Indian J. Fish., 64(1): 44-48, 2017
DOI: 10.21077/ijf.2017.64.1.60074-07

Effect of dietary incorporation of fish/prawn meal on performance of *Catla catla* (Hamilton) during nursery phase

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ABSTRACT

Nursery evaluation of catla spawn was carried out by feeding three iso-nitrogenous diets (35% protein in raw and cooked form) for a period of 30 days. The three test diets (treatments) in raw form were: T1 - groundnut oil cake (GOC) + rice bran (RB) + vitamin-mineral (V-M) premix; T2 - GOC+RB+fish meal (FM) + V-M premix, T3 - GOC+RB+prawn meal (PM)+V-M premix. The diet groups GT1, GT2 and GT3 respectively were same feed combinations in cooked form. Incorporation of prawn meal as animal protein source led to significantly higher final weight, final length, % weight gain, specific growth rate (SGR) and protein efficiency ratio (PER) compared to diet with and without fish meal incorporation. Whereas, diet containing fish meal improved the fry growth and survival rate only when it was cooked. Cooked diet either with fish or prawn meal incorporation led to better fry growth over the respective non-cooked diets, revealing the advantage of cooking process for better nourishment in catla fry during nursery phase.

Keywords: Catla, Cooking, Diet, Fry, Growth, Nursery, Spawn, Survival

Introduction

Production of quality seed is a key factor for successful aquaculture operation. In India, the major carps (IMCs) are the key species which contributed 76.5% of the total fish produced from the culture sector (DAHD & F, 2014). However, seed rearing of these species has been often marred with poor growth and survival with the approximate spawn to fry and spawn to fingerling yield ratio generally at 3:1 and 6:1 respectively in earthen ponds. Most of the studies reported on the nursery rearing of carps (Jena *et al*., 1998a; Sahu *et al*., 2007; Das *et al*., 2016) have used simple mixture of powdered groundnut oil cake (GOC) and rice bran (RB) as feed supplements and the fry survival were limited to 30 to 60%. Probably, non-compliance of this supplementary feed mixtures to the nutritional requirement of carp from spawn to fry stage could be one of the major factors for such low survival as opined by many researchers (Varghese, 1976; Basavaraja and Antony, 1997; Das *et al*., 2016). Use of artificial feed prepared from various ingredients have yielded varied levels of fry performance in nursery phase of many species of freshwater fishes (Jena *et al*., 1998b; Jahan *et al*., 2013; Das *et al*., 2016). Das *et al.* (2016) reported 20% increase in survival of olive barb fry with fish meal incorporation in the conventional nursery diet (GOC and RB at 1:1 ratio, w/w). However, only limited systematic information is available on benefit of animal protein incorporation in the nursery diet for improved nourishment of major carp spawn. Besides the feed ingredients, the method of feed preparation is also reported to influence performance of spawn to raise fry. Takeuchi *et al.* (1994) reported that feed prepared from gelatinised (cooked) ingredients improved the apparent starch digestibility, protein efficiency ratio (PER), feed efficiency as well as whole body lipid content and decreased the relative feed consumption if fed to satiation. Among the three IMCs, the fry performance of catla in nursery phase has always been lower in terms of growth and survival as reported earlier (Jena *et al*., 1998a; Swain *et al*., 1999). In addition, unlike rohu and mrigal, catla shows a wide disparity in size during the nursery phase (Jena *et al*., 1998a). Since this species prefers zooplankton during nursery phase, provision of animal protein may enhance its seed output. The present study aims to evaluate the influence of fish and prawn meal incorporation and cooking of diet on the growth performance of catla fry during nursery phase.

Materials and methods

The experiment was conducted in eighteen glass tanks (30 l capacity) placed indoor in the hatchery complex of the ICAR-Central Institute of Freshwater Aquaculture (ICAR-CIFA), Bhubaneswar, India. Spawn of catla produced in the hatchery unit of ICAR-CIFA were acclimatised for 4 h in a 100 l FRP tank. Each tank was filled with 25 l of filtered pond water and stocked with 40 nos. of the acclimatised spawn (average length - 6.0 mm; average weight - 1.6 mg). These tanks were randomly grouped into six groups with triplicates. Aeration was not provided in these tanks. Three iso-nitrogenous diets (~350 g kg^{-1} protein) were formulated and prepared in two forms, *i.e.,* raw and cooked form. Diets T1, T2 and T3 contained ingredients in the raw form *viz*., GOC + RB + vitamin-mineral (V-M) premix; GOC + RB + fish meal (FM) + V-M premix and GOC + RB + prawn meal (PM) + V-M premix, respectively, prepared by thorough mixing of the finely powdered ingredients. Diets GT1, GT2 and GT3 contained the same ingredient combinations respectively and were subjected to cooking during diet preparation. The respective feed mixtures were made into dough with addition of required quantity of water; cooked for 30 min; cooled; mixed with V-M premix and pelleted (2 mm size) using a hand pelletiser and air dried at room temperature. These pellets were further dried in an oven at 60°C for 24 h and made into powder form. The diet formulation as well as the proximate composition of different diets, as analysed following AOAC (2006), are presented in Table 1.

