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Growth Performance of *Cyprinus carpio* L. in Intensively Different Organic Manures

Chakrabarty, D.[1*], Das, M. K.[1] and Das, S. K.[2]

[1] Department of Zoology, Krishnagar Government College, Krishnagar, Nadia, India
[2] Waste Management Cell, West Bengal Pollution Control Board, Paribesh Bhavan, Block-LA, Sector-III, Bidhannagar, Kolkata-700098, West Bengal, India

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ABSTRACT: Qualitative and quantitative analyses of phyto- and zooplankton, and growth performance of *Cyprinus carpio* Linnaeus were done in earthen vats receiving compost, Diammonium Phosphate and vermicompost as direct application fertilizer were conducted. Significant differences were observed in the diversity and abundance of plankton in response to fertilization. The highest production of fish was obtained in the vats treated with vermicompost (3,970.56 kg/ha/90 days), followed by Diammonium Phosphate (3080.45 kg/ha/90 days), compost (1,952.64 kg/ha/ 90 days) and the lowest in the control (385.92 kg/ha/90 days). Vermicompost might be a cost-effective fertilizer in carp culture, replacing the expensive chemical fertilizer Diammonium Phosphate.

Key words: Organic manure, Plankton, Fish production, Diammonium Phosphate, *Cyprinus carpio* L.

INTRODUCTION

Wide variety of organic manures such as grass, leaves, sewage water, livestock manure, industrial wastes, night soil and dried blood meal have been used (Hickling, 1962; Steinberg *et al.*, 2006) to improve fish production. Although organic fertilizer can be utilized as food for fish prey organisms and fish (Taiganides, 1978; Oribhabor and Ansa, 2006), they are intended primarily to release inorganic nutrients for phytoplankton and zooplankton growth. Phytoplankton and zooplankton often contain 40"60% protein on a dry matter basis and can support excellent fish growth (Edwards, 1980; Pillay, 1995; Silva and Anderson, 1995; Wang, 2000). Studies on growth performance of cultured fish in relation to feeding provide information for successful application in the management and exploitation of the resources. The present trial was undertaken to qualitatively and quantitatively analyze various groups of phytoplankton and zooplankton, and their effect on the growth performance of the test fish *Cyprinus carpio* L. in concrete cisterns.

*Corresponding author-E-mail:debajyoti_chakrabarty@yahoo.co.in.

MATERIALS & METHODS

Twelve concrete cisterns (area 0.125 m^3; depth 50 cm; capacity 100 L) were treated with two different types of organic manures namely, compost (T-2), Diammonium phosphate (T-3) and vermicompost (T-4) each having three replicates. Three control cisterns (T-1) were also run simultaneously without manure or fertilizer. Each vat was provided with an uncontaminated soil base of 6 cm. All the cisterns were then filled exclusively with ground water (pH 7.16, temperature 34°C, DO 4.0 mg/L). The amounts of different organic manures were applied as per the P_2O_5 content of the fertilizer and manures.The present trial was conducted in a private premise at Krishnagar (longitude $88^0 33^/$E, latitude $23^0 24^/$ N) over a period of 90 days during May – July (Temp 34°C). All the treatment series received manure at 15 days intervals, with the first application occurred 15 days prior to fish introduction and the control series receiving nothing. The total phosphate content of the manures applied was determined prior to its use in the experimental cisterns. The weights of the manure were ranged from 3.04"620.0 g on 50 kg P_2O_5 content basis (Table 1). Fry of *Cyprinus carpio* L. (average weight 2.5 ± 0.01 g; average length 1.40 ± 0.02 cm) were acclimatized in out door cisterns before being stocked at 10 per cisterns (individual). A constant water level was maintained in the test cisterns by weekly supply of ground water to compensate the water loss due to evaporation. Water quality such as temperature, pH, dissolved oxygen, free carbon dioxide, total alkalinity, hardness, ammonia-nitrogen and phosphorous, were measured at 15 day intervals following the Standard Methods (2002). Qualitative and quantitative analyses of phytoplankton and zooplankton (samples preserved in 4% formalin) from each cistern were carried out using Sedgwick rafter count cell at an interval of 45 days by filtering 20 liters of water through a conical plankton net of number 25 bolting silk cloth (80 mesh.cm^{-2}). The plankton samples were then hot air dried for 24 hours at 100°C and after that measured for their dry weight. The total weight of the fish was determined at 45-day intervals by weighting more than 50% of fishes from each of the cisterns. The absolute growth (AG), growth increment (GI) and the total weight gain (TW) was estimated as follows.

