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# Note

# Growth performance of Chinese carps on feeding varying levels of protein under coldwater farming system in Arunachal Pradesh, North-east India

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## ABSTRACT

Feeding trials were conducted to investigate the growth performance of three species of Chinese carps *viz*., silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio*) with two dietary protein levels (30 and 35%) under pond aquaculture system at 1500 m above mean sea level (msl) in mid Himalayan region of Arunachal Pradesh, in north-eastern India. The experiment was carried out for 8 months with triplicate for each treatment and the fish were fed at 3% of body weight, twice a day. The present study revealed superior mean weight gain, feed conversion ratio, protein efficiency ratio and survival rate of fish when fed with ration containing 35% dietary protein as compared to fish fed with ration containing 30% dietary protein. The fish production figures indicate that culture of Chinese carps in mid Himalayan region can be suitably adopted to contribute substantial protein supplement for the tribal population of the hilly region.

Keywords: Arunachal Pradesh, Chinese carps, Coldwater, Dietary protein level, Mid Himalayas

The state of Arunachal Pradesh in the north-eastern part of India is characterised by the hilly terrain criss-crossed by a number of rivers/streams along with a good number of wetlands/beels in the lower altitude and lakes in the middle as well as higher altitudes. The state has 7000 ha of lentic and 2000 km of lotic water resources, of which 30-40% falls in the cold water zone. The state harbours more than 150 fish species, out of which 20% represents cold water forms and the remaining 80% contributed by a mix of cold and warm water species. Although the state is blessed with large varieties of fish fauna, no traditional fish farming was in vogue (Sarma *et al*., 2010). The people of Arunachal Pradesh are predominantly non-vegetarian and almost the entire population of the state relish fish in their daily diet. However, the production of fish in Arunachal Pradesh is very poor and according to the report of the State Fisheries Department, the annual fish production stands at about 3000 t. The state depends on other states in the country to meet the growing demand.

The state has potential for both cold and warm water fisheries. Although freshwater fish farming has slowly gained momentum in the state, lack of adequate knowledge in scientific practices among the farming community is considered as one of the bottlenecks for enhancing the productivity (Baruah, 2010). Three species of Chinese carps *viz.,* silver carp (*Hypophthalmichthys molitrix*), grass carp *(Ctenopharyngodon idella)* and common carp (*Cyprinus carpio*) are presently advocated for aquaculture in the state because of their high tolerance to adverse environmental conditions, their relative fast growth in low temperature regime and higher market value. Other carp species and catfishes demonstrate poor growth and low survival rates due to low temperature prevailing throughout the year (Tyagi *et al*., 2005).

Dietary protein is the most important nutrient for growth of fish (Lovell, 1989). Optimisation of fish production requires research into feeding techniques, which promotes growth and at the same time reduces the quantity of waste products released in the water (Singh *et al*., 2005). According to Sheunn *et al*. (2003) and Erondu *et al*. (2006), fish feed forms 60% of the production cost and the protein component is the most expensive in terms of overall feed cost. Though increasing protein levels in feeds can lead to improved fish production, excessive dietary protein is not economical for fish culture. Kalla and Garg (2004) concluded that dietary protein level is one of the major factors influencing growth of fish, feed efficiency and water quality. The protein requirement of fish is recognised as the protein content which gives maximum growth, economic profit and protein deposition. According to Ajiboye and Yakubu (2009), determination of protein requirement of fish is a very critical factor in aquaculture production.

Abidi and Mukhtar (2008) emphasised the need to minimise protein levels of fish, which reduces the proportion of dietary protein that is metabolised without reducing growth, minimising undesirable nitrogenous waste production. Nutrient requirements of each fish species differ and therefore it is necessary for selecting the right kind of ingredient and feedstuff during feed formulation. Determination of the required dietary protein levels is important to achieve good growth of fish and to reduce the water deterioration problems related with supplementary feeding (Engin and Carter, 2001; Jensen, 2003; Kalla *et al*., 2003). Studies have revealed that diets containing only rice bran and oil cake commonly used by farmers neither contain essential nutrients in sufficient quantity nor optimum protein levels (Singh *et al*., 2003). Protein being the most expensive macro nutrient when incorporated in excess in fish diets may be wasteful as it is excreted as ammonia and urea (Pillay, 1990). Ali *et al*. (2005) reported that feeding fish continuously with high protein diet is not economical.

