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REARING OF FRY TO FINGERLING OF SAUL (*Channa Striatus*) ON ARTIFICIAL DIETS

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ORIGINAL ARTICLE

ABSTRACT: *Three diets (F1, F2 and F3) containing protein levels of 38.60 to 38.98 % crude protein were used to assess the growth performances of Channa striatus fry (weight 0.52±0.0 to 0.53±0.02 g) in a completely randomized experiment design in five replicate set for 12 weeks. The fry were reared in 15 FRP tanks at a stocking density of 100 fry m^3 and fed ad libitum. The diets F1 and F3 showed significantly (P<0.05) low survival levels of 74±1.2% and 76±4.4% in comparison to diets F2 (82±3.1%) 84th day of rearing. The net biomass gain %, length gain %, SGR, PER and per day weight gain were found significantly (P<0.05) higher and FCR low with diet F2 in comparison to diets F1 and F3. The proximate analysis of carcass showed that the fishes fed diets F2 had significantly (P<0.5) higher deposition of crude protein and lipids in the tissue. The study revealed that the growth performance of C. striatus fry is better in feed F2 and the fry could be reared to fingerling size on formulated diets.*

Key words: *Channa striatus*, *Survival*, *Growth*

INTRODUCTION

Snakehead, *Channa striatus* (Bloch.), a carnivorous air - breather, is a valuable food fish in Asia (Wee, 1982). Snakehead can survive in harsh environments with low dissolved oxygen and high ammonia (Ng and Lim, 1990; Qin et al., 1997a) and therefore, are often cultured in fingerling ponds at densities of 40 – 80 fish. m^{-2}, with annual yields ranging from 7 to 156 tonne.ha^{-1} (Wee, 1982).

The snakehead *Channa striatus* has for long been commercially cultured in many countries for its good taste, market value, and medicinal qualities (Marimuthu and Haniffa, 2004). Snakehead *Channa striatus* is an air-breathing fish highly regarded as a food in Asia because its flesh is claimed to be rejuvenating, particularly for those recuperating from a serious illness. The early post -larvae, late post - larvae, fry and fingerlings of the different size groups of *Channa striatus* were reared from hatchling stage (Haniffa et al., 1999). A protocol was developed for weaning larval snakehead from live *Artemia* to formulated feed, but fingerling performance with formulated feed was not evaluated for this variety of murrel (Qin et al., 1997b). Haniffa et al. (2002a) reported the digestibility of lipid by the stripped murrel *Channa striatus* (0.6±0.12 g) was assessed by feeding six formulated feeds containing 7.54-22.3% lipid and energy varying between 3.54-4.38 kcal/g were prepared. The feeding experiments revealed that apparent protein digestibility (APD) was relatively higher in the diet 3 and 4 (90.24% and 90.60%) whereas; the apparent fat digestibility (AFD) was more in diet 5 and 6 (99.30% and 99.38%) respectively. Effects of feed application rates on growth, survival, and feed conversion of juvenile snakehead murrel, *Channa striatus* have been reported and it was recorded that growth, survival and feed conversion ratio of juvenile snakehead murrel (*Channa striatus*) were evaluated when fed a dry formulated feed with 50% crude protein (Qin et al., 1996b). In *Channa striatus* size and feed dependent cannibalism with juveniles were reported by Qin et al. (1996a).

Mass breeding of *Channa striatus* in an earthen pond have been reported with synthetic hormone 'ovaprim' injection was resorted to (Francis et al., 2000). The mass induced breeding technique is simple and advantageous, as it does not require expensive components like plastic pools, aquaria and hapa (Haniffa et al., 2002b). Marimuthu et al. (2001) reported a simple and low-cost breeding technology for breeding the striped murrel, *Channa striatus* in hapas in ponds was developed in India however, and the impact of dietary nutrients on breeding performance is not demonstrated and/or evaluated. The growth of intensive aquaculture production has led to a growing interest in providing fishes with dietary lipid contents to give higher energy through diet and simultaneously reduce the nitrogen load in the pond system by reducing the protein contents by supplementing the lipid contents. Because the carnivore fishes requires relatively higher levels of dietary animal protein and/or higher dietary energy for rapid

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growth and better survival (Mishra and Mukhopadhyay, 1996) the dietary protein/energy level has to be more. Suitable alternative energy nutrients such as oilseed by-products are the most promising sources of lipid and energy for aqua-feed in the future (Hardy, 2000). There was a significant increase in carcass protein and a significant decrease in ash content with progressive dietary protein substitution. Fry fed with high protein diets tended to have lower carcass lipid contents and higher moisture contents (Mohanty and Samantaray, 1996).

