Nutrition and Feeding of Indian Major Carp
- A Bibliography

CIFRI

Nutrition and Feeding of Indian Major Carp - A Bibliography

M. A. Hassan
Md. Aftabuddin
A. P. Sharma

Bulletin No. 188 February - 2014

Central Inland Fisheries Research Institute
(Indian Council of Agricultural Research)
Barrackpore, Kolkata-700 120, West Bengal

Nutrition and Feeding of Indian Major Carp - A Bibliography

A contribution from ICAR Outreach Activity-1: Fish Feeds

Editors:

M. A. Hassan
Md. Aftabuddin
A. P. Sharma

ISSN: 0970-616X

Assistance:

Pankaj Patial, Ananya Kumari, Debi Prasad Ganguly
Subhadeep Das Gupta, Sayanti Saha

Cover design:

Pankaj Patial

Published by:

The Director, CIFRI, Barrackpore

Printed by:

Eastern Printing Processor
93, Dakshindari Road
Kolkata – 700 048

Foreword

Optimization of fish productivity potential of open water fishery resources is the need of the hour to meet the growing demand of fish which could be achieved by enhancement of fish stocks in these resources. In this direction enclosure culture technology like pen and cage culture proved to be suitable package of practices to sustain productivity of ecosystem and livelihood of end users. As the demand for feed based cage culture for both seed raising and table fish production is growing at a fast space, whole gamut of knowledge available on nutrition and feeding for aquaculture species need to be documented and popularized. These knowledge and information could be adapted for the species to be cultured in cages and shared by various stakeholders (researchers, feed manufacturers and farmers).

In aqua farming, feed is the dominant and important input where feed components constitute more than 50% of the operational cost. To optimize the operational cost, formulation of cost effective feed with better conversion ratio is of utmost importance. In the formulated feed, among nutrients, protein is the costliest component. Optimization of protein level in the formulated feed is, therefore, a foremost task. Further knowledge on amino acid requirement and their optimum inclusion in the feed formulation will help fish in efficient protein utilization for growth.

Scientific culture of Indian major carp both in land based aqua-farm and open water enclosure farming in the sub-continent is of recent origin, compared to salmon, American catfish, eel, perch and yellow tail in other parts of the world. Research support for development of carp feed intensified concomitantly pertaining to nutrient requirement and information on feed stuff. The information on nutritional requirement and feed stuff thus generated are extremely useful for scientific fish farming for better economic return and environment sustainability. The knowledge base on the subject is rendering support to the feed industry in one hand and farmers and enterpreneurs on the other hand in manufacturing and formulating fish feed. In order to make the knowledge and information on Indian major carp more useful and easily accessible, the present effort was therefore directed towards gathering the information available in the public domain and compiled them in the form of a bibliography. This would help in efficient use of data, knowledge and information by the user groups and furthering the cause of nutritional research in the country.

M. A. Hassan
Md. Aftabuddin
A. P. Sharma

Acknowledgements

The editors are grateful to Dr. S. Ayyappan, Secretary, DARE and DG, ICAR for his keen interest in the Outreach Activity Consortium (# I) on 'Fish Feed' involving six research institutes under the Fisheries Division of Indian Council of Agricultural Research, viz. CIFRI, Barrackpore; CIFA, Bhubaneswar (Lead Institute); CIBA, Chennai; CIFE, Mumbai; CMFRI, Cochin, DCFR, Bhimtal.

We are thankful to former ADG (Inland Fishery), Dr. V. V. Sugunan and present ADG (Inland Fisheries), Dr. S. D. Singh, who have played an important role in formulation, planning and implementation of this project.

We acknowledge the support of Coordinator, Dr. S. S. Giri and Co-coordinator, Dr. K. A. Ambashankar for their valuable input and enthusiasm in preparation of the document. We also place on record the suggestion and guidance of former coordinators, Dr. S. A. Ali, Dr. P. K. Mukhopadhyay and Co-coordinator, Dr. S. N. Mohanty.

We also express our heartfelt thanks to Dr. S. K. Manna, In-Charge, Prioritization, Monitoring and Evaluation Cell, CIFRI for facilitating the publication. The support rendered by staff of CIFRI Library is highly appreciated.

We express our indebtedness to the project staff, Debi Prasad Ganguly, Pankaj Patial, Sayanti Saha, Subhadeep Das Gupta, Ananya Kumari and A. H. Laskar for their hard work in collection and organization of the document.

Last but not the least the team is highly thankful to ICAR for financial assistance.

M. A. Hassan
Md. Aftabuddin
A. P. Sharma

Contents

CHAPTER -1

Protein Requirement

Ahmed, I. 2007. Effect of ration size on growth, body composition, energy and protein maintenance requirement of fingerling Indian major carp, *Labeo rohita* (Hamilton). *Fish Physiology and Biochemistry*, 33(3): 203-212.

Akand, A. M., Soeb, M., Hasan, M. R. and Kibria, M. G. 1991. Nutritional requirements of Indian major carp, *Labeo rohita* (Hamilton) - 1. Effect of dietary protein on growth, food conversion and body composition. *Agriculture International*, 1: 35-43.

Anwar, M. F. and Jafri, A. K. 1995. Protein digestibility of some low-cost feed stuffs in fingerling Indian major carp. *Asian Fisheries Science,* 8: 47-53.

Chakrabarti, R. and Kumar, S. 2001. Effect of feed protein manipulation on the survival, growth and enzyme activities of *Cirrhinus mrigala* larvae. In: C.I. Hendry, G. V. Stappen, M. Wille M. and P. Sorgeloos (eds.), *larvi 2001, Fish and Shellfish Symposium*, European Aquaculture Society, Special Publication No. 30, Belgium, pp. 129 -132.

Chakraborty, S. C., Chowdhury, S. A. and Chakraborty, S. 1999. Energy budgets of Indian major Carp *L. rohita* fingerlings fed on diets with different protein level. *Asian Fisheries Science*, 12(3): 297-308.

Dalal, S., Bhattacharya, S. and Ray, A. K. 2001. Effects of dietary protein and carbohydrate levels on growth performance, feed utilization efficiency and nitrogen metabolism in rohu, *Labeo rohita* (Hamilton), fingerlings. *Acta Ichthyologica Et Piscatoria*, 31(2): 3-17.

Das, I. and Ray, A. K. 1991. Growth response and feed conversation efficiency in mrigal fingerlings at varying dietary protein level. *Journal of Aquaculture in the Tropics*, 6(2): 179-185.

Das, K. M., Mohanty, S. N. and Sarkar, S. 1991. Optimum dietary protein to energy ratio for *Labeo rohita* fingerlings. In: S. S. de Silva, (ed.), *Fish Nutrition Research in Asia, Proceedings of Fourth Asian Fish Nutrition Workshop,* Asian Fisheries Society, Special Publication, 5: 69-73.

De Silva, S. S. and Gunasekera, R. M. 1991. An evaluation of the growth of Indian and Chinese major carps in relation to the dietary protein content. *Aquaculture*, 92: 237–241.

Debnath, D., Pal, A. K., Sahu, N. P., Yengkokpam, S. and Baruah, K. 2012. Protein requirement of *Labeo rohita* fingerlings based on growth and ammonia excretion. *Journal of the Inland Fisheries Society of India*, 44(2):12-20.

Debnath, D., Pal, A. K., Sahu, N. P., Yengkokpam, S., Baruah, K., Choudhury, D. and Venkateshwarlu, G. 2007. Digestive enzymes and metabolic profile of *Labeo rohita* fingerlings fed diets with different crude protein levels. *Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology*, 146: 107-114.

Gangadhara, B., Nandeesha, M. C., Varghese, T. J. and Keshavanath, P. 1997. Effect of varying protein and lipid levels on the growth of Rohu, *Labeo rohita. Asian Fisheries Science*, 10(2): 139-147.

Hassan, M. A., Jafri, A. K., Alvi, A. S., Samad, R. and Usmani, N. 1995. Dietary energy and protein interaction - an approach to optimizing energy: protein ratio in Indian major carp, *Cirrhinus mrigala* (Hamilton) fingerling. *Journal of Aquaculture in the Tropics*, 10(3): 183-191.

Hassan, M. A., Jafri, A. K., Khan, M. A., Anwar, M. F. and Erfanullah. 1991. Effect of varying dietary energy to protein ratio on the growth, feed efficiency and carcass composition of *Labeo rohita* fingerlings: A preliminary study. In: *Proceedings of National Symposium on Freshwater Aquaculture,* Central Institute of Freshwater Aquaculture, Bhubaneshwar, India, 23-25 January, pp. 78-80.

Hossain, M. A. and Shikaa, F. H. 1996. Apparent protein digestibility co-efficient of some low protein ingredients for rohu. *Journal of Aquaculture in the Tropics*, 11(3): 161-166.

Hossain, M. A., Nahar, M. and Kamal, M. 1997. Nutrient digestibility coefficients of some plant and animal proteins for rohu (*Labeo rohita*). *Aquaculture*, 151: 37-45.

Jafri, A. K. and Anwar, M. F. 1995. Protein digestibility of some low-cost feedstuffs in fingerlings Indian major carps. *Asian Fisheries Science*, 8: 47-53.

Kalla, A., Bhatnagar, A. and Garg, S. K. 2004. Further studies on protein requirements of growing Indian major carps under field conditions. *Asian Fisheries Science*, 17: 191-200.

Khan, M. A. and Jafri, A. K. 1991. Dietary protein requirement of two size classes of the Indian major carp, *Catla catla* Hamilton. *Journal of Aquaculture in the Tropics*, 6: 79-88.

Khan, M. A. 1991. Protein and amino acid requirements and efficacy of dietary formulations in some cultivable fin fish species. PhD thesis, Department of Zoology, Aligarh Muslim University, Aligarh, India, pp.120.

Khan, M. A., Jafri A. K. and Chadha, N. 2005. Effects of varying dietary protein levels on growth, reproductive performance, body and egg composition of rohu, *Labeo rohita* (Hamilton). *Aquaculture Nutrition*, 11(1): 11-17.

Khan, M. A., Jafri, A. K., Hassan, M. A. and Erfanullah. 1993. Growth rate, protein acceration and variations in RNA-DNA ratio in fingerlings *Labeo rohita* (Hamilton) at variable dietary protein level. In: *The third Indian Fisheries Forum, Proceedings*, Pantnagar, 193 -195.

Kumar, P., Jain, K. K., Munilkumar, S., Sahu, N. P. and Pal, A. K. 2013. Effect of feeding normal and low protein diet alternately to *Labeo rohita* fingerlings on growth performance and biochemical composition. *International Journal of Science and Knowledge*, 2(1): 3-13.

Kumar, R. V., Ramesh, K. S., Patil, P., Kumar Naveen, B. T. and Manissery, J. K. 2011. Dietary protein requirement of stunted fingerlings of rohu, *Labeo rohita* (Hamilton) during grow out stage. *Indian Journal of Fisheries*, 58(4): 49-53.

Kumar, S., Garcia, C. F., Chakrabarti, R., Toro, M. and Cordova, M. J. 2007. Digestive proteases of three carps *Catla catla, Labeo rohita* and *Hypophthalmichthys molitrix:* partial characterization and protein hydrolysis efficiency. *Aquaculture Nutrition*, 13(5): 381–388.

Kumar, S., Sahu, N. P., Pal, A. K., Choudhury, D. and Mukherjee, S. C. 2006a. Non-gelatinized corn supplemented with a-amylase at sub-optimum protein level enhances the growth of *Labeo rohita* (Hamilton) fingerlings. *Aquaculture Research*, 37: 284-292.

Kumar, S., Sahu, N. P., Pal, A. K., Choudhury, D. and Mukherjee, S. C. 2006b. Studies on digestibility and digestive enzyme activities in *Labeo rohita* (Hamilton) juveniles: effect of microbial α-amylase supplementation in non-gelatinized or gelatinized corn-based diet at two protein levels. *Fish Physiology and Biochemistry*, 32(3): 209-220.

Kumar, V., Sahu, N. P., Pal, A. K., Kumar, S., Sinha, A. K., Ranjan, J. and Baruha, K. 2010. Modulation of Key enzymes of glycolysis, gluconeogenesis, amino acid catabolism and TCA cycle of the tropical freshwater fish *Labeo rohita* fed gelatinized and non-gelatinized starch diet. *Fish Physiology and Biochemistry,* 36(3): 491-499.

Manissery, J. K., Krishnamurthy, D., Gangadhar, B. and Nandeesha, M. C. 1999. Nursery rearing of catla under different dietary protein and fertilization levels. *Fishery Technology,* 36 (2): 120-124.

Manivannan, S. and Saravanan, T. S. 2012. Impact of formulated protein diets on growth of the Indian major carp, *Labeo rohita* (Hamilton). *Fisheries and Aquaculture Journal,* 57: 1-6.

Mohanty, S. N., Swamy, D. N. and Tripathi, S. D. 1990. Protein utilization in Indian major carp fry, *Catla catla* (Hamilton), *Labeo rohita* (Hamilton) and *Cirrhinus mrigala* (Hamilton) fed four protein diets. *Journal of Aquaculture in the Tropics*, 5: 173-179.

Mohanty, S. N., Swamy, D. N. and Tripathi, S. D. 1988. An attempt to formulate a protein budget for fry of three Indian major carps, *Cirrhinus mrigala* (Hamilton), *Labeo rohita* (Hamilton) and *Catla catla* (Hamilton). In: *Third Asian Finfish Nutrition Workshop,* Bangkok, 6-10 June, 1988.

Mohanty, S. N., Tripathi, S. D., Swamy, D. N. and Sarkar, S. 1992. Dietary performance of *Catla catla, Labeo rohita* and *Cirrhinus mrigala* fry in relation to casein and gelatin ratios. *Journal of Aquaculture*, 2: 63-69.

Murthy, H. S. and Naik, A. T. R. 2000. Effect of dietary protein and lipid levels on growth, survival and food conversion of Indian major carp (*Catla catla*). *The Israeli Journal of Aquaculture- Bamidgeh,* 52: 70–76.

Nandeesha, M. C., Devaraj, K. V. and Sudhakara, N. S. 1986. Growth response of four species of carps to different protein sources in pelleted feeds. In: J.L. Maclean, L.B. Dizon and L.V. Hosillos (eds.), *The First Asian Fisheries Forum, Asian Fisheries Society*, pp. 603-608.

Renukaradhya, K. M. and Varghese, T. J. 1986. Protein requirement of the carp, *Catla catla* (Hamilton) and *Labeo rohita* (Hamilton). *Proceedings of Indian National Academy of Sciences (Animal Science)*, 95: 103–107.

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. *Aquaculture Nutrition*, 9(1): 17–24.

Seenappa, D. and Devaraj, K. V. 1995. Effect of different levels of protein, fat and carbohydrate on growth, feed utilization and body carcass composition of fingerlings in *Catla catla* (Hamilton). *Aquaculture*, 129: 243-249.

Sen, P. R., Rao, N. G. S., Ghosh, S. R. and Rout, M. 1978. Observations on the protein and carbohydrate requirement of carps. *Aquaculture*, 13: 245-255.

Sethuramalingam, T. A., Haniffa, M. A. and Arockiasamy, S. 1999. Efficacy of plant protein diets on the growth performance of *Labeo rohita*. In: M. Mohan Joseph, N. R. Menon and N. Unnikrishnan Nair (eds.), *Proceedings of the fourth Indian Fisheries Forum*, 24-28 November, 1996 Kochi, pp. 319-321.

Singh, B. N. and Bhanot, K. K. 1988. Protein requirement of the fry of *Catla catla* (Ham). In: M. Mohan Joseph (ed.), *Proceedings of the first Indian Fisheries Forum*, Asian Fisheries Society, Indian Branch, Mangalore, pp. 77-78.

Singh, B. N., Sinha, V. R. P. and Kumar, K. 1987. Protein requirements of an Indian major carp, *Cirrhinus mrigala* (Ham.). *International Journal of Academy of Ichthyology*, 8(1): 71-75.

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. *Bioresources Technology*, 86: 283-291.

Singh, P. K. and Gaur, R. S. 2005. Effect of various dietary protein levels on growth, food utilization and carcass composition of rohu, *Labeo rohita* fingerlings. *Environment and Ecology*, 23 (spl-3): 492-496.

Singh, P. K., Gaur, S. R., Barik, P., 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. *International Journal of Agriculture and Biology*, 7(6): 939-941.

Singh, R. K., Balange, A. K. and Ghughuskar, M. M. 2006. Protein sparing effect of carbohydrates in the diet of *Cirrhinus mrigala* (Hamilton, 1822) fry. *Aquaculture*, 258(1-4): 680-684.