For preparation of the experimental feed, the ingredients of the rations (Table 1) were homogenously mixed with sufficient water to make a dough. The feeds in the form of dough were placed in a bamboo tray that was suspended one foot below the water surface of the pond. Fishes were fed @ 3% of the total body weight of the stocked biomass at two equal meals between 07.00 – 08.00 hrs and 15.00 – 16.00 hrs on a daily basis. After one hour of feeding, the left over feed was collected manually to determine the weight of residues for calculating actual feed consumption on dry matter basis (100 ± $2^0$C for 12 h) (AOAC, 1995). Proximate analysis of feed (dry matter DM%; crude protein CP%; crude fibre CF%; ether extract EE%; total ash TA%; organic matter OM% and nitrogen free extract NFE%) was done as per AOAC (1995). Body weight of fish was recorded at fortnightly interval and feed rations were adjusted accordingly. Feed conversion ratio (FCR) and protein efficiency ratio (PER) were calculated following Castell and Tiews (1980). Grass carp were fed additionally on terrestrial vegetation, fodder grasses and vegetable wastes. The experimental trials were conducted in three replications.

The pond management practices adopted during the experiment on Chinese carp farming primarily involved the aspects of intermittent liming and fertilisation, supplementary feeding, water management and health care. The pond bottom was initially dried followed by ploughing for eradication of undesired animals and the removal of obnoxious gases from the bottom soil. Locally available organic manure (cow dung) was applied every fortnight. Inorganic fertilisers were not used.

Table 1. Ingredients and nutrient composition of experimental ration

| Ingredient composition | Quantity (kg per 100 kg) | |
|---|---|---|
| | Ration 1 | Ration 2 |
| Maize powder | 28 | 17 |
| Rice bran | 5 | - |
| Wheat flour | 2 | - |
| Vegetable oil | 1 | 1 |
| Soya bean meal | 10 | 10 |
| Mustard oil cake | 36 | 50 |
| Groundnut oil cake | 16 | 20 |
| DCP | 0.5 | 0.5 |
| Iodised salt | 1 | 1 |
| Trace mineral premix[a] | 0.025 | 0.025 |
| Vitamin premix[b] | 0.475 | 0.475 |
| Nutrient composition (%) | | |
| Moisture (% estimated) | 12.35 | 11.02 |
| Organic matter (% calculated) | 97.55 | 97.48 |
| Crude protein (% estimated) | 30.2 | 35.4 |
| Ether extract (% estimated) | 3.50 | 3.75 |
| Crude fibre (% estimated) | 5.26 | 5.32 |
| Nitrogen free extract (% estimated) | 58.90 | 53.01 |
| Total ash | 2.45 | 2.52 |
| ME (kcal per kg calculated) | 2652 | 2624 |

[a]Trace mineral premix supplied the following per kg of ration: Cu ($Cuso_4$.5 $H_2O$, 25% (Cu), 270 mg; Fe ($Feso_4$, 7 $H_2O$, 20.09% Fe 27.03 mg; Mn ($Mnso_4$ $H_2O$, 36.01% Mn), 11.71 mg; Zn (Zn $so_4$ 40.17 %Zn), 27.03 mg; 1 (KI, 76.01% I), 5 mg; Se ($Na_2Seo_3$ 53.02% Se), 0.27 mg.