Absolute growth (AG) = Final body weight " Initial body weight

Growth increment (GI) = (Final body weight " Initial body weight) / Number of culture days after fish introduction

Total weight gain (TW) = (Final body weight " Initial body weight) / Initial body weight

RESULTS & DISCUSSION

Water quality

The various physico chemical parameters of overlying water did not varied significantly among the various treatment series. In all the experimental and control cisterns, the water temperature was similar (22.5"22.59 °C), pH was maintained at 7.06"7.43 and dissolved oxygen at 6.21"7.74 mg/L during the treatment (Table 2). The concentrations of orthophosphate and acid hydrolysable phosphate were the highest in the Diammonium Phosphate (0.52 mg/L) treatment and lowest in the control (0.09 mg/L). The amount of organic phosphate, on the other hand, was the highest (0.35 mg/L) in the vermicompost treatment. The concentration of total P was higher in Diammonium Phosphate (0.85 mg/L) than in the vermicompost treatment (0.68 mg/L). There was no significant difference ($P < 0.05$) in the concentration of total P among the treatments (T-2, T-3 and T-4). However, as expected, the control cisterns always had the lowest concentration of total and available P (Fig. 1). But the total nitrogen concentration showed significant differences among all the test combinations and this trend was also followed for available N in the Diammonium Phosphate and control cisterns (Fig. 2). The control and Diammonium Phosphate cisterns showed no significant difference in their available N concentration.

Plankton analysis

In all the treatments dry weight and population (no.–!$^{-1}$) of both phytoplankton and zooplankton populations were significantly (P<0.001) higher than in the control.Phytoplankton composition wasrepresented by four groups, namely

Table 1. Details of fish production (*Cyprinus carpio* L.) in the experiment

Parameters	Control (T-1)	Compost (T-2)	Diammonium Phosphate (T-3)	Vermicompost (T-4)
Fertilizer / Manure added (g)	0	413	3.04	340
Stocking density	10.00	10.00	10.00	10.00
Initial average individual length (cm)	1.40±0.02	1.40±0.02	1.40±0.02	1.40±0.02
Initial average individual weight (g)	2.40±0.01	2.40±0.03	2.40±0.04	2.40±0.02
Final average individual length (cm)	4.20±0.03	6.80±0.06	7.60±0.04	8.80±0.07
Final average individual weight (g)	3.76±0.01	8.29±0.05	12.92±0.03	16.76±0.07
Growth increment (g/fish/day)	0.0151	0.0654	0.1169	0.1595
Production of Fish (kg/ha/90 days)	385.92	1,952.64	3080.45	3,970.56
Total weight gain (TWG) (g/fish)	0.57	2.45	4.38	5.98
Survival (%)	85	88	86 90	90

Table 2. Mean values (± SD) of physico-chemical parameters of water, primary productivity of phytoplankton and final body weights of *Cyprinus carpio* L. (Ham.) in various treatments. Each mean value applies to three months samples

	Control (T-1)	Compost (T-2)	Diammonium Phosphate (T-3)	Vermicompost (T-4)
Temp (°C)	22.5±6.5	22.5±6.5	22.59±6.5	22.59±6.5
pH	7.06±1.3	7.16±1.6	7.34±1.1	7.43±0.9
Dissolved Oxygen (mg/L)	6.01±0.9	6.21±1.1	7.74±1.0	7.02±1.2
Ortho phosphate (mg/L)	0.09±0.09	0.19±0.06	0.52±0.10	0.30±0.14
Organic phosphate (mg/L)	0.08±0.19	0.27±0.15	0.29±0.14	0.35±0.21
Total phosphate (mg/L)	0.10±0.10	0.66±0.16	0.85±0.25	0.68±0.21
No_3-N (mg/L)	0.06±0.08	0.12±0.06	0.13±0.03	0.16±0.04
Total inorganic N (mg/L)	0.16±0.24	0.40±0.22	0.20±0.19	0.62±0.23
N / P	1.6	0.61	0.23	0.91
Community respiration (mg C/m^2/h)	20.13±9.3	28.13±12.5	35.79±18.2	38.58±13.1
Final mean body weight (g)	18.24±2.3	22.25±3.6	39.50±4.3	45.77±3.9

