

# COMPARATIVE UTILIZATION IMPACT OF VARIOUS DIETARY LIPIDS, ON GROWTH INDICES, IN STRIPED MURREL, *CHANNA STRIATUS* (BLOCH) FINGERLINGS

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**ABSTRACT:** A 84-day feeding trial was conducted to evaluate the utilization impact of dietary omega-3 HUFA as a dietary energy source by fingerlings of striped murrel, *Channa striatus* on the growth study and tissue composition. There were seven treatments (L3HUF, H3HUF, MUSOL, LINOL, MIXOL, SATOL and NATFO), each having two replicates, stocked with 100 fingerlings in circular plastic pools (300l capacity). The six feeds were formulated with basic ingredients (Soybean meal, 41%; soluble starch, 25%; Casein, 20%; carboxy-methyl-cellulose, 2%; papain, 0.5%; vitamin and mineral mix, 3.5%) with iso-energetic (19.3 kJ/g, F1-F6 ) diets and results were compared with natural food fed fishes. The isocaloric diets were formulated from semi-purified ingredients with six different types of oil supplement which were fed to replicate groups of fishes ad libitum. Based on the protein efficiency ratio (PER), specific growth rate (SGR), average per day increment (PI) and food conversion ratio (FCR), and, it was observed that *C. striatus* fingerlings utilized dietary lipid. The LINOL showing best growth performance followed by H3HUF, MUSOL on the basis of SGR and PER were significantly ( $P < 0.05$ ) influenced in striped murrel, *Channa striatus*. But lower SGR levels were obtained with diets containing L3HUF, MIXOL, SATOL and NATFO. This study suggests that the lipid from unsaturated origins could be effectively utilized by striped murrel fry with a better resultant growth.

**Key words:** Lipid, utilization, growth, *Channa striatus*

## INTRODUCTION

The snakehead murrel, *Channa striatus*, is a promising species for aquaculture exploitation with its carnivorous feeding habits, air-breathing characteristics, rapid growth and good market potential. In terms of value-added, processed fish products, this species should have potential in Asian markets. Therefore, it is important to estimate the optimum lipid/Energy ratios in a oil (Omega-3 HUFA) and other alternative oils from plant origin for practical diets. 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). The snakehead which is locally known as striped murrel is commonly distributed in Asia and African countries. It is now a popular farmed fish, preferred for its faster growth performance and delicate taste. However, farmers are facing problems in its commercial culture because of the absence of complete feed. There is some information available on its life cycle (Das, 1940; Parameswaran, 1975) but there is not sufficient data available about the dietary requirements of this fish except for scanty reports on protein requirements (Samantray and Mohanty, 1997; Haniffa and Arockiaraj, 1999a). Information on nutritional requirements of major dietary components such as protein and energy is a prerequisite for the formulation of an inexpensive and balanced diet for the fish. India have huge potential for the production of cheaper plant source e.g. deoiled cakes like linseed oil cake etc. rich in Essential Fatty Acid (EFA, Omega - 3 HUFA) which can be utilized as source of lipid in carnivorous fish nutrition. Recycling of these agro-based by-products, like mustard oil cake, linseed oil cake etc. can be used in place of animal origin oils as source of lipid and EFA. Thus, the fatty acid composition of these various ingredients of plant origin have a good source of HUFA which can be utilized for carnivore fish nutrition. These can be used in place of animal lipid source, and can be studied for the deposition of nutrients in

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terms of flesh. Sarowar et al. (2010) have studied the impacts of different diets on growth and survival of *Channa striatus* fry. Influence of dietary lipid/protein ratio requirement has been studied in *Channa striatus* (Aliyu-Paiko et al., 2010). The present study was taken up to evaluate the utilization impact of dietary lipids on the optimum growth by utilizing the various dietary lipids by the striped murrel, *C. striatus*.

## MATERIALS AND METHODS

### Experimental design

Six semi-purified experimental diets were formulated to be iso-energetic (19.3 kJ/g, F1-F6) diets. Weighed dry ingredients and some water were poured into a mixer and the resulting dough processed in a hand pelletizer to make 2 mm diameter pellets. Compounded feed pellets were dried in an oven at 60° C, packed separately and stored at -20° C until used during the feeding trial. The seven dietary treatments were designated as L3HUF, H3HUF, MUSOL, LINOL, MIXOL, SATOL AND NATFO containing lipid source @ 0.5% omega-3 fatty acid + 7.5% saturated oil; 1.0 % omega-3 fatty acid + 7.0% saturated oil; 8.0% mustard oil; 8.0% linseed oil; 4% mustard oil + 4.0% linseed oil; 8% saturated oil and natural food respectively. Table 1 gives the summary of ingredients used in the formulation of experimental diets and proximate composition of all dietary treatments.

