Utilization of Lipid as Dietary Energy Source for Fingerlings of *Channa striatus*

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ABSTRACT An experiment was carried out to determine the dietary lipid requirement of the fingerlings of the striped murrel *Channa striatus*. Cod liver oil was used as a source of lipid and six crude lipid levels (7.54 – 22.3%) and energy levels (3.54 – 4.38 kcal/g) were selected. Each diet was given as 3% of total wet body weight in two equal rations to triplicate groups of 20 fingerlings with an average individual weight of 0.62 ± 0.22g in cement aquaria (capacity: 500 l) for 8 weeks. Growth rate was the highest in fingerlings fed at 13.54% lipid diet, where the conversion was the lowest (1.33) and the specific growth rate was the highest (2.15%/day). Dietary lipid produced a significant difference in the growth of *C. striatus*.

(*Channa striatus*, lipid, dietary requirement, growth rate)

INTRODUCTION

Lipids are important in the fish diets as a source of energy [1, 2, 3 and 4], essential fatty acids, sterols, phospholipids (as carriers of fat soluble vitamins A, D, E and K) and pigments in lipid transport. They provide flavors and textural properties to the fish feed [5]. Previous studies indicated that fish could use 20-30% of dry diet ingredients as fat, provided adequate amount of choline, methionine and tocopherol are present in the ration [1 and 6]. Moreover lipids have a distinct advantage of being almost completely digestible. In fish ration the natural lipid component is useful for diet formulation and is especially desirable in feeds of fry and fingerlings, which require high energy intake for rapid growth. The principal gross signs of essential fatty acids deficiency reported for various fishes are dermal signs (fin rot), a shock syndrome, myocarditis, reduced growth rate, reduced feed efficiency and increased mortality [7, 8 and 9]. The reduction of protein percentage in feed formulation and increase in dietary lipid level to compensate the protein for energy not only increase the fish growth but also reduce the feed cost from an economic point of view [10 and 11].

Hence the present study was carried out to determine the dietary lipid requirement of the fingerlings of the snakehead *Channa striatus*.

MATERIALS AND METHODS

The induced bred fingerlings of *C. striatus* were collected from CARE aquafarm and they were stocked in cement aquaria (3m x 1.5m x 1m) and acclimatized for one week. During the period of acclimatization they were exposed to 0.5% solution of potassium permanganate (KMnO₄) on every alternate day for a period of five minutes to prevent any infection prior to start the experiment and were fed ad libitum on finely chopped chicken intestine [12]. During the experimental period dissolved oxygen 5.8 ± 0.5 mgO₂ / l, water temperature 28 ± 1°C, photoperiod 13 L/11D and pH 6.8 – 7.5 were recorded.

Feed ingredients and waste output can scientifically be estimated based on:

i. Prediction of growth and nutrient and energy gains

ii. Estimation of excretory and feed waste outputs

iii. Quantification of energy and nutrient needs

Six diets containing 7.54%, 9.54%, 13.54%, 19.80% and 22.30% lipids were prepared (Table
followed by Haniffa and Jesu [4]. The diets were formulated in such a way that they contain all predicted essential nutrients in equal quantity except the level of lipid. The dry ingredients of each diet were mixed in a mixer for about 10 minutes. Cod liver oil was gradually added to the mixture [3] and the ingredients were mixed for another five minutes. Subsequently a sufficient quantity of water was added to the dry mixture, blended for another five minutes and extruded through a mm die. The freshly prepared extruded semi moist pellets were shade dried to maintain moist level below 15% before feeding the test fish. The stability of the semi moist diet was analyzed according to Farmin et al. [13].

After ensuring complete evacuation of their guts by starving them for 24 hours, the fingerlings were randomly selected with an average length and body weight of 4.07 ± 0.56 cm and 0.62 ± 0.12 gm respectively. Twenty fish were introduced into each aquarium (capacity 500 l) and triplicates were maintained for each diet. Since air breathing fishes like murrels do not readily accept pelleted feed [14] and hence C. striatus fingerlings were supplied with semi moist pellet (at 9 and 16 hours).