Sunitha Devi, G. 2010. A major effort to explore protein level in fish (*Labeo rohita*) by triiodothyronine. *Aquaculture*, 11(2): 175-180.

Swamy, D. N. and Mohanty, S. N. 1990. Response of rohu (*Labeo rohita* Ham.) fingerlings to diets of different protein contents. *Journal of Zoological Research*, 3(2): 121-125.

CHAPTER - 2

Amino Acid Requirement

Abidi, S. F., Ahmed, I. and Khan, M. A. 2002. Dietary phenylalanine requirement of Indian major carp, *Labeo rohita* fry (Hamilton). In: *Proceedings on 4th International Conference on Recirculating aquaculture,* Food Science and Technology Department, Virginia, U.S.A.

Abidi, S. F. and Khan, M. A. 2004a. Dietary histidine requirement of fingerling Indian major carp, *Labeo rohita* (Hamilton). *The Israeli Journal of Aquaculture,* 56: 200-208.

Abidi, S. F. and Khan, M. A. 2004b. Dietary valine requirement of Indian major carp, *Labeo rohita* (Hamilton) fry. *Journal of Applied Ichthyology,* 20(2): 118–122.

Abidi, S. F. and Khan, M. A. 2007. Dietary leucine requirement of fingerling Indian major carp, *Labeo rohita* (Hamilton). *Aquaculture Research*, 38: 478-486.

Abidi, S. F. and Khan, M. A. 2008. Dietary threonine requirement of fingerling Indian major carp, *Labeo rohita* (Hamilton). *Aquaculture Research*, 39(14): 1498–1505.

Abidi, S. F. and Khan, M. A. 2009. Dietary arginine requirement of fingerling Indian major carp, *Labeo rohita* (Hamilton) based on growth, nutrient retention, body composition and RNA/DNA ratio. *Journal of Applied Ichthyology,* 25: 707-714.

Abidi, S. F. and Khan, M. A. 2009. Dietary tryptophan requirement of fingerling Indian Major Carp, rohu, *Labeo rohita* (Hamilton), based on growth and body composition. *Journal of the World Aquaculture Society*, 41: 700-709.

Abidi, S. F. and Khan, M. A. 2011.Total sulphur amino acid requirement and cystine replacement value for fingerling rohu, *Labeo rohita:* effects on growth, nutrient retention, and body composition. *Aquaculture Nutrition,* 17: e583-e594.

Abidi, S. F. and Khan, M. A. 2010.Growth, protein retention and body composition of fingerling Indian major carp, rohu, *Labeo rohita* (Hamilton) fed diets with various levels of lysine. *Journal of the World Aquaculture Society,* 41: 791-799.

Ahmed, I. 2009. Dietary total aromatic amino acid requirement and tyrosine replacement value for phenylalanine in Indian major carp, *Cirrhinus mrigala* (Hamilton) fingerlings. *Journal of Applied Ichthyology,* 25(6): 719–727.

Ahmed, I. and Khan, M. A. 2004a. Dietary arginine requirement of fingerling Indian major carp, *Cirrhinus mrigala* (Hamilton). *Aquaculture Nutrition,* 10: 217-225.

Ahmed, I. and Khan, M. A. 2004b. Dietary lysine requirement of fingerling Indian major carp, *Cirrhinus mrigala* (Hamilton). *Aquaculture,* 235: 499-511.

Ahmed, I. and Khan, M. A. 2005a. Dietary histidine requirement of fingerling Indian major carp, *Cirrhinus mrigala* (Hamilton). *Aquaculture Nutrition,* 11: 359-366.

Ahmed, I. and Khan, M. A. 2005b. Dietary tryptophan requirement of fingerling Indian major carp, *Cirrhinus mrigala* (Hamilton). *Aquaculture Research,* 36: 687-695.

Ahmed, I. and Khan, M. A. 2006. Dietary branched-chain amino acid valine, isoleucine and leucine requirements of Indian major carp, *Cirrhinus mrigala* (Hamilton). *British Journal of Nutrition*, 96: 450-460.

Ahmed, I., Khan, M. A. and Jafri, A. K. 2003. Dietary methionine requirement of fingerling Indian major carps, *Cirrhinus mrigala* (Hamilton). *Aquaculture International,* 11(5): 449-462.

Ahmed, I., Khan, M. A. and Jafri, A. K. 2004. Dietary threonine requirement of fingerling Indian major carp, *Cirrhinus mrigala* (Hamilton). *Aquaculture Research*, 35: 162-170.

Benkappa, S. and Varghese, T. J. 2003. Isoleucine, leucine, and valine requirement of juvenile Indian major carp, *Cirrhinus cirrhosus* (Bloch, 1795). *Acta Ichthyologica et Piscatoria*, 33(2): 161–172.

Benakappa, S. and Varghese, T. J. 2002a. Dietary threonine requirement of Indian major carp, *Cirrhinus mrigala (Hamilton)* juvenile. *Israeli Journal of Aquaculture-Bamidgeh,* 54: 183–188.

Benakappa, S. and Varghese, T. J. 2002b. Requirement of dietary lysine by fry mrigal, *Cirrhinus mrigala* (Hamilton). *Indian Hydrobiology*, 5: 49–54.

Benakappa, S. and Varghese, T. J. 2002c. Dietary requirement of tryptophan for growth and survival of the Indian major carp, *Cirrhinus mrigala* (Hamilton-Buchanan). *Indian Journal of Experimental Biology*, 41: 1342–1345.

Khan, M. A. and Abidi, S. F. 2007a. Dietary leucine requirement of fingerling Indian major carp, *Labeo rohita* (Hamilton). *Aquaculture Research,* 38(5): 478-486.

Khan, M. A. and Abidi, S. F. 2007b. Total aromatic amino acid requirement of Indian major carp *Labeo rohita* (Hamilton). *Aquaculture,* 267: 111-118.

Khan, M. A. and Abidi, S. F. 2007c. Dietary isoleucine requirement of fingerling Indian major carp, *Labeo rohita* (Hamilton). *Aquaculture Nutrition*, 13(6): 424–430.

Khan, M. A. and Abidi, S. F. 2008.Growth, feed utilization and nutrient retention efficiencies of fingerling *Catla catla* (Hamilton) fed lysine and methionine supplemented soybean meal based diets. *Journal of the Inland Fisheries Society of India*, 40(1): 139-144.

Khan, M. A. and Abidi, S. F. 2011. Dietary methionine requirement of Indian major carp fry, *Cirrhinus mrigala* (Hamilton) based on growth, feed conversion and nitrogen retention efficiency. *Aquaculture Research*, 44(2): 268-281.

Khan, M. A. and Jafri, A. K. 1993. Quantitative dietary requirement for some indispensible amino acids in the Indian major carp, *Labeo rohita* (Hamilton) fingerling. *Journal of Aquaculture in the Tropics*, 8: 67-80.

Mohanty, S. N., Das, K. M. and Sarkar, S. 1995. Effect of feeding varying dietary amino acid levels on growth and whole body amino acid composition of rohu fry. *Journal of Aquaculture*, 3: 29-34.

Mohanty, S. N. and Kaushik, S. J. 1991. Whole body amino acid composition of Indian major carps and its significance. *Aquatic Living Resources*, 4: 61–64.

Mukhopadhyay, N. and Ray, A. K. 2001. Effects of amino acid supplementation on the nutritive quality of fermented linseed meal protein in the diets for rohu, *Labeo rohita*, fingerlings. *Journal of Applied Ichthyology*, 17(5): 220-226.

Murai, T., Akiyama, T. and Nose, T. 1981. Use of crystalline amino acids coated with casein in diets for carp. *Bulletin of the Japanese Society of Scientific Fisheries*, 47: 523–527.

Murthy, H. S. 1994. Studies on the quantitative amino acid requirements for the growth of the Indian major carp, *Labeo rohita* (Hamilton). Ph.D. Thesis, University of Agricultural Sciences, Bangalore.

Murthy, H. S. and Varghese, T. J. 1995. Arginine and histidine requirements for the Indian major carp, *Labeo rohita* (Hamilton). *Aquaculture Nutrition*, 1: 235–239.

Murthy, H. S. and Varghese, T. J. 1996a. Quantitative dietary isoleucine requirement for growth and survival of Indian major carp, *Labeo rohita* (Hamilton) fry. *Indian Journal of Experimental Biology*, 34: 1141–1143.

Murthy, H. S. and Varghese, T. J. 1996b. Quantitative dietary requirement of threonine for the growth of the Indian major carp, *Labeo rohita* (Hamilton). *Journal of Aquaculture in Tropics*, 11: 1–8.

Murthy, H. S. and Varghese, T. J. 1996c. Dietary requirements of the Indian major carp, *Labeo rohita* (Hamilton) for total aromatic amino acids. *Israieli Journal of Aquaculture – Bamidgeh*, 48: 78–83.

Murthy, H. S. and Varghese T. J. 1997a. Dietary tryptophan requirement of the Indian major carp, *Labeo rohita*. *Journal of Applied Aquaculture*, 7(2): 71–79.

Murthy, H. S. and Varghese, T. J. 1997b. Dietary requirement of the Indian major carp, *Labeo rohita* for the essential amino acid leucine. *Mysore Journal of Agricultural Sciences*, 31: 348–353.

Murthy, H. S. and Varghese, T. J. 1997c. Dietary requirement of juveniles of the Indian major carp, *Labeo rohita*, for the essential amino acid lysine. *Israel journal of Aquaculture*, 49: 19–24.

Murthy, H. S. and Varghese, T. J. 1998. Total sulphur amino acid requirement of the Indian major carp, *Labeo rohita* (Hamilton). *Aquaculture Nutrition*, 4: 61–65.

Rajan, M. R. and Shyamala, M. 2006. Role of L- methionine and L- lysine in mrigal nutrition. *Environment and Ecology*, 24(1): 20-22.

Ravi, J. and Devaraj, K. V. 1991. Quantitative essential amino acid requirements for growth of *Catla catla* (Hamilton). *Aquaculture*, 96: 281–291.

Sardar, P., Abid, M., Randhawa, H. and Prabhakar, S. 2009. Effect of dietary lysine and methionine supplementation on growth, nutrient utilization, carcass compositions and haemato-biochemical status in Indian major carp, Rohu (*Labeo rohita*, Hamilton) fed soy protein-based diet. *Aquaculture Nutrition*, 15(4): 339–346.

Satheesha, S. K. and Murthy, H. S. 1999. Dietary requirement of the Indian major carp, *Catla catla* for essential amino acid lysine. *Indian Journal of Animal Sciences*, 69: 277–279.

Singh, B. N. 1987. On the sulphur amino acids (methionine+cystine) and lysine requirements of rohu, *Labeo rohita* (Hamilton) and essential amino acid composition of certain promising feeds evolved for carps. In: *The first Indian Fisheries Forum*, Mangalore, India, pp. 67.

Singh, B. N., Sarkar, M., Kanungo, G., Mahapatra, C. T. and Pandey, A. K. 1999. Role of lysine and methionine on the growth of *Catla catla* fry under the field condition. In: *Proceedings of National Seminar on Environmental Biology and Fish Biology*, Department of Zoology, Visva Bharati University Santiniketan, 6-7 April 1999.

Singh, B. N., Aravindakshan, P. K., Sarkar, M., Mahapatra, C. T., Kanungo, G., Sahoo, G. C., Muduli, H. K. and Pandey, A. K. 2000. Role of lysine and methionine on the growth of *Labeo rohita* fingerlings under field conditions. In: *Proceedings of the International Conference on 'Probing in biological system'*, Department of Zoology. The Institute of Science, Mumbai.

Tejpal, C. S., Pal, A. K., Sahu, N. P., Jha, A. K., Muthappa, N. A., Sagar, V. and Rajan, M. G. 2009. Dietary supplementation of L-tryptophan mitigates crowding stress and augments the growth in *Cirrhinus mrigala* fingerlings. *Aquaculture*, 293(3-4): 272-277.

Zehra, S. and Khan, M. A. 2013. Dietary arginine requirement of fingerling of Indian major carp, *Catla catla* (Hamilton). *Journal of the World Aquaculture Society*, 44 (3): 363–373.

Zehra, S. and Khan, M. A. 2013. Dietary lysine requirement of fingerling *Catla catla* (Hamilton) based on growth, protein deposition, lysine retention efficiency, RNA/DNA ratio and carcass composition. *Fish Physiology and Biochemistry*, 39: 503-512.

Zehra, S. and Khan, M. A. 2013. Dietary isoleucine requirement of fingerling catla, *Catla catla* (Hamilton), based on growth, protein productive value, isoleucine retention efficiency and carcass composition. *Aquaculture International*, 21: 1243-1259.

CHAPTER - 3

Lipid and Fatty Acid Requirement

Anwar, M. F. and Jafri, A. K. 2001. The influence of dietary lipid levels on growth, feed conversion and carcass composition of fingerling Indian major carp *Labeo rohita*. In: *Aquaculture, Book of abstracts*, pp. 22.

Chittem, P. B. and Kunda, S. K. 2013. Effect of dietary Omega-3 fatty acid diets on growth and physico-chemical parameters of cultured water in fingerlings of *Labeo rohita*. *International Journal of Innovative Research in Science, Engineering and Technology*, 2(8): 3716-3722.

Hassan, M. A. 1993. Energy nutrition and biological aspects of energetics in selected cultivable fish species. Ph.D. thesis, Aligarh Muslim University, Aligarh, pp.111.

Hassan, M. A. and Jafri, A. K. 1996. Influence of feeding varying levels of dietary energy on growth, utilization efficiency, and carcass composition of fry of the Indian major carp, *Cirrhinus mrigala* (Hamilton). *Journal of Aquaculture in the Tropics*, 11(2): 143-152.

Hasan, M. R., Ali, M. A., Akand, A. M. and. Ali, M. M. 1996. Nutritional requirements of Indian major carp *Labeo rohita* - 2. Effect of dietary lipid on growth, food conversion and body composition. *Bangladesh Journal of Aquaculture*, 18: 24-31.

Jafri, A. K., Anwar, M. F., Usmani, N., Samad, R. and Alvi, A. S. 1995. Influence of dietary lipid levels on the growth and body composition of fingerling of an Indian major carp, *Cirrhinus mrigala*. *Journal of Aquaculture in the Tropics*, 10(2): 151-157.

Mukhopadhyay, P. K. and Rout, S. K. 1996. Effects of different dietary lipids on growth and tissue fatty acid changes in fry of the carp, *Catla catla* (Hamilton). *Aquaculture Research*, 27(8): 623-630.

Mishra, K. and Samantaray, K. 2004. Interacting effects of dietary lipid level and temperature on growth, body composition and fatty acid profile of rohu, *Labeo rohita* (Hamilton). *Aquaculture Nutrition*, 10(6): 359–369.

Nandi, S., Chattopadhyay, D. N., Verma, J. P., Sarkar, S. K. and Mukhopadhyay, P. K. 2001. Effect of dietary supplementation of fatty acids and vitamins on the breeding performance of the carp *Catla catla*. *Reproduction Nutrition Development*, 41(4): 365–375.

Paul, B. N., Nandi, S., Sarkar, S. and Mukhopadhyay, P. K. 1998. Dietary essentiality of phospholipids for Indian major carp larvae. *Asian Fisheries Science*, 11(3-4): 253-259.

CHAPTER - 4

Carbohydrate Requirement

Dalal, S., Bhattacharya, S. and Ray, A. K. 2001. Effects of dietary protein and carbohydrate levels on growth performance, feed utilization efficiency and nitrogen metabolism in rohu, *Labeo rohita* (Hamilton), fingerlings. *Acta Ichthyologica et Piscatoria*, 31(2): 3-17.

Erfanullah and Jafri, A. K. 1993. Effects of dietary carbohydrate level on the growth and conversion efficiency of the Indian major carp fingerling *Labeo rohita* (Hamilton): A preliminary study. *Asian Fisheries Science*, 6: 249-254.

Erfanullah and Jafri, A. K. 1995a. Growth response of rohu fingerlings to various sources of dietary carbohydrates. *Journal of Aquaculture in the Tropics*, 10: 287-296.

Erfanullah and Jafri, A. K. 1995b. Protein-sparing effect of dietary carbohydrate in diets for fingerling *Labeo rohita*. *Aquaculture*, 136: 331-339.

Erfanullah and Jafri, A. K. 1998a. Growth rate, feed conversion, and body composition of *Catla catla, Labeo rohita* and *Cirrhinus mrigala* fry fed diets of various carbohydrate-to-lipid ratios. *Journal of World Aquaculture Society*, 29(1): 84–91.

Erfanullah and Jafri, A. K. 1998b. Growth response, feed utilization and nutrient retention in *Catla catla* (Ham.) fry fed varying levels of dietary carbohydrate. *Asian Fisheries Science*, 11(3-4): 223-230.