**Table 1 - Ingredients composition (w/w) of feeds for *Channa striatus***

Ingredients	F-1	F-2	F-3	F-4	F-5	F-6	F-7
	L3HUF	H3HUF	MUSOL	LINOL	MIXOL	SATOL	NATFO
Soybean meal	41.0	41.0	41.0	41.0	41.0	41.0	-
Starch Soluble	25.0	25.0	25.0	25.0	25.0	25.0	-
Casein	20.0	20.0	20.0	20.0	20.0	20.0	-
Carboxy Methyl Cellulose	2.0	2.0	2.0	2.0	2.0	2.0	-
Papain	0.5	0.5	0.5	0.5	0.5	0.5	-
Vitamin & Mineral Mix.	3.5	3.5	3.5	3.5	3.5	3.5	-
Omega-3 HUFA	0.5	1.0	-	-	-	-	-
Saturated Oil	7.5	7.0	-	-	-	8.0	-
Mustard Oil	-	-	8.0	-	4.0	-	-
Linseed Oil	-	-	-	8.0	4.0	-	-
Live Fish/Natural Food	-	-	-	-	-	-	100.0

L3HUF = Low Omega-3 HUFA; H3HUF = High Omega-3 HUFA; MUSOL = Mustard Oil; LINOL = Linseed Oil; MIXOL = Mixed Oil (Mustard Oil: Linseed Oil :: 1 : 1 w/w); SATOL = Saturated Oil; NATFO = Natural Food

### Fish rearing and feeding trials

*Channa striatus* fry were hatchery bred at NBFGR, Lucknow and shifted to the wet laboratory in air-blower aerated, 300 l capacity plastic pools with two-thirds filled with water and covered with plastic covers. Fishes were acclimated to laboratory conditions in a 1000 l capacity FRP tank, feeding on post-larval crumbled pellets containing a minimum of 450 g per kg crude protein for one week. Fry (mean initial weight 0.54 ± 0.02 to 0.54 ± 0.03g) were randomly distributed into each of 14 plastic pools containing about 200 l of water. The fishes were fed twice a day at 1000 and 1700 hours *ad libitum* per day. Fish were weighed every 4 wk to determine the weight gain ratio for each plastic pool. The weighing of fish during and on termination of the experimentation was done as determined by Hasan et al. (1989). All pools were covered with plastic perforated covers throughout the experiment, to prevent fish from jumping out. Culture pools were cleaned every week and about half the water in the system changed to reduce the nitrogenous waste accumulated. Fishes were weighed individually at the beginning and end of the experiment, whereas batch weighing per tank was carried out once every 2 weeks to monitor growth performance alongside measuring feed consumption. At the end of the experiment after 12 weeks, surviving fish were randomly grouped into three per tank and used to determine body indices, intestinal lipase activity and carcass proximate composition.

Specific growth rate  $\{[(\log_e \text{ final body weight} - \log_e \text{ initial body weight}) / \text{time}] \times 100\}$ , food conversion ratio (dry food intake/live weight gain), protein efficiency ratio (live weight gain/protein intake), average daily gain (growth/experiment duration), survival rate  $\{[(\text{initial no. of fish} / \text{final no. fish}) \times 100\}$  and weight gain (%)  $\{[(\text{final weight} - \text{initial weight}) / \text{initial weight}] \times 100\}$ . Variations in weight gain (%), SGR, FCR, PER after feeding of the test diets were analyzed by one-way ANOVA and Tukey's multiple range test and their mean differences by least significant differences (LSD).

## RESULTS

During the feeding trial, the fish readily accepted the diets, and survival rates were 65% to 95%. The growth responses under different treatments are given in Table 2. Initial body weight of the various dietary groups did not



vary significantly, but the performances were significantly different ( $P < 0.05$ ) in terms of weight gain, SGR, FCR, PER, PI and survival %. The weight gain was significantly different in LINOL, MUSOL and H3HUF ( $P < 0.05$ ) from the NATFO, SATOL and MIXOL. The specific growth rate (SGR) ranged between 5.38 to 7.52 %/day. There was no significant interaction between FCR and lipid contents and was not significantly different ( $P < 0.05$ ). The Protein efficiency ratio (PER) ranged between  $1.02 \pm 0.03$  to  $1.83 \pm 0.07$ . The PER was significantly higher in LINOL ( $P < 0.05$ ) followed by MUSOL and L3HUF.

