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RESEARCH ARTICLE

PREVALENCE OF CARP DISEASES IN RELATION TO WATER QUALITY PARAMETERS IN THE CULTURE AREAS OF WEST BENGAL, INDIA

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ABSTRACT

In this study attempts have been made to find out the correlation and variation of the major disease problems encountered in carp culture sectors with the physicochemical characteristics of the important cultural areas of West Bengal. Water quality parameters such as temperature, pH, dissolved oxygen, free CO_2, total alkalinity, transparency and hardness were analyzed during the investigation. The recorded sampling values of these variables were correlated with diseases noticed. Most of the parameters were found to be significant at 5 % level and few are significant at 1 % level whereas only the temperature was found to be significantly varied at 0.01% level indicatinges the importance of these is parameter in disease development. The above variables were found to have a definite impact individually or as a whole on the prevalence of diseases at different locations. However, among these water quality parameters transparency, DO, total alkalinity and hardness were found to be significantly varied with locations at 0.01% level due to the change in the culture regime and management practices undertaken.

INTRODUCTION

Water quality determines not only how fish will grow well in an aquaculture system, but also its survivalance. Fish influence water quality through processes like nitrogen metabolism and respiration. Knowledge of testing procedures and interpretation of results is important to the fish farmers (Boyd, 1979). When the physicochemical factors are in normal or conducive range, the water body is usually productive. But when they are present in Quantities above or below the normal range, the fisheries and other aquatic organisms may be under stress, which may lead to fish diseases or mortalities in due course (Nath, 2002; Subasinghe and Phillips, 2002). Physico-chemical parameters of any water body assume importance since slight variation in any one of them may alter the whole ecological picture of the water area which may create disaster for all aquatic lifes inhibiting it (Qureshi *et al.,* 2007). In an aquatic ecosystem there exists profound and inverse relationship between physicochemical quality of water and fish diseases. According to report, the unfavorable water quality responsible for higher bacterial load seems to act as a predisposing factor for fish disease out-breaks (Das, 1994). Habitat distortion and soil and water quality deterioration have wide-ranging adverse effects on productivity, fish community and fish yield (Konar *et al.,* 1997).

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MATERIALS AND METHODS

The present study was carried out for a period between April-2007 and March- 2008. A total of 15 locations covering 67 freshwater carp culture areas in South -24 Parganas (L_1), North-24 Parganas (L_2) and suburbs of Kolkata (L_3) of West Bengal, India were selected for this work. These areas were representing the freshwater as well as traditional or improved traditional culture systems. The water sample along with the diseased fish were collected from the sampling station and brought to the laboratory for further investigations. Water samples were separately collected from every sampling site in labeled and pretreated polyethylene bottles by random sampling technique taking all the necessary precautions not to entrap any air bubbles and without disturbing the bottom sediment.

The methods for different analyses and the instruments used are mentioned below:

Parameters Water quality parameters	Methods/used instruments	References/Brand name of Instruments
1.P^H	Digital pH meter	HANNA, Portugal.
2.Temperature (^{O}C)	Mercury thermometer	(APHA, AWWA, WPCF 1998)
3.Transparency (cm)	Secchi disc	
4.Dissolved oxygen (DO) (ppm)	Winkler's method	(APHA 1995)
5.Hardness as $CaCO_3$ (ppm)	Titration method	(APHA, AWWA, WPCF 1998)
6.Total alkalinity as $CaCo_3$ (ppm)	Titration method	(APHA 1995)
7.Free carbon dioxide (ppm)	Titramatric method	(APHA 1995)

Statistical analyses of the data were carried out following standard methods (Snedecor and Cochran, 1967). Simple correlation coefficient test association with't' distribution was done to know the pattern and the level of significance of the relation between diseases occurred and different water quality parameters of sampling zones. The ANOVA of water quality and diseases was also carried out to see the variation amongst the soil parameters in relation to disease outbreaks; simultaneously t-test was done to find out which of the parameter was most significantly related to diseases irrespective of location.