[b]Vitamin premix supplied the following per kg of ration: Vitamin A, 20,000 IU, Vitamin $D_3$ 3,000 IU; Vitamin E, 16 mg; Vitamin K, 2 mg, Vitamin $B_1$, 16 mg; Vitamin $B_2$ 10 mg; Vitamin $B_6$, 3.2 mg; Vitamin $B_{12}$ 0.014 mg; Nicin, 24 mg, Ca Pantothenate, 16 mg, Folic acid 1.6 mg; Biotin, 1 mg; Ascorbic acid, 100 mg; Cholin, 1,560 mg.

Fish seeds (60 mm in length) were stocked @ 3 nos. $m^{-2}$, in the proportion 30% silver carp (*Hypophthalmichthys molitrix*), 35% grass carp (*Ctenopharyngodon idella*) and 35% common carp (*Cyprinus carpio*). During the post-stocking management, liming was done once in a month, 1-2 days after the application of organic manure for correction of soil and water pH as well as for pond disinfection. The work calendar for each activity for the three-pronged Chinese carp farming technology during the period was prepared before starting the program (Table 2). The level of management practice for adopting the farming technology suitable under the climatic conditions of the study area was also formulated (Table 3).

The growth response (in terms of weight gain and production) of the Chinese carps fed on two different dietary levels during the culture period is highlighted in Table 4. Regular feeding on low protein diet (30% CP) resulted in slower growth in grass carp and common carp, while feeding on high protein diet (35%) resulted in better growth performance. Similarly, feed conversion

Table 2. Work calendar for composite carp farming system

| Period | Work done |
|---|---|
| March - April 2010 | Drying of pond bottom till soil cracks.<br>Removal of unwanted materials from the pond.<br>Removal of marginal weeds. |
| May 2010 | Ploughing of pond bottom soil.<br>Manuring of pond bottom with raw cow dung.<br>Liming of pond bottom.<br>Filling of pond with fresh streamwater. |
| June 2010 | Stocking of pond with Chinese carps. |
| June 2010 - Jan 2011 | Culture period and post-stocking management. |
| 5 February 2011 | Harvesting of stocked fish. |

A production level of 0.63 kg fish $m^{-2}$ 8 $months^{-1}$ and 0.80 kg of fish $m^{-2}$ 8 $months^{-1}$ was achieved in this experiment with dietary protein levels of 30 and 35% respectively. It was observed that feed comprising 30% and 35% protein gave an average production of 95.25 kg 150 $m^{-2}$ 8 $months^{-1}$ and 121.25 kg 150 $m^{-2}$ 8 $months^{-1}$ respectively. In a span of 8 months, silver carp (30%), grass carp (35%) and common carp (35%) attained maximum individual weights of 235 g, 300 g and 500 g respectively.

The results substantiate the findings of Rajbanshi *et al*. (1989), who reported that 45 days old rohu (*Labeo rohita*) fingerlings gave the highest growth rate on diets containing 39.18% protein than diets containing 25.4% protein. Similarly Salim and Sheri (1999) observed significant effects of high protein diet (50%) on the growth of mrigal (*Cirrhinus mrigala*) fingerlings, followed by medium (45%) and low protein diets (40%). In another experiment by Ghazala *et al*. (2011), maximum growth of grass carp juvenile was observed when fed a diet containing 40% protein level. The fish yield depends on growth rate and retrieval of the stocked fishes at harvest.