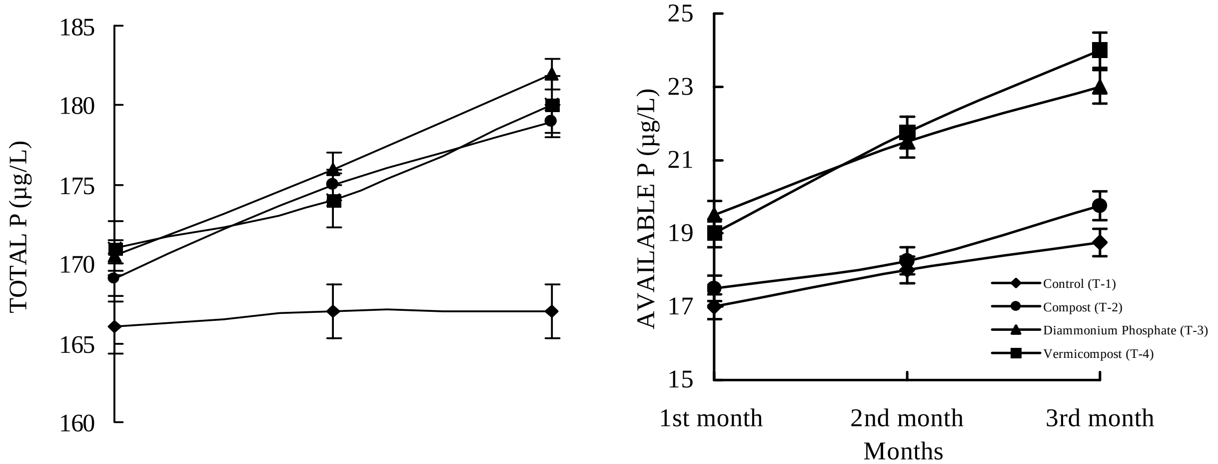

Fig.1.Temporal changes of available and total P contents of water in the three treatments and control

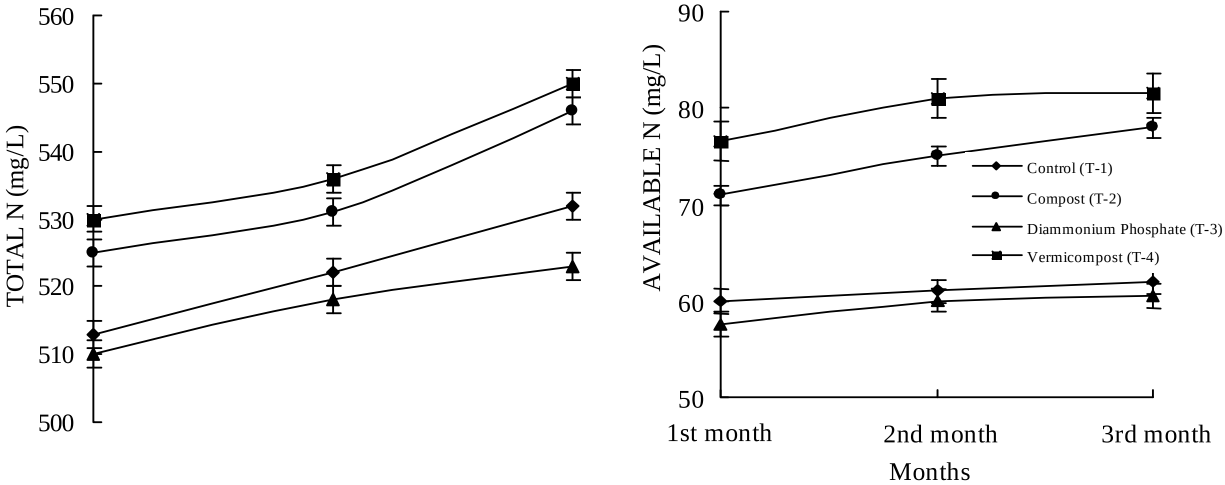

Fig. 2. Temporal changes of available and total P contents of water in the three treatments and the control

Myxophyceae, Chlorophyceae, Cyanophyceae and Bacillariophyceae in all the cisterns. Among the four phytoplankton groups Bacillariophyceae exhibited highest percentage composition (66.25"72.31%) in all the three treatments and control on various sampling days, whereas Cyanophyceae exhibited the lowest (5.33"12.28%) in all the treatments and control. The phytoplankton population was found (Fig. 3) in increasing order in the cisterns treated with vermicompost (2,759 nos./L), followed by Diammonium Phosphate (2,441 nos./L), then by compost (2,080 nos./L). Also, overall observation revealed an increasing trend of phytoplankton population in various sampling days of the experimental period in all the treatments. Significant differences were also found between vermicost and compost treatments.