Whenever test fish died, they were recorded and replaced. Faeces were collected from the aquaria every morning prior to feeding [15]. The unfed was collected two hours after feeding with minimal disturbance to test fish and were dried at 60°C in a hot air oven [15] and weighed for further calculations. The length and weight of the test fish were measured every fortnight. The scheme of energy budget followed in the present work is that of the IBP formula of Petruszewicz and Macfadyen [16]. Specific growth rate is widely used to describe growth rate of fish. Fish growth rate expression: Specific growth rate (SGR), which is based on the natural logarithmic of body weight.

SGR = (ln FBW - ln IBW)/D
FBW = Final body weight
IBW = Initial body weight
D = Number of days

Food conversion ratio (FCR) (dry food intake / live weight gain), protein efficiency ratio (PER) (live weight gain / dry protein intake) and average daily gain (ADG) (live weight gain / experimental duration) were calculated according to Petruszewicz and Macfadyen [16].

Gross energy values were calculated based on standard physiological values of 4.5 Kcal/g proteins [17], 3.49 Kcal/g carbohydrates [18] and 8.51 Kcal/g fats [19]. The protein, lipid and carbohydrate of the diets were calculated according to Haniffa and Jesu [4]. The data were subjected to one way ANOVA and the mean differences were analyzed by Tukey's multiple range tests [20].

RESULTS AND DISCUSSION

The proximate composition of the feed ingredients is reported in Table 1. All the six prepared diets were isoprotein in nature (49.32% - 49.94%). Lipid level varied between 7.54% and 22.30% and carbohydrate level ranged from 7.68% to 18.66% (Table 1). In the present study C. striatus readily accepted all the six diets and survival was the highest (97.5%) in D6 followed by D3 (95%), D2 (85%), D5 (65%), D1 (40%) and D4 (35%). Akand et al. [21] formulated eight isoprotein diets (34.8% - 3.53%) with variation in the lipid level from 2.8 to 14.9% for H. fossilis and reported 82% to 93% survival.

Feeding rate of C. striatus ranged between 14.5 mg/g/day in D1 and 25.2 mg/g/day in D4. Pandian [22] suggested that the dietary protein level might determine the feeding rate of herbivores but not carnivores [6 and 23]. Since the diets are isoprotein in the present study any conclusion could not be arrived between dietary protein level and the feeding rate. But it is possible to suggest that lipids contain more energy / unit weight than any other dietary component and they are used efficiently by fish as energy sources [4]. In the present investigation feeding rates were high (22.5 - 25.2 mg/g/day) for the lipids level between 13.5 - 19.8%. Test diet containing (D6) the highest lipid level of 22.3% produced not only a decrease in feeding rate (15.9 mg/g/day) but also conversion rate (3.5 mg/g/day) (Table 2) and the difference were statistically significant (p< 0.001).

According to Bogut and Opacak [24] the optimum growth was attained in Oncorhyncus kisutch, O. keta, O. nerka, O. tsawytsch and O. mykiss at 9.5% level of lipid. Lipid requirement of African fish species viz., Clarias gariepinus.
C. isheriensis, Heterobranchus longifilis, H. kidorsalis, Asian species viz., C. batrachus, C. macrocephalus, C. fuscus and Heteropneustes fossilis and European species viz., Siltinus glanis ranged between 5% and 10% [25]. However in Dendex dentex diets containing 17.3% lipid produced better growth [25]. De Silva and Anderson [26] recommended 10-20.5% lipid in fish diet for optimal growth without any excessive fatty carcass. However the optimum lipid requirements of Indian major carps and common carp were determined as 4-6% [27, 28].

From an initial body weight of 620mg, C. striatus fed on D3 (14% lipid level) reached 2.26g followed by 2.01g in D5 after eight weeks. Poor growth recorded in D1 and D2 could be due to low lipid level. The value obtained for average daily gain (ADG) was also very high (2.13mg/day) in D3 followed by 1.98 mg/day in D5 (Table 3). ADG was significantly different (p<0.001) with the dietary lipid level. The SGR increased from 1.185%/day to 2.15%/day with increase in dietary lipid level from 7.5 to 13.5% and thereafter decreased. Similar results are also available for Cirrhinus mrigala and H. fossilis (13% lipid level) [6] in the literature.

