
Akhilesh Kumar Yadav1, Prem Prakash Srivastava2*, Shrivastava3, Shipra Chowdhary4, Rajesh Dayal5 and Joy Krushna Jena2

1Aquaculture Research Training Unit, National Bureau of Fish Genetic Resources, Chinhat, Faizabad Road, Lucknow - 227 002, UP, India
2National Bureau of Fish Genetic Resources, Canal Ring Road, Teli Bagh, Lucknow – 226 002, UP, India
3Department of Applied Aquaculture and Zoology, Barkatullah Vishwavidyalaya, Bhopal, MP, India

**Abstract**

A 84-days long experiment was conducted with a view to observe the effects of different feeds on growth and survival of *Clarias batrachus* grow-out. There were seven treatments (FISOL, BETAL, SOYAL, LINOL, MIXOL, SATOL and NATFO containing Fish oil, Beef tallow, Soybean oil, Linseed oil, Mixed oil (i.e. containing in 1:1:1:1 ratio of Fish oil, Beef tallow, Soybean oil, Linseed oil), Vegetable oil and minced chicken meat as natural food, respectively, each having three replications, stocked with 30 grow-out having an initial average weight 55.83 ± 3.14 in a circular plastic pools (capacity 300 L). The six feeds were formulated with basic ingredients (Soybean meal, 35%; soluble starch, 29%; Casein, 19.5%; carboxyl - methyl - cellulose, 2%; papain, 0.5%; vitamin and mineral mix, 4.0%) with iso-energetic (19.55 kJ/g, F1-F6) diets and results were compared with natural food fed fishes. Each diet was hand fed two times daily for 84-days to duplicate homogenous groups of 30 fish. The fishes fed with live chicken waste showed significantly poor results (p > 0.05) in terms of weight gain and Specific Growth Rate (SGR%) compared to the rest six treatments. The survival was recorded as 100% in all the treatments. Results showed that the growth performance significantly (p < 0.05) different with various lipid of animal and plant origin. At the end of the 84-days study the highest weight gain % was recorded in LINOL (F4) as 105.1%. For other treatment weight gain was recorded as 40.3%, 75.4%, 25.6%, 60.2%, 37.0%, and 44.1% for FISOL, BETAL, SOYAL, MIXOL, SATOL and NATFO respectively. The feed efficiency in terms of Feed Conversion Ratio (FCR) recorded as 2.46 to 3.22 among all the feeding trials. It could be concluded, based on the results of this trial, that a diet formulated with a gross energy of 19.55kJ/g is sufficient to promote better feed efficiency and growth performance in *C. batrachus* grow-out however, the best growth was recorded in linseed oil (LINOL) followed by BETAL and MIXOL.

**Keywords:** *Clarias batrachus*, Dietary lipids; Growth

**Introduction**

Air-breeding Catfish, *Clarias batrachus*, commonly known as Magur. It is commercially important and high market value fish. Feed management determines the viability of aquaculture as it accounts for at least 40-60% of the cost of fish production [1]. *Clarias batrachus* is a promising species for aquaculture exploitation with its carnivorous feeding habits. In order to increase growth rate and deposition of energy nutrients in terms of flesh, besides the protein, the research towards feeding habits. In order to increase growth rate and deposition of energy nutrients in terms of flesh, besides the protein, the research towards the inclusion of cheaper lipid sources has to be studied towards increasing lipid/energy ratios in the diet. Suitable alternative energy nutrients such as oiled- by-products are the most promising sources of lipid and energy for aqua-feed in the future [2]. In aquaculture, dietary lipids play an important role in commercial diets as source of energy, essential fatty acids for growth and development of fish [3]. Fish oil is the major source of dietary lipids in aquaculture nutrition. Fish oil is produced from small marine pelagic fish and represents a finite fishery resource [4]. India has huge potential for the production of cheaper source of lipids from plant and animal origin e.g. beef tallow, Soybean oil, saturated oil etc., which can be utilized as source of lipid in carnivorous fish nutrition. Sarowar et al. [5] have studied the impacts of different diets on growth and survival of *Clarias batrachus* grow-outs. The present study was taken up to evaluate the utilization impact of various diets on growth and survival of *C. batrachus* grow-out. The pre- sent study was taken up to evaluate the utilization impact of various dietary lipids on the optimum growth in Magur (*Clarias batrachus*), at grow-out stage.