RESULTS

The range of temperature for location L_1 was found to be 20.4^0C to 31^0C with varying temperatures in respect to different disease outbreaks in that region. Different cases of diseases found in L_1 within that temperature range were ulcer, tail/fin rot, dropsy, argulosis, hemorrhages; white spot on gill, fungal infections and some of the unspecified diseases (Table 1). Similar to that the ranges of different other water quality parameters in relation to the above mentioned diseases for L_1 were pH - 6.5 to 8.3, DO - 4.8 to 6.7 ppm, CO_2 - nil - 1.7 ppm, alkalinity - 162 to 265 ppm, transparency - 12.9 to 29.0 cm., hardness - 130 to 185 ppm. However, for location L_2 temperature ranged 20^0C to 28^0C whereas the other parameters recorded were pH - 6.5 to 7.5, DO - 5.2 to 6.6 ppm, CO_2 - 1.0 to 3.6 ppm, total alkalinity - 136.76 to 217.60 ppm, transparency -12.0 to 18.0 cm., hardness - 156.75 to 235.5 ppm and the diseases found to occur within this range of water quality parameters were ulcer, fungal infections, stunted growth, tail/fin rot, argulosis, hemorrhages, dropsy and white spot on gill (Table 2).

Similarly for the location L_3 temperature was found in the range of 25.8^0C to 31^0C while the other water quality parameters noticed in accordance to the diseases were pH - 7.2 to 7.9, DO- 4.2 to 5.6 ppm , CO_2- Nil to 1.05 ppm, total alkalinity- 210 to 332 ppm, transparency-12.3 to 18.5 cm., hardness-138 to 185 ppm, ammonia-nitrogen- 0.06 to 1.2 ppm and the different diseases observed within that water parameter ranges were argulosis, ulcer, stunted growth, hemorrhages and dropsy (Table 3).

Significant positive correlations between temperature ($r = 1.60$, $p < 0.05$) and diseases were observed, where as all other water quality parameters were found to be insignificantly varied (Table 4). Temperatures in different locations were insignificantly varied or almost equally distributed (Table 5). pH similar to water temperature was found to be almost equally distributed with less significant difference in all the three locations (Table 5). However, the mean calculated for different diseases occurred in variable pH values also did not varied significantly as the distribution of pH was almost the same. DO ($F= 4.94$, $p= 0.04$), Total alkalinity ($F= 12.02$, $p= 0.00$), transparency ($F= 7.78$, $p<0.05$), hardness ($F=6.41$, $p= 0.02$) were found to be significantly varied with locations in relation to different disease outbreaks (Table 4). However, DO of the locations L_1 and L_2 were found to be significantly higher than L_3 location (Table 5) whereas total alkalinity of location L_3 was found significantly higher than L_1 and L_2 locations interms of distribution irrespective of disease outbreaks (Table 5). However, transparency and hardness of location L_1 were found significantly higher than L_2 and L_3 locations irrespective of disease outbreaks (Table 5).

Table 1. Occurrence of different diseases of carps in relation to water quality for South-24 pgs (L_1)

Water quality / Diseases	Temp. (ºC)	pH	Transparency (cm.)	DO (mg/l)	Free- CO_2 (ppm)	Total Alkalinity (ppm)	Hardness (ppm)
Ulcer	21.5	7.5	28.0	5.5	1.7	162.0	130.0
Tail/ fin rot	22.0	8.1	25.0	5.2	1.09	185.0	166.0
Dropsy	31.0	7.6	27.0	5.6	1.3	210	185.0
Argulosis	29.8	8.3	12.9	4.8	Nil	265.0	160.0
Hemorrhages	27.6	7.8	29.0	5.4	Nil	190.0	155
White spot on gills	21.5	6.5	15.0	6.7	Nil	165.0	182
Fungal infections	20.4	7.2	28.0	5.2	1.13	175.0	156.0
Unspecified diseases	20.8	7.1	17.8	5.6	1.09	185.0	166.0

Table 2. Occurrence of different diseases of carp (IMC) in relation to water quality parameters for North -24 pgs (L_2)

