Determination of Protein, Lipid and Carbohydrate Contents of Conventional and Non-Conventional Feed Items Used in Carp Polyculture Pond

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Abstract

A study was conducted during April’2010-September’2010 with a view to compare the protein, lipid and carbohydrate contents in conventional and non-conventional feed items and to recommend suitable strategy in selecting feed item for the development of weed based fish farming in carp polyculture pond. The experiment was carried out at the Protein and Enzyme Research Laboratory, Department of Biochemistry and Molecular Biology, Rajshahi University, Rajshahi. Six different conventional and non-conventional fish feed items like rice bran, wheat bran, mustard oilcake, Azolla, grass and banana leaves were tested to determine the nutrient contents under 6 treatments as T1, T2, T3, T4, T5 and T6 respectively. In this study, nutrient contents (protein, lipid and carbohydrate) were monitored monthly. Significant variations (P<0.05) were found in the mean values of nutrient contents with different treatments of feed items but in case of same feed item no significant difference was found in the nutrient content at different months. Among the non-conventional feed items treatment T4 (Azolla) varied more significantly (P<0.05) for the mean values of protein content. Findings indicated that Azolla was more nutritive and low cost effective diets for fish farming in Bangladesh.

Keywords: Azolla, Conventional and non-conventional feed; Carp polyculture; Bangladesh

Introduction

The technique of polyculture of fish is based on the concept of utilization of different trophic and spatial niches of a pond in order to obtain maximum fish production per unit area. Different compatible species of fish of different trophic and spatial niches are raised together in the same pond to utilize all sorts of natural food available in the pond [1]. Supplementary feed plays an important role in achieving higher fish production. Unfortunately lack of low cost supplementary feed is found as one of the major problems in aquaculture in Bangladesh [2]. Commercial fish feeds are not easily available and unaffordable to poor fish farmers in Bangladesh. Consequently, there is no regular organized supplementary feeding practice and the fish production is found as low as 0.5-1.5 t/ha/year [3]. It was thus considered necessary to look for cheaper and locally available materials as substitutes.

The optimal protein requirements of carp are affected by the nutritional value of the dietary protein and level of non-protein energy in the carp diet. When sufficient energy sources such as lipids and carbohydrates are available in the diet, most of the ingested protein goes to protein synthesis. Adult Indian major carps require 30% dietary protein for proper growth and survival. Lipids or fats are required as sources of energy and essential fatty acids, and serve as carriers for fat-soluble vitamins. The gross lipid requirement of Indian major carp is 7-8% of the diet, and young fish require relatively more fat and protein than adults. Carbohydrate is the least-expensive nutrient and also a less expensive energy source for carp. Indian major carp, being herbivorous/ omnivorous feeders, easily digest appreciable quantities of carbohydrates in their diets. A dietary level up to 30% carbohydrate does not affect the growth of carp and growth retardation and reduced feed efficiency are observed, however, when carbohydrate levels exceeded 35% of diet [4]. Fish culture is induced primarily by the need for increased protein supply. One of the most essential prerequisites for the successful management of fish culture programme is a comprehensive understanding of feeding [5]. The increase in cost and demand of feed protein from conventional sources necessitates fish culturists of the developing countries to incorporate cheap and locally available ingredients in fish feeds. Recently the utilization of aquatic plants having high food value are used to supplement fish food has taken a new dimension for producing the much required animal protein at low cost [6].

Aquatic macrophytes have been known to have potential food value. A perusal of the available literature shows that some of the aquatic weeds are highly nutritive and, therefore, one alternative solution to check the massive population of these weeds might be their utilization through incorporation as components of feedstuff for fish. In fact, significant effort has been directed towards evaluating the nutritive value of different non-conventional feed resources, including terrestrial and aquatic macrophytes, to formulate nutritionally balanced and cost-effective diets for fish and poultry [7-10]. Most of these nutritional studies are carried out abroad and no comprehensive studies are found in comparing the nutritional quality of both conventional and non-conventional feeds for fish farming in Bangladesh. However, before advocating the utilization of these aquatic weeds for supplementation of fish feeds, there is an urgent need to explore their nutritional quality, throughout the major culture season in ponds under carp polyculture system. Therefore, the present study aimed at evaluating the protein, lipid and carbohydrate content in conventional and non-conventional feeds, to recommend suitable strategy in selecting feed item for the development of weed based fish farming in carp polyculture pond.
feed items used for carp polyculture system in Bangladesh.

Materials and Methods

Duration and location of the study

The study was conducted for a period of six months from April 2010 to September 2010. Feed items were collected from the fish farming study site located at Alampur village under Kushtia district of Bangladesh. Whereas nutrient analysis was done at the Protein and Enzyme Research Laboratory under the Department of Bio-Chemistry and Molecular Biology, Rajshahi University, Rajshahi, Bangladesh.