The different dietary groups of catla spawn were fed daily *ad libitum* with respective diet in morning hours between 0900 - 1000 hrs. Unconsumed diet and faecal matter were removed daily by siphoning and an equal volume of water was replenished using filtered pond water stocked in a nearby tank. Water samples were collected from each tank between 0800 and 0900 hrs at 6 days interval for analysis. Except for water temperature and pH, which were recorded *in situ*, the dissolved oxygen, total alkalinity, total hardness, total ammonia nitrogen (TAN), nitrite nitrogen (NO_2-N), total nitrate nitrogen (NO_3-N) and free CO_2 were analysed in the laboratory following standard methods (APHA, 1998).

Table 1. Ingredients and proximate composition of the experimental diets

	Diet 1	Diet 2	Diet 3
Ingredients (g kg dry matter^{-1})			
Fish meal[≠]	-	320	-
Prawn meal[$]	-	-	300
Groundnut oil cake[@]	800	320	340
Rice bran[*]	180	340	340
Vitamin- mineral and premix	20	20	20
Proximate composition (g kg dry matter^{-1})			
Crude protein	348.9	349.5	351.3
Ether extract	62.3	67.8	64.4
Ash	71.9	74.1	80.8
Total carbohydrate (TC)	516.9	508.6	503.5
Calculated digestible energy (DE) (MJ kg^{-1}) (Halver, 1976)	16.82	16.89	16.59

Diet 1-ground nut oil cake (GOC) +rice bran (RB); Diet 2 - GOC+RB+fish meal; Diet 3 - GOC + RB+prawn meal along with vitamin-mineral premix

[≠]Crude protein and ether extract (g kg^{-1}): 596 and 120

[$]Crude protein and ether extract (g kg^{-1}): 557 and 100

[@]Crude protein and ether extract (g kg^{-1}): 420 and 75

[*]Crude protein and ether extract (g kg^{-1}): 72 and 20

Mortality of fish if any in the experimental tanks were monitored and recorded. At the end of 30 days experiment, fry were counted individually in each tank. Ten fry from each tank were randomly sampled and the individual total length and weight were measured. Further, the % weight gain, specific growth rate (SGR) and protein efficiency ratio (PER) were estimated using standard formulae:

Weight gain % = (final weight-initial weight) / (initial weight) x 100

Specific growth rate (SGR) =100 x (*ln* final weight - *ln* initial weight)/number of culture days

Protein efficiency ratio (PER) = Weight gain/protein fed

Statistical analysis of the data on growth performance and survival was done using SPSS 16. One-way analysis of variance and Duncan's Multiple Range Test were used to compare means among the treatments at 95% significance level.

Results and discussion

The proximate composition of the three experimental diets in raw form as given in Table 1 showed variation in crude protein in the range : 348.9 - 351.3 g kg^{-1}, ether extract: 62.3 - 67.8 (g kg^{-1}), ash: 71.9 - 80.8 g kg^{-1}, total carbohydrate : 503.5 - 516.9 g kg^{-1} and digestible energy : 16.59 - 16.89 MJ kg^{-1}.

There was no significant difference in water quality parameters among the treatment tanks (Fig. 1). The water pH (7.51 - 8.45) and dissolved oxygen content (3.2 - 4.8 mg l^{-1}) were within the suitable range as reported earlier in many fry rearing studies (Ahmed, 1997; Basavaraja and Antony, 1997; Jena *et al*., 1998a, b; Jahan *et al*., 2013; Das *et al*., 2016). Total alkalinity and hardness were above 40 mg l^{-1} in all the treatments and were also within the ranges recommended for carp fry (Ahmed, 1997; Basavaraja and Antony, 1997; Das *et al*., 2016). Similarly, TAN, NO_2-N and NO_3-N levels were within ideal range (Ahmed, 1997; Basavaraja and Antony, 1997; Jena *et al*., 1998a, b; Das *et al*., 2016) for the carp fry indicating an ideal growing condition of fry in all the experimental tanks.