**Materials and Methods**

**Experimental diets**

Six semi-purified experimental diets were formulated to be iso-energetic (19.55 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 dietary treatments were designated as FISOL (Fish oil), BETAL (Beef tallow), SOYAL (Soybean oil), LINOL (Linseed oil), MIXOL and SATOL (Vegetable oil) containing lipid source @ 10% lipid source in all the five feeds except in MI-
XOL (containing FISOL, BETAL, SOYAL, LINOL in the ratio of 1: 1: 1 w/w) and results are compared with natural food (NATFO). Table 1 provides the summary of ingredients used in the formulation of experimental diets and proximate composition of all dietary treatments.

**Fish rearing and feeding trials**

*Clarias batrachus* grow-outs were hatchery bred at National Bureau of Fish Genetic Resources (NBGR), Lucknow and shifted to the wet laboratory. Fishes were acclimated to laboratory conditions in a 1500 L capacity Fibre Reinforced Plastic (FRP) tank, feeding on crumbled pellets feed containing a minimum of 500 g per kg crude protein for one week. Further, fishes were accustomed to aerated, 300 L capacity plastic pools with two - thirds filled with water and covered with plastic covers. Four hundred twenty (Replicate 3 X Feed 7 X Fish 20) grow-outs ( Avg. initial weight 55.83 ± 3.14 g) were randomly sampled and used to determine lipid source @ 10% lipid source in all the five feeds except in MI-
XOL containing FISOL, BETAL, SOYAL, LINOL in the ratio of 1: 1: 1 w/w) and results are compared with natural food (NATFO). Table 1 provides the summary of ingredients used in the formulation of experimental diets and proximate composition of all dietary treatments.

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Table 1: Ingredient composition (w/w) of feeds for *Clarias batrachus*.

Fish performance was evaluated on the basis of Specific growth ratio = \((\log e_{final weight} - \log e_{initial weight})/\text{time}\times 100\), food conversion ratio= (dry food intake/live weight gain), average daily gain = (growth/experiment duration), survival rate = \([[\text{initial no. of Fishes/final no. Fishes}}\times 100] \) and weight gain (%) = \([[\text{final weight - 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). Duncan's multiple Range test was used to determine which treatment means differed significantly (P < 0.05) using SPSS version 16.0. Water analyses were carried out following methods APHA [8].

**Results**

Various water quality parameters (HIMEDIA Kit): water temperature, pH and Dissolved Oxygen (DO), total alkalinity were observed and found to be least affected by different treatment feeds. The values of all the parameters of ambient water, i.e. temperature, pH, DO and alkalinity were almost similar for all the feeding treatments during the experimental period and were well within the optimal range. The water quality recorded for water temperature, pH, dissolved oxygen and total alkalinity as 24 ± 2°C, 6.8 - 7.6, 6.8 - 7.5 ppm and 136 – 139 ppm, respectively.

During the feeding trial, the fishes readily accepted the diets, and survival rates were 100% in all the feeding trials. The growth responses under different treatments are given in Table 2 and 3 and Figure 1. 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, PI and survival %. At the end of the 84-days study the weight gain was recorded as 74.34 ± 3.43g, 98.56 ± 5.47g, 75.38 ± 3.65g, 109.33 ± 4.22g, 89.23 ± 3.87g, 79.59 ± 4.62g and 78.54 ± 6.26g for FISOL, BETAL, SOYAL, LINOL, MIXOL, SATOL and NATFO respectively. The highest growth recorded in LINOL followed by BETAL, MIXOL. The SGR, FCR and PI ranged between 0.12 to 0.37 %, 2.46 to 3.22 and 0.18 to 0.67 respectively. Results are shown in Table 3. The proximate composition of fish flesh is shown in Table - 4. HSI
and VSI ranged between 1.8 ± 0.09 to 2.1 ± 0.4 and 2.7 ± 0.2 to 3.8 ± 0.4 respectively.