The present study was conducted to assess the feasibility of the development of feed for this premium commodity for the aquaculture.

MATERIALS AND METHODS

Physico – chemical parameters of water

The physico-chemical parameters of water of the NBFGR farm site recorded as (Temp., 26±1°C; pH, 7.4 -7.5; DO, 6.5-8.0 ppm) following the protocols from APHA (1998). Hatchery water temperature, pH, total alkalinity and dissolved oxygen ranged from 26±2°C, 6.9–7.3, 127–132 ppm and 6.4–7.6 ppm, respectively during the entire rearing period.

The hatchery bred spawn were acclimatized and after resorption of yolk sac fry were fed with, *Artemia* nauplii, followed by laboratory made egg custard feed (Table 1). The ingredients were mixed to prepare semi-moist dough (37.5% moisture). The feed was further grated and sieved to get desired size (150-200 μ) before feeding to fish. The healthy fish were separated to conduct feeding experiment.

Table 1 - Feed compositions used during rearing of fry of *Channa striatus*

Ingredients	Percentage
Hen egg with yolk	17.3
Lactogen powder	30.7
Fishmeal powder	50.0
Vitamin & Mineral Mix*	2.0
Vitamin and Mineral composition (Per 100 g) [1]	
Vitamin A (IU)	70000
Vitamin D_3 (IU)	7000
Vitamin E (mg)	25
Nicotinamide (mg)	100
Cobalt (mg)	15
Copper (mg)	120
Iodine (mg)	32.5
Iron (mg)	150
Magnesium (mg)	600
Manganese (mg)	150
Potassium (mg)	10
Selenium (mg)	1
Sodium (mg)	0.59
Sulphur (%)	0.72
Zinc (mg)	960
Calcium (%)	25.50
Phosphorus (%)	12.75

[1] From Agrivet Farm Care Division, GlaxoSmithKline Pharmaceuticals Limited (Mfg. by Sunder chemicals Pvt. Ltd., Chennai).

Feed preparation and feeding

During the acclimation the fishes were fed *ad libitum* with the moist feed containing Goat intestine, Wheat flour, Soybean meal and vitamin and mineral mix mixed in a ratio of 45 : 15 : 5 : 1 w/w (Table 2) for further weaning and rearing on artificial feed. After seven days various economical feeds with gross protein as 38.60 – 38.98% (Table 3) were formulated and growth study was carried out for 12 week rearing period for the fingerlings of *Channa striatus* with different feeds and the growth performances was recorded (Table 4).

Protein contents in ingredients and feed:

Protein** contents in feed and ingredients are given below -
Protein in mustard cake(MOC) was = 32.0 %
Potato Starch = 2.0 %
Protein in fish meal (FM) = 60.0 %
Protein in Prawn head meal = 50.0 %
Average protein contents in prepared feed ranged between 38.60 – 38.98% from F-1 to F-3 (F-1 Crude Protein, 38.60%; F-2 Crude Protein, 38.64%; F-3 Crude Protein, 38.98%. ** Protein estimated using N x 6.25.

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Analytical methods and analysis of data

For the experimentation of *Channa striatus* fingerlings were kept in separate tanks/pools with five replicates per feed totalling fifteen pools and were fed *ad libitum* with different feeds in these fifteen pools (300 l capacity) arranged in Random Block Designing. The performance of the feeds, in terms of the weight gain (%), Specific growth rate (SGR), feed conversion ratio (FCR), Protein efficiency ratio (PER). The growth in length and weight and the survival data were analysed using One-way ANOVA. Duncan's multiple Range test was used to determine which treatment means differed significantly ($P<0.05$) using SPSS version 16.0.