Water quality / Diseases	Temp. (ºC)	pH	Transparency (cm.)	DO (mg/l)	Free CO_2 (ppm)	Total Alkalinity (ppm)	Hardness (ppm)
Ulcer	22.3	6.5	14.8	5.82	Nil	154.12	156.75
ungal infection	21.5	6.5	15.0	6.36	Nil	143.50	160.5
Stunted growth	28.0	7.26	12.5	5.5	1.86	217.60	180.6
Tail/ fin rot	22.8	7.12	12.75	5.2	1.09	150.30	175.2
Argulosis	27.2	6.88	12.0	6.6	Nil	156.80	195.75
Hemorrhages	25.0	7.43	13.25	5.94	1.86	217.60	235.5
Dropsy	20.0	7.5	18.0	5.2	1.28	136.76	191.53
White spot on gills	21.2	7.25	15.75	6.6	Nil	156.80	195.75

Table 3. Occurrence of different diseases of carp (IMC) in relation to water quality parameters for Kolkata (L_3)

Water quality / Diseases	Temp. (ºC)	pH	Transparency (cm.)	DO (mg/l)	Free CO_2 (ppm)	Total Alkalinity (ppm)	Hardness (ppm)
Argulosis	29.5	7.5	12.6	4.21	Nil	329.9	156.0
Ulcer	25.8	7.2	12.3	4.75	1.05	332.7	138.0
Stunted growth	24.2	7.9	16.5	4.2	Nil	281.4	142.0
Hemorrhages	25.8	7.2	12.3	4.75	1.05	332.7	138.0
Dropsy	31.0	7.6	18.5	5.6	Nil	210.5	185.0

Table 4. Water quality parameters in relation to diseases and locations (All three locations) [ANOVA]

Source	Variable	SS	df	MS	F	Sig.
DISEASE	Temp.	139.52	9	15.50	1.60	**0.05***
	pH	2.02	9	0.22	1.15	0.42
	Transparency	194.57	9	21.62	1.17	0.41
	DO	3.22	9	0.36	1.26	0.37
	Total Alkalinity	11729.81	9	1303.31	0.81	0.62
	Hardness	4825.01	9	536.11	1.53	0.27
LOCATION	Temp.	19.07	2	9.54	0.98	0.41
	pH	0.95	2	0.47	2.44	0.14
	Transparency	287.08	2	143.54	7.78	**0.01***
	DO	2.81	2	1.41	4.94	**0.04***
	Total Alkalinity	38848.70	2	19424.35	12.02	**0.00****
	Hardness	4505.75	2	2252.88	6.41	**0.02***

N.B.: * Denotes significance at 5% and ** denotes significance at 1%
Only bold coefficients are significant at the .05 level.

Table 5. Location wise distribution of water quality parameters in relation disease occurrence

Water parameters	Locations			Sig.
	L_1	L_2	L_3	
Temperature	24.33 a	23.50 a	27.26 a	0.06
pH	7.51 a	7.06 a	7.48 a	0.10
Transparency	22.84 a	14.26 b	14.44 b	0.94, 1.00
DO	5.50 a	5.90 a	4.70 b	1.00, 0.20
Free CO_2	--	--	--	--
Total Alkalinity	192.13 b	166.69 b	297.44 a	0.28, 1.00
Hardness	162.50 b	186.45 a	151.80 b	0.33, 1.00

N.B.: Two significance values due to calculation in two sub sets; Only coefficient are significant at 1%; a>ab>b.

However, in statistical pair-wise comparison, it was observed that with the temperature increment argulosis was significantly ($p<0.05$) higher than fungal infections, white spot on gill and unspecified diseases were found insignificant but positively correlated at 0.05 levels. However, No pair-wise comparison of diseases in relation to total alkalinity was found to be significant ($p<0.05$). In relation to transparency changes only dropsy was found to be occurreing significantly ($p<0.05$) higher than argulosis where as other diseases were insignificant with transparency changes. In the pair-wise comparison of diseases with hardness it was observed that occurrence of dropsy, hemorrhage and white spot on gill were significantly ($p<0.05$) and positively correlated with ulcer where as other diseases were insignificant.