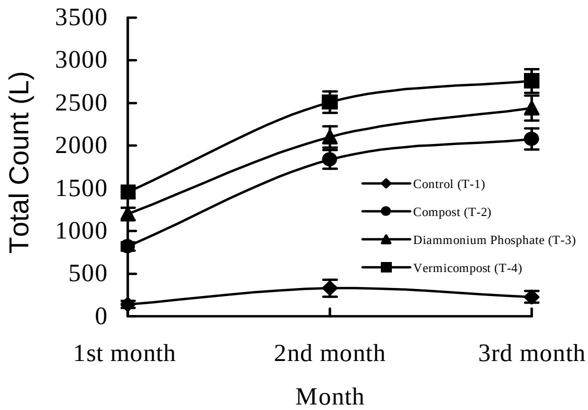

Fig. 3. Monthly Sampling of Phytoplankton

The zooplankton composition was represented by three groups, namely, Rotifera, Cladocera and Copepoda. The contribution of different zooplanktons groups showed similar trend in all the treatment groups. Cladocera (33.74"42.94%) and Copepoda (38.23"55.81%) dominated the zooplankton, with rotifera accounted for 6.98"24.54% of the populations. Among the various treatments, the highest zooplankton population was observed (Fig. 4) in the cisterns treated with vermicompost (680 nos./L), followed by Diammonium Phosphate (448 nos./L), compost (326 nos./L) and control (43 nos./L). Moreover, the zooplankton count increased with days of sampling in all the treatments, but not in the control cisterns where a declining trend of zooplankton count was observed.

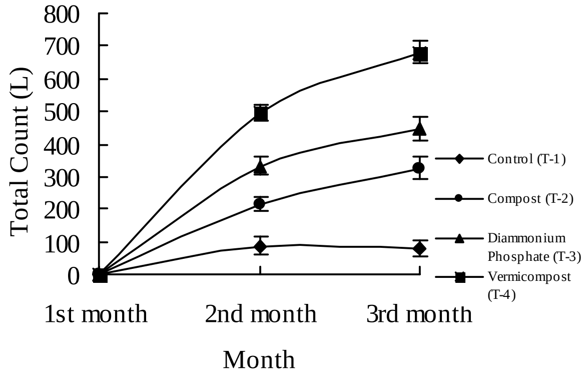

Fig. 4. Monthly Sampling of Zooplankton

Fish growth and production

There was a steady increase in weight of fish in all the cisterns; however, the growth was much greater in the treated cisterns than in the control. Among the various treatments, maximum growth increment, total gains were recorded with vermicompost, followed by Diammonium Phosphate, compost. Minimum growth rate was recorded in the control.The average growth of individual fishes (Fig. 5) among the treatments varied significant ($P < 0.05$) and a stepwise multiple regression analysis also attested the findings (Fig. 5). The total yield of fish was higher in the treatments with high plankton counts as revealed from the cisterns treated with vermicompost (3,970.56 kg/ha/90 days) as compared to low plankton count in the control sets (3,85.92 kg/ha/90 days). The net production of fish from the cisterns manured with Diammonium Phosphate was 3080.45 kg/ha/ 90 days and with compost was 1,952.64 kg/ha/ 90 days (Table 1).Manuring of fish ponds, whether it is a nursery, growth-out or a stocking pond, is one of the well known practices in efficient farm management to boost up its fish production. The vermicompost applied to the culture waters is utilized for fish growth in many ways. It served as a direct feed for the fish and also acted as pond fertilizer for autotrophic and for heterotrophic production of natural fish food organisms (Muendo *et al.*, 2006). Because the average weight and total fish yield achieved in the vermicompost treatment were higher than those of the Diammonium Phosphate treatment, it is apparent that the cost of vermicompost might be considered as a cost-effective fertilizer in carp culture, replacing the expensive chemical fertilizer Diammonium