Table 3. Composite carp farming technology and its operational calendar

| Area of operation | : | NRC on Yak (ICAR), Dirang, A.P. (1500 m asl) |
|---|---|---|
| Operational period | : | June 2010 – January 2011 (8 months) |
| Nature of pond | : | Earthen |
| Pond size and shape | : | 150 $m^2$ for each replicate, Rectangular |
| Pond depth | : | 1.5 m |
| Source of water | : | Rain, stream |
| Fish species | : | Silver carp, grass carp and common carp |
| Stocking density | : | 3 nos./ $m^2$ |
| Stocking percentage | : | Silver carp (30%), Grass carp (35%) and common carp (35%) |
| Fish size during stocking | : | 60 mm |
| Feed | : | |
| (i) % of body weight | : | 3% |
| (ii) Frequency | : | Daily |
| (iii) Items | : | Diet (1) for 30% protein content: Mixture of maize crush, rice polish, wheat flour, vegetable oil, MOC, GNOC, Iodised salt, trace mineral mixture and vitamin mix. |
| | : | Diet (2) for 35% protein content: Mixture of maize crush, vegetable oil, MOC, GNOC, Iodised salt, trace mineral mixture and vitamin mix. |
| (iv) Feed for grass carp | : | Terrestrial grasses, vegetable wastes |
| (v) Protein content | : | 30% and 35% |
| Liming (in installments) | : | |
| (i) Dose | : | 250 kg $ha^{-1}$ $yr^{-1}$ |
| (ii) Frequency | : | Fortnightly |
| Manuring (in installments) | : | |
| (i) Dose | : | 10000 kg $ha^{-1}$ $yr^{-1}$ |
| (ii) Frequency | : | Weekly |
| Production (at 30% protein level ) | : | 95.25 kg 150 $m^{-2}$ 8 $months^{-1}$ |
| Production (per $m^2$) | : | 0.63 kg $m^{-2}$ 8 $months^{-1}$ |
| Production (per hectare) | : | 6350 kg $ha^{-1}$ 8 $months^{-1}$ |
| Production (at 35% protein level ) | : | 121.25 kg 150 $m^{-2}$ 8 $months^{-1}$ |
| Production (per $m^2$) | : | 0.80 kg $m^{-2}$ 8 $months^{-1}$ |
| Production (per hectare) | : | 8083 kg $ha^{-1}$ 8 $months^{-1}$ |

ratio (FCR) and protein efficiency ratio (PER) were found to be superior in high protein (35%) diet than the low protein (30%) diet in case of grass carp and common carp. However, in case of silver carp, low protein (30%) diet was found to be better in terms of growth performance, FCR and PER. Interestingly, survival rate of fish groups fed with two dietary protein levels was similar (90%).

Table 4. Performance of fish species under culture conditions with 30% and 35% dietary protein level

| Performance indicators | Performance of carps at varying dietary protein levels | | | | | |
|---|---|---|---|---|---|---|
| | Silver carp | | Grass carp | | Common carp | |
| | 30% | 35% | 30% | 35% | 30% | 35% |
| Stocking density (nos.) considering 10% mortality | 122 | 122 | 142 | 142 | 142 | 142 |
| Average initial weight (g) | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 |
| Average final weight (g) | 170.66 | 134.92 | 208.10 | 348.94 | 315.63 | 388.87 |
| Mean weight gain (g) | 165.16± 0.14 | 129.42±0.10 | 202.60±0.12 | 343.44±0.15 | 310.13±0.08 | 383.37±0.10 |
| Growth (g month$^{-1}$) | 20.65± 1.51 | 16.18± 1.28 | 25.33± 1.34 | 42.93± 1.51 | 38.77± 1.12 | 47.92± 1.15 |
| Growth (g day$^{-1}$) | 0.69 | 0.54 | 0.84 | 1.43 | 1.29 | 1.60 |
| Production (kg 150 m$^{-2}$ 8 months$^{-1}$) | 20.82 | 16.46 | 29.55 | 49.55 | 44.82 | 55.22 |
| Production (kg m$^{-2}$ 8 months$^{-1}$) | 0.14 | 0.11 | 0.20 | 0.33 | 0.30 | 0.37 |
| Contributed production (%) | 21.87 | 13.58 | 31.04 | 40.87 | 47.08 | 45.55 |
| Dry matter (% body weight) | 3.05 | 2.95 | 3.29 | 3.52 | 3.89 | 3.92 |
| Feed conversion ratio | 3.11 | 3.25 | 3.49 | 3.21 | 4.05 | 3.42 |
| Protein efficiency ratio | 2.99 | 2.05 | 2.16 | 2.42 | 2.34 | 2.52 |
| Survival rate % | 90 | 90 | 90 | 90 | 90 | 90 |
| Rank | 3 | 3 | 2 | 2 | 1 | 1 |

The growth and survival of fishes were found to have direct correlation with water temperature, quality and quantity of supplementary feed, natural food availability in ponds and the methodology followed.