**Discussion**

In general, fish uses dietary lipid poorly. For instance, Furui-chi and Yone [9] noted depressed growth and feeding efficiency in red sea bream, *P. major*, and common carp, *C. carpio* fed diets with high carbohydrate and low lipid contents. The optimum level of dietary nutrients should enhance maximum growth and feed efficiency [10] and so the decrease weight gain and the specific growth rate may due to higher energy content and high carbohydrate and lipid content in the diets [11]. An inverse relationship between growth and dietary nutrients should enhance maximum growth and feed efficiency [10] and so the decrease weight gain and the specific growth rate may due to higher energy content and high carbohydrate and lipid content in the diets [11]. An inverse relationship between growth and dietary nutri-ents was reported by Daniels and Robinson [12] in juvenile red drum, *S. ocellatus*. 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 [7]. Lin et al. [13] reported that better SGR may have partly resulted from better protein-sparing effects of non-protein nutrients such as lipids and carbohydrate can be used effectively in reducing feed costs [7]. Lin et al. [13] reported that better SGR may have partly resulted from better carbohydrate utilization by Magur grow-outs followed by BETAL, MIXOL, SATOL and control diet was devoid of lipids and so the proteins might have been used for energy production and not for growth.

Deposition of high lipid contents in the fishes fed higher amounts of lipid may be due to the availability of sufficient energy in those diets [20]. Fatty carcasses of fishes at higher dietary lipid and carbohydrate levels were also reported by Wee and Ng [18]. Inversely, higher amounts of dietary carbohydrate usually retard growth [21]. The requirements of dietary lipids vary among different species according to their mode and habits of feeding. Lin et al. [13] reported that the capacity to utilize different lipid sources varies among fishes species. Tilapia [22], yellow tail [23] and channel catfishes [24] 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 [25]. According to the researchers the air breathing did not intake the purified diets [26,27]. The best growth performance and feed utilization was gained in LINOL followed by BETAL, MIXOL, SATOL groups and the decline in growth in the FISOL and feed utilization with different dietary lipid above this level was observed in present study. Similar results have been reported in turbot [28,29], salmon [30], rainbow trout [31], Carp [32]. However, some reports showed no effect of dietary lipid on body weight gain in juvenile turbot [33] and Atlantic halibut [34]. Martino et al. [35] reported in Surubim, a carnivorous freshwater fish in Brazil, that fish weight gain increased with dietary lipid levels were also reported by Wee and Ng [18]. Inversely, higher amounts of dietary carbohydrate usually retard growth [21]. The requirements of dietary lipids vary among different species according to their mode and habits of feeding. Lin et al. [13] reported that the capacity to utilize different lipid sources varies among fishes species. Tilapia [22], yellow tail [23] and channel catfishes [24] 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 [25]. According to the researchers the air breathing did not intake the purified diets [26,27]. The best growth performance and feed utilization was gained in LINOL followed by BETAL, MIXOL, SATOL groups and the decline in growth in the FISOL and feed utilization with different dietary lipid above this level was observed in present study. Similar results have been reported in turbot [28,29], salmon [30], rainbow trout [31], Carp [32]. However, some reports showed no effect of dietary lipid on body weight gain in juvenile turbot [33] and Atlantic halibut [34]. Martino et al. [35] 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 [36-39], 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 & Oliva-Teles [40] 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. [39], 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 of 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, suggests an increased proportion of lipid used for energy. This agrees with Cho & Watanabe [41] who observed in rainbow trout, that the highest lipid diet did not promote the highest lipid retention. Peres & Oliva-Teles [40] also reported decreasing lipid retention when dietary lipid increased from 120 to 300 g per kg. Lipid utilization demonstrated by Akand et al. [42] for stinging catfishes, Clarias batrachus estimated that types of lipid effects on the growth performance of the fish. 8.

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References


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