http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 9 (9): 1732-1737, 2006
ISSN 1028-8880

Effect of Different Stocking Ratio of Pangasid Catfish (*Pangasius hypophthalmus*) and Silver Carp (*Hypophthalmicthys molitrix*) on Better Water Quality Maintenance in Cat Fish Farming

[1]Zannatul Ferdoushi and [2]Farhana Haque
[1]Department of Fisheries Management, Faculty of Fisheries,
Hajee Mohammed Danesh Science and Technology University, Dinajpur, Pakistan
[2]Department of Fisheries Management, SFM Fisheries College,
Melandah, Jamalpur, Bangladesh

Abstract: An experiment was conducted in Bangladesh Agricultural University for a period of three and half months from 1st May to 15th August 2002 to observe the effects of different stocking ratio of pangasid catfish and silver carp on better water quality maintenance and impacts of using fence in cat fish farming. Four treatments each with three replicates were used. The fishes were stocked at the rate of 120 fishes/decimal. The stocking ratios were: 100% pangasid catfish in Treatment 1(T_1), 50% pangasid catfish plus 50% silver carp in Treatment 2 (T_2), 60% pangasid catfish plus 40% silver carp in Treatment 3 (T_3) and 50% pangasid catfish plus 50% silver carp in Treatment 4 (T_4). Bamboo made fence were used in treatments 2 and 3 to keep the pangasid catfish and silver carp separately along the breadth wise considering the density of each species. Treatment 4 was set without fence. During the period of study, significant differences were found in dissolved oxygen, NO_3-N and chlorophyll-a concentrations among different stocking ratios of pangasid catfish and silver carp. The highest concentration of PO_4-P and NO_3-N were found in T_1 (2.7 and 3.1 mg L^{-1}, respectively) followed by treatments T_3, T_2 and T_4. This higher concentration of NO_3-N and PO_4-P enhanced the plankton biomass especially Cyanophyceae and Euglenophyceae in ponds of treatment 1 and identified dominant bloom forming cyanophytes were *Microcystis* and *Gloeocapsa,* which formed the heavy phytoplankton bloom throughout the culture period and deteriorated the water quality in pangasid catfish monoculture ponds (100% pangasid catfish). Whereas better water quality were found in composite culture. Among different stocking ratios, in composite culture 1:1 without fence (treatment 4) gave the best result in better water quality maintenances than 2:1 and 1:1 (with fence, treatment 3 and 2) ratios. In treatment 4 when the nutrients concentrations enhanced the phytoplankton production then silver carp grazed over phytoplankton throughout water body, which prevented the phytoplankton bloom formation during culture period and maintained a better environmental condition. Some algal bloom occurred in the portion of pangasid catfish in treatment 2 and treatment 3. It might be due to the grazing activity of silver carp over phytoplankton was restricted by the fence in those treatments. Considering the above facts composite culture of pangasid catfish and silver carp with 1:1 ratio and without fence may help in maintaining the good environmental condition of catfish farming through preventing the algal bloom.

Key words: *Pangasius hypophthalmus*, *Hypophthalmicthys molitrix*, composite culture, standard ratio, water quality

INTRODUCTION

Pangasius hypophthalmus is commonly known as Thai pangasid catfish, which belongs to the family Pangasid catfish under the order Siluriformes. The origin of *Pangasius hypophthalmus* was from the Mekong River of Vietnam to the Chao Phraya River of Thailand and then their distribution was spreaded to other countries such as Malaysia, Indonesia and China (Roberts and Vidmayanon, 1991). Among the various species of cultivable catfishes, Thai pangasid catfish, *Pangasius hypophthalmus* is particularly well known for its good taste, faster growth rate, easy culture system, high disease resistance, tolerance of wide ranges of environmental parameters and high market demand.