In the upland water of low thermal regime, the Chinese carps were found to have grown well as compared to the Indian major carps (Tyagi *et al.,* 2005; Mahanta *et al.,* 2009). The water temperature in the present study was lower (<20ºC) than the optimum temperature for carps and was perhaps the main reason for lower growth of carps in traditional fish farming practices where supplementary feeding is barely followed on scientific lines. The pH values ranged from 7.2 to 7.6. Total hardness ranged from 33-37 mg l$^{-1}$, 34-41 mg l$^{-1}$, 32-43 mg l$^{-1}$, and 39-47 mg l$^{-1}$ in pre-monsoon, monsoon, post-monsoon and winter seasons respectively. The low calcium and magnesium levels are responsible for soft nature of water. Total alkalinity of the pond water ranged from 26-57 mg l$^{-1}$. The nitrate and BOD levels ranged from 4.1-6.0 mg l$^{-1}$ and 1.2-2.1 mg l$^{-1}$ respectively throughout the year. Oxygen content in the pond water was recorded above the optimum requirement of the fishes at the rate of >8.0 mg l$^{-1}$ which can be attributed to breezy weather in the Dirang Valley. Thus, it can be concluded that water quality parameters in high altitude ponds was observed to be well within the optimum limit specified for fish culture.

The present study suggests that with higher levels of protein in diets, more biomass could be obtained by stocking fish seeds @ 3 nos. m$^{-2}$ in hilly areas as compared to generally recommended stocking density of 1 no. m$^{-2}$ in plain areas. The growth performance of grass carp was found to depend on the quality and quantity of the grass and vegetable wastes fed (Baruah, 2014). Common carp feeding on unutilised feed, faecal matter of grass carp and benthic organisms contributed the bulk of the catch. In a hilly district like West Kameng, the quantity and quality of supplementary feed play a very important role and the results of the present study may help in formulation of plans for expanding scientific aquaculture practices in order to enhance fish productivity.

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## References

Ajiboye, O. O. and Yakubu, A. F. 2010. Some aspects of biology and aquaculture potentials of *Tilapia guineensis (dumeril)* in Nigeria. Rev. *Fish Biol. Fish*., 20: 441- 455.

Ali, M. Z., Hossain, M. A. and Mazid, M. A. 2005. Effect of mixed feeding schedules with varying dietary protein levels on the growth of sutchi catfish, *Pangasius hypophthalmus* (Sauvage) with silver carp, *Hypophthalmichthys molitrix* (Valenciennes) in ponds. *Aquacult. Res.,* 36: 627-634.

Abidi, S. F. and Mukhtar, A. K. 2008. Dietary threonine requirement of fingerling Indian major carp, *Labeo rohita* (Hamilton). *Aquacult. Res.,* 39: 1498-1505.

AOAC 1995. *Official methods of analysis*. Association of Official Analytical Chemists,16th edn. Washington, D.C., USA.

Baruah, D. 2010. Impact of training on high altitude fishers of Arunachal Pradesh. *Aquaculture*, 11(2): 231-235.

Baruah, D. 2014. Aquaculture and fisheries in hilly regime of Arunachal Pradesh. In: Tamuli, K. K., Borthakur, S., Phukan, B. and Baishya, S. (Eds.), *Indigenous fin fish* *species for aquaculture diversification: Current status and prospects in North-eastern region*, College of Fisheries, Assam Agricultural University, Raha, Assam, p. 150-157.

Castell, J. D. and Tiews, K. 1980. *Report EIFAC, IUNS and ICES working group on standardisation of methodology in fish nutrition research.* EIFAC Technical Paper 36, Hamburg, Federal Republic of Germany, 24 pp.

Engin, K. and Carter, C. G. 2001. Ammonia and urea excretion rates of juvenile Australian short-finned eel (*Anguilla australis australis*) as influenced by dietary protein level. *Aquaculture*, 194: 123-136.