Manjappa, K., Keshavanath, P. and Gangadhara, B. 2009. Performance of *Catla catla* (Hamilton) fingerlings fed with carbohydrate-rich diets in manured tanks. *Asian Fisheries Society*, 22(3): 857-1069.

Mohapatra, M., Sahu, N. P. and Chaudhari, A. 2003. Utilization of gelatinized carbohydrate in diets in *Labeo rohita* fry. *Aquaculture Nutrition*, 9: 189-196.

Saha, A. K. and Ray, A. K. 2001. Optimum dietary carbohydrate requirement of rohu, *Labeo rohita* (Hamilton), fingerlings. *Acta Ichthyologica et Piscatoria*, 31(1): 81-96.

Sethuramalingam, T. A. and Haneefa, M. A. 2001. Utilization of carbohydrate rich ingredient in the feed of Indian major carp *Labeo rohita*. *Indian Journal of Fisheries*, 48(3): 303-312.

Swamy, D. N., Mohanty, M. N. and Tripathi, S. D. 1990. Dietary carbohydrate requirements of *Catla catla* (Hamilton) fry and fingerlings. In: *abstracts*, *The Second Asian Fisheries Forum, Asian Fisheries Society*, Indian Branch, 27-31 May, College of Fisheries, University of Agricultural Sciences, Mangalore, Karnataka, India, pp. 80.

CHAPTER - 5

Mineral Requirement

Firdaus, S., Jafri, A. K. and Khan, M. A. 2002. Effect of dietary levels on mineral mixture on the growth, body composition and hematology of catfish, *Heteropneustes fossilis* Bloch. *Journal of Aquaculture in the Tropics,* 17: 273-281.

Gupta, A. K. and Soni, M. K. 1998. Dietary requirement of zinc for the fingerlings of *Cirrhinus mrigala*. *Geobios*, 25: 261-265.

Midha, M. and Singhal, R. N. 1994. Effect of cobaltous chloride on the growth of *Labeo rohita*. *Geobios,* 21(4): 297-302.

Mukherjee, S. and Kaviraj, A. 2009. Effects of dietary mineral supplements on the growth of fingerlings of *Labeo rohita* (Hamilton) and *Labeo bata* (Hamilton). In: *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences,* 79(1): 34-37.

Nandeesha, M. C. and Gangadhar, B. 2000. Effect of dietary sodium chloride supplement on growth, biochemical composition and digestive enzyme activity of young *Cyprinus carpio* (Linn.) and *Cirrhinus mrigala* (Ham.). *Journal of Aquaculture in the Tropics,* 15(2): 135-144.

Paul, B. N. and Mukhopadhyaya, M. K. 2001. Importance of trace minerals in aquaculture nutrition. *Fishing Chimes,* 21(8): 34-36.

Paul, B. N., Sarkar, S., Giri, S. S., Rangacharyulu, P. V. and Mohanty, S. N. 2004. Phosphorus requirement and optimum calcium: phosphorus ratio in the diet of mrigal, *Cirrhinus mrigala* (Hamilton) fingerlings. *Journal of Applied Ichthyology,* 20(4): 306-309.

Sajini, C. B., Rajbanshi, V. K. and Gupta, A. K. 1989. Growth performance of *Cirrhinus mrigala* (Hamilton) fingerlings on manganese supplemented and deficient diets. *Geobios,* 16(2-3): 53-56.

Saxena, P. K. and Talwar, P. 1996. Effect of dietary potassium on the growth and flesh quality of Indian major carp, *Cirrhina mrigala* (Hamilton). *Indian Journal of Experimental Biology,* 34(2): 135-137.

Sinha, G. M. 1997. Effect of cadmium on protein content in plasma, body muscle and liver in an Indian major carp *Labeo rohita* (Hamilton). *Environment and Ecology,* 15(2): 275-282.

Singh, B. N. and Radheyshyam. 1995. A big role for micronutrients in artificial feed on growth, survival and economic profitabillity in carp seed production from nursery ponds. In: *Proceedings of Seminar-cum-Workshop on Techniques of Increased Fish Production in Tripura,* Deparment of Fisheries, Government of Tripura, Agartala.

Sharma, O. P. and Rai, H. 1997. Efficacy of 'Agrimin' in the growth of Indian major carp *Labeo rohita* fingerlings. *Fishing Chimes,* 17(6): 15-16.

Sukumaran, K., Pal, A. K., Sahu, N. P., Jahageerdar, S., Kamabadakone, D. and Debnath, D. 2010. Influence of dietary phosphorus on mineralization and morphology of Indian major carp, catla (*Catla catla*) fingerlings. *Aquaculture International,* 19(4): 749-763.

Sukumaran, K., Pal, A. K., Sahu, N. P., Debnath, D. and Patro, B. 2009. Phosphorus requirement of catla (*Catla catla* Hamilton) fingerlings based on growth, whole-body phosphorus concentration and non-fecal phosphorus excretion. *Aquaculture Research*, 40(2): 139–147.

CHAPTER - 6

Vitamin Requirement

Ahmed, I. 2010. Effect of dietary niacin on the growth and body composition of two Indian major carps rohu, *Labeo rohita* and mrigala, *Cirrhinus mrigala* (Hamilton), fingerlings based on dose-response study. *Aquaculture International.* 19(3): 567-584.

Chattopadhyay, D. N., Marandi, K., Verma, J. P., Sarkar, S. K., Mukhopadhyay, P. K. and Giri, S. S. 2002. Effect of dietary vitamin supplementation on performance of Indian major carp under semi-intensive polyculture system. *Indian Journal of Fisheries,* 49(2): 179-186.

Gupta, A. K. and Hussain, S. 2010. Requirement of dietary vitamin E in relation to growth, feed conversion and deficiency symptoms for the fingerlings of *Labeo rohita* (Hamilton). *Geobios,* 37(1): 95-99.

Hasan, M. R., Saha, D. K., Das, P. M. and Hossain, M. A. 1994. Quantitative dietary ascorbic acid requirement of Indian major carp, *Labeo rohita* (Hamilton). In: S.S. de Silva (ed.), *Fish nutrition research in Asia,* Asian Fisheries Society, Spec. Publication No. 6, pp. 15-21.

Keshavanath, P. and Renuka, P. 1998. Effect of dietary L-carnitine supplements on growth and body composition of fingerling rohu, *Labeo rohita* (Hamilton). *Aquaculture Nutrition*, 4(2): 83–87.

Mahajan, C. L. and Agrawal, N. K. 1980. Nutritional requirement of ascorbic acid by Indian major carp *Cirrhinus mrigala*, during early growth. *Aquaculture,* 19(1): 37-48.

Mukhopadhyay, P. K., Nandi, S., Hassan, M. A., Dey, A. and Sarkar, S. 1995. Effect of dietary deficiency and supplementation of ascorbic acid on performance, vertebral collagen content, tissue vitamin and enzyme status in the carp *Labeo rohita*. In: M.S. Hameed and B.M. Kurup (eds.), *Technological Advancement in Fisheries, Pubication.,* Cochin University of Science and Technology, Cochin, vol. 1**:** pp. 101–107.

Mitra, G. and Mukhopadhyay, P. K. 2003. Dietary essentiality of ascorbic acid in rohu larvae: Quantification with ascorbic acid enriched zooplankton. *Aquaculture International,* 11(12): 81-93.

Muruganandam, M., Nagarajan, M. and Rajapermalsamy, P. R. 2004. Supplementary effect of Vitamin A on growth performance of *Catla catla* fry. *Environment and Ecology*, 22(spl-2): 239-241.

Misra, C. K., Das, B. K., Mukherjee, S. C. and Pradhan, J. 2007. Effects of dietary vitamin C on immunity, growth and survival of Indian major carp *Labeo rohita,* fingerlings. *Aquaculture Nutrition,* 13(1): 35–44.

Paul, B. N., Sarkar, S. and Mohanty, S. N. 2004. Dietary vitamin E requirement of mrigal, *Cirrhinus mrigala* fry. *Aquaculture*, 242(4): 529-536.

Rangacharyulu, P. V., Sarkar, S. and Mukhopadhyay, P. K. 1999. Effect of dietary vitamin-A supplementation on growth and survival of rohu (*Labeo rohita*) fry. *Journal of Aquaculture,* 7: 33-36.

Sinha, A. and Sinha, Y. K. P. 1994a. Effects of dietary vitamin C in the tissue composition of catla (*Catla catla*) fry. *Proceedings of National Academy of Sciences, India Section B: Biological Sciences,* 64(4): 357-360.

Sinha, A. and Sinha, Y. K. P. 1994b. Role of vitamin E on the growth of catla *(Catla catla). Journal of the Indian Fiseries Association,* 24: 91-96.

Sobhana, K. S., Mohan, C. V. and Shankar, K. M. 2002. Effect of dietary vitamin C on the disease susceptibility and inflammatory response of mrigal, *Cirrhinus mrigala* (Hamilton) to experimental infection of *Aeromonas hydrophilla*. *Aquaculture,* 207(3-4): 225-238.

Sahoo, P.K. and Mukherjee, S. C. 2002. Influence of high dietary α-tocopherol intakes on specific immune response, nonspecific resistance factors and disease resistance of healthy and aflatoxin B_1-induced immunocompromised Indian major carp, *Labeo rohita* (Hamilton). *Aquaculture Nutrition,* 8(3): 159–167.

Sahoo, P. K. and Mukherjee, S. C. 2003. Immunomodulation by dietary vitamin C in healthy and alfatoxin-B_1-induced immunocompromised rohu (*Labeo rohita*). *Comparative Immunology Microbiology and Infectious Disease,* 26: 65-76.

Sahoo, M., Nayak, S. and Mukhopadhyay, P. K. 2006. Effect of dietary ascorbyl polyphosphate on the immune response of Indian major carp, rohu (*Labeo rohita,* Hamilton). *Biochemical and Cellular Archives,* 6(2): 233-239.

Sahoo, M. and Mukhopadhyay, P. K. 2005. Vitamin-C is vital to ensure overall health and stable production of cultured fish. *Fishing Chimes,* 25(1): 114-116.

Sau, S., Paul, B. N., Mohanta, K. N. and Mohanty, S. N. 2004. Dietary vitamin E requirement, fish performance and flesh quality of rohu (*Labeo rohita*) fry. *Aquaculture,* 240: 359-368.

Tewary, A. and Patra, B. C. 2008. Use of vitamin C as an immunostimulant- effect on growth, nutritional quality and immune response of *Labeo rohita* (Ham.). *Fish Physiology and Biochemistry,* 34(3): 251-259.

CHAPTER - 7

Efficacy of Feedstuff/Feed

Abidi, S. F., Khan, M. A., Firdaus, S., Ahmed, I. and Singh, S. 2004.Nutritional richness of locally available feed ingredients for developing fish feeds. *Journal of Aquaculture in the Tropics*, 19: 93-102.

Abidi, S. F., Khan, M. A., Afrin, S., Sayeda, S. and Seemab, Z. 2008. Effects of replacing fish meal with soybean meal on growth, feed utilization efficiencies and body composition of fingerlings of *Labeo rohita* (Hamilton). *Journal of the Inland Fisheries Society of India*, 40(1): 121-127.

Ali, M. Z. 1994. Evaluation of fish silage prepared from underutilized marine fishes as protein sources in the diet of major carp. *Journal of Aquaculture in the Tropics*, 9(3): 247-254.

Asad, F., Salim, M., Shahzad, K. and Noreen, U. 2005. Estimation of apparent digestibility coefficient of guar, canola and meat meal for *Labeo rohita*. *International Journal of Agriculture and Biology*, 7(5): 816–819.

Athithan, S. and Singh, S. 2010. Evaluation of palm oil as a dietary energy ingredient and fish oil replacer in the diet of *Labeo rohita* (Hamilton). *Aquaculture*, 11(1): 9-20.

Azim, M. E. and Wahab, M. A. 2003. Development of a duckweed-fed carp polyculture system in Bangladesh. *Aquaculture*, 218(1-4): 425-438.

Bairagi, A., Ghosh, K. S., Sen, S. K. and Ray, A. K. 2002. Duckweed (*Lemna polyrhiza*) leaf meal as a source of feedstuff in formulated diets for rohu (*Labeo rohita Ham.) fingerlings after fermentation with a fish intestinal bacterium. Bioresource Technology*, 85: 17-24.

Bairagi, A., Ghosh, K. S., Sen, S. K. and Ray, A. K. 2004. Evaluation of the nutritive value of *Leucaena leucocephala* leaf meal, inoculated with fish intestinal bacteria *Bacillus subtilis* and *Bacilus circulans* in formulated diets for rohu, *Labeo rohita* (Hamilton) fingerlings. *Aquaculture Research*, 35: 436-446.

Bakthavathsalam, R., Anuradha, G. and Lakshmi Prabha, S. R. 2002. Effect of different feeds on growth rate of Indian major carp *Catla catla* kept under laboratory conditions. *Environment and Ecology*, 20(4): 852-857.

Bakthavathsalam, R. and Gukula, K. J. 2002. Effect of different supplementary feeds on growth rate of Indian major carp *Catla catla* reared under field conditions. *Environment and Ecology*, 20(4): 833-838.

Borthakur, S. and Keshavanath, P. 1997. Pellets quality of fish feeds incorporated with non-conventional protein sources. *Environment and Ecology*, 15(2): 311-314.

Bhat, G. K., Shetty, H. P. C. and Nandeesha, M. C. 1986. Formulation and evalution of pelleted fish feed based on soybean meal and squilla meal. In: J. L. Maclean, L.B. Dizon and L.V. Hosillos (eds.), *The First Asian Fisheries Forum*, Asian Fisheries Society, pp. 539-542.

Bhatt, S. S., Chovatiya, S. G. and Shah, A. R. 2011. Evaluation of raw and hydrothermically processed *Prosopis juliflora* seed meal as supplementary feed for the growth of *Labeo rohita* fingerlings. *Aquaculture Nutrition*, 17(2): 164-173.

Bhuiyan, A. S. and Rahman, M. 1989. Effect of six different supplementary feeds on growth of the hatchlings of fish *Cirrhinus reba*. *Environment and Ecology*, 7(4): 975-977.

Chakrabarty, N. M. 1996. Efficacy of fish feed formulated in fish and poultry offal. *Environment and Ecology*, 14(4): 791-793.

Chattopadhyay, D. N., Verma, J. P., Radheshyam, Behera. B., Sarkar, S. and Mukhopadhyay, P. K. 2011. On-farm evaluation of formulated feeds on the breeding performance of *Catla catla* reared in rural ponds. *Aquaculture Nutrition*, 17(2): 30-38.

Chovatiya, S. G., Bhatt, S. S. and Shah, A. R. 2011. Evaluation of corn steep liquor as a supplementary feed for *Labeo rohita* (Ham.) fingerliongs. *Aquaculture International*, 19(1): 1-12.

Datta, S. N. 2011. Culture of *Azolla* and its efficacy in diet of *Labeo rohita*. *Aquaculture*, 310(3-4): 376-379.

Erfanullah. and Jafri, A. K. 1998. Evaluation of digestibility coefficients of some carbohydrate-rich feedstuffs for Indian major carp fingerlings. *Aquaculture Research*, 29(7): 511-519.

Garg, S. K., Kalla, A. and Bhatnagar, A. 2002. Evaluation of raw and hydrothermically processed leguminous seeds as supplementary feed for the growth of two Indian major carp species. Aquaculture Research, 33(3): 151-163.

Getha, K., Chong, V.C. and Vikineswary, S. 1998. Potential use of the phototrophic bacterium, Rhodopseudomonas palustris, as an aquaculture feed. Asian Fisheries Science, 10(3): 179-268.

Ghosh, K., Sen, S. K. and Ray, A. K. 2005. Feed utilization efficiency and growth performance in rohu, Labeo rohita (Hamilton, 1822), fingerlings fed yeast extract powder supplemented diets. Acta Ichthyologica et Piscatoria, 35 (2): 111–117.

Harish, K. M. and Gajaria, S. C. 1995. Growth of Indian major carps fed on *Spirogyra* sp. diets. In: *Proceedings of the National Symposium on Algal Potential and Its Exploitation,* Dec. 27-29, Madurai, India, pp. 46-46.

Hasan, M. R., Azad, A. K., Omar Farooque, A. M. O., Akand, A. M. and Das, P. M. 1991. Evaluation of some oilseed cakes as dietary protein sources for the fry of Indian major carp, *Labeo rohita* (Hamilton). In: S.S. de Silva (ed.), *Fish nutrition research in Asia, Proceedings of the fourth Asian fish nutrition workshop,* Asian Fisheries Society, Special Publication No. 5, pp. 107–117.