Experimental design

The current experiment was carried out under six treatments of feed items each with three replications. The treatment assignments were designated as T1, T2, T3, T4, T5 and T6 for rice bran, wheat bran, mustard oilcake, grass and banana leaves, respectively. Conventional feed items (rice bran, wheat bran, mustard oilcake) were collected from local market during the experimental period. Non-conventional feed item like was collected from ponds adjacent to the research area whereas grass and banana leaf were collected from adjacent grass field and banana garden. Both conventional and non-conventional feed items were collected once a month for nutritional analysis during the experimental period.

Nutrient analysis of the collected samples

Total protein, total lipid and total carbohydrate of the collected samples were determined by the micro-kjeldahl method [11,12] method and Anthrone method [13] respectively.

Statistical analysis

All the data were subjected to ANOVA (analysis of Variance) using computer software SPSS (Statistical Package of Social Science). The mean values were also compared to see the significant difference from the DMRT (Duncan Multiple Range Test) [14].

Results

Monthly variations

Protein content significantly varied from 6.05 ± 0.45% with T6 (banana leaf) at 6th month (September, 2010) to 31.20 ± 0.32% with treatment T2 (wheat bran) at 2nd month (May, 2010). Lipid content significantly varied from 2.95 ± 0.21% with treatment T6 (banana leaf) at 5th month (August, 2010) to 13.72 ± 0.36% with T3 (mustard oilcake) at 4th month (July, 2010). Carbohydrate content ranged from 32.85 ± 0.14% with T6 (mustard oilcake) at 4th month to 66.12 ± 0.47% (T2, wheat bran). The highest protein and lipid content was found in treatment T6 (mustard oilcake) whereas the highest carbohydrate content was found in treatment T3 (mustard oilcake) to 66.12 ± 0.47% (T2, wheat bran). The highest protein and lipid content was found in treatment T6 (mustard oilcake) to 66.12 ± 0.47% (T2, wheat bran).

Mean variations

The variations in the mean values of nutrient contents (protein, lipid and carbohydrate) with different treatments of feed items are presented in Table 7 and Figure 1. Protein content significantly varied from 6.18 ± 0.13% with treatment T5 (banana leaf) to 30.53 ± 0.40% with treatment T3 (mustard oilcake) from 3.92 ± 0.29% with treatment T6 (wheat bran) to 13.73 ± 0.10% with treatment T3 (mustard oilcake). Carbohydrate significantly varied from 32.95 ± 0.29% with treatment T3 (mustard oilcake) to 66.12 ± 0.47% with treatment T2 (wheat bran).

Discussion

Monthly variations of the nutrient contents

Protein content varied from 6.05 ± 0.45% with (T6 at 6th month) to 31.20 ± 0.32% (T2 at 2nd month). Lipid content ranged from 2.95 ± 0.21% (T3 at 5th month) to 13.72 ± 0.36% (T6 at 4th month). Carbohydrate content ranged from 32.85 ± 0.14% (T4 at 4th month) to 66.35 ± 0.32% (T2 at 3rd month). Suresh and Mandal [3] worked on the determination of nutritive value of rice bran, mustard oil cake and Azolla for a period of 4 months from July to October. In rice bran they found crude protein and crude fibre as 12.6% and 21.9%, respectively. In mustard oilcake, crude protein and crude fibre was 38.6% and 20.4%, respectively and in Azolla, crude protein and crude fibres was 26.5% and 6.8%, respectively.

Mean variation of the nutrient contents

In the present study the protein content varied from 6.18 ± 0.13% (T6, banana leaf) to 30.53 ± 0.40% (T6, mustard oilcake), lipid content varied from 3.06 ± 0.09% (T6, banana leaf) to 13.33 ± 0.10% (T3, mustard oilcake) and carbohydrate content varied from 32.95 ± 0.29% (T6, mustard oilcake) to 66.12 ± 0.47% (T2, wheat bran). The highest protein and lipid content was found in treatment T6 (mustard oilcake) whereas the highest carbohydrate content was found in treatment T3 (mustard oilcake) to 66.12 ± 0.47% (T2, wheat bran). The highest protein and lipid content was found in treatment T6 (mustard oilcake) whereas the highest carbohydrate content was found in treatment T3 (mustard oilcake) to 66.12 ± 0.47% (T2, wheat bran).

The chemical composition of Azolla species varies with ecotypes
**Table 1:** Monthly variations in nutrient (protein, lipid and carbohydrate) contents with treatment T1 (Rice, Oryza sativa bran).