Weight Gain (%) = {(Final body weight) – (Initial body weight)/ (Initial body weight)} x 100
Specific Growth Rate (SGR; % day $^{-1}$) = {(Final body weight) - (Initial body weight) / (experimental days)} x 100
Survival (%) = 100 x (No. of total fish - No. of dead fish)/Number of total fish
Biomass = Final average weight x Total no. of fish

The results were recorded in terms of specific growth (SGR), protein efficiency ratio (PER), per day increment (PI) and feed conversion ratio/efficiency (FCR) (Tables 4, 5). The survival was recorded at the end of the 4th, 8th and 12th week (Tables 6, 7).

Biochemical Analysis

Proximate compositions of feeds and fish carcass were analyzed following methods. All samples were analysed in triplicate. Dry matter was estimated after drying in oven at 105°C for 24 hours; crude protein (N x 6.25) by the Kjeldahl method after acid digestion; Crude lipid by di-ethyl ether extraction method using Soxhlet apparatus. Proximate analysis study was carried out for the reared Fingerlings of *Channa striatus*, fed with different feeds was analysed for body composition (Table 6). The body tissue, feed of the experiments were analysed for dry matter (DM), crude protein (CP), lipid and total ash according to AOAC (1990). The organic matter (OM) was calculated by subtracting the total ash from dry matter (DM).

Table 2 - Feed composition used during acclimatization of grow-out of *Channa striatus*

Ingredients	Percentage
Goat intestine	45.0
Wheat Flour	15.0
Soybean meal	5.0
Vitamin & Mineral Mix[1]	1.0
Composition:	
Protein	47.04
Carbohydrate	16.54
Fat	14.18
Ash	10.34
Fiber	3.55
Gross Energy (k Cal/ 100g)	434.10
Vitamin and Mineral composition (Per 100 g) [1]	
Vitamin A (IU)	70000
Vitamin D_3 (IU)	7000
Vitamin E (mg)	25
Nicotinamide (mg)	100
Cobalt (mg)	15
Copper (mg)	120
Iodine (mg)	32.5
Iron (mg)	150
Magnesium (mg)	600
Manganese (mg)	150
Potassium (mg)	10
Selenium (mg)	1
Sodium (mg)	0.59
Sulphur (%)	0.72
Zinc (mg)	960
Calcium (%)	25.50
Phosphorus (%)	12.75

[1] From Agrivet Farm Care Division, GlaxoSmithKline Pharmaceuticals Limited (Mfg. by Sunder chemicals Pvt. Ltd., Chennai).

Table 3 - Feeds compositions used during rearing of grow-out of *Channa striatus*

Feed	Mustard Oil Cake (%)	Potato Starch (%)	Fish Meal (%)	Prawn Head meal (%)	Vitamin Mineral* (%)	Gross protein (%)
F-1	56	6	30	5	3	38.60
F-2	32	17	40	8	3	38.64
F-3	9	27	50	11	3	38.98
Vitamin and Mineral composition (Per 100 g) [1]						
Vitamin A (IU)						70000
Vitamin D_3 (IU)						7000
Vitamin E (mg)						25
Nicotinamide (mg)						100
Cobalt (mg)						15
Copper (mg)						120
Iodine (mg)						32.5
Iron (mg)						150
Magnesium (mg)						600
Manganese (mg)						150
Potassium (mg)						10
Selenium (mg)						1
Sodium (mg)						0.59
Sulphur (%)						0.72
Zinc (mg)						960
Calcium (%)						25.50
Phosphorus (%)						12.75

[1] From Agrivet Farm Care Division, GlaxoSmithKline Pharmaceuticals Limited (Mfg. by Sunder chemicals Pvt. Ltd., Chennai).

RESULTS AND DISCUSSION

The growth performances, survival and proximate composition of *Channa striatus* are depicted in Tables 4, 5, 6, 7 and 8. The survival ranged between 74±1.2 to 82±3.1% and F1 and F3 diets were significantly different from F2 diet ($P<0.05$).

