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Comparative Growth of Different Catfish and Carps under Sewage Treated Water

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***Abstract*:** Achieving an environmentally stable and sustainable future of fisheries sector requires the conservation of natural resources and biodiversity. Based on growth parameters, suitability of sewage treated water for different catfish and carps were determined. Four different type of fish species; advance fingerlings of *Pangasius hypopthalamus*, *Catla catla*, fry of *Cyprinus carpio haematopterus* and fingerlings of *Clarias batrachus* were cultured in sewage treated water and freshwater. The weight of catfishes (*P. hypopthalamus* and *C. batrachus*) reared in sewage treated water showed significant increment from 3.64 g and 1.86 g to 9.71 g and 6.21 g within 30 days of experimental period. Similarly, length of fish increased from 8.17 cm and 6.46 cm to 11.85 cm and 8.71 cm. Sewage treated water provides essential nutrients, organic matter, microorganisms that assures the growth of living and non-living food organism for better growth and survival of aquatic animals under aquatic environment, even in the absence of supplementary feeding. However, carps (*C. carpio haematopterus* and *C. catla*) were not able to grow well in the sewage treated water under in vitro conditions. The weight and length of both the fishes declined within 30 days. Additionally, the fry of *C. carpio haematopterus* released in sewage treated water was not able to survive in spite of feeding as the mortality (50%) recorded at 15th day increased to 100 % at 30th day. The growth (weight, length) of catfishes showed significant positive correlation with various water quality parameters as compared to that of the carps.

***Keywords*:** Growth, Catfishes, Carps, Treated sewage water, Water quality

There has been an ongoing practice of utilizing waste products as nutrients in fish ponds since middle ages. Many countries have used treated wastewater for aquaculture as an environmentally friendly resource including Germany (Prein et al 1990), Hungary (Etnier and Guterstam 1996), India (Roy et al 2011), USA (Cuevas-Uribe and Mims 2014) and China (Phong Lan et al 2007). Even in the absence of supplementary feeding, sewage treated water provides essential nutrients, organic matter, and microbes vital for the growth of living and non-living food organisms and therefore, leading to better growth and survival of aquatic organism. By utilizing nitrogen, phosphorous and carbon, algae and phytoplankton grow rapidly. They consume nutrients, bacteria and produce oxygen. A higher oxygen level in the water allows fish to survive and consume algae and phytoplankton (Vansintjan 2021). With the use of treated waste water, existing aquaculture operations can reduce both freshwater demand and water costs, thus increasing profitability. An important key factor in utilizing sewage effectively in fish culture is the choice of fish species. Air breathing fish species like *Clarias batrachus*, *Heteropneustes fossilis*, *Channa* spp., *Pangasius hypophthalmus, Oreochromis mossambicus* and *Ctenopharyngodon idella* can be considered for culture in sewage treated ponds due to their ability to survive in water with low dissolved oxygen content (Samiksha 2019). In addition to a faster growth rate, catfishes can tolerate a wide range of water quality conditions and dense population. Carps being sensitive to lesser dissolved oxygen content cannot survive in sewage treated water. Nevertheless, different species of carps grow at varying rates in sewage-fed ponds. Mandal et al (2021) cultured carps species namely bata (*Labeo bata*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*) in different sewage concentration to test their survivability. To investigate the growth evaluation of different catfish and carps under sewage treated water, the present study was conducted.

MATERIAL AND METHODS

To conduct the present study, sewage treated water was collected from sewage treated ponds of the university and brought to the water quality laboratory of College of Fisheries Science, CCSHAU, Hisar. Filtration was done before filling the tanks to ensure that twigs and debris were removed and aerators were installed to ensure adequate oxygen availability. Four fish species were procured from fish farmers to conduct the experiments. At the time of procurement, the weight and length of advance fingerling of *Pangasius*

hypophthalmus, Catla catla, fry of *Cyprinus carpio haematopterus* and fingerling of *Clarias batrachus* were recorded. The fry, fingerlings and fishes were acclimatized for ten days at room temperature before the experimental setup. The fishes were fed with commercially available pellet feed at 6 % of their body weight twice a day.