Erondu, E. S., Bekibela, D. and Gbulubo, A. T. 2006. Optimum crude protein requirement of cat fish, *Chrysichthys nigrodigitatus*. *J. Fish. Int.*, 1(1-2): 40-43.

Ghazala, R., Tabinda, A. B. and Yasar, A. 2011. Growth response of juvenile grass carp (*Ctenopharyngodon idella*) fed isocaloric diets with variable protein levels. *J. Anim. Plant Sci.,* 21(4): 850-856.

Jensen, F. B. 2003. Nitrite disrupts multiple physiological functions in aquatic animals. *Comp. Biochem. Physiol*., 135: 9-24.

Kalla, A. and Garg, S. K. 2004. Use of plant proteins in supplementary diets for sustainable aquaculture. In: Garg, S. K. and Jain, K. L. (Eds.), *Proceedings of the National Workshop on Rational use of water resources for aquaculture*, CCS, HAU, Hisar, India, p. 31-47.

Kalla, A., Garg, S. K. and Kaushik, C. P. 2003. Effect of dietary protein source on growth, digestibility, body composition, total ammonia and reactive phosphate excretion in the fingerlings of *Cirrhinus mrigala* (Ham.). In: Garg, S. K. and Arasu, A. R. T. (Eds.), *Proceedings of the 3rd International Workshop (NATP)on Fish production using brackishwater in arid-ecosystem*. CCS, HAU, Hisar, India, p. 139-145.

Lovell, R. T. 1989. *Nutrition and feeding of fish*. Van Nostrand-Reinhold, New York, 260 pp.

Mahanta, P. C., Tyagi, B. C. and Sarma, D. 2009. *Culture of carps in high altitude - some ideas on its successful management*. In: Goswami, U. C. and Kumar, D. (Eds.), *Aquaculture management*, Narendra Publishing House, New Delhi.

Pillay, T. V. R. 1990. *Aquaculture: Principles and practices*. Fishing News Book. Blackwell Scientific Publications, Ltd., Oxford, U.K, 575 pp.

Rajbanshi, V. K., Mumtazuddin, M. and Shim, K. F. 1989. Reciprocation of dietary protein with growth and its utilization in rohu *Labeo rohita* (Ham.) fingerlings. *Singapore J. Indus.*, 17: 128-131.

Salim, M. and Sheri, A. N. 1999. Influence of protein sources, levels of protein and levels of feeding on growth of rohu (*Labeo rohita*) fingerlings under intensive system. *Pakistan J. Sci. Res.,* 51: 85-88.

Sarma, D., Baruah, D. and Mahanta, P. C. 2010. Performance of three pronged Chinese carp farming in mid Himalayas of West Kameng District, Arunachal Pradesh. *J. Inland Fish. Soc. India*, 42 (2): 48-51.

Sheunn, D. Y., Tain, S. L., Chyng, H. L. and Hung, K. P. 2003. Influence of dietary protein levels on growth performance, carcass composition and liver lipid classes of juvenile *Spinibarbus hollandi* (Oshima). *Aquacult. Res*., 34: 661-666.

Singh, K., Garg, S. K., Kalla, A. and Bhatnagar, A. 2003. Oilcakes as protein sources in supplementary diets for the growth of *Cirrhinus mrigala* (Ham.) fingerlings : laboratory and field studies. *Biores.Technol.,* 86: 283-291.

Singh, P. K., Gaur, S. R., Barik, P., Sulochana, Shukla, S. and Singh, S. 2005. Effect of protein levels on growth and digestibility in the Indian Major Carp*, Labeo rohita* (Hamilton) using slaughter house waste as the protein source*. Int. J. Agri. Biol*., 7(6): 939-941.

Tyagi, B. C., Sunder, S. and Mohan, M. 2005. *Coldwater fisheries research and development in North-east region of India*, NRCCWF (ICAR), Bhimtal.

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