Fish fed prawn meal incorporated diet either in raw diet (T3), or in cooked form (GT3) showed significantly higher ($p<0.05$) survival rate compared to other diet groups, except fish in GT2, which did not show significant difference in survival rate with the fish of former groups (Table 2). Average total length and wet weight of the fry after 30 days rearing were in the range of 1.65 - 2.03 cm

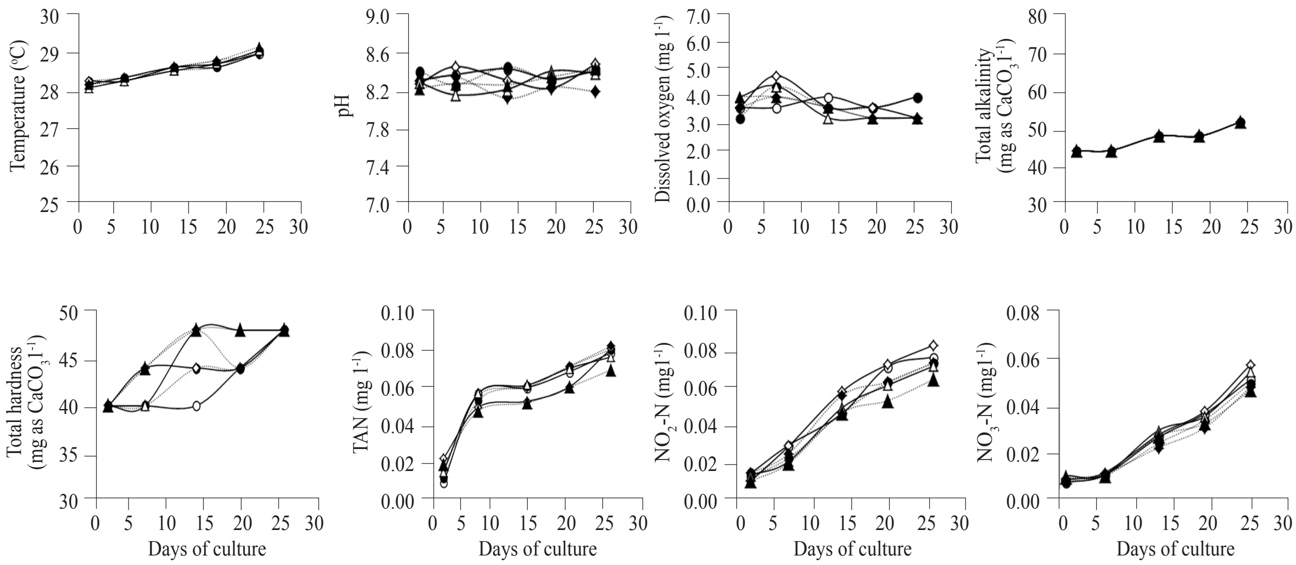

Fig. 1. Water quality parameters in the experimental tanks during the nursery rearing of catla

and 37.57 - 78.44 mg, respectively (Table 2). Jena *et al*. (1998a) reported final length and weight of catla fry in the range of 19.8 - 20.2 mm and 71 - 79 mg, respectively after 15 days nursery trial in earthen pond at rearing density of 5 million ha^{-1}. Growth of fry in their study was comparatively higher compared to the present results. Lower growth observed in the present study may be attributed to fry rearing under indoor condition as well as the higher stocking density of 1.6 fry l^{-1} as compared to the usual density of 0.5 fry l^{-1} used in earthen ponds.

Cooking process of the diets did not yield any marked change in the growth attributes of fish when only GOC and RB were used as the ingredients in GT1 in comparison to fish of T1 ($p>0.05$). However, with incorporation of either fish meal or prawn meal, cooked diets yielded significantly higher final weight, % weight gain and PER in GT2 and GT3 diet groups compared to fish of respective counterparts in raw dietary groups *i.e.* T2 and T3, respectively ($p<0.05$). Though fish of GT2 exhibited significantly higher SGR than fish of T2, there was no significant difference of SGR between the fish of T3 and GT3 ($p>0.05$), which indicated the advantage of cooking process. Cooking of the diets might have helped in the improved utilisation of carbohydrates as the energy source and use of protein for the growth, which was evidenced from the enhanced PER in the cooked diets with either fish meal or prawn meal incorporation.