Fish species	Stage	Weight	Length
Pangasius hypophthalmus	Advance fingerling	1.76 to 6.1 g	6.20 to 10.10 cm
Catla catla	Fish	8.60 to 19.19 g	8.60 to 13.00 cm
Cyprinus carpio haematopterus	Fry	0.22 to 0.52 g	2.30 to 3.90 cm
Clarias batrachus	Fingerling	0.84 to 3.10 g	5.00 to 7.70 cm

All the fish species were cultured in sewage treated water under triplicate conditions to see the effect on weight, length, weight gain (g), percent increment in weight, percent increment in length, average daily weight gain (g/day), biomass (g), feeding rate (g/day), feed conversion ratio, specific growth rate (%) and survivability (%). The fishes were fed at the rate of 8 % of their body weight twice a day. Before setting up the experiment, water quality parameters were estimated following standard methodology.

Statistical analysis: For the statistical evaluation of the study, OPSTAT was used.

RESULTS AND DISCUSSION

Pangasius hypophthalmus: *P. hypophthalmus* cultured in sewage treated water, all growth parameters increased significantly (Table 1). Survivability of the fish was 100 % during the whole treatment. The weight of the fish increased significantly from 3.61 g to 9.71 g as observation days increased from 0 to 30. The fish weight at 10^{th} (5.82 g) and 20^{th} (6.91 g) day were statistically at par with each other. Throughout the study period, the fish length increased significantly at different intervals (Table 3). Furthermore, weight gain, average daily weight gain, percent increment in weight, percent increment in length, biomass and specific growth rate increased continuously. The average weight gain attained the highest value on the 30^{th} day of the study period. The maximum feed conversion ratio was between days 10 and 20. Nile tilapia fed with the sewage sludge showed the best feed conversion ratio (3.18) compared to silver carp and common carp (Abdelhamid et al 2014). Liney et al (2006) reported that after 3 months of rearing in 80 % secondary treated waste water. *Rutilus rutilus* showed significantly greater post-hatch sizes than fish reared in tap water or in 40 % treated waste water. The growth performance was significantly higher for fishes cultured in sewage treated water as represented in our study on *P. hypophthalmus*.

The substantial changes in physicochemical parameters of water causes stress to the fish, thereby, adversely affecting its physiology. The correlation between *P. hypophthalmus* growth parameters (weight and length) and water quality parameters of sewage treated water are presented in Table 2. The weight and length of *P. hypophthalmus* showed significant positive correlation with temperature (0.96), conductivity (0.99) and salinity (0.95) of sewage treated water. The sewage-treated water was have temperature range between 23 and 24.9°C. Similar range of water temperature i.e. 20 to 30°C in the ponds was reported by Bhatnagar and Devi (2013). The optimal water temperatures are 28 to 30°C within which maximal growth rate, efficient food conversion, best condition of fish, resistance to disease and tolerance of toxins (metabolites and pollutants) (Suman et al 2017). The pH ranged from 7.0 to 8.4 which is ideal for fish culture as reported earlier by Santhosh and Singh (2007). The increase in weight (3.92 g to 16.73 g) and length of fish with the increase in water salinity up to 10 % salinity was recorded by Kang'ombe and Brown (2008). In sewage treated water, ammonia and nitrite are not significantly correlated with weight, and there is no significant correlation between length and alkalinity, nitrite, or ammonia in the water. The total dissolved solids (0.94), dissolved oxygen (0.61) and hardness (0.90) of sewage treated water was positively correlated with *P. hypophthalmus* weight and length.

Cyprinus carpio haematopterus: In *Cyprinus carpio haematopterus* (Amur carp) fry fish weigh at 0^{th} day was 0.40g was significantly decreased to 0.35g at 15^{th} day and

Table 1. Growth parameters of *Pangasius hypophthalmus* in sewage treated water at different durations

Observation days	Weight (g)	Length (cm)	Weight gain (g)	Average daily weight gain (g)	Percent increment in weight	Percent increment in length	Biomass (g)	Feeding rate (g/day)	Feed conversion ratio	Specific growth rate (%)	Survivability (%)
0	3.61	8.17					72.88	58.20			100.00
10	5.82[a]	9.68	44.32	0.21	59.77	18.45	116.45	93.10	1.31	2.04	100.00
20	6.91[a]	10.58	66.04	0.10	89.57	29.46	138.17	110.40	4.28	1.39	100.00
30	9.71	11.85	122.06	0.28	166.43	44.94	194.20	155.20	1.97	1.42	100.00