Phosphate. This is particularly significant in developing nations, where the purchasing power of fish farmers for chemical fertilizer is very low, and vermicompost forms an abundant alternative natural resource for inexpensive P fertilizer.Large variation of fish yield (> 9.5 times) among the three treatments and control might be explained in terms of N/P ratio of water. The lowest and highest production of fish in vermicompost (T-4) and control (T-1) (Table 1) was related to the lowest and moderate N/P ratio of the cisterns (Fig. 6). There was direct relationship between dry weight of plankton and fish yield (r=0.88) in all the treatments and control. Superiority of vermicompost was well pronounced as it served the double role as direct feed to growing fishes

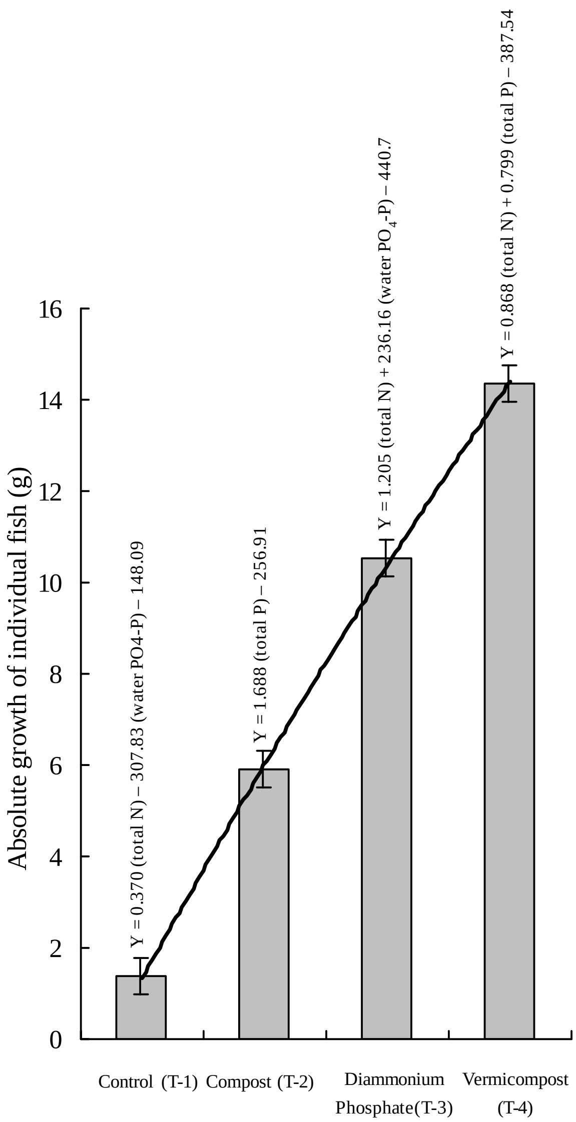

Fig. 5. Absolute growth of individual fish

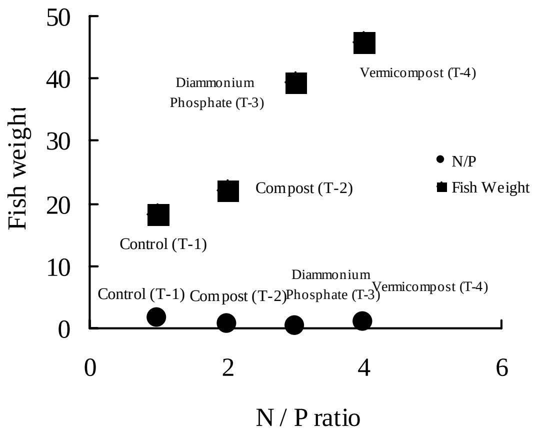

Fig. 6. Fianl mean body weight (g) of fish vs. N/P ratio of water

and as direct manure for increasing growth of fish food. Large variations of fish yield among the treatments were attributable to variations in the available P contents of surface sediments as well as orthophosphate level of water. It is likely that the sediment phosphorus in each treatment eventually affected fish growth through mud-water exchange mechanisms and induced the orthophosphate level of water which, in turn, maintained sustained primary productivity of phytoplankton for functional stability of the grazing food chain. The primary productivity of phytoplankton was, however, not directly dependent upon the orthophosphate level of water in these treatments ($P > 0.05$).The results of multiple regression analysis (Fig. 5) were significant ($P < 0.05$) in each case. It is evident that both total P and total N of surface sediments exerted considerable influence in the vermicompost treatment. Total P of surface sediments and orthophosphate of water, on the other hand, were the major determinants in Diammonium Phosphate treatment.The addition of manures affects the relative abundance of the plankton and their community structure. Proper combinations of inorganic nutrients (NPK) are the major factors that influence the growth and production of phytoplankton in a pond. Vermicompost contains all the major organic nutrient components (N, P and K). Trace elements are also found in vermicompost. Several investigators observed high total phytoplankton in ponds treated with organic manure, mainly due to content of phosphates and nitrates (Dhawan, 1989). Thus, the greater volume of plankton in the cisterns treated with vermicompost and

