Pakistan J. Zool., vol. 51(4), pp 1483-1487, 2019. **DOI:** http://dx.doi.org/10.17582/journal.pjz/2019.51.4.1483.1487

Comparison of Growth, Proximate and Minerals Composition of Commonly Polycultured Fish Species by Replacing Surface Feeder Fish

Muhammad Ahmad, Zohaib Noor*, Karim Johar Khan, Waqar Younas and Ajmal Hussain

Fisheries and Aquaculture Laboratory, Animal Sciences Department, Quaid-i-Azam University, Islamabad

ABSTRACT

The experiment was conducted in the earthen ponds as two experimental groups were set each stocked with three different fish species at the rate of 800/Acre in the semi intensive polyculture system by supplementing inorganic and organic fertilizers in the ponds. Fish were stocked at the ratio of 35:40:25 in both the ponds designated as group 1 and group 2. Group 1 pond was stocked with *Catla catla* (*C. catla*) a surface feeder, *Labeo Rohita (L. rohita)* a column feeder and *Cirrhinus mrigala* (*C. mrigala)* bottom feeder, respectively, while, in group 2 only (*C. catla*) was replaced with (*Hypophthalmichthys molitrix*) *H. molitrix* as a surface feeder keeping other species the same as in group 1. At the end of experiment *H. molitrix* showed considerably high weight gain ($P < 0.05$) in group 2 as compare to column and bottom feeder fish species, conversely in group 1 higher weight gain was comparatively prominent in column and bottom while, *C. catla* showed low weight gain. Mean values of water quality parameters were conducive however temperature fluctuated between 26°C-29°C. Significantly higher values of ($P<0.05$) crude protein, fats, carbohydrates, Mg (%) and K (%) was recorded in the *H. molitrix* than *C. catla*. The results of the study showed that *H. molitrix* probably consumed all the phytoplankton density by filtering the water continuously resulting in the reduction of growth in other fish species in the polyculture system.

Article Information
Received 17 February 2018
Revised 12 May 2018
Accepted 18 January 2019
Available online 15 May 2019

Authors' Contribution
MA performed and designed the experiments. ZN analyzed the data. KGH, WY and AH wrote the manuscript.

Key words
L. rohita, Crude proteins, Fats, Filter feeding, Weight gain.

INTRODUCTION

Semi-intensive culture condition utilized moderate inputs, with least production cost to achieve a productive output. It is the primary method for culturing fish, as the system provides majority of the fish production for commercial and domestic consumption (FAO, 1996). Amalgamation of semi-intensive with polyculture system increases production manifolds as fish in this system utilized food from three different strata. Thus multi -species utilizes tropic layers according to the feeding behavior (de Silva *et al*., 2006).

Fish production is linked with the aquatic environment and their biotic factors, biological land physical characteristics of water. Water quality can be assessed with various parameters like hardness, pH, nitrite, dissolved oxygen, carbon dioxide concentration, plankton density *etc*. (Gatlin *et al*., 2007). By providing a conducive environment and managing essential parameters in the water can increase the production rate and decrease the production cost. Additionally by adding fertilizers primary production in the ponds can be increased resulting in maximum utilization by fish species. Supplementary feed with all essential micronutrients can also increase fish production (Diana *et al*., 1994).

The carp's production reaches 80% approximately followed by Tilapia in the semi intensive culture system (Naylor *et al*., 2000). This study was conducted in two different ponds with dominant aquaculture species, *L. rohita*, *C. mrigala*, *C. catla* and *H. molitrix* as these species are widely consumed and economically preferable among South Asian countries (Kanak *et al*., 1999).

Feed cost increases the total production cost, more over the species compatibility is also of prime importance in the polyculture practices, in order to evaluate the effect of fertilized ponds on the polyculture of major carps and replacement of top feeder species the present study was designed.

MATERIALS AND METHODS

Experimental ponds

Experiment was conducted in the earthen ponds from June to August. Prior to experimental trial, all the ponds were drained, cleaned and dried, properly fertilized with animals manure (cow and buffalo dungs) 90 kg/ponds

* Corresponding author: zohaibnoor@bs.qau.edu.pk
0030-9923/2019/0004-1483 $ 9.00/0

(Jena and Das, 2006; Sahu *et al*., 2007) 45 kg of poultry litter 45 kg, single superphosphate (2.5 kg and urea was also added at the rate of 2.25 kg urea/pond, for the thriving of plankton density in the rearing ponds. The same dosage for fertilization was repeated fort night for maintaining fertility in the ponds. Average area of ponds was 0.04ha and they were supplied with freshly aerated tubewell water.