Values denoted by similar letter do not differ significantly with each other

0.21 g at 30th day (Table 3). The fry released in sewage treated water was not able to survive even when the feed was provided. Fish mortality (50%) was at 15th day which increased to 100 % mortality at 30th day. Duration-wise no significant effect of treatment was recorded on fish length, i.e., 3.21, 3.22 and 2.96 cm after 0th, 15th and 30th day, respectively. But due to fry mortality, there was decrease in number of live fish in sewage treated water, hence, average length showed decreasing trend at 15th and 30th day. Kumar *et al.* (2019) observed that Amur carp showed highest growth as compared to catla and rohu in pond integrated with poultry. Sakalli et al (2018) exposed common carps to pond that receive water from sewage treatment part effluents for 360 days under natural conditions. Fish from the exposed pond had different compositions of fatty acids (FA) than those from the control pond. The concentration of 18:1 n-9 and 18:2 n-6 were significantly elevated FA and the longer chain 20:5, 22:5 and 22:6 significantly lowered FA. The reason for mortality in this study may be due to age factor where adults may survive in treated water as reported by Sakalli et al (2018).

Clarias batrachus: Monthly observations on the growth parameters of *C. batrahus* (Desi Magur) in sewage treated water with feed in triplicate condition revealed that there was significant increase in the weight of fish at each observation period (Table 4). Maximum weight was d at 30th day (6.46 g) as compared to 0th day (1.86 g). The water quality of sewage treated water significantly favoured the *C. batrachus* growth. Similarly the length also showed significant increase with increase in observation period and was 6.21 cm at 0th day which significantly increased to 8.71 at 30th day (Table 4). Correlation between weight, length of *C. batrachus* and temperature, conductivity, total dissolved solids, salinity, dissolved oxygen and ammonia were significantly positive (Table 4). The significant negative correlation was recorded with pH and alkalinity whereas nitrite content did not show any correlation with *C. batrachus* growth parameters. In the present study, there was significant increase in the weight and length of C. *batrachus* in sewage treated water. Fingerlings cultured in 100 % treated waste water exhibited elevated growth (720.7 g) compared to the control fingerlings (412.9 g), which were cultured in a commercial pond over a 29-week period. In another study, *C. angullaris* growth was significantly higher in the treated domestic sewage as compared with fish growth in untreated and control set ups (Nwabueze 2013).

Catla catla: There was significant decrease in the fish weight of *C. catla* being 10.48 g at 0th day which decreased to 9.84 g at 30th day; both values being statistically at par with each other (Table 5). After this stage, 50 % mortality in fishes was recorded. The length of fishes at 0th day (10.01cm) and 30th day (10.02 cm) were statistically comparable. The correlation between weight, length of C. *catla* and water quality parameters indicated water temperature, conductivity, salinity, nitrite, ammonia, hardness and alkalinity, showed significant negative correlation with weight and length of C. *catla*, respectively. Total dissolved solids showed positive correlation and pH remained constant during the study period. The C. *catla* in sewage treated water during present study showed that there was a significant decrease in the growth performance due to lower survivability of fish in

Table 3. Effect of sewage treated water on weight and length of *Cyprinus carpio haematopterus* fry at different durations

Observation days	*Cyprinus carpio haematopterus* fry	
	Weight (g)	Length (cm)
0	0.40	3.21
15	0.35*	3.22*
30	0.21**	2.96**
Mean	0.32	3.13

*50% mortality; **100% mortality

Table 2. Correlation between weight of *Pangasius hypophthalmus* and sewage treated water quality parameters

Days	Fish weight (g)	Fish length (cm)	Temperature (°C)	Conductivity (ms/cm)	Total dissolved solids (ppm)	Salinity (ppt)	Dissolved oxygen (mg/L)	pH	Ammonia (mg/L)	Nitrite (mg/L)	Hardness (mg/L)	Alkalinity (mg/L)
0	3.64	8.17	23.00	2.02	565.00	0.99	4.50	7.60	0.01	0.01	260.00	180.00
10	5.82	9.68	24.10	2.03	506.00	1.14	3.00	8.20	2.50	0.05	240.00	200.00
20	6.91	10.58	24.70	2.08	523.00	1.18	3.00	7.80	1.60	0.28	176.00	180.00
30	9.71	11.85	24.90	2.19	548.00	1.23	6.50	7.20	0.80	0.30	280.00	160.00
Mean	6.52	10.07	24.18	2.08	535.5	1.13	4.25	7.7	1.23	0.16	239	180
Correlation with weight			0.96	0.99	0.94	0.95	0.61	0.45*	-0.48*	-0.01*	0.90	0.13*
Correlation with length			0.95	0.97	0.86	0.99	0.71	0.32*	-0.47*	0.10*	0.86	0.19*