Hasan, M. R. and Das, P. M. 1993. A preliminary study on the use of poultry offal meal as dietary protein source for the fingerling of Indian major carp *Labeo rohita* (Hamilton). In: S. J. Kaushik and P. Luquet, (eds.), *Fish nutrition in practice,* Paris, INRA, pp. 793-801.

Harish, K. M., Gajaria, S. C. and Radha, K. S. 2004. Growth and development of catla (*Catla catla*) fed with different levels of diet containing *Spirogyra* sp. *Bioresource Technology*, 95: 73-76.

Hasan, M. R., Haq, M. S., Das, P. M. and Mowlah, G. 1997. Evaluation of poultry feather meal as a dietary protein source for Indian major carp, *Labeo rohita* (Hamilton) fry. *Aquaculture*, 151(1-4): 47-54.

Hassan, M. A., Khan, M. A. and Jafri, A. K. 1999. Efficacy of animal wastes as supplementary feed for Indian major carp, *Labeo rohita* fingerling. *Journal of Inland Fisheries Society of India*, 31(2): 52-57.

Hasan, M. R., Moniruzzaman, M. and Farooque, A. M. O. 1990. Evaluation of leucaena and water hyacinth leaf meal as dietary protein sources for the fry of Indian major carp, *Labeo rohita* (Hamilton). In: R. Hirano and I. Hanyu, (eds.), *The Second Asian Fisheries Forum*, Asian Fisheries Society, Manila., pp. 275-278.

Hasan, M. R. and Roy, P. K. 1994. Evaluation of water hyacinth leaf meal as dietary protein source for Indian major carp, *Labeo rohita* fingerlings. In. L. M. Chou, A. D. Munro, T. J. Lam, T. W. Chen, L. K. K. Cheong, J. K. Ding, K. K. Hooi, W. H. Khoo,V. P. E. Phang, K. F. Shim and C. H. Tan (eds.), *The Third Asian Fisheries Forum. Manila,* Asian Fisheries Society, pp. 671-674.

Hasan, M. R., Rouf, M. A., Rahman, M. S. and Hossain, M. A. 1994. A Preliminary study on the use of some oilseed cakes as dietary protein sources for Indian major carp (*Labeo rohita*) fingerlings. *Aquaculture,* 124(1-4): 65.

Hasan, M. R., Roy, P. K. and Akand, A. M. 1994. Evaluation of leucaena leaf meal as dietary protein source for Indian major carp, *Labeo rohita* fingerling. In: S. S. de Silva (ed.), *Fish Nutrition Research in Asia* , Special Publication No. 6, Asian Fisheries Society, Manila, pp. 69–76.

Hasan, M. R., Roy, P. K., Shaheen, N. and Mowlah, G. 1988. Evaluation of *Leucaena* leaf meal as dietary protein source for the fry of Indian major carp (*Cirrhinus mrigala*). *Bangladesh Journal of Aquaculture*, 10: 69-82.

Hasan, M. R. and Roy, P. K. 1994. Evaluation of water hyacinth meal as a dietary protein source for Indian major carps (*Labeo rohita*) fingerlings. *Aquaculture,* 124(1-4): 63.

Hossain, M. A. and Shikha, F. H. 1996. ADC coefficients of some low protein ingredients for Rohu (*Labeo rohita*). *Journal of Aquaculture in the tropics,* 11: 161-166.

Jadhav, A. G. and. Rao, P. D. 1991. Effect of supplementary feed such as abattoir and fish market waste on growth of the fingerlings of *Labeo rohita* (Hamilton). In: *Proceedings of the National Symposium on New Horizons in Freshwater Aquaculture,* Central Institute of Freshwater Aquaculture, Jan. 23-25, Bhubaneswar, pp. 81-83.

Jafri, A. K., Jafri, D. K., Khan, M. A., Anwar, M. F., Hassan, M. A. and Erfanullah. 1991. Growth and survival of Indian major carp spawn fed artificial diets. In: V. R. P. Sinha and C. Srivastava (eds.), *Aquaculture Productivity,* Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, pp. 485-490.

Jafri, A. K., Jafri, D. K., Khan M. A., Anwar, M. F., Hassan, A. and Erfanullah. 1991. On the use of locally available feedstuffs in formulated fish feeds: Proximate composition and gross energy content. In: J. K.Wang. and P.V. Dehadrai (eds.), *Aquaculture Research Needs for 2000 A.D.*, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, pp. 143-151.

Jayadev, W. and Viswanath, W. 2000. Water stability of pelleted fish feeds prepared from non-conventional source. *Fishery Technology*, 37(1): 51-54.

Jayaram, M. G. 1978. Studies on the formulation of artificial feeds and their effect on the growth of *Catla catla* (Hamilton), *Labeo rohita* (Hamilton) and *Cyprinus carpio* (Linn.). M.F.Sc. thesis, University of Agricultural Sciences, Bangalore, pp. 120.

Jayaram, M. G. and Shetty, H. P. C. 1980a. Studies on the growth rates of catla, rohu and common carp fed on different formulated feeds. *Mysore Journal of Agricultural Science*, 14: 598-606.

Jayaram, M. G. and Shetty, H. P. C. 1980b. Digestibility of two pelleted diets by *Cyprinus carpio* and *Labeo rohita*. *Mysore Journal of Agricultural Sciences*, 14: 578–584.

Jayaram, M. G. and Shetty, H. P. C. 1980c. Influence of different diets on the proximate body composition of *Catla catla*, *Labeo rohita* and *Cyprinus carpio*, *Mysore Journal of Agricultural Sciences*, 14: 381–384.

Jayaram, M. G. and Shetty, H. P. C. 1981. Formulation, processing and water stability of two new pelleted feeds. *Aquaculture*, 23: 355–359.

Jayaram, M. G., Shetty, H. P. C. and Udupa, K. S. 1980. Organoleptic evaluation of flesh of carps fed on different kinds of feeds. *Mysore Journal of Agricultural Sciences*, 14: 421–424.

Jafri, A. K. and Hassan, M. A. 1999. Energy digestibility coefficients of commonly used feedstuffs in different size-classes of Indian major carps, *Labeo rohita* (Hamilton) and *Cirrhinus mrigala* (Hamilton). *Asian Fisheries Science*, 12: 155–163.

Jafri, A. K., Jafri, D. K., Khan, M. A., Anwar, M. F., Hassan, A. and Erfanullah. 1992. On the use of locally available feedstuffs in formulated fish feeds: Proximate composition and gross energy content. In: J. K. Wang. and P. V. Dehadrai (eds.), *Aquaculture Research Needs for 2000 A.D.*, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, pp. 143-151.

Jahan, D. A., Hussain, L., Islam, M. A. and Naima, A. 2013. Evaluation of soybean meal as a dietary protein source on the performance of *Labeo rohita* (Ham.) spawn reared under pond condition. *The Agriculturists*, 11(2): 14-20.

Jena, J. K., Mukhopadhyay, P. K., Sarkar, S. J., Aravindakshan, P. K. and Muduli, H. K. 1996. Evaluation of a formulated diet for nursery rearing of Indian major carp under field condition. *Journal of Aquaculture in Tropics*, 11: 299–305.

Jena, J. K., Mukhopadhyay, P. K. and Arvindakshan, P. K. 1999. Evaluation of a formulated diet for raising carp fingerlings in field condition. *Journal of Applied Ichthyology*, 15: 188-192.

Jena, J. K., Mukhopadhyay, P. K. and Aravindakshan, P. K. 1998. Dietary incorporation of meat meal as a substitute for fish meal in carp fry rearing. *Indian Journal of Fisheries*, 45(1): 43-49.

Jose, S., Mohan, M. V., Shyama, S., Ramachandran Nair, K. G. and Mathew, P. T. 2006. Effect of soybean-meal-based diets on the growth and survival rate of the Indian major carp, *Cirrhinus mrigala* (Hamilton). *Aquaculture Nutrition,* 12: 275–279.

Joseph, I., Raj, R. P. and Bahtnagar, D. 2008. Effect of solid state fermentation on nutrient composition of selected feed ingredients. *Indian Journal of Fisheries*, 55(4): 327-332.

Kalita, P., Mukhopadhyay, P. K. and Mukherjee, A. K. 2007. Evaluation of the nutritional quality of four unexplored aquatic weeds from northeast India for the formulation of cost effective fish feeds. *Food Chemistry*, 103(1): 204-209.

Kalla, A. 2002. Effect of supplementary feeding in some teleosts on growth, digestibility and water quality parameters under intensive fish culture system, Ph.D. Thesis. Guru Jambheswar University, Hissar, India.

Kalla, A. and Garg, S. K. 2004. Use of plant proteins in supplementary diets for sustainable aquaculture. In: S. K. Garg and K. L. Jain (eds.), *Proceedings of National Workshop on Rational Use of Water resources for Aquaculture,* CCS Haryana Agricultural University, Hisar, India, pp. 6-20.

Kaur, V. I. and Saxena, P. K. 2004. Incorporation of brewery waste in supplementary feed and its impact on growth in some carps. *Bioresource Technology,* 91(1): 101-104.

Kavitha, O., Anandan, R., Mathew, S. and Viswanathan Nair, P. G. 2003. Biochemical composition and nutritive value of common fish feed of plant and animal origin. *Fishery Technology,* 40(2): 121-126.

Khan, M. A., Jafri, A. K., Chadha, N. K. and Usmani, N. 2003. Growth and body composition of rohu (*Labeo rohita*) fed diets containing oilseed meals: partial or total replacement of fish meal with soybean meal. *Aquaculture Nutrition,* 9: 391-396.

Khan, M. A. and Jafri, A. K. 1992. Replacement of fishmeal with offal meal in formulated diets for the carp fingerling, *Labeo rohita* (Hamilton). *Journal of Aquaculture,* 2: 56-62.

Khan, M. A. and Jafri, A. K. 1994. Replacement of fishmeal with soybean meal in diets formulated for fingerling carp, *Labeo rohita* Hamilton. In: Chou, *et al.* (eds.), *Proceedings of the Third Asian Fisheries Forum,* Manila, Philippines, pp. 663-666.

Khan, M. A., Jafri, A. K., Anwar, M. F., Hassan, M. A. and Erfanullah. 1991. Nutritional efficacy of oilcakes in diets compounded for fingerlings of Indian major carp *Labeo rohita* (Ham). In: *Proceedings of National Symposium on Freshwater Aquaculture,* Central Institute of Freshwater Aquaculture, Bhubaneswar, India, 23-25 January, pp. 37-77.

Khan, M. A., Jafri A. K. and Chadha, N. K. 2004. Growth and body composition of rohu, *Labeo rohita* (Hamilton), fed compound diet: winter feeding and rearing to marketable size. *Journal of Applied Ichthyology*, 20(4): 265-270.

Khan, M. A. 2004. Formulation and preparation of nutritionally balanced fish feed. In: *Proceedings of the Summer School on Development of Sustainable Aquaculture Technology in Fresh and Saline Water*, Department of Zoology and Aquauculture, CCS Haryana Agricultural University, Hisar, India, June 14-July 4, 2004, pp. 333-342.

Kowtal, G. V., Gupta, S. D., Ghosh, S. R., Jana, R. K. and Bhowmick, R. M. 1982. Efficiency of conventional and formulated fish feeds in rearing carp spawn. *Journal of Inland Fisheries Society of India,* 14(1): 80-83.

Kumar, K., Ayyappan, S., Murjani, G. and Bhandari, S. 1991. Utilization of mashed water hyacinth as feed in carp farming. In: *National Symposium on New Horizons in Freshwater Aquaculture, Proceedings,* Association of Aquaculturists and CIFA, Bhubaneswar, 23-25 Jan 1991, pp. 89-91.

Kumar, R., Mukherjee S. C., Prasad, K. P. and Pal, A. K. 2006. Evaluation of *Bacillus subtilis* as a probiotic to Indian major carp *Labeo rohita* (Ham.). *Aquaculture Research,* 37(12): 1215-1221.

Lakshmanan, M. A. V., Murty, D. S., Pillai, K. K. and Banerjee, S. C. 1967. On a new artificial feed for carp fry. *FAO Fisheries Reports,* (44)3: 373–387.

Maity, J. and Patra. B. C. 2002. Effect of feeding raw or heated soybean meal on the growth and survival of *Cirrhinus mrigala* (Ham.) fingerlings. *Applied Fisheries and Aquaculture,* 2: 19 - 24.

Maity, J. and Patra, B. C. 2013. Effect of feeding Soybean meal on the bioenergetic and physiological changes in the fingerlings of *Labeo rohita* (Ham.). In: *Proceedings of the 100th session of Indian Science Congress,* Kolkata, 3-7 January 2013, pp. 91-92.

Mandal, S. and Ghosh, K. 2010. Inhibitory effect of *Pistia* tannin on digestive enzymes of Indian major carps: an in vitro study. *Fish Physiology and Biochemistry,* 36: 1171–1180.

Mazid, M. A., Zaher, M., Begum, N. N., Ali, M. Z. and Nahar, F. 1997. Formulation of cost-effective feed from locally available ingredients for carp poly-culture system for increased production. *Aquaculture,* 151(1-4): 71-78.

Mohanty, S. N., Swain, S. K. and Tripathi, S. D. 1996. Rearing of catla (*Catla catla,* Ham.) spawn on formulated diets. *Journal of Aquaculture in the Tropics,* 11(4): 253–258.

Mohanty, S. N., Swamy, D. N. and Tripathi, S. D. 1990a. Growth, nutritional indices and carcass composition of the Indian major carp fry, *Catla catla*, *Labeo rohita* and *Cirhinus mrigala* fed four dietary protein levels. *Aquacultura Hungarica,* 6: 211-217.

Mohanty, S. N. and Dash, S. P. 1995. Evaluation of *Azolla caroliniana* for inclusion in carp diet. *Journal of Aquaculture in the Tropics,* 10(4): 343.

Mohanty, S. N., Swain, S. K. and Tripathi, S. D. 1993. Growth and survival of rohu spawn fed on a liver based diet. *Journal of the Inland Fisheries Society of India,* 25(2): 41-45.

Mandal, R. N., Chattopadhyay, D. N., Paul, B. N. and Mukhopadhyay, P. K. 2012.The duck weed (*Wolffia Arrhiza*) as feed ingredient for nursery rearing of *Labeo rohita* and *Labeo calbasu*. *Journal of the Inland Fisheries Society of India,* 44(2): 21-27.

Mondal, T. K. and Ray, A. K. 1999. The nutritive value of *Acacia auriculiformis* leaf meal in compounded diets for *Labeo rohita* fingerlings. In: M. Mohan Joseph, N. R. Menon and N. Unnikrishnan Nair (eds.), *Proceeding of the fourth Indian Fisheries Forum,* Kochi,24-28, November, 1996, pp. 295-298.

Mondal, K., Kaviraj, A. and Mukhopadhyay, P. K. 2011. Partial replacement of fishmeal by fermented fish-offal meal in the formulation of diet for Indian minor carp, *Labeo bata*. *Journal of Applied Aquaculture,* 23(1): 41–50.

Mondal, K., Kaviraj, A. and Mukhopadhyay, P. K. 2012. Effects of partial replacement of fishmeal in the diet by mulberry leaf meal on growth performance and digestive enzyme activities of Indian minor carp *Labeo bata*. *International Journal of Aquatic Science*, 3(1): 72-83.

Mukherjee, J. K. and Sinha, G. M. 1993. Correlation between food efficiency and growth of a fresh water teleost, *Labeo rohita* (Hamilton). *Geobios*, 20: 211-217.

Mukhopadhyay, N. 2001. Effect of fermentation on apparent total and nutrient digestibility of sesame *(Seasamum indicum)* seed meal in rohu, *Labeo rohita* (Hamilton) fingerlings. *Acta Ichthyologica et Piscatoria,* 31(2): 19-28.

Mukhopadhyay, N. and Ray, A. K. 1996. The potential of deoiled sal *(Shorea robusta)* seed meal as feedstuff in pelleted feed for Indian major carp, rohu, *Labeo rohita* (Hamilton), fingerlings. *Aquaculture Nutrition,* 2: 221-227.

Mukhopadhyay, N. and Ray, A. K. 1997. The apparent total and nutrient digestibility of sal seed meal *(Shorea robusta)* in rohu, *Labeo rohita* (Hamilton), fingerlings. *Aquaculture Research*, 28: 683-689.

Mukhopadhyay, N. and Ray, A. K. 1998. Use of coconut oilseed as a feedstuff in formulation of carp (*Labeo rohita)* diets through digestibility study. In: M.S. Hameed and B.M. Kurup (eds.), *Technology Advancements in Fisheries,* Publication No. 1, Cochin University of Science and Technology, Cochin, pp. 141-146.