For instance SGR increased from 1.62%/day to 1.98%/day with the increase in lipid level from 3-10% and after that the SGR decreased in H. fossilis [29]. The highest SGR (2.15%/day) was observed in C. striatus fed diet, which contained 13.5% lipid and 3.88 Kcal/g of energy. Previous authors suggested that the high energy content in the diet could be the reason for the decreasing SGR and weight gain and also found an inverse relationship between dietary energy and growth [11, 30 and 31]. Diet 3 containing 13.5% dietary lipid level was significantly different (p<0.001) with the other treatments in terms of SGR.

Akand et al. [21] reported FCR values ranging between 1.6 and 2.3 for H. fossilis and Clarias batrachus. FCR calculated in the present study ranged between 1.3 and 2.7 and FCR was better among the groups, where SGR and weight gain were also high (D3 and D5) and FCR was statistically significant (p<0.001) with the dietary level. PER values ranged between 1.14 and 1.31 among the test diets. Increasing dietary lipid level produced elevated values in PER and similar trend was also noticed by Page and Andrews [30] Daniels and Robinson [31]. Low PER values obtained in D1 and D2 could be due to inadequate dietary lipid as suggested by Daniels and Robinson [31] and Hanifa and Jesu [4]. In terms of PER there was no significant difference except in diet 5. Since Diet 3 produced the best results with regard to SGR, FCR and PER, it is possible to suggest that 14% lipid level is optimum for rearing fingerlings of C. striatus.

Table 1. Percentage and proximate composition of ingredients in the formulated diets

<table>
<thead>
<tr>
<th>Ingredients (%)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken intestine</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Dextrin</td>
<td>14.5</td>
<td>12.5</td>
<td>10.5</td>
<td>10</td>
<td>8</td>
<td>4.5</td>
</tr>
<tr>
<td>Rice bran</td>
<td>10</td>
<td>10</td>
<td>8</td>
<td>6.5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Cod liver oil</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>9.5</td>
<td>12</td>
</tr>
<tr>
<td>Ground nut oil cake</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Cellulose</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Mineral mix</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Vitamin mix</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

| Nutrient contents | | | | | | |
|-------------------|---|---|---|---|---|
| Protein (%) | 49.99 | 49.99 | 49.72 | 49.52 | 49.32 | 49.32 |
| Carbohydrate (%) | 18.66 | 16.66 | 14.27 | 13.47 | 11.18 | 7.68 |
| Lipid (%) | 7.54 | 9.54 | 13.54 | 15.38 | 19.80 | 22.30 |
| Gross energy (Kcal/g) | 3.54 | 3.64 | 3.87 | 4.00 | 4.29 | 4.38 |

3 Trace mineral mix use providing the following concentration (ppm) Cu 10; Fe 100; Mn 50; Zn 50; Co 0.01; and I 0.1.
4 Vitamin mixture providing the following concentration per kg diet. Vitamin A 5000 IU; Vitamin D 400 IU; Vitamin E 20mg; Thiamin mononitrate (B1) 4mg; Riboflavin (B2) 2mg; Niodinamide 50mg; Pyridoxine 5mg; Calcium pantothenate 10mg; Cyanocobalamin (B12) 2mg; Ascorbic acid (Vitamin C) 100mg; Biotin 0.1mg.
Table 2. Energy budget of C. striatus fed on diets with different lipid levels (x ± SD)