Monoculture of pangasid catfish is mainly being practiced in Bangladesh and culture fully depends on supplementary feed such as pelleted feed, rice bran,

Corresponding Author: Zannatul Ferdoushi, Department of Fisheries Management, Faculty of Fisheries,
Hajee Mohammed Danesh Science and Technology University, Dinajpur, Bangladesh
Tel: 0531-63156

mustard oil cake, wheat bran, snail meat and bone etc. Due to lack of proper culture guideline from any organization, in pangasid catfish culture practice, the farmers maintain high stocking density, excessive amount of feed and even sometimes non-conventional feed, like dead animals, hospital residues etc. The uneaten portion of feed and feces of the catfishes accumulate on the pond bottom throughout the culture period. Decomposition of these organic matters and excretory products of fishes cause water quality deterioration and severe oxygen depletion in cat fish ponds. Sidthimunka (1972) conducted an experiment on the culture of *Clarias* sp. and reported that waste products from excretion of fish and the left over feed accumulated in the pond brought problems such as poor water quality. Boyd (1988) also stated that catfish wastes include organic compound, which contribute directly to oxygen demand and mineral nutrients, which indirectly contribute to oxygen demand by increasing phytoplankton growth. Since pangasid catfish do not eat algae, in most cases they form heavy bloom and deteriorate the water quality. Due to water quality deterioration, mortality of fish hatchlings occur, reduce or hamper the growth of fishes and spreading of different fish diseases occur that ultimately hinders the total fish production.

It was reported that tilapia reared in cages feeding on phytoplankton in intensive catfish ponds were shown to improve pond water quality as well as production of an extra crop (Perschbacher, 1995). In Thailand composite culture of hybrid *Clarias* catfish and planktivorous tilapia resulted good water quality and fish production. An optimum stocking density of pangasid catfish will help to reduce the amount of leftover food particles and planktivore fish will save the aquatic environment by grazing phytoplankton, which may prevent algal bloom formation and sedimentation of dead algal mats. Watson (2001) got very good results to control blue green algal bloom in Alberta, Canada by using silver carp (*Hypophthalmicthys molitrix*).

Much research is being undertaken in the eutrophication, algal blooms and their control measures in many countries of the world but their negative impact in aquaculture in Bangladesh are very limited. For this reason, we urgently need to conduct such type of research work in this field in detail to save our aquatic environment. Water quality management in pangasid catfish ponds through composite culture system (*Pangasius hypophthalmus* and *Hypophthalmicthys molitrix*) may help to get sustainable fish production and also can mitigate the eutrophication problem of a pond to some extent. So, if we can utilize the heavy thick algal bloom or scum of catfish culture ponds as food of silver carp (*Hypophthalmicthys molitrix*), then the water quality could be maintained properly and the farmers can get higher fish production with reduced input cost. These reduced input cost and higher fish production may encourage the rural farmers to do the culture of pangasid catfish (*Pangasius hypophthalmus*) and silver carp (*Hypophthalmicthys molitrix*). Considering the above facts the stocking ratio of pangasid catfish and silver carp in composite cat fish farming is very much important for controlling the algal bloom. For this, that study was undertaken to observe:

- The effect of different stocking ratio of pangasid catfish (*Pangasius hypophthalmus*) and silver carp (*Hypophthalmicthys molitrix*) on maintaining better water quality and
- Impacts of using fence for proper utilization of phytoplankton as fish food by silver carp (*Hypophthalmicthys molitrix*) in composite culture

MATERIALS AND METHODS

The experiment was carried out for a period of three and a half months from 1st May to 15th August 2002 in twelve ponds located in the field laboratory of the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh. Each pond was of about 200 m^2 and depth was about 1 m. At first the experimental ponds were prepared accordingly for stocking of experimental fish. Fish species used in the present study were Thai pangasid catfish (*Pangasius hypophthalmus*) and Silver carp (*Hypophthalmicthys molitrix*) and the stoking density in each pond was 120 fishes/decimal.

In the present study, ponds were randomly selected for four treatments each with three replicates were used. In T_1 only pangasid catfish was stocked, in T_2 pangasid catfish and silver carp were stocked at the ratio of 1:1 and the ratio was 2:1 in T_3. In T_2 and T_3, the two species were separated from each other by using a bamboo made fence along the breadth wise considering the density of each species. In T_4 the stoking ratio of pangasid catfish and silver carp was 1:1 and which was set without any bamboo made fence.

Throughout the experimental period, pelleted feed was used for stocked catfish (*Pangasius hypophthalmus*). Initially feeding rate was 8% body weight. After one month of stocking the rate was 6% and then finally the feeding rate was 5% body weight up to the harvesting period.

Physico-chemical properties of pond water were recorded during the whole period of study. The water temperature, pH, transparency, depth, dissolved oxygen (DO) were determined weekly, nitrate-nitrogen (NO_3-N)

and phosphate-phosphorus (PO_4-P) concentration and plankton abundance were determined at 15 days interval and concentration of chlorophyll-a was determined on every alternate day. For this purposes water samples were collected within 9.00 to 10.00 am on each sampling day.