**Table 2 - Initial and final weights and lengths, weight gain and percent weight gain of the *C. striatus* fingerling of different treatments during 84 days 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 (L3HUF)	4.2±0.1	10.30±0.10 <sup>b</sup>	0.54±0.03	5.85±0.05 <sup>c,d</sup>	6.1	145.2	5.31	983.3 <sup>b</sup>
F2 (H3HUF)	4.2±0.1	11.85±0.05 <sup>a</sup>	0.54±0.02	6.24±0.09 <sup>b</sup>	7.65	182.1	5.70	1055.5 <sup>c</sup>
F3 (MUSOL)	4.2±0.1	10.45±0.45 <sup>b</sup>	0.54±0.03	5.95±0.05 <sup>c</sup>	6.25	148.8	5.41	1001.8 <sup>c</sup>
F4 (LINOL)	4.2±0.1	12.15±0.15 <sup>a</sup>	0.54±0.03	6.86±0.03 <sup>a</sup>	7.95	189.2	6.31	1170.3 <sup>c</sup>
F5 (MIXOL)	4.2±0.1	9.80±0.10 <sup>b</sup>	0.54 0.03	5.74±0.04 <sup>d,e</sup>	5.60	133.3	5.20	962.9 <sup>b</sup>
F6 (SATOL)	4.2±0.1	9.75±0.15 <sup>b,c</sup>	0.54±0.02	5.57±0.02 <sup>e</sup>	5.55	132.1	5.03	931.4 <sup>b</sup>
F7 (NATFO)	4.2±0.1	9.10±0.10 <sup>c</sup>	0.54±0.02	5.06±0.03 <sup>f</sup>	4.90	116.6	4.52	837.0 <sup>a</sup>

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 3 - 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 84 days**

Feed	In weight (g)	Fn weight (g)	% of SGR /day	FCR	PER	PI (mg)	Survival (%)
F1 (L3HUF)	0.54±0.03	5.85±0.05 <sup>c,d</sup>	6.32	2.46	1.42±0.04 <sup>b</sup>	63.21	48 <sup>b</sup>
F2 (H3HUF)	0.54±0.02	6.24±0.09 <sup>b</sup>	6.78	2.48	1.55±0.09 <sup>c</sup>	67.85	54 <sup>c</sup>
F3 (MUSOL)	0.54±0.03	5.95±0.05 <sup>c</sup>	6.44	2.56	1.83±0.07 <sup>d</sup>	64.40	59 <sup>c,d</sup>
F4 (LINOL)	0.54±0.03	6.86±0.03 <sup>a</sup>	7.52	2.35	1.34±0.03 <sup>b</sup>	75.23	62 <sup>d</sup>
F5 (MIXOL)	0.54±0.03	5.74±0.04 <sup>d,e</sup>	6.19	2.53	1.07±0.02 <sup>a</sup>	61.90	45 <sup>b</sup>
F6 (SATOL)	0.54±0.02	5.57±0.02 <sup>e</sup>	5.98	2.55	1.11±0.01 <sup>a</sup>	59.88	43 <sup>b</sup>
F7 (NATFO)	0.54±0.02	5.06±0.03 <sup>f</sup>	5.38	2.54	1.02±0.03 <sup>a</sup>	53.80	40 <sup>a</sup>

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

## DISCUSSION

Fish in general utilize dietary lipid poorly. For instance, Furuichi and Yone (1980) noted depressed growth and feeding efficiency in red sea bream, *Pagrus major*, and common carp, *Cyprinus carpio* fed diets with high carbohydrate and low lipid contents. The optimum level of dietary nutrients should enhanced maximum growth and feed efficiency (Shiau, 1997) and so the decrease weight gain and the specific growth rate may due to higher energy content and high carbohydrate content in the diets (Page and Andrews, 1973; Daniels and Robinson 1986). An inverse relationship between growth and dietary energy was reported by Daniels and Robinson (1986) in juvenile red drum, *Sciaenops ocellatus*. Dietary carbohydrate levels of 12% and 20% are recommended for trout (Phillips et al., 1948) and Chinook salmon (Bubler and Halver, 1961), respectively. Habib et al., (1994) demonstrated that 30% carbohydrate level and low protein levels were well suited for silver barb, *Puntius gonionotus*, and 35% carbohydrates with low protein was well suited for *Heteropneustes fossilis* (Akand et al., 1991). Mollah and Allam (1990) reported that 15%-20% carbohydrate level was well suited for *Clarias batrachus*. In terms of protein efficiency ratio (PER), the protein is responsible for large part of the cost of most prepared feeds. The expensive protein fraction should therefore be optimally utilized for protein synthesis rather than for energy by the fish. Knowledge of the optimal level of protein and protein-sparing effects of non-protein nutrients such as lipids and carbohydrate can be used effectively in reducing feed costs (Shiau, 1997). Our PER value is comparable with the values of Daniels and Robinson (1986). Lin et al. (1997) reported that better SGR may have partly resulted from better carbohydrate and lipid utilization by snakehead fingerling feeding strategy and carbohydrate source. Furthermore, snakehead fingerlings tended to be fatter indicating that they may be able to better utilize lipids for growth. The better lipid utilization by snakehead fingerlings may be related to differences of their natural diets. The snakehead is carnivorous in nature (Parameswaran, 1975) and it mainly feeds on a carnivore diet containing some carbohydrates during the fingerling stages, mainly on zooplankton (Haniffa and Arockiaraj, 1999b), which contains little digestible lipid and carbohydrates. Our SGR values are comparable with that value of De Silva et al. (1989). Although the carcass protein, carbohydrate, and lipid contents increased after feeding the test diet, there was no appreciable change in body composition of the following treatments. Deposition of high lipid contents in the fish

