primary productivity, Acta. Botanica Indica Vol. 20, 55-62.

Mathew V., Chauhan and Naik L P., (1992), Hydrobiological studies of a domestically polluted tropical pond -1,Physico-Chemical Characteristics, Poll.Res.II Vol. (2), 95-100

Mathur, K., K.K.Sharma,K.C.Nand and Sharma(1991). "Water quality assessment of the river Chambal over the stretch of National Chambal sanctuary in Madhya Pradesh." Indian J.Ecol.18:1-4.

Mitra, A.K.(1995). "Water qualities of some tributaries of Mahanadi". Indian J.Env.Health.37:26-36

Mukherjee B., Mehrotra P N., Patil M., Tetrawan S., Prasad T., Mukherjee M and Dher S., (1991), A preluiminary study on the geomorphology and environmental dynamics of a stream ecosystem at Dasong in Ranchi, J.Ecobiol., Vol. 3, 43-51.

Naik S K and Purohit K M (2001) , Status of water quality at Boundamuda of Rourekela industrial complex Part-II metallic parameter, Indian J.Env. and Ecoplan., Vol.5, 115-118.

Negi R K., Johal M S and Tarana Negi., (2006), Study of the physico-Chemical parameters of water of Pangdam reservoir, Himachal Pradesh: A. Ramsar site, Him.J.Env.2001.Vol.20(2), 247-251.

Padhi M., (1995), Algal environment of polluted and unpolluted freshwater ponds, Kargupta, A N and Siddiqui A N (Eds) Algal Ecology: An overview, International Book Distributor, Dehradun, India.

Pandey P C., Pathak J K and Bhatt S D., (1991), In Ecology of mountain water, (Ed) Bhatt S D and Pande R.K Ashish Publishing House New Delhi, pp 174-179.

Patki Saroj .,(2002), Hydrobiological studies of Banshelki dam at Udgir, Ph.D. thesis, Dr.Babasaheb Ambedkar Marathwada University, Aurangabad.

Rana B N and Dungrakoti B D (1975), Ecology of the area between Nainital and Champawat, Kumaun Himalaya U.P, Him Geol Vol. 5, 1-25.

Rana B C., Nirmalkumar J I and Sreenivas S S., (1995), Phytoplankton ecology of certain inland water bodies of central Gujarat, India, Kargupta A N and Siddiqui E N (Eds), Algal Ecology – an overview, International Book Distributers, Dehradun, India, pp 122-145.

Roy N N., (1996), Studies on organic pollutants in rivers around Jamshedpur, Indian J. Env. Prot., Vol.16, 913-920.

Salve B S and Hiware C J., (2006), Studies on water quality of Wanparkalpa reservoir, Nagapur, Near Parli Vaijinath, Dist Beed, Marathwada region, J Aqua. Bio.Vol.21 (2), 113-117.

Saxena K L, Chakraborti R N., Khan A G., Chattopadhya S N and.Chandra H., (1966), Pollution studies of river Ganga near Kanpur, Env.Health, Vol. 8, 270-285.

Saksena D N., (1987), Rotifera as indicators of water quality, Acta Hydrochem.Hydrobiol., Vol. 15, 481-485.

Sharma V K., (1986), Ph.D thesis, Punjab University, Chandigarh.

Shastree K U and Malik D S (1992), Seasonal variations in Physico-Chemical Characteristics of fresh water fish pond at village, Balliana Hariyana, Adv. Biol.Sci., Vol.11, 25-32.

Shinde S B., (2006), Ph.D.thesis Dr.Babasaheb Ambedkar Marathwada University, Aurangabad.

Shivakumar R.., Mohanraj R and Azee P A., (2000), Physico-Chemical analysis of water sources of Ooty, South India, Poll.Res.Vol.19 (1), 143-146.

Singh R. and Mahajan I., (1987), Geobios, Vol.14 (1), 6.

Subrahmanyam P V R., Seerhapti D and Murthi Y S., (1976), Pollution of river Godavari at Rajahmoundry due to paper mill waste. II , Nat.conven.Env.Engg, New Delhi.

Sugunan V V., (1995), FAO, Fisheries technical paper No.345.

Swarnalatha N and Narsinga Rao A., (1991), Trophic status and assessment of water quality of lentic environment, Res.J.P.Env., Vol. 7, 107-118.

Thorat S R and Sultana M., (2001), Pollution status of Salim Ali lake, Aurangabad (M.S), Poll.Res., Vol.19, 307-309.

Thresh J C., Suckling E V and Bele J F., (1944), In the observation of water supply (Ed), Taylor, E.W. Blackstone and Son Co.London.

Trivedi R K and Goel P K., (1986), Chemical and Biological methods for water pollution studies, Environmental publications, Karad, Maharashtra pp 64-66.

Vass K K., (1980), Hydrobiologia, Vol. 86, 6

Verma S R., Tyagi A K and Dalela R C., (1978), Physico-Chemical and Biological Characteristics of Karadabad drain in U.P., Ind. J. Environ. Health, Vol. 20 (1), 1-13.

Yousuf A R (1989), In management of aquatic ecosystem (Eds Aggarwal, Desai and Abidi), Society of Biosciences, Muzaffarnagar.