In the present study, temperature and dissolved oxygen were measured by using a YSI model 58, USA dissolved oxygen meter. Secchi disc and a pH meter (CORNING pH meter 445) were used to determine the transparency and pH of water samples respectively. A HACH Kit (DR/2001), a direct reading spectrophotometer using pillow Nitraver-5 nitrate reagent and Phosver-3 phosphate reagent, determined NO_3-N and PO_4-P respectively. The concentration of Chlorophyll-a was measured spectrophotometrically on every alternative day after acetone extraction according to American Public Health Association (APHA) and titrimetric method was used to determine the total alkalinity (Stirling, 1985). For qualitative and quantitative study of plankton, water samples were collected from each of the experimental ponds and passed through fine meshed (25 μm) plankton net. Then the collected plankton samples were preserved in 10% buffered formalin. From each of preserved sample, 1 mL sub sample was examined using Sedgewick-Rafter counting cell under a compound microscope (Olympus, Model BH-2 with phase contrast facilities) and calculation of plankton cell density ($\times 10^3$ cells L^{-1}) was done by using the following formula (Stirling, 1985)

$$N = \frac{A \times 100 \times C}{V \times F \times L}$$

Where,

N = No. of plankton cells or units per litre of original water
A = Total No. of plankton counted
C = Volume of final concentrate of the sample in mL
V = Volume of a field in cubic mm
F = No. of field counted
L = Volume of original water in litre

Identification of plankton was also performed following the standard method APHA (1992) and Bellinger (1992).

After the completion of experiment, the observed data were analyzed following Analysis of Variance (ANOVA) in split-plot design with treatments as the main plot factor and time as the subplot (Gomez and Gomez, 1984) using the Mstat-c programmed. When the main effect was significant, then ANOVA was followed by Duncan's Multiple Range Test. Statistical significance was assessed using a probability level of $p = 0.05$.

RESULTS AND DISCUSSION

The average value and ranges of physico-chemical water quality parameters in different treatments are shown in Table 1. The values of temperature, pH, transparency, depth, PO_4-P concentration and amount of alkalinity did not varied significantly among different stocking ratios, but the values of dissolved oxygen, NO_3-N concentration varied significantly when compared using ANOVA (Table 2).

Boyd (1990) stated that the nutrients budget in intensive and semi-intensive fish culture ponds, large quantity of feed is not utilized by fish and often accumulated in pond. Fedoruk (1981) also stated that waste products were generated within *Clarias* rearing tanks. Some are derived from the fish metabolic wastes themselves and some from uneaten feed as in the case of excessive feeding.

The highest concentration of nitrate-nitrogen was 3.1 mg L^{-1} and phosphate-phosphorus was 2.7 mg L^{-1} found in T_1 (Table 1) where monoculture of pangasid catfish was practiced with high amount of feed. Among the composite culture in T_2-T_4, the fortnightly variation of nutrient concentration was mostly found higher in T_3 followed by T_2 and T_4. Because in that treatment the stocking ratio of pangasid catfish and silver carp was 2: 1 whereas the stocking ratio were 1: 1 in T_2 and T_4. As a result, high amount of feed was also applied in T_3. Uneaten portion of the applied feed were decomposed and nutrients were released from the organic matter. It might be caused of higher concentration of NO_3-N and PO_4-P in T_1 and T_3.

Srisuwantach *et al.* (1980) reported in his study that the high ammonia nitrogen and the low dissolved oxygen concentration were related to the decomposition of uneaten food and the excretory products of *Clarias*. In the present investigation, the dissolved oxygen concentrations in T_1 and T_3 were significantly lower than that's of T_2 and T_4 (Table 2). Tucker *et al.* (1979) also found the deterioration of water qualify, especially low concentration of dissolved oxygen, increasing in frequency and serving with increasing feeding rate during his study on the effects of feeding rate on water, production of channel catfish and economic returns. The statements of the above authors were agreed with the findings of the present study.