DISCUSSION

In course of the present study, it has been observed that the moderate temperature was more conducive for the development of bacterial diseases. This is supported by the works some earlier workers who confirmed higher infestation of bacteria at normal temperature ranges (Plumb, 1994; Carviho *et al.,* 2003). Previous study opined that, seasonal changes in water level and temperature could also influence the rate of infection as reported by Rab *et al.* (2001) that the ectoparasites viz. *Lernea*, *Argulus* were more virulent in low water temperature (10-12^{o}C). As regards outbreak of parasites, bad zoohygeinic conditions accompanied by increased water temperature play an important role (Poulin and Fitzgerald, 1988). The pH is known to exert its influence on the occurrence of different diseases as observed during study. Best growth of bacteria was observed at a pH range of 6.0 to 8.0, (Plumb, 1994) whereas parasitic infestation was found at a range of 4.65 to 8.3 (Awa *et al.,* 1988) that corroborates with the present findings. It was observed that the fish cultured in low pH of ambient waters are more susceptible to diseases (ElFAC, 1968). Dissolved oxygen (DO) concentration is considered as the major critical water quality variable in aquaculture. Statistical data interpretation during study indicate this fluctuative range of DO in the area of study were noticed along with the outbreak of different diseases, which might have put the fishes under stress and lead to the diseased condition as reported by earlier workers (Allan and Maguire, 1991; Chanratchakool *et al.,* 1994; Plumb, 1994). Some are of the opinion that ulceration is associated with the reduction in the dissolved oxygen concentration also noticed during the present study. It is reported that the parasitic infestation was more at a DO range of 1.9 – 9.2 mg/ L also noticed during the present study (Awa *et al.,* 1988).

It is reported that free CO_2 at the range of 5- 10 mgl^{-1} in ponds is conducive for fish growth which conform the present observations where no correlation was observed with the occurrence of diseases in all the three locations (Nath *et al.,* 1994). The absence of free CO_2 may either be due to its complete utilization in photosynthetic activity or because of its inhibition by the presence of appreciable amount of calcium carbonate in water. The value of CO_2 varies with the increase in temperature that enhances the bacterial decomposition which results in the formation of CO_2 (Manna *et al.,* 2001).

It is suggested that alkalinity ranges of 80- 160 ppm is beneficial for the good production and better health management of fish (Nath *et al.,* 1994). In the present investigation, it has been observed that relatively higher values of alkalinity were conducive for infection, which contradict with the findings that low alkalinity (70 mg/lit) favor the attack of diseases in freshwater fishes (Rab *et al.,* 2001). However, while the properties of alkalinity are usually beneficial, highly alkaline waters are also being problematic for fish, as ammonia excretion and production can be inhibited (Wilson *et al.,* 1998).

The low range of transparency may be attributed to the high productivity of the culture areas due to massive plankton growth , may be due to utrfication results from the unused feeds. It opined that changes in transparency can influence the rate of infection specially ulceration that supports present study (Carviho *et al.,* 2003). At transparency level dropsy was found to be occurring significantly ($p<0.05$) higher than ulceration and may be attributed to high plankton density that leads to increase in transparency and ultimately higher oxygen levels leading to dropsy.

It is suggested that hardness of 80 - 150 ppm is beneficial for good production and better health management of fish (Nath *et al.,* 1994). It was attributed that higher value acts as a prophylactic means to ulceration and other diseases in freshwater culture areas in West Bengal, which corroborated by the work that the ectoparasite infestation was more in lower hardness (75 mg/l) condition (Rab *et al.,* 2001).

Conclusion

From the present study it is evident that water quality parameters commands the occurrence of different fish diseases and almost all the water quality parameters are directly or indirectly related to the disease out-breaks and is needed to be maintained within the normal range for better fish health and to prevent the occurrence of diseases related to them.

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