Mukhopadhyay, N. and Ray, A. K. 1999. Utilization of copra meal in the formulation of compounded diets for rohu, *Labeo rohita,* fingerlings. *Journal of Applied Ichthyology*, 15: 127-131.

Mukhopadhyay, N. and Ray, A. K. 2005. Effect of fermentation on apparent total and nutrient digestibility of linseed, *Linum usitatissimum,* meal in rohu, *Labeo rohita*, fingerlings. *Acta Ichthyologica et Piscatoria,* 35(2): 73–78.

Murthy, H. S. and Devaraj, K.V. 1990. Effect of *Eichhornia* based feed on the growth of carps. In: M. Mohan Joseph (ed.), *The Second Indian Fisheries Forum Proceedings*, Mangalore, Asian Fisheries Society, Indian Branch, pp. 9-11.

Murthy, H. S. and Devaraj, K. V. 1991a. Utility of pistia (*Pistia stratiotes*) in the diet of carps. *Journal of Aquaculture in the Tropics,* 6: 9–14.

Murthy, H. S. and Devaraj, K. V. 1991b. Comparison of growth of carps fed on *Salvinia* based feed and conventional feed. *Fisheries Technology*, 28: 106–110.

Naskar, K., Banerjee, A. C., Chakraborty, N. M. and Ghosh, A. 1986. Yield of *Wolffia arrhiza* (L.) Horkel ex Wimmer from cement cisterns with different sewage concentrations and its efficacy as a carp feed. *Aquaculture*, 51(3-4): 211-216.

Nandeesha, M. C., Basavaraja, N., Keshavanath, P., Varghese, T. J., Sudhakara, N. S., Srikanth, G. K. and Ray, A. K. 1989. Formulation of diets with sericulture wastes and their evaluation in carp culture. *Indian Journal of Animal Sciences,* 59: 1198–1205.

Nandeesha, M. C., Srikanth, G. K., Keshavnath, P. and Das, S. K. 1991. Protein and fat digestibility of five feed ingredient by an Indian major carp, *Catla catla* (Hamilton). In: S.S. de Silva (ed.), *Fish Nutrition Research in Asia, Proceedings of the Fourth Asian Fish Nutrition Workshop,* Asian Fisheries Society, Manila, Philippines, pp. 75-81.

Pandey, A. K., Sarkar, M., Kanungo, C., Mahapatra, T., Aravindakshan, P. K., Muduli, H. K. and Singh, B. N. 2003. Early maturation of the broodstock of Indian major carps maintained on semi-balanced diet supplemented with lysine and methionine. *Fishing Chimes,* 23(5): 10-12.

Patnaik, S., Swamy, D. N., Rout, M. and Das, K. M., 1991. Use of Ottelia and Nymphoides leaf meal as protein source in the feed of Indian major carp fry. In: *National Symposium on New Horizons in Freshwater Aquaculture, Proceedings*. Association of Aquaculturists and CIFA, Bhubaneswar, pp. 100-102.

Patra, B. C. and Ray, A. K. 1988. A preliminary study on the utilization of the aquatic weed, *Hydrilla verticillata* (L.f.) Rayle as feed by the carp, *Labeo rohita* (Hamilton): growth and certain biochemical composition of flesh. *Indian Biology,* XX(I): 44-50.

Patra, B. C., Maity, J., Banerjee, S. and Patra, S. 1999. Making aquatic weeds useful III: nutritive value of *Nechamandra alternifolia* (Roxb.ex Weight) Thw. meal as feed for the Indian major carps *Labeo rohita* (Hamilton). *Journal of Biological Sciences,* 5: 35-45.

Patra, B. C., Maity, J., Debnath, J. and Patra, S. 2001. Making aquatic weed useful: as feed for an Indian major carp *Labeo rohita* (Ham.). In: S. K. Ghosal and D Ray (eds.), *Recent Advances in Animal Science Research* (Vol. II), Orion Press International, West Bengal, pp. 293 – 305.

Patra, B. C., Maity, J., Debnath, J. and Patra, S. 2007. Making aquatic weeds useful V: Nutritional evaluation of *Nymphoides cristatum* (Roxb.) O. Kuntze leaf meal as a feed ingredient for an Indian major carp *Cirrhinus mrigala* (Ham.). *Journal of Biological Sciences,* 11: 40-54.

Patra B. C., Maity J., Debnath J. and Patra S. 2002. Making aquatic weeds useful II: Nymphoides cristatum (Roxb.) O. Kuntze as feed for an Indian major carp *Labeo rohita* (Hamilton). *Aquaculture Nutrition,* 8: 33-42.

Paul, B. N., Sarkar, S. and Mukhopadhyay, P. K. 1997. Partial replacement of expensive plant protein component of a carp feed by mustard cake for cost effectiveness. In: *National Workshop on Fish and Prawn Feeds*. Central Institute of Freshwater Aquaculture, Bhubaneswar, 2-3 September 1997, pp. 17.

Paul, B. N., Sarkar, S. and Mukhopadhyay, P. K. 2000. Comparative effect of varied dietary plant protein sources on growth performance in rohu, *Labeo rohita*. *Journal of Animal Nutrition,* 7: 11-15.

Radheyshyam., Sarkar, S. K., Sarkar, S., Verma, J. P., Chattopadhyay, D. N. and Mukhopadhyay, P. K. 1996. On-farm trial to study the efficacy of formulated feed for fingerlings of *Labeo rohita* in a monoculture system. *Journal of Aquaculture,* 4: 19-28.

Rangacharyulu, P. V., Giri, S. S., Paul, B. N., Yashoda, K. P., Rao, R. J., Mahendrakar, N. S., Mohanty, S. N. and Mukhopadhyay, P. K. 2003. Utilization of fermented silkworm pupae silage in feed for carps. *Bioresource Technology,* 86(1): 29-32.

Ray, A. K. and **Das, I.** 1992. Utilization of diets containing composted aquatic weed (*Salvinia cuculata*) by the Indian major carp, rohu, *Labeo rohita* (Ham.), fingerlings. *Bioresource Technology*, 40(1): 67-72.

Ray, A. K. and Das, I. 1993. Incorporation of dried aquatic weeds (*Salvinia cuculata*) meal in the pelleted feed for rohu, *Labeo rohita* (Ham.) fingerlings. In: M. Mohan Joseph and C.V. Mohan (eds.), *The Third Indian Fisheries Forum, Proceedings*, Pantnagar, pp. 9-12.

Ray, A. K. and Das, I. 1994. Apparent digestibility of some aquatic macrophytes in rohu, *Labeo rohita* (Ham.) fingerlings. *Journal of Aquaculture in the Tropics,* 9: 335-342.

Ray, A. K. and Das, I. 1996. Evaluation of dried aquatic weed, *Pistia stratiotes*, meal as a feedstuff in pelleted feed for rohu, *Labeo rohita*, fingerlings. *Journal of Applied Aquaculture,* 5(4): 35 – 44.

Ramachandran, S. and Ray, A. K. 2004. Inclusion of extruded grass pea, *Lathyrus sativus* seed meal in compound diets for rohu, *Labeo rohita* (Hamilton, 1822) fingerlings. *Acta Ichthyologica et Piscatoria*, 34: 205–218.

Ramachandran, S. and Ray, A. K. 2007. Nutritional evaluation of fermented black gram (*Phaseolus mungo*) seed meal in compound diets for rohu, *Labeo rohita* (Hamilton), fingerlings. *Journal of Applied Ichthyology*, 23(1): 74–79.

Rao, L. M. and Satish, K. K. 2005. Performance of squilla meal incorporated diet on the juveniles of *Labeo rohita*. *Indian Journal of Fisheries*, 52(2): 221-225.

Satpathy, B. B. 1997. Nutritional evaluation of protein level and sources in formulated diets of rohu, *Labeo rohita* (Hamilton). Ph.D. Thesis. Kalyani University, Kalyani, India.

Saha, A. K. and Ray, A. K. 1998. Evaluation of chuni, a commercially available low cost cattle fodder, in the diet for rohu, *Labeo rohita* (Hamilton), fingerlings. *Aquaculture Research*, 29(10): 761–768.

Saha, A. K. and Ray, A. K. 1998. Incorporation of animal byproducts in carp diets; evaluation of poultry litter and goat blood meal as dietary protein source for rohu fingerlings. *Journal of Aquaculture in the Tropics*, 13(4): 277-284.

Saha, S. and Ghosh, K. 2013. Evaluation of nutritive value of raw and fermented de-oiled physic nut, *Jatropha curcas* seed meal in the formulated diets for rohu, Labeo rohita (Hamilton) fingerlings. *Proceedings of the Zoological Society*, 66(1): 41–50.

Seenappa, D. 1992. Nutritional requirements of Indian major carp, *Catla catla* (Ham.) and formulation of enriched feeds. Ph.D. Thesis, Mangalore University, India.

Sethuramalingam, T. A. and Haniffa, M. A. 2001. Digestibility of Cod liver oil in the diet of *Labeo rohita* fingerlings. *Indian Journal of Fisheries*, 48(4): 361-367.

Singh, B. N. 1992. The digestibility of protein and energy from feedstuffs and pelleted diets in mrigal, *Cirrhinus mrigala* (Ham.) and grass carp, *Ctenopharyngodon idella* (Val.). In: J.K. Wang and P.V. Dehadrai (eds.), *Aquaculture Research Needs for 2000 A.D.*, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, pp. 135-142.

Singh, B. N. 1991. Digestibility of lipids in different feeds by mrigal, *Cirrhinus mrigala* (Ham.) and grass carp, *Ctenopharyngodon idella* (Val.). In: S. S. de Silva, (ed.), *Fish Nutrition Research in Asia-Proceeding of the 4th Asian Fish Nutrition Workshop*, Asian Fisheries Society, Manila, pp. 83-86.

Singh, B. N., Das, R. C., Sahu, A. K., Kanungo, G., Sarkar, M., Sahoo, G. C., Nayak, P. K. and Pandey, A. K. 2000. Balanced diet for the broodstock of *Catla catla* and *Labeo rohita* and induced breeding performance using ovaprim. *Journal of Advanced Zoology*, 21(2): 92-97.

Singh, K., Garg, S. K., Bhatnagar, A. and Kalla, A. 2004. Comparison of five different practical diets with various concentrations of dietary protein in nursery ponds: survival and growth of Indian major carp fry. *Asian Fisheries Science*, 17: 121-134.

Srivastava, P. P., Jena, J. K., Chowdhary, S., Sharma, P., Raizada, S. and Dayal, R. 2013. Performances of Catla (*Catla catla*) fingerling reared on locally available feed ingredients. *Journal of Animal and Feed Research*, 3(4): 153-158.

Swamy, D. N., Mohanty, S. N. and Tripathi, S. D. 1988. Growth of mrigal (*Cirrhinus mrigala*, Ham.) fingerlings fed on fishmeal based formulated diets. In: M. Mohan Joseph (ed.), *The First Indian Fisheries Forum, Proceedings*. Asian Fisheries Society, Indian Branch, Mangalore, 81-83.

Swamy, H. V. V. and Devaraj, K. V. 1999. Digestibility of soybean and soybean products in the diets of *Catla catla* (Ham.). In: M. Mohan Joseph, N. R. Menon and N. Unnikrishnan Nair (eds.), *The fourth Indian* Fisheries *Forum, Proceedings* Kochi, 24-28 November 1996 , pp. 307-309.

Usmani, N., Jafri, A. K. and Alvi, A. S. 1997. Effect of feeding glanded cottonseed meal on the growth, conversion efficiencies and carcass composition of *Labeo rohita* fry. *Journal of Aquaculture in the Tropics*, 12(1): 73-78.

CHAPTER - 8

Feed Additives

Ayyappan, S., Pandey, B. K., Sarkar, S., Saha, D. and Tripathy, S. D. 1991. Potential of *Spirulina* as feed supplement for carp fry. In: *Proceedings of the National Symposium of freshwater Aquaculture,* CIFA, Bhubneswar, India, pp. 86-88.

Bandyopadhyay, P. and Mohapatra, P. K. D. 2009. Effect of a probiotic bacterium *Bacillus circulans* PB7 in the formulated diets: on growth, nutritional quality and immunity of *Catla catla* (Ham.). *Fish Physiology and Biochemistry*, 35: 467–478.

Baruah, K., Pal, A. K., Sahu, N. P., Jain, K. K., Mukherjee, S. C. and Debnath D. 2005. Dietary protein level, microbial phytase, citric acid and interactions on bone mineralization of *Labeo rohita* (Hamilton) juveniles. *Aquaculture Research*, 36(8): 803–812.

Baruah, K., Pal, A. K., Sahu, N. P., Jain, K. K., Mukherjee, S. C. and Debnath D. 2007. Dietary microbial phytase and citric acid synergistically enhances nutrient digestibility and growth performance of *Labeo rohita* (Hamilton) juveniles at sub-optimal protein level. *Aquaculture Research*, 38(2): 109–120.

Baruah, K., Sahu, N. P., Pal, A. K., Debnath, D., Yengkokpam, S. and Mukherjee, S. C. 2007. Interactions of dietary microbial phytase, citric acid and crude protein level on mineral utilization by rohu, *Labeo rohita* (Hamilton), juveniles. *Journal of the World Aquaculture Society*, 38(2): 238-249.

Choudhury, D., Pal, A. K., Sahu, N. P., Kumar, S., Das, S. S. and Mukherjee, S. C. 2005. Dietary yeast RNA supplementation reduces mortality by *Aeronomonas hydrophila* in rohu (*Labeo rohita* L) juveniles. *Fish and Shellfish Immunology,* 19: 281-291.

Das, B. C. 1965. Yeast dosage level and the post-embryonic survival and growth of the carp *Labeo rohita* (Ham.). *Journal of Experimental Zoology*, 159 (3): 405–412.

Das, B. C. and Krishnamurthy, H. 1959a. Comparative effects of yeast, ruminant stomach extract on the survival rate of Indian carp during the first three weeks of life. *Indian Journal of Fisheries*, 6: 211–221.

Das, B. C. and Krishnamurthy, H. 1959b. Comparative effects of yeast, vitamin B complex and vitamin B12 on the survival rate of Indian major carp during the first two weeks of life. *Proceedings of National Institute of Science, India B,* 25: 300–306.

Deb, D. and Varghese, T. J. 1988. Effect of 17 α-Methyl-testosterone on the growth and food conversion of Major Carps. In: M. Mohan Joseph (ed.), *Proceedings of the First Indian Fisheries Forum,* Asian Fisheries Society, Indian Branch, Mangalore, pp. 69-71.

Gangadhar, B., Nandessha , M. C., Varghese, T. J. and Keshavanath, P. 1998. Effect of feeding 19-norethisterone on growth and body composition of rohu, *Labeo rohita*. *Asian Fisheries Science,* 11(1): 51-58.

Ghosh, K., Sen, S. K. and Ray, A. K. 2002. Characterization of bacilli isolated from the gut of rohu, *Labeo rohita*, fingerlings and its significance in digestion. *Journal of Applied Aquaculture*, 12(3): 33 – 42.

Ghosh, K., Chakraborty, K., Sen. S. K. and Ray, A. K. 2001. Effect of thermo stable bacterial α-amylase on growth and feed utilization in rohu, *Labeo rohita* (Hamilton), fingerlings. *The Israeli Journal of Aquaculture- Bamidgeh,* 53: 101- 109.

Ghosh, K., Sen, S. K. and Ray, A. K. 2004a. Supplementation of *Lactobacillus acidophilus* in compound diets for *L. rohita* fingerlings. *Indian Journal of Fisheries,* 51(4): 521-526.

Ghosh, K., Sen, S. K. and Ray, A. K. 2004b. Growth and survival of rohu, *Labeo rohita* (Hamilton, 1822) spawn fed diets fermented with intestinal bacterium, *Bacillus circulans*. *Acta Ichthyologica et Piscatori,* 34(2): 155-165.

Ghosh, S., Sinha, A. and Sahu, C. 2007. Isolation of putative probiont from the intestine of an Indian major carp. *Israeli Journal of Aquaculture*, 59(3): 127-132.

Gireesha O., Ramesha T. J., Varghese, T. J. and Manjappa, K. 2002. Impact of dietary livol on the growth, biochemical composition and gut digestive enzyme activity of Catla (*Catla catla*) (Hamilton). *Journal of Aquaculture in the Tropics,* 17(1): 35-42.

Hassan, M.A., Aftabuddin, Md., Meena, D. K., Saha, S., Das Gupta, S., Ganguly, D., Jha, B. C. and Sharma, A. P. 2013. Comparative studies on the role of probiotic, attractants and their combination on feed consumption, growth performance and conversion efficiencies in Indian Major Carps, Labeo rohita fingerlings. In: *Proceedings of the 100th session of Indian Science Congress*, Kolkata, 3-7 January 2013, pp. 93-94.