Mean values (±SD) and ranges of cell density ($\times 10^3$ cells L^{-1}) of different plankton groups in four treatments throughout the period of study was shown in Table 3. Due to highest concentration of nutrients, the plankton production found higher in ponds of T_1 followed by T_3, T_2 and T_4. During the period of study, about 36

Table 1: Mean±SD and ranges of each water quality parameters in different treatments throughout the period of study

Parameters	T_1	T_2	T_3	T_4
Temperature (°C)	30.13±1.28	30.10±1.31	30.06±1.34	30.08±1.33
	(28.00-33.00)	(28.00-33.00)	(28.00-33.10)	(28.00-33.00)
pH	9.10±0.54	7.12±0.49	7.23±0.46	7.19±0.45
	(6.18-8.55)	(6.03-8.04)	(6.16-8.25)	(6.20-8.01)
Transparency (cm)	24.76±10.49	35.14±12.02	28.08±9.33	34.30±12.49
	(10.14-53.65)	(16.64-59.98)	(12.70-50.48)	(15.24-65.5)
Depth (cm)	112.88±7.72	114.92±8.21	117.21±9.29	117.66±10.19
	(97.24-127.71)	(97.26-136.29)	(97.72-135.86)	(94.13-142.29)
DO(mg L^{-1})	3.44±1.09	4.77±0.81	4.18±1.18	4.8510.88
	(1.55-7.10)	(3.03-6.10)	(1.10-6.80)	(2.90-6.10)
$N0_3$-N (mg L^{-1})	1.98±0.90	1.30±0.70	1.54±0.70	1.16±0.6
	(0.30-3.10)	(0.10-2.50)	(0.20-2.40)	(0.20-2.10)
$P0_4$-P (mg L^{-1})	1.49±0.90	1.12±0.65	1.40±0.59	1.08±0.60
	(0.04-2.70)	(0.17-2.05)	(0.47-2.31)	(0.07-2.01)
Alkalinity (mg L^{-1})	111.38±33.13	99.92±19.75	114.0-±30.80	100.13±23.44
	(41.00-208.00)	(65.00-140.00)	(75.00-226.00)	(65.00-166.00)
Chlorophyll-a (μg L^{-1})	405.89±269.01	239.29±116.29	274.25±154.46	222.40±117.64
	(48.79-1097.00)	(28.51-785.40)	(28.51-785.40)	(31.94-529.39)

Table 2: Comparison of different water quality parameters (temperature, pH, transparency, depth, dissolved oxygen, NO_3-N, PO_4-P, alkalinity and chlorophyll-a) between four treatments by using ANOVA

Parameters	T_1	T_2	T_3	T_4	F-value	Level of significance
Temperature (°C)	30.13	30.10	30.06	30.08	2.36	NS
pH	9.10	7.12	7.23	7.19	1.05	NS
Transparency (cm)	24.76	35.14	28.08	34.30	3.62	NS
Depth (cm)	112.88	114.92	117.21	117.66	0.59	NS
DO (mg L^{-1})	3.44^c	4.77^a	4.18^b	4.85^a	30.83	**
N03-N(mg L^{-1})	1.98^a	$1.30b^c$	1.54^b	1.16^c	31.05	**
P04-P (mg L^{-1})	1.49	1.122	1.40	1.08	4.65	NS
Alkalinity (mg L^{-1})	111.38	99.92	114.00	100.13	2.86	NS
Chlorophyll-a (μg L^{-1})	405.89^a	239.29^b	274.25^b	222.40^b	10.78	**

NS indicates, non significant at 5% level, ** Indicates significant difference at 5% level, Figure in the same row having same superscript are not significant different

Table 3: Mean±SD and ranges of cell density (×10^3 cells L^{-1}) of different plankton groups in four treatments throughout the period of study