Table 4 - The growth performance of the fingerlings of *Channa striatus*

Feed	Initial weight (g)	Final weight (g) 4th week	Final weight (g) 8th week	Final weight (g) 12th week	Specific growth rate (SGR) after 12 weeks	Survival (%)	FCR
F-1	0.52 ± 0.0^{a}	2.6 ± 0.2^{a}	$4.2^{a}\pm0.1^{a}$	6.22 ± 0.02^{a}	6.79^{a}	74 ± 1.2^{a}	3.45 ± 0.12^{b}
F-2	0.53 ± 0.01^{a}	$3.8\pm0.3^{*,c}$	$6.4^{a}\pm0.2^{c}$	8.35 ± 0.12^{c}	$9.31^{c,**}$	82 ± 3.1^{b}	2.55 ± 0.19^{a}
F-3	0.53 ± 0.02^{a}	3.4 ± 0.1^{b}	$5.5^{b}\pm0.2^{b}$	7.18 ± 0.10^{b}	7.92^{b}	76 ± 4.4^{a}	$2.87\pm0.15^{a,**}$

Same alphabet in superscript in a column represents no significant difference in weight gain. * = P<0.01; **= p< 0.05. The results are of five replicates of feeding trial.

Table 5 - Initial and final weights and lengths, weight gain and percent weight gain of the *C. striatus* fingerling different treatments during 12 week experimental period

Feed	In length (cm)	Fn length (cm)	In weight (g)	Fn weight (g)	Length gain (cm)	% Length gain	Weight gain (g)	% Weight gain
F1	4.2 ± 0.1^{a}	11.20 ± 0.20^{b}	0.52 ± 0.01^{a}	6.22 ± 0.02^{a}	7.0^{a}	166.7^{a}	5.7^{a}	1096.2^{a}
F2	4.4 ± 0.4^{a}	13.38 ± 0.03^{a}	0.53 ± 0.01^{a}	8.35 ± 0.12^{c}	9.0^{c}	204.1^{c}	7.82^{c}	1475.5^{c}
F3	4.1 ± 0.3^{a}	11.88 ± 0.28^{b}	0.53 ± 0.02^{a}	7.18 ± 0.10^{b}	7.8^{b}	189.8^{b}	6.65^{b}	1254.7^{b}

Means in a given column having the same letter superscript are not significantly different at (P<0.05) by ANOVA and Duncan multiple range test.

Table 6 - Average initial and final weight, specific growth rate (SGR), food conversion ratio (FCR), protein efficiency ratio (PER), per day increment (PI) and survival rate (%) of *C. striatus* fingerlings fed various experimental diets for 12 weeks.

Feed	In weight (g)	Fn weight (g)	SGR %/day	FCR	PER	PI (mg)	Survival (%)
F1	0.52 ± 0.01^{a}	6.22 ± 0.02^{a}	6.79^{a}	3.45 ± 0.12^{b}	1.37 ± 0.02^{a}	74.0^{a}	74 ± 1.2^{a}
F2	0.53 ± 0.01^{a}	8.35 ± 0.12^{c}	$9.31^{c,**}$	2.55 ± 0.19^{a}	1.52 ± 0.03^{b}	99.4^{c}	82 ± 3.1^{b}
F3	0.53 ± 0.02^{a}	7.18 ± 0.10^{b}	7.92^{b}	$2.87\pm0.15^{a,**}$	1.45 ± 0.05^{b}	85.5^{b}	76 ± 4.4^{a}

Means in a given column having the same letter superscript are not significantly different at (P<0.05) by ANOVA and Duncan multiple range test

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Table 7. Survival percentage of *Channa striatus* on every 4th week				
Feed	**Stocking Nos. (N=100 X 5 replicates)**	**4th Week (%)**	**8th Week (%)**	**12th Week (%)**
F-1	500	90±2.1 [a]	81±2.9[a]	74±1.2[a]
F-2	500	92±3.5 [a]	77±4.3[b,*]	82±3.1[b,**]
F-3	500	88±2.8 [a]	80±5.2[a,*]	76 ±4.4[a]

Same alphabet in superscript in a column represents no significant difference in survival. * = P<0.01; **= P<0.05. The results are of five replicates of feeding trial.