fed higher amounts of lipid may be due to the availability of sufficient energy in those diets (Habib et al., 1994). Fatty carcasses of fish at higher dietary lipid and carbohydrate levels were also reported by Wee and Ng (1986). Inversely, higher amounts of dietary carbohydrate usually retard growth (Austreng et al., 1977). The requirements of dietary lipid vary among different species according to their mode and habits of feeding. The carnivorous fish, *C. striatus*, needs a low amount (12%) of dietary carbohydrate for its maximum growth, whereas Habib et al. (1994) reported a comparatively high requirement of dietary carbohydrate (30%) for maximum growth in silver barb which may be due to its herbivorous nature. Herbivorous fish can metabolize carbohydrates better than carnivorous species (Shiemeno et al., 1979; Cowey and Sargent, 1979). Lin et al. (1997) reported that the capacity to utilize different lipid sources varies among fish species. Common carp, red sea bream (Furuichi and Yone, 1982), tilapia (Anderson et al., 1984), yellow tail (Furuichi et al., 1986) and channel catfish (Wilson and Poe, 1987) grew better when fed a lipid with enriched carbohydrate diet. On the other hand, there was no significant difference in net weight gain between lipid and starch fed white sturgeon (Hung et al., 1989). According to the researchers the *Channa spp.* did not intake the purified diets (Wee and Tacon, 1982; Qin et al., 1997). The best growth performance and feed utilization was gained in LINOL H3HUF, MUSOL and L3HUF groups and the decline in growth in the NATFO and SATOL and feed utilization with increasing dietary lipid above this level was observed in present study. Similar results have been reported in turbot (Cacerez-Martinez et al., 1984; Regost et al., 2001), salmon (Silverstein et al. 1999), rainbow trout (Weatherup et al., 1997), Carp (Murai et al., 1985). However, some reports showed no effect of dietary lipid on body weight gain in juvenile turbot (Danielssen and Hjertnes, 1993) and Atlantic halibut (Berge and Storebakken, 1991). Martino et al. (2002) reported in Surubim, a carnivorous freshwater fish in Brazil, that fish weight gain increased with dietary lipid from 60 to 180 g per kg. Although many species like salmonids, sea bass or rainbow trout, where a protein sparing effect of lipids has been well demonstrated (Lee and Putnam, 1973; Watanabe, 1982; Beamish and Medland, 1986; Dias et al., 1998), an increase in dietary lipid level from 40 to 120 g per kg does not appear to improve protein utilization in grass carp with no clear protein sparing effect of dietary lipid. Peres and Oliva-Teles (1999) believed this lack of protein sparing effect by dietary lipid may be related to the high protein level of the diet and according to Dias et al. (1998), the beneficial effects of an increase of the lipid level from 100 to 180 g per kg in sea bass diets were significant only with a low protein diet, but not with a high protein diet. But in the present study, although the dietary protein content was relatively high, when lipid level was below 40 g per kg, the protein utilization increased with the lipid level. This suggests, even in high protein diets, the protein sparing effect by lipid is possible within a low upper limit. This was further proved by the lowest protein retention in the lipid-free diet group. The significant decreased lipid retention with the increased dietary lipid levels, suggest an increased proportion of lipid used for energy. This agrees with Cho and Watanabe (1985) who observed in rainbow trout, that the highest lipid diet did not promote the highest lipid retention. Peres and Oliva-Teles (1999) also reported decreasing lipid retention when dietary lipid increased from 120 to 300 g per kg). Lipid utilization demonstrated by Akand et al. (1991) for stinging catfish, *H. fossilis*, by Hasan et al. (1989) for Asian catfish, *Clarias batrachus*, by Hasan et al. (1990) for Indian major carps and by Habib et al. (1994) for *Puntius gonionotus*. The relationship of body lipid content with protein and moisture contents is a common phenomenon in fish, and our results are comparable to those of Stansby and Olcott (1976). Based on the results of the present investigation, it is estimated that types of lipid effects on the growth performance of the fingerlings of *Channa striatus*.

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