Dietary incorporation of prawn meal either in raw or cooked form led to significantly higher final weight, final length, % weight gain, SGR and PER in fish compared to fish of all other dietary groups. But, fishmeal incorporated diet could improve the fry growth and nutrient utilisation significantly only when it was cooked (GT2), whereas the same in raw form yielded growth in fish similar to fish fed diets without animal protein (T1 and GT1). In corroboration to our finding, Gomes *et al.* (1995), Hasan *et al*. (1997) and Fontainhas-fernandes *et al*. (1999) reported similar inferior growth and survival in fry/fingerlings fed diet having only plant protein (100% replacement of animal protein), as compared to fish fed

Table 2. Growth attributes (Mean±SE, n = 3) of catla spawn fed different experimental diets

Experimental diets	Initial length (cm)/ weight (mg)	Final length (cm)	Final weight (mg)	Length gain (cm)	% weight gain	SGR	PER	Survival (%)
T1	0.6/1.6	1.65±0.01^{b}	37.57±1.69^{d}	1.05±0.01^{b}	2248.27±105.3^{d}	10.52±0.10^{c}	0.012±0.001^{d}	53.33±8.8^{b}
GT1	0.6/1.6	1.68±0.08^{b}	39.55±4.30^{d}	1.08±0.08^{b}	2371.9±268.6^{d}	10.68±0.4^{c}	0.013±0.003^{cd}	64.2±10.4^{b}
T2	0.6/1.6	1.72±0.02^{b}	42.98±3.05^{d}	1.12±0.02^{b}	2586.3±190.4^{d}	10.96±0.2^{c}	0.013±0.003^{cd}	65.0±11.5^{b}
GT2	0.6/1.6	1.94±0.01^{a}	55.67±5.19^{c}	1.13±0.01^{a}	3379.6±324.2^{c}	11.82±0.3^{b}	0.020±0.005^{bc}	75.8±3.8^{ab}
T3	0.6/1.6	1.91±0.01^{a}	69.42±3.55^{b}	1.31±0.01^{a}	4239±221.7^{b}	12.56±0.2^{a}	0.023±0.003^{b}	84.2±1.4^{a}
GT3	0.6/1.6	2.03±0.14^{a}	78.44±6.30^{a}	1.43±0.14^{a}	4802.3±393.6^{a}	12.97±0.3^{a}	0.031±0.007^{a}	88.3±3.8^{a}

SGR - specific growth rate, PER - protein efficiency ratio, Initial weight of spawn = 1.6 mg

Values bearing different superscripts in the same column differ significantly ($p>0.05$)

Raw diets : T1 (GOC+RB+V-M premix), T2 (GOC+FM+RB+V-M premix) and T3 (GOC+PM+RB+V-M premix)

Cooked diets : GT1 (GOC+RB+V-M premix), GT2 (GOC+FM+RB+V-M premix) and GT3 (GOC+PM+RB+V-M premix)

GOC - ground nut oil cake, RB - rice bran, FM - fish meal, PM - prawn meal diet with partial replacement of animal protein. Several other authors have also demonstrated the advantage of using animal protein in the fry diet of common carp (Hossain and Jauncey, 1989), rohu (Hasan *et al*., 1991; Jena *et al*., 1998b), olive barb (Das *et al*., 2016) and juveniles of red drum (Kureshy *et al*., 2000). Further, better fry performance in T3 (raw diet with prawn meal incorporation) and GT3 (cooked diet with prawn meal incorporation) over fish meal incorporated diet indicated superiority of the former. Since zooplankton containing chitin, forms the main natural food of catla, the additional availability of chitin from the prawn meal (Fanimo *et al*., 2000) in the present study might have contributed towards the higher growth observed in the prawn meal diet. Many authors also have reported that chitin in addition to acting as an immunostimulant, also helps in improving growth and survival of fish (Mohan *et al*., 2009; Mastan, 2015; Naveen Kumar *et al*., 2015). Further, Raja *et al*. (2014) also demonstrated shrimp waste meal as an alternative protein source which could replace 50% of fish meal in diet of koi carp. The present study while reiterated advantages of cooking and incorporation of animal protein in the larval diet for better nourishment, it also revealed prawn meal to be a better protein source compared to fish meal in the nursery diet of catla.

Acknowledgements

The authors are grateful to the Director, ICAR-CIFA, Bhubaneswar, for providing all the necessary facilities to conduct the study.

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Date of Receipt : 19.07.2016
Date of Acceptance : 31.01.2017