Experimental design and fish stocking

The experiment was conducted in the replicate of three, total six ponds were prepared. All the ponds were divided into two experimental groups denoted, by group 1 and group 2 and three species were stocked in each ponds with a replacement of one surface feeder species *i.e.* Rohu (*L. rohita*), Thaila (*C. catla*), Silver fish (*H. molitrix*) and Mori (*C. mrigala*). Fish were obtained from local fish hatchery, conditioned and maintained in the polyculture system. In the group 1 three different fish species total 320 fishes were stocked as polyculture at numbering *C. catla* at 110 (34.375%), *L. rohita* 130 (40.625%) and *C. mrigala* 80 (25%), respectively. However in group 2 *C. catla* was replaced with the *H. molitrix* as a surface feeder for polyculture system while the number of each fish species were stocked same as group 1.

Proximate composition analysis

All the fish reared under polyculture system were analyzed for proximate composition by extracting their muscles. A total of 15 samples of each species were taken from both the groups for proximate analysis and followed standard techniques suggested by AOAC (2002). Ash content of each species was determined by heating 2 g to 4 g of the sample in the muffle furnace, then heated at 600°C for 24 h, Kjeldahl's method was used after digesting samples in the acid for crude protein analysis, fats were analyzed without hydrolysis with acid, soxhlet apparatus was used using hexane. Carbohydrate content was analyzed by the digestion of samples properly dried in 1.25% H_2SO_4, after that, by 1.25% NaOH solutions in ankom fiber analyzer (Model: A200, USA).

Minerals analysis

Calcium, potassium, and magnesium were analyzed by using atomic absorptions spectrometer (Model: Z-8100) (AOAC, 2002), while phosphorus was determined by colorimetric spectrophotometer at 400 nm wave length (Perkin Elmer Pin AAcle 900H Atomic absorption spectrophotometer).

Growth performance

Growth parameters were calculated by taking the weight and length of the fish, length was measured with a standard scale expressed in centimeters and weight was calculated with a standard weight balance expressed in grams.

Gain in biomass = Final weight gain – Initial weight

Measuring water quality

Temperature and dissolved oxygen values were measured daily while other parameters were noted on weekly basis with multiparameter (Thermo Scientific™ Orion™ StarA329). All the parameters were within the tolerable range suitable for the growth of Carp fish. The obtained data were analyzed statistically by using statistical software SPPS Version 20.

Table I.- Weight gain, length, average weight gain and gain in biomass of the fish reared under polyculture.

Growth parameters	Group 1			Group 2		
	C. catla	*L. rohita*	*C. mrigala*	*H. molitrix*	*L. rohita*	*C. mrigala*
Weight gain(g)	92.44±66.07[a]	98.17±83.40[b]	102.04±67.84[a]	151.20±4.3	54.84±2.3	84.19±3.1
Length (cm)	17.81±4.31[c]	18.48±7.70[b]	19.74±4.61[a]	23.45±8.35	15.70±3.17	18.53±3.32
Average weight gain	208.2±13.2[a]	234.3±11.3[b]	224.1±14.2[a]	324.8±11.00	134.3±12.3	112.6±11.2
Gain in biomass	19.60±0.06[c]	21.3±0.01[b]	25.79±0.09[a]	35.72±0.07	10.74±0.04	14.63±0.05

[a, b, c, d], significant difference. All the data are presented as Mean±SE.

Table II.- Proximate composition of the two polyculture ponds fish.

Proximate composition	Group 1			Group 2		
	C. catla	*L. rohita*	*C. mrigala*	*H. molitrix*	*L. rohita*	*C. mrigala*
Crude protein (%)	15.11±1.4[a]	13.3±1.3[c]	14.1±1.4[b]	16.17±1.1[a]	13.1±1.5[c]	13.1±1.7[b]
Crude lipid (%)	5.2±1.3[c]	6.2±1.2[b]	8.8±1.4[a]	6.9±1.2[b]	5.1±1.2[c]	8.1±1.2[a]
Ash (%)	3.1±1.1[b]	3.1±1.3[a]	3.3±1.2[a]	3.5±1.3[a]	3.2±1.4[a]	3.3±1.2[a]
Carbohydrates	4.1±1.3[a]	4.3±1.3[a]	3.1±1.4[b]	4.4±1.1[b]	5.4±1.3[a]	3.7±1.2[c]

[a, b, c], significant difference. All the data are presented as Mean±SE.

Table III.- Mineral analysis of the two polyculture ponds fish.