Jayaprakas, V. and Euphrasia, C. J. 1997. Growth performance of *Labeo rohita* (Ham.) to livol (IHF-1000), a herbal product. *Proccedings of Indian National Science Academy*, 63(1-2): 21-30.

Kadhar, M. A., Musthafa, M. S., Chitrarasu, P., Arunkumar, M. S. and Ali, A. J. 2012. Growth response of two Indian major carps *Catla catla* (Hamilton) and *Cirrhinus mrigala* (Hamilton) fingerlings fed diet containing different nutritional supplements. *International Journal of Applied Biology and Pharmaceutical Technology*, 3(3): 280-286.

Kaur, V. I. and Saxena, P. K. 2005. Incorporation of maize gluten in supplementary feed and its impact on growth and flesh quality of some carps. *Aquaculture international*, 13(6): 555-573.

Kumar, S., Sahu, N. P., Pal, A. K., Sagar, V., Sinha, A. K. and Baruah, K. 2009. Modulation of key metabolic enzyme of Labeo rohita (Hamilton) juvenile: effect of dietary starch type, protein level and exogenous α-amylase in the diet. *Journal of Fish Physiology and Biochemistry*, 35(2): 301-315.

Maheshappa K., Ramesha T. J., Gangadhar, B. and Varghese, T. J. 2002. Effect of feeding livol incorporated diet on nutrient digestibility, body indices and organoleptic quality of rohu, *Labeo rohita*. *Indian Journal of Fisheries,* 49(4): 447-450.

Mukhopadhyay, N. and Ray, A. K. 1999. Improvement of quality of sesame *Seasamum indicum* seed meal protein with supplemental amino acids in feeds for rohu, *Labeo rohita* (Hamilton) fingerlings. *Aquaculture Research,* 30(8): 549–557.

Nandeesha, M. C., Gangadhara, B., Manissery, J. K. and Venkataraman, L. V. 2001. Growth performance of two Indian major carps, catla (*Catla catla*) and rohu (*Labeo rohita*) fed diets containing different levels of *Spirulina platensis*. *Bioresource Technology*, 80: 117-120.

Pandey, A. K., Mahapatra, C. T., Kanungo, G., Sarkar, M., Aravindakshan, P. K., and Singh, B. N. 2002. Effect of dietary thyroxine supplementation on growth of fry of Indian major carp, *Catla catla* (Hamilton-Buchanan). *Journal of Advanced Zoology*, 23(2): 88-91.

Paul, B. N., Sarkar, S., Mohanty, B. and Mukhopadhyay, P. K. 1999. Effect of dietary supplementation of some attractants on feeding response and growth performance in rohu fingerlings. In: *IX Animal Nutrition Research Worker's Conference,* Andhra Agriculture University, Rajendranagar, Hyderabad, 2-4 December 1999.

Raj, K., Sharma, B. K. and Sharma, L. L. 2007. Impact of *Glycyrrhiza glabra* Linn. as growth promoter in the supplementary feed of an indian major carp *Cirrhinus mrigala* (Ham.). *Indian Journal of Animal Research*, 41(1): 35 - 38.

Rathore, R. M., Kumar, S. and Chakrabarti, R. 2005. Digestive enzyme patterns and evaluation of protease classes in *Catla catla* (Family: Cyprinidae) during early developmental stages. *Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology*, 142(1): 98-106.

Sahoo, P. K., Sahoo, S. K. and Mukherjee, S. C. 1998. Effects of feeding Trigon– a herbal product on growth of rohu, *Labeo rohita* fingerlings. In: *National Symposium Sustainable Aquaculture,* University of Delhi, 20-21 February 1998.

Singh, B. N., Ayyappan, S., Nayak, P. K., Mishra, T. K. and Pandey, A. K. 2001. Evaluation of potential for using HGH to enhance growth in juvenile catla. *Indian Journal of Fisheries*, 48(1): 27-33.

Vasanthakumar, D. and Aruna, D. 2013. Effect of certain probiotics on the growth of Indian Major carp *Cirrhinus mrigala* (Ham.) In: *Proceedings of the 100th session of Indian Science Congress,* Kolkata, 3-7 January 2013, pp. 162.

Victor, B., Ramesh U. and Maridass, M. 2003. Effect of dietary β-chitosan levels on survival and growth of fingerlings of *C. carpio, C. catla and C. mrigala*. *Fishery Technology*, 40(1): 5-7.

CHAPTER - 9

Physiology/Metabolism

Ahmed, K. K. U., Amin, S. M. N., Haldar, G. C., Dewan, S. and Hossain, M. M. 2005. A study on the intestinal lipase of Indian major carp *Labeo rohita*. *Asian Fisheries Science,* 18(1): 1-83.

Akhtar, M. S., Pal A. K., Sahu N. P., Alexander C., Gupta S. K., Choudhary A. K., Jha A. K. and Rajan, M. G. 2010. Stress mitigating and immuno-modulatory effect of dietary pyridoxine in *Labeo rohita* (Hamilton) fingerlings. *Aquaculture Research.* 41(7): 991-1002.

Ali, M., Salam, A., Razaq, S. and Ansari, T. M. 2005. Dynamics of body composition, RNA: DNA ratio and elemental concentration of rohu *Labeo rohita* (Ham.) in relation to stress induced by fasting. *Asian Fisheries Science,* 18(1): 15-23.

Andrews, S. R., Sahu, N. P., Pal, A. K. and Kumar, S. 2009. Haematological modulation and growth of *Labeo rohita* fingerlings: effect of dietary mannan oligosaccharide, yeast extract, protein hydrolysate and chlorella. *Aquaculture Research,* 41(1): 61-69.

Bairagi, A., Sarkar, G. K., Sen, S. K. and Ray, A. K. 2002. Enzyme producing bacterial flora isolated from fish digestive tracts. *Aquaculture International,* 10: 109–121.

Baruah, K., Pal, A. K., Sahu, N. P., Debnath, D., Yengkokpam, S., Norouzitallab, P. and Sorgeloos, P. 2009. Dietary crude protein, citric acid and microbial phytase interacts to influence the hemato-immunological parameters of Rohu, *Labeo rohita*, juveniles. *Journal of World Aquaculture Society,* 40(6): 824-831.

Besra, S. 2002. Ammonia excretion in fishes with different feeding habits. *Proceedings of National Academy of Science, India,* 72(1): 76-81.

Chakrabarti, R., Rathore, R. M. and Kumar, S. 2006. Study of digestive enzyme activities and partial characterization of digestive proteases in a freshwater teleost, *Labeo rohita*, during early ontogeny. *Aquaculture Nutrition*, 12(1): 35–43.

Chakrabrati, R. and Rathore, R. 2010. Ontogenic changes in the digestive enzyme patterns and characterization of proteases in Indian major carp *Cirrhinus mrigala*. *Aquaculture Nutrition,* 16(6): 569–581.

Das, T., Pal, A. K., Chakraborty, S. K., Manush, S. M., Dalvi, R. S., Apte, S. K., Sahu, N. P. and Baruah, K. 2009. Biochemical and stress responses of *Labeo rohita* (Hamilton) and *Cirrhinus mrigala* (Hamilton) in relation to acclimation temperatures. *Journal of Fish Biology*. 74(7): 1487-1498.

Debnath, D., Pal, A. K., Sahu, N. P., Yengkokpam, S., Baruah, K., Choudhury, D. and Venkateshwarlu, G. 2007. Digestive enzymes and metabolic profile of *Labeo rohita* fingerlings fed diets with different crude protein levels. *Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology,* 146: 107-114.

Dhange, K. P. 1968. Studies of the digestive enzymes in the three species of the major carps of India. *Journal of Biological Sciences*, 11: 63-74.

Gangadhara, B., Nandeesha, M. C., Keshavanath, P. and Varghese, T. J. 2004. Growth response and biochemical composition of rohu, *Labeo rohita,* fed salt-incorporated diets. *Journal of Applied Aquaculture,* 16(1): 169 – 176.

Gupta, S. K., Pal A. K., Sahu, N. P., Dalvi, R. S., Akhtar, M. S., Jha, A. K., Baruah K. 2010. Dietary microbial levan enhances tolerance of *Labeo rohita* (Hamilton) juveniles to thermal stress. *Aquaculture,* 306: 398-402.

Gupta, S. K., Pal, A. K., Sahu, N. P., Dalvi, R. S., Kumar,V. and Mukherjee, S. C. 2008. Microbial levan in the diet of *Labeo rohita* Hamilton juveniles: effect on non-specific immunity and histopathological changes after challenge with *Aeromonas hydrophilla*. *Journal of fish diseases*. 31: 649-657.

Jha, A. K., Pal, A. K., Sahu, N. P., Kumar, S. and Mukherjee, S. C. 2007. Haematoimmunological responses to dietary yeast RNA, ω-3 fatty acid and β-carotene in *Catla catla* juveniles. *Fish and Shellfish Immunology,* 23: 917-927.

Kaleeswaran, B., Ilavenil, S. and Ravikumar, S. 2011. Growth response, feed conversion ratio and anti-protease activity of *Cynodon dactylon* (L.) mixed diet in *Catla catla* (Ham.) *Journal of Animal and Veterinary Advances,* 10(4): 511-517.

Kiran, B. R., Puttaiah, E. T., Anantha, C. S. and Manissery, J. K. 2001. Larval rearing of mrigala and catla by change in fishmeal. *Geobios*, 28(2-3): 105-108.

Kumar, V., Sahu, N. P., Pal, A. K., Kumar, S., Sagar, V., Sinha, A. K., Ranjan, J., and Baruah, K. 2010. Modulation of key enzymes of glycolysis, gluconeogenesis, amino acid catabolism and TCA cycle of a tropical freshwater fish *Labeo rohita* fed gelatinized and non-gelatinized starch diet. *Fish Physiology and Biochemistry*, 36(3): 491-99.

Kumar, V., Sahu, N. P., Pal, A. K., Kumar, S., Sharma, P., Chettri, J. K. and Sinha, A. K. 2009. Non-gelatinized starch influences the deposition of n-3 fatty acids in the muscle of a tropical freshwater fish, *Labeo rohita*. *Fish Physiology and Biochemistry,* 93(5), 659-668.

Mahajan, C. L. and Sharma, K. P. 1976. Studies on the effect of some vitamins and antibiotics on the survival and growth of carps in the first few weeks of their life. *Journal of the Inland Fisheries Society of India,* 8: 192–199.

Mahboob, S. and Sheri, A. N. 2002. Influence of fertilizers and artificial feed on the total dressing losses, meat: bone ratios, specific gravity and density of fish and regression studies of dry weight of planktonic biomass on physicochemical parameters. *Journal of Aquaculture Tropics,* 17(1): 43-58.

Maitra, S. K. and Chattoraj, A. 2007. Role of photoperiod and melatonin in the regulation of ovarian functions in Indian carp, *Catla catla:* basic information for future application. *Fish Physiology and Biochemistry*, 33(4): 367-382.

Misra, C., Das, B. and Mukherjee, S. 2009. Immune response, growth and survival of *Labeo rohita* fingerlings fed with levamisole supplemented diets for longer duration. *Aquaculture Nutrition*, 15(4): 356-365.

Mitra, G. and Mukhopadhyay, P. K. 2002. Growth, nutrient utilization and tissue biochemical changes in rohu, *Labeo rohita* fed with natural and prepared diets. *Journal of Applied Aquaculture,* 12(3): 65 – 80.

Mohanty, R. K. 2003. Feed intake pattern and growth performance of Indian major carps, common carp and freshwater prawn in a rice-fish integration system. *Asian Fisheries Science,* 16: 307-316.

Mohanty, S. N., Das, K. M. and Sarkar, S. 1995. Effects of feeding varying dietary formulations on body composition of rohu fry. *Journal of Aquaculture,* 3: 23-28.

Mohanty, S. N., Swain, S. K. and Panigrahi, A. 1997. Daily energy budget of rohu (*Labeo rohita*, Ham.) fingerlings fed two diets. In: *National Seminar on Fish Biology,* Visva-Bharati University, Santiniketan, 17-19 March.

Mohanty, S. N., Swain, S. K. and Panigrahi, A. 1999. Energy budgets of different sizes of Rohu (*Labeo rohita*) fry fed two diets. *Journal of Aquaculture in the Tropics,* 14(3): 217-226.

Mukherjee, S. and Jana, B. B. 2007. Water quality affects SDH activity, protein content and RNA: DNA ratios in fish (*Catla catla, Labeo rohita* and *Oreochromis mossambicus*) raised in ponds of a sewage-fed fish farm. *Aquaculture*, 262(1): 105-119.

Mukhopadhaya, P. K. 2005. Fish feed and their quality attributes with reference to high yielding aquaculture. *Journal of the Indian Society of Coastal Aquaculture Research,* 22(1-2): 274-284.

Mukhopadhyay, P. K. and Chattopadhyay, D. N. 2002. Feed strategies for carps. *Aquafeed International,* 5: 23-25.

Mukhopadhyay, P. K., Mohanty, S. N., Das, K. M., Sarkar, S. and Patra, B. C. 1991. Growth and changes in carcass composition in young of *Labeo rohita* and *Cirrhinus mrigala* during feeding and starvation. In: *Fish Nutrition Research in Asia, Proceedings of the 4th Asian Fish Nutrition Workshop, Special Publication,* Asian Fish Society, 5: 87-91.

Mukhopadhyaya, P. K., Mohanty, S. N., Nandi, S., Paul, B. N. and Rangacharyulu, P. V. 1997. Nutritional requirements and diet development for Indian major carps with special reference to genetically improved rohu. In: *Workshop on Genetic Improvement of rohu (L. rohita) for Growth through Selective Breeding*, Central Institute of Freshwater Aquaculture, Bhubaneswar, pp.17-20.

Nandeesha, M. C., Gangadhara, B. Manissery, J. K. and Venkataraman, L. V. 2001. Growth performance of two Indian major carps, catla (*Catla catla*) and rohu (*Labeo rohita*) fed diets containing different levels of *Spirulina platensis*. *Bioresource Technology*, 80(2): 117-120.

Nayak, J., Nair, P. G. V., Mathew, S. and Ammu, K. 2004. A study on the intestinal lipase of Indian major carp *Labeo rohita*. *Asian Fisheries Science*, 173(4): 333-340.

Pandey, A. K., Mahapatra C. T., Sarkar M., Kanungo G. and Singh B. N. 2004. Effect of dietary thyroxine supplementation on growth of fry of Indian major carp, *Cirrhinus mrigala* (Hamilton-Buchanan). *Journal of Experimental Zoology India*, 7: 73-77.

Paul, B. N., Nandi, S., Sarkar, S., Sahoo, P. K. and Mukhopadhyay, P. K. 1995. Effect of feeding unconventional animal protein on the growth performance and certain enzyme levels in *Labeo rohita* fingerlings. In: *Ninth National Congress on Zoology*. Burdwan University and Zoological Society of India, Burdwan, 26-28 September 1995, pp. 8-9.

Paul, B. N., Rangacharyulu, P. V., Sarkar, S. and Mukhopadhyay, P. K. 1994. Effect of feed colour on the growth and responses at enzymatic and tissue levels in carps, *L. rohita*. In: *National Symposium on Aquacrops*, Indian Fisheries Association, Bombay.

Paul, B. N., Nandi, S., Sarkar, S. and Mukhopadhyay, P. K. 1997. Effect of feeding unconventional animal protein sources on the nitrogen metabolism in rohu, *L. rohita* (Ham.). *Israeli Journal of Aquaculture, Bamidgeh*, 49(4): 183-192.

Phadate, S. V. and Srikar, L. N. 1988. Effect of formulated feeds on protease activity and growth of three species of carps. In: *The First Indian Fisheries Forum, Proceedings,* Asian Fisheries Society, Indian Branch, Mangalore, pp. 85-88.

Premila, C. L. and Sampath, K. 2001. Optimum feeding frequency as a function of body weight in *Cirrhinus mrigala*. *Environment and Ecology*, 19(4):893-899.

Rajyasree, M. and Naidu, K. R. P. 1989. Starvation induced changes in biochemical aspects of hepatic tissue of fish, *Labeo rohita*. *Indian Journal of Fisheries*, 36: 339-341.

Rao, Y. V. and Chakrabarti, R. 2004. Enhanced antiproteases in *Labeo rohita* fed with diet containing herbal ingredients. *Indian Journal of Clinical Biochemistry*, 19: 132-134.

Ramaneswari, K. and Rao, L. M. 2006. Feed utilization and growth in juveniles of *Labeo rohita* under the stress of monocrotophos. *Asian Fisheries Science*, 19(1): 91-96.