<table>
<thead>
<tr>
<th>Diet</th>
<th>Consumption rate (mg/g/day)</th>
<th>Absorption rate (mg/g/day)</th>
<th>Absorption efficiency (%)</th>
<th>Conversion rate (mg/g/day)</th>
<th>Gross conversion efficiency (%)</th>
<th>Net. Conversion efficiency (%)</th>
<th>Metabolic rate (mg/g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>14.46 ± 0.48</td>
<td>10.30 ± 1.02</td>
<td>71.15 ± 4.73</td>
<td>4.96 ± 1.30</td>
<td>32.3 ± 7.19</td>
<td>45.05 ± 8.13</td>
<td>5.65 ± 0.27</td>
</tr>
<tr>
<td>D2</td>
<td>17.65 ± 1.62</td>
<td>14.57 ± 1.72</td>
<td>82.4 ± 2.4</td>
<td>5.61 ± 0.82</td>
<td>32.0 ± 7.63</td>
<td>39.6 ± 10.32</td>
<td>8.99 ± 2.5</td>
</tr>
<tr>
<td>D3</td>
<td>22.5 ± 1.37</td>
<td>20.03 ± 1.37</td>
<td>88.79 ± 1.75</td>
<td>7.88 ± 1.09</td>
<td>34.95 ± 0.21</td>
<td>39.4 ± 0.98</td>
<td>12.14 ± 1.03</td>
</tr>
<tr>
<td>D4</td>
<td>25.21 ± 1.42</td>
<td>22.9 ± 1.55</td>
<td>90.80 ± 1.08</td>
<td>4.83 ± 1.09</td>
<td>19.3 ± 5.37</td>
<td>21.25 ± 6.15</td>
<td>17.75 ± 2.12</td>
</tr>
<tr>
<td>D5</td>
<td>24.45 ± 0.63</td>
<td>22.05 ± 0.77</td>
<td>90.3 ± 0.55</td>
<td>5.56 ± 1.15</td>
<td>22.75 ± 5.44</td>
<td>25.2 ± 6.08</td>
<td>16.09 ± 1.27</td>
</tr>
<tr>
<td>D6</td>
<td>15.87 ± 0.82</td>
<td>13.07 ± 0.24</td>
<td>79.84 ± 1.04</td>
<td>3.52 ± 0.20</td>
<td>22.25 ± 2.47</td>
<td>28.25 ± 3.88</td>
<td>9.14 ± 1.02</td>
</tr>
</tbody>
</table>

Similar alphabet did not significantly differ at p<0.00/level

Table 3. Survival and growth response of C. striatus fed on diets with different lipid levels (x ± SD)

<table>
<thead>
<tr>
<th>Diet</th>
<th>Initial weight (g)</th>
<th>Final weight (g)</th>
<th>FCR</th>
<th>PER</th>
<th>ADG (mg/day)</th>
<th>SGR (%/day)</th>
<th>Survival (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>0.63 ± 0.12</td>
<td>1.78 ± 0.21</td>
<td>1.14 ± 0.01</td>
<td>1.22 ± 0.11</td>
<td>1.18 ± 0.15</td>
<td>40 ± 4.24</td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>0.62 ± 0.12</td>
<td>1.82 ± 0.23</td>
<td>2.56 ± 0.12</td>
<td>1.17 ± 0.02</td>
<td>1.47 ± 0.15</td>
<td>12.2 ± 0.18</td>
<td>85 ± 0</td>
</tr>
<tr>
<td>D3</td>
<td>0.62 ± 0.12</td>
<td>2.26 ± 0.15</td>
<td>1.37 ± 0.09</td>
<td>1.21 ± 0.28</td>
<td>2.15 ± 0.14</td>
<td>21.5 ± 0.11</td>
<td>95 ± 4.07</td>
</tr>
<tr>
<td>D4</td>
<td>0.62 ± 0.12</td>
<td>2.19 ± 0.13</td>
<td>1.66 ± 0.04</td>
<td>1.22 ± 0.26</td>
<td>1.79 ± 0.12</td>
<td>1.33 ± 0.21</td>
<td>35 ± 3.52</td>
</tr>
<tr>
<td>D5</td>
<td>0.62 ± 0.12</td>
<td>2.01 ± 0.11</td>
<td>1.52 ± 0.09</td>
<td>1.34 ± 0.09</td>
<td>1.98 ± 0.4</td>
<td>1.49 ± 0.15</td>
<td>65 ± 3.52</td>
</tr>
<tr>
<td>D6</td>
<td>0.62 ± 0.12</td>
<td>1.89 ± 0.11</td>
<td>2.37 ± 0.11</td>
<td>1.22 ± 0.14</td>
<td>1.55 ± 0.14</td>
<td>1.28 ± 0.16</td>
<td>97 ± 3.53</td>
</tr>
</tbody>
</table>

Similar alphabet did not significantly differ at p<0.00/level

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REFERENCES