Minerals composition	Group 1			Group 2		
	C. catla	*L. rohita*	*C. mrigala*	*H. molitrix*	*L. rohita*	*C. mrigala*
Mg (%)	0.04±0.01[a]	0.04±0.01[a]	0.03±0.01[a]	0.05±0.01[a]	0.03±0.02[b]	0.01±0.01[b]
K (%)	0.1±0.03[b]	0.4±0.03[a]	0.2±0.01[a]	0.3±0.02[a]	0.4±0.02[a]	0.3±0.01[a]
P (%)	0.9±0.04[a]	0.5±0.03[a]	0.6±0.04[a]	0.7±0.03[a]	0.5±0.04[b]	0.5±0.01[b]
Ca (%)	1.3±0.07[a]	1.3±0.04[a]	1.5±0.03[a]	1.1±0.09[b]	1.4±0.06[a]	1.3±0.06[b]

[a, b], significant difference. All the data are presented as Mean±SE.

Table IV.- Water quality variables are presented in the table.

Variable	Treatment	
	Group 1	Group 2
Temperature (°C)	29.49±0.51[a] to 26.11±0.04	29.40±1.56[a] to 26±0.05
pH	8.99±0.13[a]	8.11±0.09[a]
DO (mgL^{-1})	6.02±0.07[a]	6.09±0.12[a]
Salinity (mgL^{-1})	0.86±0.02[a]	0.87±0.03[a]
EC (μScm^{-1})	1.91±0.07[a]	2.32±0.04[a]
TDS (mgL^{-1})	1108.90±204.67[a]	1213.36±232.72[a]
Light penetration (cm)	25.46±3.23[a]	18.57±2.37[b]
Phosphate (mgL^{-1})	3.50±1.30[a]	2.75±1.50[ab]
Nitrate (mgL^{-1})	20.00±2.165[b]	27.50± 9.57[a]

All the data are presented as Mean±SE. Similar letters in a row are statistically non-significant.

RESULTS

The results of this study showed that replacing surface feeder species in the polyculture system it is inter related with the weight gain and length of the column and bottom feeder fish species.

Weight gain of the *H. molitrix* was considerably high ($P<0.05$) in group 2 while column (*L. rohita*) and bottom (*C. mrigala*) feeder have low weigh gain, conversely group 1 fish have, high weight gain in the column and bottom while *C. catla* stocked as a surface feeder have low weight (Table I). After proximate analysis and minerals crude proteins, fats carbohydrates, Mg (%) and K (%) were significantly high ($P<0.05$) in the surface feeder *H. molitrix,* in the group 2, while low Ash content compared to *C. catla* in group 1. *L. rohita* in group 1 ponds have considerably high ($P<0.05$) crude proteins, lipid and carbohydrates, while low ash content (Table II). While non-significant difference ($P>0.05$) in the minerals contents. *C. mrigala* have high crude proteins and Ash contents in group 1 compared to group 2, while considerably high ($P<0.05$) minerals contents (Table III). Mean values of all the water quality variables were within suitable range required for carps culture, except the temperature which fluctuated month wise, salinity 0.76 to 0.77 (mgL^{-1}), DO 6.03 to 6.07 (mgL^{-1}), electrical conductivity (μScm^{-1}) varies from 1.91 to 2.32 and pH 8.11 to 8.99. The non-significant difference was observed in the nitrate (mgL^{-1}) value of all the ponds. While, phosphates (mgL^{-1}) values have a considerable difference in both the treatments, light penetration (cm) was high in group 1 ($P< 0.05$) (Table IV).

DISCUSSION

The significant increase and decrease in the weight gain of fish in the polyculture system by replacing the surface species might be incompatibility of species feeding behavior, *i.e. H. molitrix* voracious eater of plankton capable of filtering plenty of water, resulting in the depletion of phytoplankton which directly affect the zooplankton population, that ultimately effect the growth rate of other species.

Natural feed greatly influences growth rate in the aquaculture also in the ponds Supplemented with the prepared feed (Sohail, 2010). Fish species reared in the polyculture having different ecological niches, stocking density greatly influence natural feed in the water (Milstein and Svirsky, 1996). The weight gain in the present findings are supporting the above statement *i.e. H. molitrix* have gained more weight in group 2 compared to *C. catla* in group 1 ponds. While in the other Niches fish gain, different weight in both the treatments. The association between fish and food organism is acknowledgeable (Milstein *et al*., 1988). The evidence is scarce that *H. molitrix* exercise same pressure on zooplankton density in the polyculture condition previously described (Opuszynski, 1981). A possible cause for the low fish growth might be low appetite and low feed consumption (Islam, 2002).