Plankton	T_1	T_2	T_3	T_4
Euglenophyceae	127.72±l00.11	32.47±23.39	46.83±26.26	28.86±23.42
	(8.10-316.59)	(5.60-89.70)	(8.64-89.70)	(2.28-91.80)
Bacillarophyceae	43.40±29.68	11.52±14.36	42.48±43.06	11.65±7.24
	(7.02-92.88)	(2.26-60.55)	(3.95-194.00)	(1.98-27.20)
Chlorohyceae	96.99±69.20	30.45±22.16	71.11±43.15	32.54±16.91
	(18.88-252.58)	(1.86-77.60)	(6.80-178.35)	(10.35-67.26)
Cyanophyceae	176.61±132.30	86.97±72.49	141.98±128.29	67.69±64.91
	(10.24-445.48)	(2.70-244.44)	(13.04-465.08)	(3.22-277.89)
Total phytoplankton	469.92±324.82	161.40±90.08	288.37±158.38	146.56±76.00
	(70.40-1312.74)	(24.80-331.74)	(66.72-585.20)	(37.72-348.54)
Crustaceac	0.66±1.35	1.00±1.37	0.80±1.78	0.29±0.75
	(0.00-5.37)	(0.00-4.35)	(0.00-6.52)	(0.00-3.00)
Rotifera	5.22±5.61	3.31±4.77	2.77±4.10	2.85±4.25
	(0.00-25.20)	(0.00-15.57)	(0.00-17.40)	(0.00-15.51)
Total zooplankton	5.88±5.28	4.31±5.19	3.70±5.30	3.14±4.32
	(0.00-25.20)	(0.00-19.03)	(0.00-18.85)	(0.00-15.51)
Total plankton	475.80±323.05	165.72±88.60	297.57±162.42	149.70±74.48
	(81.92-1319.37)	(26.48-327.86)	(71.52-585.20)	(43.50-48.54)

Table 4: Comparison among cell numbers (×10^3 cells L^{-1}) of different plankton groups of four treatments by using ANOVA

Plankton group	T_1	T_2	T_3	T_4	F-value	Level of significance
Euglenophyceae	127.72^a	32.47^b	46.83^b	28.86^b	29.49	**
Bacillarophyceae	43.40^a	11.52^b	42.48^a	11.65^b	19.38	**
Chlorohyceae	96.99^a	30.45^b	71.11^a	32.54^b	17.41	**
Cyanophyceae	176.61^a	86.97^{bc}	141.98^{ab}	67.69^c	14.84	**
Crustacean	0.66	1.00	0.80	0.29	0.85	NS
Rotifera	5.23^a	3.31^b	2.77^b	2.85^b	11.64	**
Total plankton	475.80^a	165.72^b	297.57^b	149.72^b	15.72	**
Total phytoplankton	469.92^a	161.41^b	288.37^b	146.56^b	16.29	**

NS indicates, non significant at 5% level, **Indicates significant difference at 5% level, Figure in the same row having same superscript are not significant different

genera of plankton consisting 30 genera of phytoplankton and 6 genera of zooplankton were recorded through the microscopic observation. Among the different groups of phytoplankton, 3 belong to Euglenophyceae, 6 to Cyanophyceae, 7 to Bacillariophyceae and 14 to Chlorophyceae. Among the different groups of phytoplankton, Cyanophyceae ranked first position in respect of abundance. When ANOVA was performed, significant differences were found among the treatments (Table 4). In order of abundance, Euglenophyceae was the second dominant group throughout the study period. The most dominant genus of Euglenophytes was *Euglena*. Chlorophyceae ranked first position in respect of species composition. Belonging to the Chlorophyceae, the identified genus were *Ankistrodesmus*, *Actinastrum*, *Chlorella*, *Scenedesmus*, *Characium*, *Staurcistrum* and *Pediastrum* and most dominant genus were *Chlorella* and *Scenedesmus*. When ANOVA was performed significant difference was found in the group of Rotifera ($p>0.05$) but there was no significant difference in the group of Crustacea ($p>0.05$) (Table 4).

Both the mean values of total phytoplankton and zooplankton were higher in T_1 (475.80 and 5.88×10^3 cells L^{-1}) followed by the T_3, T_2 and T_4 (Table 3). The high concentration of nutrients derived from the decomposition of uneaten portion of feed and catfish wastes helped in forming heavy phytoplankton growth throughout the culture period. Moore (1986) reported that unconsumed particles were decomposed by heterotrophic activity, affecting all levels of nutrient availability and organisms growth in such system.

Chlorophyll-a concentration was also found higher in T_1 and T_3 than that of T_2 and T_4. Algal blooms occurred in those treatments and it might be the cause of lower transparency in ponds of T_1 and T_3. Because of higher phytoplankton growth, more carbon dioxide was adding from excess respiration of algae and increased the total alkalinity in T_1 and T_3 followed by T_2 and T_4.