Diammonium Phosphate proved the superior nutrient status from the cisterns treated with compost. High rates of fish yield and excellent growth in the present experiment can largely be attributed to higher availability of natural food of high nutritional value in the treatments. Smith and Swingle (1939) established a direct relationship between average plankton and fish production. Similar results were observed in the present experiment where the absolute growth of fish in all the treatments exhibited a highly positive correlation with the primary productivity of water. A positive correlation (r = 0.95) observed between absolute growth of test fish, *Cyprinus carpio* L. and dry weight of plankton signifies that natural food (plankton) alone offers all the constituents of a complete and balance diet required for fish growth. Moreover, some carps even feed upon the undigested fraction of these manures directly, which may be low in nutrient value but the micro-organisms adhering to them are of high protein value (Schroeder, 1980; Ansa and Jiya, 2002).

CONCLUSION

The present study thus demonstrates that fish production under similar culture conditions can be greatly enhanced using vermicompost, in place of traditionally used compost or costly chemical fertilizer. Higher rates of nutrient, increased plankton production of high nutritional value and optimum water quality conditions in the vermicompost applied cisterns account for the increased growth rate of fish as compared to control cisterns without manure.

REFERENCES

Ansa, E. J. and Jiya, J., (2002). Effect of pig manure on the growth of *Oreochromis niloticus* under integrated fish-cum-pig farming System. J. Aqua. Sci., **17**, 85-87.

Dhawan, A., (1989). Impact of organic manure and supplementary diet on plankton production and fish growth and fecundity of an Indian major carp, *Cirrhinus mrigala* (Ham.) in fish ponds. Biol. Wast., **29**, 289-297.

Edwards, P., (1980). A review of recycling organic wastes into fish, with emphasis on the tropics. Aquaculture, **21**, 261-279.

Hickling, C. F., (1962). Fish culture. Faber and Faber, London, UK.

Muendo, P. N., Milstein, A., Dam, A. A van., Gamal, El-N., Stoorvogel, J. J. and Verdegem, M. C. J., (2006). Exploring the trophic structure in organically fertilized and feed-driven tilapia culture environments using multivariate analyses. Aquacul. Res., **37**, 151–163.

Oribhabor, B. J. and Ansa, E. J., (2006). Organic waste reclamation, recycling and re-use in integrated fish farming in the Niger Delta. J. Appl. Sci. Environ. Manag., **10**, 47-53.

Pillay, T. V. R., (1995). Aquaculture – Principles and practices. Fishing News Books, Cambridge, England.

Schroeder, G. L., (1980). Fish farming in manure loaded ponds. Pages 73-86 *in* Pullin, R.S.V. and Shahadah, H. editors. Integrated agriculture / aquaculture farming systems. ICLARM, Conf. Proc. 4.

Silva, S. S. and Anderson, T. A., (1995). Fish nutrition in aquaculture. Chapman and Hall Publ., New Delhi, India.

Smith, E. V. and Swingle, H. S., (1939). The relation between plankton production and fish production in ponds. Trans. Am. Fish. Soc., **68**, 310-315.

Standard Methods (2002). Standard methods for the examination of water and waste waters (21st Ed.), American Water Works Association (AWWA), Water Pollution Control Federation (WPCF) and American Public Health Association (APHA) Washington DC, USA.

Steinberg, C. E. W., Kamara, S., Prokhotskaya, V. Yu., Manusadžianas, L., Karasyova, T. A., Timofeyev, M. A., Jie, Z., Paul, A., Meinelt, T., Farjalla, V. F., Matsuo, A. Y. O., Burnison, B. K. and Menzel, R., (2006). Dissolved humic substances – ecological driving forces from the individual to the ecosystem level? Fresh. Bio., **51**, 1189–1210.

Taiganides, E. P., (1978). Principles and techniques of animal waste management and utilization. FAO Soils Bull., **36**, 341-362.

Wang, Wu., (2000). Fish Culture and Enhancement. China Agricultural Press, Beijing, China. 661.