Fish are cold blooded vertebrate external temperature, have a considerable role in regulating most features of body metabolism, feed consumption and growth (de Silva and Anderson, 1995). The temperature was within optimal range. There were slight fluctuations month wise from (June to August) in the temperature of the water while all other parameters were within normal range (Table IV). A study conducted by Khan and Abidi (2010) has also the same fluctuations in the temperature as recorded during the present study. The significance of fertilizers and supplementary feed in aquaculture sector has well studied by Garg and Bhatnagar (1996), in the carp polyculture system. During the present study both the fertilized ponds have high production while *H. molitrix* has high weight gain compared to rest of species in both the groups. Similar results were also documented by Mahboob *et al*. (1995), recorded an increase in the production of carps upon fertilizing ponds with both organic and inorganic fertilizers.

These differences in the Chinese carps and Indian major carps might be due to the differences in voluntary feed intake, composition, weight gain transport and metabolism, digestion, absorption (Mahboob *et al*., 1995). Finding of the Naeem and Salam (2010) of *Aristichthys nobilis* and Naeem and Ishtiaq (2011) of *Mystus bleekeri* shows that body muscles composition vary with body size, condition factor and species. The study conducted by Zeitler *et al*. (1984) reveled a negative relation between dietary supplemented protein with energy contents and, body fats while a positive relationship with water contents and body protein in *Cyprinus carpio* (Satpathy *et al*., 2003).

Increasing dietary protein supplementation, increase muscles proteins and fats contents. During the present findings *H. molitrix* have a high proximate composition in term of crude proteins, fats and carbohydrates in the group 2 compared to group 1, which might be filtering of more water for feed, while column feeder *L. rohita* and *C. mirgila* in group 1 have high proximate composition compared to group 2. Khan and Abidi (2010) stated that increase of protein (40%) diet produces fish with high fats in the muscle proximate composition (Table II).

Minerals analysis show high concentration in the *H. molitrix* group 2 polyculture pond compared to *C. catla in* the group 1 pond. While overall non-significant difference was observed in all the minerals contents (*i.e.,* magnesium, potassium, calcium and phosphorus). Similarly non-Significant difference was observed in the minerals content of *C. catla*, *C. mrigala and C. mrigala* (Khan *et al*., 2012) (Table III). Thus from the presented study it is concluded that in polyculture practice of carps surface feeder *H. molitrix* gain high weight while bottom *C. mirgila* and column results *L. rohita* results in low weight gain, replacing *H. molitrix* with *C.catla* surface feed results in the high weight gain of both the column and bottom feeder, thus *C. catla* is recommended as a top feeder for the polyculture of carps.

ACKNOWLEDGMENT

We all are thanks full to the finance department of university for providing funds for conducting research.

Statement of conflict of interest

The authors declare no conflict of interest.

REFERENCES

AOAC, 2002. *Official methods of analysis,* 17th edition. Association of Official Analytical Chemists, Washington, D.C., USA.

Ayyappan, S., Jena, J.K., Gopalakrishnan, A. and Pandey, A.K., 2006. *Handbook of fisheries and aquaculture*. Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, New Delhi, India.

da Silva, L.B., Barcellos, L.J.G., Quevedo, R.M., de Souza, S.M.G., Kreutz, L.C., Ritter, F. and Bedin, A.C., 2006. Alternative species for traditional carp polyculture in southern South America: Initial growing period. *Aquaculture*, **255**: 417-428. https://doi.org/10.1016/j.aquaculture.2005.12.024

de Silva, S.S. and Anderson, T.A., 1995. *Fish nutrition in aquaculture*. Chapman & Hall, London, pp. 319.

Diana, J.S., Lin, C.K. and Jaiyen, K., 1994. Supplemental feeding of tilapia in fertilized ponds. *J. World. Aquacult. Soc*., **25**: 497-506. https://doi.org/10.1111/j.1749-7345.1994.tb00818.x

FAO, 1996. *State of the world agriculture*. FAO, Rome.

Garg, S.K. and Bhatnagar, A., 1996. Effect of varying closes of organic and inorganic fertilizers on plankton production and fish biomass in brackish water fish ponds. *Aquacul. Res*., **27**: 157-166. https://doi.org/10.1111/j.1365-2109.1996.tb00980.x

Gatlin, D.M., Barrows, F.T., Brown, P., Dabrowski, K., Gaylord, T.G., Hardy, R.W. and Overturf, K., 2007. Expanding the utilization of sustainable plant products in aquafeeds: A review. *Aquacul. Res*., **38**: 551-579. https://doi.org/10.1111/j.1365-2109.2007.01704.x

Islam, M.S., 2002. Evaluation of supplementary feeds for semi-intensive pond culture of Mahseer, *Tor putitora* (Hamilton). *Aquaculture*, **212**: 263-276. https://doi.org/10.1016/S0044-8486(02)00194-1

Jena, J.K. and Das, P.C., 2006. *Carp culture: Handbook of fisheries and aquaculture*. Indian Council of Agricultural Research: New Delhi, India. pp. 265-

282.