Starling (1993) postulated that microzooplankton, net phytoplankton, total phytoplankton biomass and net primary productivity were significantly reduced by silver carp. Between the same stocking ratio of pangasid catfish and silver carp (T_2 and T_4) the phytoplankton cell density and chlorophyll-a concentration were found lower in T_4 than T_2. In T_4 when phytoplankton production increased then the absence of fence promoted silver carp to graze over the phytoplankton throughout the water body, which prevented the algal bloom formation in the ponds of T_4. Lin *et al.* (1990) and Lin and Diana (1995) also reported that the wastes from catfish cultures in cages have been shown to be effective for producing phytoplankton to support Nile tilapia culture in same pond. But in case of T_2 some algal bloom of *Euglena* occurred in the portion of pangasid catfish during culture period. It might be due to the grazing activity of silver carp over the phytoplankton population were restricted by the fence.

From the discussion, it may be concluded that in monoculture pangasid catfish farming, high amount of supplemental feed increase the nutrient concentration and which ultimately affected the other physico-chemical properties of water through which the monoculture farming practice may be seriously threatened by algal bloom due to eutrophication. But in intensive pangasid catfish farming system, composite culture of pangasid catfish with planktivore fish such as, silver carp and their stocking ratio is very much important to save the aquatic environment from water quality deterioration. Silver carp may help the environment by grazing on phytoplankton and hopefully may prevent algal bloom formation and sedimentation of dead algal mats. It is suggested that in composite culture system, 1:1 stocking ratio of pangasid catfish and silver carp without fence may be helpful to maintain the water quality and for better production.

REFERENCES

APHA (American Public Health Association), 1992. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington DC.

Bellinger, E.G., 1992. A Key to common algae: Freshwater, Estuarine and Some Coastal Species. The Institute of Water and Environmental Management, London, UK.

Boyd, C.E., 1988. Water Quality in Warmwater Fish Ponds. Agricultural Experiment Station, Auburn University, Auburn, Albania, USA.

Boyd, C.E., 1990. Water quality in ponds for Aquaculture. Alabama Agricultural Experiment Station, Auburn University.

Fedoruk, A.N., 1981. A management perspective on stress and infectious disease in *Clarias* farming. Programme for the Development of Pond Management Techniques and Disease Control (DOF-UNDP/FAO THA/75/012), National Inland Fisheries Institute, Bangkok, Thailand.

Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedures for Agricultural Research. 2nd Edn., John Wiley and Sons, New York.

Lin, C.K. and J.S. Diana, 1995. Co-culture of catfish (*Clarias macrocephalus* × *Clarias gariepinus*) and tilapia (*Oreochormis niloticus*) in ponds. Aquatic Living Resource, 8: 449-454.

Lin, C.K., K. Jaiyen and V. Muthuwan, 1990. Integration of intensive and semi-intensive aquaculture: Concept and example. Thai Fisheries Gazette, 43: 425-430.

Moore, L.B. 1986. Input of organic materials into aquaculture systems: Emphasis on feeding in semi intensive systems. Aquacul. Eng., 5: 123-133

Perschbacher, P.W., 1995. Algal management in intensive channel catfish production trials. World Aquacul., 26: 65-68.

Roberts, T.R. and C. Vidthayanon, 1991. Systematic revision of the Asian catfish family Pangasid catfishidae, with biological observations and descriptions of three new species. Proc. Acad. Natl. Sci. Philad, 143: 97-144.

Sidthimunka, A., 1972. The culture of pla duk (*Clarias* spp.). Report Inland Fisheries Division, Department of Fisheries, Bangkok, Thailand, No. 12.

Srisuwantach, V.R., R. Soimgchomphan and P. Sitasti, 1980. Comparison on the effects of trash fish and pelleted diets in *Clarias* grow out operations Programme for the Development of Pond Management Techniques and Disease Control (DOF-UNDP/FAO THA/75/012), National Inland Fisheries Institute, Bangkok, Thailand, pp: 2.

Starling, F.L.D.R.M., 1993. Control of eutrophication by silver carp (*Hypophthalmichthys molitrix*) in the tropical Paranoa Reservoir (Brasilia, Brazil): A mesocosm experiment. Hydrobiologia, 257: 143-152.

Stirling, H.P., 1985. Chemical and Biological methods of water analysis for Aquaculturists. Institute of Aquaculture, University of Stirling, Scotland FK9 4LA, pp: 119.

Tucker, L., C.E. Boyd and E.W. McCo, 1979. Effects of feeding rate on water quality, production of channel cat fish and economic returns. Trans. Am. Fish. Soc., 108: 389-396.

Watson, D., 2001. Silver carp algae control trials. Alberta Agriculture, Food and Rural Development.