Rangacharyulu, P. V., Paul, B. N., Nandi, S., Sarkar, S. and Mukhopadhyay, P. K. 2000. Effect of different protein and energy levels on growth, nitrogen metabolism and body composition of rohu (*Labeo rohita*). *Journal of Aquaculture*, 8: 17-24.

Rangacharyulu, P. V., Sarkar, S., Mohanty, S. N., Das, K. M. and Mukhopadhyay, P. K. 1991. Growth and protein utilization in rohu, *Labeo rohita*, under different feeding levels. In: *National Symposium on New Horizons in Freshwater Aquaculture, Proceedings*. Association of Aquaculturists and CIFA, Bhubaneswar, 23-25 Jan 1991, pp. 95-97.

Rangachryulu, P. V. and Sarkar, S. 1997. Effect of feeding varying levels of protein in growth and carcass composition in *Labeo calbasu*. In: *National Workshop on Fish and Prawn Feeds,* Central Institute of Freshwater Aquaculture, Bhubaneswar, 2-3 September 1997, pp.7.

Rao, Y. V., Romesh, M., Singh, A. and Chakrabarti, R. 2004. Potentiation of antibody production in Indian major carp *Labeo rohita*, rohu by *Achyranthes aspera* as an herbal feed ingredient. *Aquaculture,* 238(1-4): 67-73.

Ray, A. K., Roy, T., Mondal, S. and Ringo, E. 2010. Identification of gut-associated amylase, cellulose and protease-producing bacteria in three species of Indian major carps. *Aquaculture Research*, 41(10): 1462-1469.

Roy, A. K. and Das, I. 1994. Apparent digestibility of some aquatic macrophytes in rohu fingerlings. *Journal of Aquaculture in the Tropics*, 9(4): 335-342.

Saha, A. K. and Ray, A. K. 1993. Nutrient digestibility of three oil cakes by the fingerlings of an Indian major carp *Labeo rohita* (Ham.). In: *Proceedings of The Third Indian Fisheries Forum,* Pantnagar, pp. 1-4.

Saha, A. K. and Ray, A. K. 1998. Cellulase activity in rohu fingerlings. *Aquaculture International,* 6: 281–291.

Sahoo, P. K. and Mukherjee, S. C. 2001. Dietary intake of levamisole improves non-specific immunity and disease resistance of healthy and aflatoxin-induced immunocompromised rohu, *Labeo rohita*. *Journal of Applied Aquaculture,* 11(4): 15 – 25.

Sahoo, P. K. and Mukherjee, S. C. 2002. The effect of dietary glucan, levamisole, ascorbic acid and α-tocopherol on disease resistant and non-specific immunity level in alfatoxin B_1 induced immunocompromised rohu (*Labeo rohita*). In: *Proceedings of Fifth Indian Fisheries Forum,* AFSIB, Mangalore and AOA, Bhubaneswar, pp. 119-126.

Sales, J. 2008. The use of linear regression to predict digestible protein and available amino acid contents of feed ingredients and diets for fish. *Aquaculture,* 278(1-4): 128-142.

Sales, J. 2009. Prediction of digestible energy content across feed ingredients and fish species by linear regression. *Fish Physiology and Biochemistry*, 35(4): 551-565.

Sardar, P., Prabhakar, S. K., Dutta, S. C. and Minhas, H. S. 2007. Effect of feed quality restriction followed by realimentation on nutrient utilization, biochemical changes and hematological profiles of Indian major carp, rohu (*Labeo rohita* Ham.). *Environment and Ecology*, 25S (2): 464-469.

Satpathy, B. B., Mukherjee, D. and Ray, A. K. 2001. Effects of dietary inclusion of the beta-adrenergic agent, salbutamol, on growth performance and whole body composition of rohu *Labeo rohita* (Hamilton) fingerlings fed diets containing two protein levels. *Aquaculture Research,* 32(9): 739–747.

Satpathy, B. B., Mukhopadhyay, P. K. and Ray, A. K. 1995. Nutritive utilization and growth bioenergetics of *Labeo rohita* fry in relation to o different dietary protein sources and dietary inclusion of 17-methyl-testosterone. In: *Proceeding of the National Symposium on Sustainable Agriculture in Sub-humid Zone,* Visva Bharati University, Santiniketan, pp. 262-265.

Saurabh, S. and Sahoo, P. K. 2008. Lysozyme: an important defence molecule of fish innate immune system. *Aquaculture Research*, 39(3): 223–239.

Sehgal, H. S. and Sharma, S. 1991. Efficiency of two supplementary diets for an Indian major Carp, mrigala effects on flesh composition. *Journal of Aquaculture in the Tropics*, 6(1): 25-34.

Sen, P. R. 1972. Effect of growth promoting substances on survival and growth of fry of Indian major carps. In: *Proceedings of the symposium on aquaculture as an industry*, Central Inland Fisheries Research Institute, Barrackpore, India, pp. 8.

Sethuramalingam, T. A. 2006. Influence of feeding level on ammonia excretion by Indian major carp, *Cirrhinus mrigala* (Hamilton). *Environment and Ecology*, 24(3): 617-622.

Singh, B. N., Das, R. C., Sahu, A. K., Kanungo, G., Sarkar, M., Sahoo, G. C., Nayak, P. K. and Pandey, A. K. 2000. Balanced diet for broodstocks of *Catla catla* and *Labeo rohita* and induced breeding using ovaprim. *Journal of Advance Zoology*, 21: 92-97.

Singh, B. N., Sarkar, M., Mahapatra, C. T., Kanungo, G. and Pandey, A. K. 2000. Effect of 17 a-methyltestosterone on growth of *Catla catla* fry under hatchery condition. In: *Proceedings of the Ninth All India Congress of Zoology*, Department of Zoology, Utkal University, Bhubaneswar, pp. 5-7.

Singh, B. N., Sinha, V. R. P. and Chakraborty, D. P. 1980. Feed intake, absorption, conversion and growth of fry and fingerlings of rohu. *Indian Journal of Fisheries*, 27(1-2): 193-200.

Singh, R. and Dhawan, A. 1993. Incorporation of molasses with mustard meal and rice polish for the development of cost effective feed for carps. In: *The Third Indian Fisheries Forum, Proceedings*, Pantnagar, pp. 19-21.

Sukumaran, K., Pal, A. K., Sahu, N. P., Dalvi, R. S. and Debnath, D. 2008. Hemato-biochemical responses and induction of HSP70 to dietary phosphorus in *Catla catla* (Hamilton) fingerlings. *Fish Physiology and Biochemistry*, 34(4): 299-306.

Swain, S. K. and Mohanty, S. N. 1997. Effects of dietary qualities on nitrogen and energy excretions in rohu (*Labeo rohita*, Ham.). In: *National Workshop on Fish and Prawn Feeds*, Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar, 2-3 September 1997, pp. 28.

Swain, S. K., Rangacharyulu, P. V., Sarkar, S. and Das, K. M. 1996. Effect of a probiotic supplement on growth, nutrient utilization and carcass composition in mrigal fry. *Journal of Aquaculture*, 4: 29–35.

Tejpal, C. S., Pal, A. K., Sahu, N. P., Jha, A. K., Muthappa, N. A., Vidya, S. and Rajan, M. G. 2009. Dietary supplementation of L-tryptophan mitigates crowding stress and augments the growth in *Cirrhinus mrigala* fingerlings. *Aquaculture*, 293: 272-277.

Yengkokpam., S, Pal, A. K., Sahu, N. P., Jain, K. K., Dalvi, R., Misra, S. and Debnath, D. 2008. Metabolic modulation in *Labeo rohita* fingerlings during starvation: Hsp70 expression and oxygen consumption. *Aquaculture*, 285(1-4): 234-237.

Yusuf, K. M. 1967. Studies on the food and alimentary canal of the Indian major Carps. *Indian Journal of Fisheries*, 14(1-2): 24-47.

CHAPTER - 10

Feeding Practice

Abidi, S. F. and Khan, M. A. 2012. Evaluation of feeding rate based on growth, feed conversion, protein gain and carcass quality of fingerling Indian major carp, *Catla catla* (Hamilton). *Aquaculture Research,* 45(3): 439-447.

Aftabuddin, Md., Hassan, M. A., Ganguly, D., Saha, S., Das Gupta, S., Jha, B. C. and Sharma, A. P. 2012. Standardization of feeding strategy for carp cage culture in reservoir: effect of feeding frequency. In: *Book of Abstracts, Global Symposium for Eradicating Hunger and Malnutrition – Opportunities and Challenges*. December 3 -6, Mangalore, Karnataka, pp.176.

Ali, M. R., Ahmed, I., Ahmed, M. and Sahar, L. 2003. Influence of different levels of supplementary feeding on the growth performance of major carps. *Pakistan Journal of Biological Sciences,* 6(9): 849-853.

Azim, M. E., Verdegem, M. C. J., Khatoon, H., Wahab, M. A., van Dam, A. A. and Beveridge, M. C. M. 2002. A comparison of fertilization, feeding and three periphyton substrates for increasing fish production in freshwater pond aquaculture in Bangladesh. *Aquaculture*, 212(1-4): 227-243.

Bandhopadhyay, S. and Puste, A. M. 2001. Effect of carp and fish feed on yield and soil nutrient availability under integrated rice-fish culture. *Asian Fisheries Science*, 14: 357-455.

Bhakta, J. N., Sarkar, D., Jana, S. and Jana, B. B. 2004. Optimizing fertilizer dose for rearing stage production of carps under polyculture. *Aquaculture,* 239(1-4): 125-139.

Biswas, G., Jena, J. K., Singh, S. K., Patmajhi, P. and Muduli, H. K. 2006. Effect of feeding frequency on growth, survival and feed utilization in mrigal, *Cirrhinus mrigala,* and rohu, *Labeo rohita,* during nursery rearing. *Aquaculture,* 254(1-4): 211-218.

Biswas, G., Joy, J., Singh, S. K. and Muduli, H. K. 2006b. Effect of feeding frequency on growth, survival and feed utilization in fingerlings of *Catla catla* (Hamilton), *Labeo rohita* (Hamilton) and *Cirrhinus mrigala* (Hamilton) in outdoor rearing systems. *Aquaculture Research,* 37(5): 510–514.

Chakrabarti, R., and Jana, B. B. 1998. Effects on growth and water quality of feeding exogenous plankton compared to use of manure in the culture of mrigal, *Cirrhinus mrigala*, and rohu, *Labeo rohita*, fry in tanks. *Journal of Applied Aquaculture*, 8(2): 87 – 95.

Chakrabarty, R. D., Sen, P. R., Chatterjee, D. K. and Kowtal, G. V. 1973. Observations on the relative usefulness of different feed for carp spawn and fry. *Journal of Inland Fisheries Society of India,* 5: 182–188.

Chakrabarty, R. D., Sen, P. R., Chatterjee, D. K. and Jena, S. 1975. On the use of fertilizer and supplementary feed for enhancing fish production in composite fish culture of Indian and exotic carps. *Proceedings of National Academy of Sciences, India*, 45 (B): III: 192–196.

Chatterjee, N. R. 1996. Influence of cow dung on the productivity and rearing of Indian major carp spawn. *Geobios*, 23: 117-121.

Chattopadhyay, D. N., Marandi, K., Verma, J. P., Sarkar, S. K., Mukhopadhyay, P. K. and Giri, S. S. 2002. Effect of dietary vitamin supplementation on Indian major carps and aquatic eco-system under semi-intensive polyculture system. *Indian Journal of Fisheries,* 49: 179-186.

Deolalikar, A.V. and Mitra, A. 2004. Effect of vermicompost on growth of fish *Labeo rohita* (Hamilton). *Aquaculture in the Tropics,* 19(1): 63-79.

Dewan, D., Wahab, M. A., Beveridge, M. C. M., Rahman, M. H. and Sarkar, B. K. 1991. Food selection, electivity and dietary overlap among planktivorous Chinese and Indian major carp fry and fingerlings grown in extensively managed rain-fed ponds in Bangladesh. *Aquaculture Research,* 22(3): 277–294.

Dinesh, K., Kumaran, M. and Nair, C. 2000. High density indoor rearing of *Labeo rohita* spawns using different diets. *Fishery Technology,* 37(2): 121-124.

Gangadhara, B., Keshavanath, P., Ramesha, T. J. and Priyadarshini, M. 2004. Digestibility of bamboo-grown periphyton by carps (*Catla catla, Labeo rohita, Cirrhinus mrigala, Cyprinus carpio, Ctenopharyngodon idella*, and *Tor khudree*) and hybrid red tilapia (Oreochromis mossambicus × O. niloticus). *Journal of Applied Aquaculture*, 15(3-4): 151-162.

Hassan, M. A., Aftabuddin, Md., Meena, D. K., Saha, S., Das Gupta S., Ganguly, D., Jha, B. C. and Sharma, A. P. 2013. Effect of circadian rhythm on feeding on feeding of *Labeo rohita* fingerlings reared in open water cages. In: *Proceedings of the 100th session of Indian Science Congress,* Kolkata, 3-7 January 2013, pp. 184-185.

Keshavanath, P., Gangadhar, B., Ramesh, T. J., van Dam, A. A., Beveridge M. C. M. and Verdegem M. C. J. 2002. The effect of periphyton and supplemental feeding on the production of the indigenous carps *Tor khudree* and *Labeo fimbriatus*. *Aquaculture,* 213(1-4): 207-218.

Khan, M. A., Ahmed, I. and Abidi, S. F. 2004. Effect of ration size on growth, conversion efficiency and body composition of fingerling mrigal, *Cirrhinus mrigala* (Hamilton). *Aquaculture Nutrition,* 10: 47-53.

Kumar, P., Jain, K. K., Munilkumar S., Sahu, N.P. and Pal, A. K. 2013. Effect of feeding normal and low protein diet alternately to *Labeo rohita* fingerlings on growth performance and biochemical composition. *International Journal of Science and Knowledge,* 2(1): 3-13.

Langer, S., Sharma, C. and Devi, A. 2010. Effects of alternate starvation and re-feeding cycles on compensatory growth response in *Cyprinus carpio* and *Cirrhinus mrigala:* a comparative study. *Journal of Inland Fisheries Society of India,* 42(1): 46-52.

Mehmood, E., Ashraf, M. and Qureshi, A. H. 1998. Complete or partial replacement of natural food by inert diets for rearing of first feeding rohu (*Labeo rohita*). *Pakistan Journal of Zoology,* 30(4): 277-281.

Miaje, M. A. H., Hossain, M. A., Hasan, M. R. and Siddique, M. A. L. 1999. Effect of form of supplemental feed on the growth and production of Indian major carps and silver barb in polyculture. *Bangladesh Journal of Aquaculture*, 21: 41-46.

Mitra, G., Mukhopadhyay, P. K. and Ayyappan, S. 2007. Biochemical composition of zooplankton community grown in freshwater earthen ponds: Nutritional implication in nursery rearing of fish larvae and early juveniles. *Aquaculture*, 272(1-4): 346-360.

Mohanty, S. N. and Samal, J. K. 1994. Effect of mixed feeding schedule on growth and nutrient utilisation in Rohu, *Labeo rohita* (Hamilton) fingerlings. *Journal of Indian Fisheries Association*, 24: 81-89.

Mohanty, S. N. and Swamy, D. N. 1986. Enriched conventional feed for Indian major carps. In: J. L. Maclean, L. B. Dizon and L.V. Hosillos (eds.), *Proceedings of the First Asian Fisheries Forum,* Manila, Philippines, 26-31 May, pp. 597-598.

Mookerji, N. and Rao. T. R. 1993. Patterns of prey selection in rohu (*Labeo rohita*) and singhi (*Heteropneustes fossilis*) larvae under light and dark conditions. *Aquaculture*, 118(1-2): 85-104.

Mookerji, N. and Rao, T. R. 1995. Prey capture success, feeding frequency and daily food intake rates in rohu, *Labeo rohita* (Hamilton) and singhi, *Heteropneustes fossilis* (Bloch) larvae. *Journal of Applied Ichthyology,* 11(1-2): 37–49.

Mukhopadhyay, N. and Ray, A. K. 1999. Effect of fermentation on the nutritive value of sesame seed meal in the diets for rohu, *Labeo rohita* (Hamilton), fingerlings. *Aquaculture Nutrition*, 5(4): 229–236.

Murthy, H. S., Pavadi, P., Sudhakar, N. S., Manjappa, N., Chinthamani, V. S. and Shankar, R. 2009. Fish compost and its effect on growth and survival of Indian major carp, *Labeo rohita. Journal of Applied Aquaculture*, 21(1): 50 – 60.

Nandeesha, M. C., De Silva, S. S. and Krishna, M. D. 1993. Evaluation of mixed feeding schedules in two Indian major carps, catla (*Catla catla*) and rohu (*Labeo rohita*). *In:* S. J. Kaushik and P. Luquet (eds.*), Fish nutrition in practice*,. INRA Editions, Paris, France, pp. 753-765.