Kanak, M.K., Dewan, S. and Salimullah, M., 1999. Performance of exotic fishes with Indian major carps in polyculture under three different species combinations. *Bangladesh. J. Fish*., **22**: 1-6.

Khan, M.A. and Abidi, S.F., 2010. Optimum ration level for better growth, conversion Efficiencies and body composition of fingerling *Heteropneustes fossilis* (Bloch). *Aquacul. Int*., **18**: 175-188. https://doi.org/10.1007/s10499-008-9234-2

Khan, N., Ashraf, M., Qureshi, N.A., Sarker, P.K., Vandenberg, G.W. and Rasool, F., 2012. Effect of similar feeding regime on growth and body composition of Indian major carps (*Catla catla, Cirrhinus mrigala* and *Labeo rohita*) under mono and polyculture. *Afr. J. Biotechnol*., **11**: 10280-10290.

Mahboob, S., Sheri, A.N. and Javed, M., 1995. Influence of fertilizers and artificial feed on the nitrogen incorporation efficiency of fish. *Pakistan* J. Zool., **27**: 349-352.

Milstein, A. and Svirsky, F., 1996. Effect of fish species combinations on water chemistry and plankton composition in earthen fish ponds. *Aquacul. Res*., **27**: 79-90. https://doi.org/10.1111/j.1365-2109.1996.tb00970.x

Milstein, A., Hepher, B. and Teltch, B., 1988. The effect of fish species combination in fish ponds on plankton composition. *Aquacul. Res*., **19**: 127-137. https://doi.org/10.1111/j.1365-2109.1988.tb00415.x

Naeem, M. and Ishtiaq, A., 2011. Proximate composition of *Mystus bleekeri* in relation to body size and condition factor from Nala Daik, Sialkot, Pakistan. *Afr. J. Biotechnol*., **10**: 10765-10773. https://doi.org/10.5897/AJB10.2339

Naeem, M., and Salam, A., 2010. Proximate composition of fresh water bighead carp, *Aristichthys nobilis*, in relation to body size and condition factor from Islamabad, Pakistan. *Afr. J. Biotechnol*., **9**: 8687-8692.

Naylor, R.L., Goldburg, R.J., Primavera, J.H., Kautsky, N., Beveridge, M.C., Clay, J. and Troell, M., 2000. Effect of aquaculture on world fish supplies. *Nature*, **405**: 1017-1024. https://doi.org/10.1038/35016500

Opuszyński, K., 1981. Comparison of the usefulness of the silver carp and the bighead carp as additional fish in carp ponds. *Aquaculture*, **25**: 223-233. https://doi.org/10.1016/0044-8486(81)90184-8

Sahu, P.K., Jena, J.K., Das, P.C., Mondal, S. and Das, R., 2007. Production performance of *Labeo calbasu* (Hamilton) in polyculture with three Indian major carps *Catla catla* (Hamilton), *Labeo rohita* (Hamilton) and *Cirrhinus mrigala* (Hamilton) with provision of fertilizers, feed and periphytic substrate as varied inputs. *Aquaculture*, **262**: 333-339. https://doi.org/10.1016/j.aquaculture.2006.11.016

Satpathy, B.B., Mukherjee, D. and Ray, A.K., 2003. Effects of dietary protein and lipid levels on growth, feed conversion and body composition in rohu, *Labeo rohita* (Hamilton), fingerlings. *Aquacul. Nutr*., **9**: 17-24. https://doi.org/10.1046/j.1365-2095.2003.00223.x

Sohail, M., 2010. *Variation of the primary and secondary productivity in monoculture and polyculture system of fish pond.* Doctoral dissertation, M. Phil thesis, Department of Fisheries and Aquaculture, University of Veterinary and Animal Sciences, Lahore, Pakistan.

Zeitler, M.H., Kirchgassner, M. and Schwarz, F.J., 1983. Effect of different protein end energy supplied on carcass composition of carp (*Cyprinus carpio*). *Aquaculture*, **36**: 37-48. https://doi.org/10.1016/0044-8486(84)90052-8