Table 8 - Whole body composition of *Channa striatus*					
Feed	**Dry Matter (%)**	**Crude Protein (%)[1]**	**Lipid (%)[1]**	**Ash (%)[1]**	**Organic Matter[1] (%)**
F-1	24.2±0.88[b]	63.1±3.4[b]	7.5±0.4[a]	15.3±0.2[a]	84.1±2.0[a]
F-2	25.6±0.56[b]	65.2±1.9[b]	8.8±0.7[b]	14.7±0.6[a]	84.2±1.9[a]
F-3	22.1±0.45[a]	60.4±1.6[a]	7.7±0.1[a]	14.5±0.3[a]	84.7±1.6[a]

Different alphabet in superscript in a column differ significantly (p< 0.05). The results are of five replicates of feeding trial. [1] Dry matter basis

It is well known that Snakeheads observed great amount of cannibalism at all stages of life and it is one of the major reasons of low survival during their culture (Ng and Lim 1990). In the process of cannibalism although shooters are able to prey on fish measuring 2/3 in length (Diana et al., 1985) or 63-80% (Qin and Fast 1996a) to predator size in case of *C. striatus*, no information as to predator-prey ratio is available for *C. marulius* though the species is known to be more predatory and cannibalistic in nature in comparison to *C. striatus*. *C. striatus* in the process of cannibalism ingested comparatively smaller numbers (more than 10%) of prey and large numbers of them die due to injury, shock and spread of diseases (Qin and Fast, 1996b). Qin and Fast (1998) have also revealed that when snakehead begin feeding on formulated feed, the progressive size variation as fish grow does not necessarily provoke cannibalism when an adequate amount of suitable food is available.

The growth performance was higher in F2 than F1 and F3. This was well corroborated with the work of Mohanty and Samantaray (1996) who obtained highest growth performances in *C. striata* fry fed formulated diet containing 550 g kg^{-1} protein (energy 4320 kcal kg^{-1}) fed at the rate of 10% bw . day^{-1}. Similar observations have also been made in case of juvenile *C. striata* (Wee, 1986), *C. micropeltes* (Wee and Tacon 1982), *Chanos chanos* (Lim et al., 1979), *Epinephelus tauvina* (Teng et al., 1978), *Cyprinus carpio* (Ogino & Saito 1970), *Ictalurus punctatus* (Prather and Lovell, 1973) and *Sarotherodon mossambicus* (Jauncey 1982). The diet containing 49.72% protein and 13.54% fat in the feed were well suited for better growth of *C. striatus*. Growth and survival of larval snakehead (*Channa striatus*) fed different diets has been reported by Qin et al. (1997c). They reported the culture performance of larval snakehead (*Channa striatus*) and they have also examined in a three-phase feeding experiment. During Phase - I, diet treatments included: no food; formulated feed only; live *Artemia* nauplii and decapsulated *Artemia* cysts; decapsulated *Artemia* cysts only; formulated feed plus live *Artemia* nauplii; and formulated feed with *Artemia* cysts.

Protein efficiency studies on snakehead body tissue have been performed in good number of cases both from capture and culture stocks (Aliyu-Paiko et al., 2010; Gam et al., 2006; Mohanty and Samantaray 1996; Yang, 1980; Zuraini et al., 2006). Barring the study of Zuraini et al. (2006), the level of protein in body tissues in case of *C. striatus* has been reported to be 230 g kg^{-1} (Zuraini et al., 2006) to 449.0 g kg^{-1} (Gam et al., 2006) in natural stocks whereas in experimental culture, protein level as high up to 713 g kg^{-1} has been reported when fish fed dietary protein level 450 g kg^{-1} along with a lipid level of 65 g kg^{-1} (Aliyu-Paiko et al., 2010). The later, therefore support the present findings in which protein levels in body carcass of *C. striatus.* The availability of protein in body carcass greatly depends on species, size, age, season, protein quality, dietary level of energy, water quality and presence of natural food and culture management (Gam et al., 2006; NRC, 1993).

Protein efficiency in *C. striatus* was found almost directly proportional to the dietary protein levels as all treatments had significantly ($P<0.05$) different carcass protein with highest protein in diet F2 (Table 8). These results were similar to the work of Aliyu-Paiko et al. (2010) and Mohanty and Samantray (1996). Therefore, on the basis of survival, growth and protein efficiency indices recorded in the present study, the growth of *C. striatus* fry was assessed best in F2 diet. However, this needs to be confirmed with other natural feed ingredients in future studies to reduce the cost of formulated diets.

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