*Non-significant at 5%

Table 4. Effect of sewage treated water on weight and length of *Clarias batrachus* fingerlings at different durations

Days	Fish weight (g)	Fish length (cm)	Temperature (^{0}C)	Conductivity (ms/cm)	Total dissolved solids (ppm)	Salinity (ppt)	Dissolved oxygen (mg/L)	pH	Ammonia (mg/L)	Nitrite (mg/L)	Hardness (ppm)	Alkalinity (mg/L)
0	1.86	6.21	24.70	2.32	2.27	1.23	5.50	8.40	0.02	0.05	280.00	114.00
30	6.46	8.71	26.18	2.55	2.79	1.40	5.50	8.40	0.04	0.05	295.00	113.00
Mean	4.16	7.46	25.4	2.43	2.53	1.31	5.5	8.4	0.03	0.05	287.5	113.5
Correlation with weight			0.93	0.98	0.92	1.00	0.87	-0.87	0.87	#N/A	0.98	-0.93
Correlation with length			0.91	0.94	0.94	0.98	0.81	-0.85	0.89	#N/A	0.92	-0.90

Table 5. Effect of sewage treated water on weight and length of *Catla catla* at different durations

Days	Fish weight (g)	Fish length (cm)	Temperature (^{0}C)	Conductivity (ms/cm)	Total dissolved solids (ppm)	Salinity (ppt)	Dissolved oxygen (mg/L)	pH	Ammonia (mg/L)	Nitrite (mg/L)	Hardness (mg/L)	Alkalinity (mg/L)
0	10.48	10.01	25.90	7.25	3.62	4.07	3.50	8.40	0.30	0.03	430.00	100.00
30	9.84	10.02	26.10	7.55	2.79	4.20	4.00	8.40	0.50	0.05	450.00	125.00
Mean	10.16	10.01	26	7.4	3.20	4.13	3.75	8.4	0.4	0.04	440	112.5
Correlation with weight			-0.92	-0.92	0.92	-0.96	-0.40[1]		-0.60	-0.96	-0.92	-0.90
Correlation with length			-0.86	-0.87	0.86	-0.92	-0.50[1]		-0.50[1]	-0.92	-0.86	-0.84

* 50% mortality, [1] Non-significant at 5%

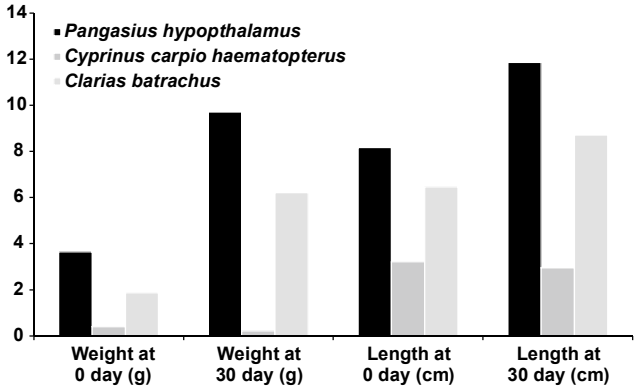

Fig. 1. Comparative evaluation of growth of experimental fishes in sewage treated water

sewage treated water. Carps, being very sensitive to low dissolved oxygen content, were not able to survive in sewage tanks. Dasgupta et al (2008) observed better growth of carps in diluted sewage water than raw sewage water. Nwabueze (2013) reported an increasing sequence of length in 100% < 25% < 75% < 50% concentrations and increasing sequence of weight in 25% <100% <75% <50% concentrations of sewage. Jana et al (2016) recorded highest growth of *L. rohita* at 75 % concentration of sewage than other treatments. Vijaykumar et al (2020) also reported highest specific growth rate of *Catla* in the ponds integrated with poultry farm followed by Amur carp and Rohu.

CONCLUSION

The depiction of growth parameters of the four experimental fishes indicated that catfishes (*P. hypopthalamus* and *C. batrachus*) are suitable for culture in sewage treated water in terms of growth parameters and survival. The length and weight of P. *hypopthalamus* and C. *batrachus* increased within 30 days. However, carps reared in sewage treated water, i.e., *C. carpio haematopterus* and *C. catla* were not able to grow in sewage treated water under *in vitro* conditions. The weight and length of both the fishes decreased within a time period of 30 days. Additionally, the survived fish species i.e. *P. hypopthalamus*, *C. batrachus* were successfully cultured for an extended period of 90 and 60 days respectively.

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