Nandeesha, M. C., De Silva, S. S., Murthy, D. K. and Dathatri, K. 1994. Use of mixed feeding schedules in fish culture: field trials on catla, *Catla catla* (Hamilton-Buchanan), rohu, *Labeo rohita* (Hamilton), and common carp, *Cyprinus carpio* (L.). *Aquaculture Research*, 25(6): 659–670.

Nandeesha, M. C., Srikanth, G. K., Varghese, T. J., Keshavanath, P. and Shetty, H. P. C. 1989c. Growth performance of an Indian major carp, *Catla catla* (Ham.), on fish meal free diets. In: S.S. de Silva, (ed.), *Fish Nutrition Research in Asia, Proceedings of the Third Asian Fish Nutrition Network Meeting, Asian Fisheries Society Special Publication No. 4,* Asian Fisheries Society, Manila, Philippines. pp. 137–142.

Patra, B. C., Maity, J. and Patra, S. 2001. Appetite and daily pattern of feed intake and faeces release in Indian major carps, *Catla catla* (Hamilton), *Labeo rohita* (Hamilton) and *Cirrhinus mrigala* (Hamilton). *Applied Fisheries and Aquaculture*, 1: 57 – 60.

Paul, B. N., Saha, C., Ghosh, A. S. and Adhikari, S. 1999. Effect of feed pellet diameter on growth of rohu juveniles in flow-through aquaculture system. *Indian Journal of Animal Nutrition,* 16(1): 34-37.

Rahman, M. M., Jo, Q., Gong, Y. G., Miller, S. A. and Hossain, M. Y. 2008. A compararive study of common carp (*Cyprinus carpio* L.) and (*Labeo calbasu*, Hamilton) on bottom soil resuspension, water quality, nutrient accumulations, food intake and growth of fish in stimulated rohu *Labeo rohita* (Hamilton) ponds. *Aquaculture*, 285(1-4): 78-83.

Rahman, M. M., Nagelkerke, L. A. J., Verdegem, M. C. J., Wahab, M. A. and Verreth, J. A. J. 2008. Relationships among water quality, food resources, fish diet and fish growth in polyculture ponds: A multivariate approach. *Aquaculture*, 275(1-4): 108-115.

Rahman, M. M., Verdegem, M. C. J., Nagelkerke, L. A. J., Wahab, M. A., Milstein, A. and Verreth, J. A. J. 2006. Growth, production and food preference of rohu *Labeo rohita* (H.) in monoculture and in polyculture with common carps *Cyprinus carpio* (L.) under fed and non-fed ponds. *Aquaculture*, 257(1-4): 359-372.

Rajan, M. R. 1997. Survival, feed utilization and growth of *Cirrhinus mrigala* (Ham.) in domestic waste waters. *Environment and Ecology*, 15(2): 291-295.

Rangacharyulu, P. V. and Sarkar, S. 1995. Growth and body composition of rohu, *Labeo rohita* (Hamilton) fingerlings reared at different feeding levels during winter. *Journal of Aquaculture*, 3: 35-39.

Rangacharyulu, P. V., Paul, B. N., Nandi, S., Sarkar, S. and Mukhopadhyay, P. K. 1997. Low pollution diet for carp culture. In: *National Seminar on Fish Biology*, Visva-Bharati University, Santiniketan, 17-19 March 1997.

Rao, N. G. S. 1987. Studies on the growth of fry and fingerlings of selected carps fed on formulated fish feeds. PhD Thesis. Bangalore University, Bangalore, India.

Sahu, A. K., Sahoo, S. K. and Giri, S. S. 2002. Efficacy of water hyacinth compost in nursery ponds for larval rearing of Indian major carp, *Labeo rohita*. *Bioresource technology*, 85: 309-311.

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(2-4): 333-339.

Sampath, K. and Ravindran, J. 1988. Optimum meal frequency in the fry of *Cirrhinus mrigala (*Hamilton). In: M. Mohan Joseph (ed.), *The First Indian Fisheries Forum, Proceedings,* Asian Fisheries Society, Indian Branch, Mangalore, 65-67.

Sardar, P., Kumar, R., Datta, S., Sinha, A., Das, R. C. and Patra, P. K. 2008. Assessment of production potential and nutritional status of Indian major carps and giant freshwater prawn under polyculture system in relation to feeds and feedings methods. *Environment and Ecology*, 26(2): 632-636.

Sen, P. R. and Mohanty, A. N. 1985. Observations on the rate of feeding, conversion and growth of rohu fry. In: *Proceeding of the Second International Conference on Warm Water Aquaculture-Fin Fish*, pp.131-140.

Singh, B. N. and Bhanot, A. K. 1991. Efficiency of pelleted diet over moist diet on rohu fingerlings. *Journal of Applied Zoological Research*, 2(1): 27-29.

Singh, B. N., Sinha, V. R. P., Kumar, K. and Swamy, D. N. 1986. Observations on the feed formulations and fortification of conventional fish feed for rohu, *Labeo rohita* and mrigal, *Cirrhinus mrigala* fry and fingerlings. *International Journal of Academy of Ichthyology*, 7: 31–34.

Sinha, V. R. P. 1979. Contribution of supplementary feed in increasing fish production through composite fish culture in India. In: Halver, J.E. and K.Tiews (eds.) *Proc. World Symp. on Finfish Nutrition and Fishfeed Technology*, Hamburg, W. Germany 20–23 June, 1978, 1: 565–571.

Sulochana Gaur, S. R. and Chari, M. S. 2007. Comparative efficiency of organic manures as producers of fish food organisms (Plankton). *Environment and Ecology*, 25(3): 481-483.

Swain, S. K., Mohanty, S. N. and Tripathi, S. D. 1999. Growth and survival in relation to various stocking densities of catla (*Catla catla* Ham.) spawn fed on a dry artificial diet. *Indian Journal of Fisheries*, 46: 87-90.

CHAPTER - 11

Nutrition and Health

Andrews, S. R., Sahu, N. P., Pal, A. K., Mukherjee, S. C. and Kumar, S. 2009. Yeast extract, brewer's yeast and spirulina in diets for *Labeo rohita* fingerlings affect haemato-immunological responses and survival following *Aeromonas hydrophila* challenge. *Research in Veterinary Science*, 41: 61-69.

Ayyappan, S., Pandey, B. K. and Tripathi, S. D. 1990. Nutritive quality of microbial communities as feed components in experimental carp culture. *Indian Journal of Experimental Biology*, 28: 977-980.

Baruah, K., Pal, A. K., Sahu, N. P., Debnath, D., Yengkokpam, S., Norouzitallab, P. and Sorgeloos, P. 2009. Dietary crude protein, citric acid and microbial phytase interact to influence the hemato-immunological parameters of rohu, *Labeo rohita,* juveniles. *Journal of World Aquaculture Society*, 40(6): 824-831.

Chilke, A. M. 2010. Kinetic study of hepatic β-glucuronidase in the Indian major carp, *Labeo rohita* (Hamilton). *Fish Phyology and Biochemistry*, 36(4): 1145-1149.

Devi, C., Vijayaraghavan, S. and Srinivasulu, C. 1999. Effect of soybean meal (*Glycine max*) feeding on the biochemical composition of *Labeo rohita* fingerlings. *Journal of Aquaculture in tropics,* 14(3): 181-185.

Euphrasia, C. J. and Jayaprakash, V. 1999. Growth response of the Indian major carp *Cirrhinus mrigala* to livol (IHF-1000). In: M. Mohan Joseph, N. R. Menon and N. Unnikrishnan Nair (eds.), *The fourth Indian Fisheries Forum, Proceedings,* Kochi, 24-28 November, 1996. pp. 303-305.

Gupta, S. K., Pal, A. K., Sahu, N. P., Dalvi, R. S., Akhtar, M. S., Jha, A. K. and Baruah, K. 2010. Dietary microbial levan enhances tolerance of *Labeo rohita* (Hamilton) juveniles to thermal stress. *Aquaculture*, 306(1-4): 398-402.

Gupta, S. K., Pal, A. K., Sahu, N. P., Dalvi, R., Kumar, V. and Mukherjee, S. C. 2008. Microbial levan in the diet of *Labeo rohita* (Hamilton) juveniles: effect on non-specific immunity and histopathological changes after challenge with *Aeromonas hydrophila*. *Journal of Fish Diseases,* 31(9): 649–657.

Kavita, K. and Sharma, L. L. 1999. Use of Herb (*Asparagus racemous* wild) supplemented diet for promoting growth in the fry of *Labeo rohita*. In: M. Mohan Joseph, N. R. Menon and N. Unnikrishnan Nair (eds.), *The fourth Indian Fisheries Forum, Proceedings* 24-28 November, 1996. Kochi, pp. 241-243.

Kour, D., Sharma, L. L. and Sharma, B. K. 2004. Use of herb, Bala, (*Sida cordifolia Linn.*) as growth promoter in the supplementary feed of *Cirrhinus mrigala (Ham.). Indian Journal of Fisheries,* 51(4): 501-504.

Mandal, S. and Ghosh, K. 2010. Inhibitory effect of *Pistia tannin* on digestive enzymes of Indian major carps: as in votro study. *Fish Physiology and Biochemistry,* 36(4): 1171-1180.

Mishra, B. K., Kumar, D. and Dey, R. K. 1988. Combined prophylactic drug treatment and balanced diet in rearing fry of the Indian major carp, *Labeo rohita*. *Asian Fisheries Science*, 1(2): 107-218.

Misra, C. K., Das, B. K., Mukherjee, S. C. and Pattnaik, P. 2006. Effect of long term administration of dietary β-glucan on immunity, growth and survival of *Labeo rohita* fingerlings. *Aquaculture*, 255(1-4): 82-94.

Misra, S., Sahu, N. P., Pal, A. K., Xavier, B., Kumar, S. and Mukherjee, S.C. 2006. Pre- and post - challenge immuno-haematological changes in *Labeo rohita juveniles fed gelatinized or non-gelatinized carbohydrate with 3-3 PUFA. Fish and Shellfish Immunology*, 21 (4): 346-356.

Mohapatra, S., Sahu, N. P., Pal, A. K., Prusty, A. K. and Kumar, V. 2010. Hemato-immunology and histo-architectural changes in *Labeo rohita* fingerlings: effect of dietary aflatoxin and mould inhibitor. *Fish Physiology and Biochemistry*, 37(1): 177-186.

Mukhopadhyay, P. K., Nandi, S. and Jayashankar, P. 2013. Broodstock nutrition and feeding: key to the enhancement of quality carp seed production. In: *Proceedings of the 100th session of Indian Science Congress*, Kolkata, 3-7 January 2013, pp. 108-109.

Nair, J. R. and Sherief, P. M. 1998. Acute toxicity of phenol and long-term effects on food consumptions and growth of rohu, *Labeo rohita* (Hamilton) under tropical conditions. *Asian Fisheries Science*, 10(3): 179-268.

Nanjundappa, T. and Varghese, T. J. 1988. Effect of diethylstibestrol on growth and food conversion of *Labeo rohita* (Hamilton). In: *The First Indian Fisheries Forum, Proceedings*, Asian Fisheries Society, Indian Branch, Mangalore, pp. 79-80.

Rao, Y. V., Romesh, M., Singh, A. and Chakrabarti, R. 2004. Potentiation of antibody production in Indian major carp *Labeo rohita*, rohu, by *Achyranthes aspera* as an herbal feed ingredient. *Aquaculture*, 238(1-4): 67-73.

Sahu, B. B., Meher, P. K., Mohanty, S., Reddy, P. V. G. K. and Ayyappan, S. 2000. Evaluation of the carcass and commercial characteristics of carps. *The ICLARM Quarterly*, 23: 10-14

CHAPTER-12

Reviews

Albert, G. J. T. and De Silva, S. S. 1997. Feed preparation and feed management strategies within semi-intensive fish farming systems in the tropics. *Aquaculture,* 151(1-4): 379-404.

Azad, I. S. 1996. Nutrition and health management in aquaculture. *Fishing Chimes,* 16(2): 31-35.

Bhanot, K. K., Mohanty, S. N., Swamy, D. N., Das, K. M. and Sarkar, S. 1989. Advances in carp nutrition research. In: *Souvenir, National Seminar on Forty Years of Freshwater Aquaculture in India,* CIFA, Kausalyagang, 7-9 Nov 1989, pp. 44-45.

De, H. K. and Saha, G. S. 2001. Indigenous technical knowledge (ITK) in feed and nutrition. *Aquaculture Asia,* (2): 20-21.

Hasan, M. R. 2007. Study and analysis of feeds and fertilizers for sustainable aquaculture development. In: *FAO Fisheries Technical Paper No.497,* FAO, Rome.

Kaushik, S. J. 1995. Nutrient requirements, supply and utilization in the context of carp culture. *Aquaculture,* 129(1-4): 225-241.

Khan, M. A. and Abidi, S. F. 2007. Significance of fish nutrition in sustainable development of aquaculture. *Fishing Chimes,* 27: 26-27.

Khan, M. A. 2002. Role of fish nutrition and diet development in boosting aquafarming production in Uttaranchal. In: *Proceedings of the workshop on development of research strategy for aquafarming in Uttaranchal,* Pantnagar, India, 22 April, 2002 pp. 59-64.

Mitra, G. N. and Das, I. 1965. On the nutrition of Indian major carp fry. *Indian Journal of Fisheries*, 12 A (1): 1–24.

Mukhopadhyay, P. K. and Kaushik, S. J. 2001. Nutrition requirements of the Indian major carps. In: *International Aqua Feed, Directory and Buyers' Guide,* 2001, Turret, RAI, Middlesex, England, pp. 28–32.

Mukhopadhyay, P. K. 1995a. Aspects of nutrition and feeding of carps in polyculture. In: *Souvenir,* Deparment of Fisheries, Government of Tripura, Agartala, pp. 27-31.

Mukhopadhyay, P. K. 1995b. Recent advances in aquaculture nutrition research: a review. In: *National Seminar on Current and Emerging Trends in Aquaculture and its Impact on Rural Development*. College of Fisheries Berhampur, pp. 73.

Mukhopadhyay, P. K. 2000. Present status of carp nutrition and feed development studies in India. In: George John and A.S. Ninawe, (eds.), *Aquaculture Feed and Health*, Biotech Consortium India Ltd., New Delhi, pp. 3-11.

Mukhopadhyay, P. K. and Jena, J. K. 1999. Use of non-conventional dietary ingredients in fish feed formulation. In: D. N. Saksena, (ed.), *Ichthyology recent research advances,* Oxford and IBH Publishing Co. New Delhi, Calcutta, pp. 225-248.

Mukhopadhyay, P. K., Mohanty, S. N., Nandi, S., Paul, B. N. and Rangacharyulu, P. V. 1997. Nutritional requirements and diet development for Indian major carps with special reference to genetically improved rohu. In: *Workshop on Genetic Improvement of rohu (L. rohita) for growth through selective breeding*, Central Institute of Freshwater Aquaculture, Bhubaneswar, pp.17-20.

Mukhopadhyay, P. K. and Paul, B. N. 1996. Value addition components in aquaculture feeds. *Fishing Chimes*, 16(1): 15-16.

Nandi, S, Rangacharyulu, P. V. and Mukhopadhyay, P. K. 1997. Aspects of carp broodstock nutrition. *Fishing Chimes*, 17(7): 7-8.

Shetty, H. P. C. and Nandeesha, M. C. 1988. An overview of carp nutrition research in India. In: S.S.de Silva, (ed.), Fish Nutrition Research in Asia, Singapore, Heinemann Asia, pp. 96-116.

Singh, B. N. and Sinha, V. R. P. 1981. Observations on the nutrition of the Indian major carp, *Cirrhinus mrigala* (Hamilton). In: *All India seminar on fish Biology*, Bihar University, Muzaffarpur, Nov. 26–28, 1981, pp. 21.

Singh, B. N. 1991. Nutrition and feed development strategies for aquaculture in India. *Journal of Inland Fisheries Society India*, 23: 99-112.

Swamy, D. N. 1985. Formulated feeds for Asiatic carps. In: *Lecture Notes on Composite Fish Culture and its Extension in India* NACA/TR/85/15.

Swamy, D. N. 1983. Feed formulation for carps. In: *Lectures on Composite Fish Culture and its Extension in India for 1983–84 Session of the NACA Training* , FARTC Sept. 1983, pp. 7.

Zambre, S.G. and Shrivastav P. 2013. Effect of supplementary feeds on the growth performance of *Catla catla* seed in earthen ponds. *Research Link - An International Journal*, 12(4): 31-33.

Author Index

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z

Notes