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (%)</td>
<td>14.60 ± 0.22a</td>
<td>13.92 ± 0.19a</td>
<td>14.65 ± 0.19a</td>
<td>14.50 ± 0.36a</td>
<td>14.22 ± 0.28a</td>
<td>14.50 ± 0.24a</td>
</tr>
<tr>
<td>Lipid (%)</td>
<td>10.42 ± 0.31a</td>
<td>10.50 ± 0.25a</td>
<td>10.64 ± 0.25a</td>
<td>10.20 ± 0.21a</td>
<td>10.24 ± 0.15a</td>
<td>10.45 ± 0.26a</td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>44.25 ± 0.41a</td>
<td>43.72 ± 0.19a</td>
<td>43.85 ± 0.19a</td>
<td>44.20 ± 0.24a</td>
<td>44.32 ± 0.20a</td>
<td>44.20 ± 0.16a</td>
</tr>
</tbody>
</table>

Figures bearing common letter(s) in a row as superscript do not differ significantly (P<0.05).

**Table 2:** Monthly variations in nutrient (protein, lipid and carbohydrate) contents with treatment T2 (Wheat, Triticum aestivum bran).

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (%)</td>
<td>16.85 ± 0.08a</td>
<td>18.45 ± 0.41a</td>
<td>18.35 ± 0.41a</td>
<td>18.45 ± 0.32a</td>
<td>18.75 ± 0.24a</td>
<td>18.80 ± 0.26a</td>
</tr>
<tr>
<td>Lipid (%)</td>
<td>3.25 ± 0.09a</td>
<td>3.15 ± 0.12a</td>
<td>3.12 ± 0.12a</td>
<td>3.35 ± 0.18a</td>
<td>3.14 ± 0.34a</td>
<td>3.10 ± 0.41a</td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>50.36 ± 0.75a</td>
<td>50.45 ± 0.61a</td>
<td>50.20 ± 0.61a</td>
<td>50.15 ± 0.54a</td>
<td>50.20 ± 0.17a</td>
<td>49.88 ± 0.27a</td>
</tr>
</tbody>
</table>

Figures bearing common letter(s) in a row as superscript do not differ significantly (P<0.05).

**Table 3:** Monthly variations in nutrient (protein, lipid and carbohydrate) contents with treatment T3 (Mustard, Brassica napus Oillcake).

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (%)</td>
<td>7.26 ± 0.35a</td>
<td>7.32 ± 0.25a</td>
<td>7.45 ± 0.25a</td>
<td>7.15 ± 0.14a</td>
<td>7.25 ± 0.19a</td>
<td>7.12 ± 0.23a</td>
</tr>
<tr>
<td>Lipid (%)</td>
<td>6.35 ± 0.05a</td>
<td>6.28 ± 0.06a</td>
<td>6.60 ± 0.06a</td>
<td>6.23 ± 0.12a</td>
<td>6.21 ± 0.18a</td>
<td>6.32 ± 0.28a</td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>46.58 ± 0.12a</td>
<td>46.30 ± 0.41a</td>
<td>45.95 ± 0.41a</td>
<td>46.85 ± 0.38a</td>
<td>46.70 ± 0.19a</td>
<td>45.76 ± 0.14a</td>
</tr>
</tbody>
</table>

Figures bearing common letter(s) in a row as superscript do not differ significantly (P<0.05).

**Table 4:** Monthly variations in nutrient (protein, lipid and carbohydrate) contents with treatment T4 (Azolla pinnata).  

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (%)</td>
<td>17.20 ± 0.05a</td>
<td>17.05 ± 0.12a</td>
<td>17.25 ± 0.12a</td>
<td>16.95 ± 0.24a</td>
<td>17.10 ± 0.34a</td>
<td>17.22 ± 0.18a</td>
</tr>
<tr>
<td>Lipid (%)</td>
<td>6.75 ± 0.41a</td>
<td>6.66 ± 0.69a</td>
<td>8.80 ± 0.69a</td>
<td>7.12 ± 0.46a</td>
<td>6.47 ± 0.32a</td>
<td>6.32 ± 0.38a</td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>66.20 ± 0.36a</td>
<td>65.75 ± 0.32a</td>
<td>66.35 ± 0.32a</td>
<td>66.32 ± 0.26a</td>
<td>66.12 ± 0.15a</td>
<td>65.99 ± 0.23a</td>
</tr>
</tbody>
</table>

Figures bearing common letter(s) in a row as superscript do not differ significantly (P<0.05).

**Table 5:** Monthly variations in nutrient (protein, lipid and carbohydrate) contents with treatment T5 (Grass, Cynodon dactylon).  

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (%)</td>
<td>6.25 ± 0.11a</td>
<td>6.20 ± 0.21a</td>
<td>6.32 ± 0.21a</td>
<td>6.12 ± 0.36a</td>
<td>6.14 ± 0.36a</td>
<td>6.05 ± 0.45a</td>
</tr>
<tr>
<td>Lipid (%)</td>
<td>3.05 ± 0.03a</td>
<td>3.12 ± 0.11a</td>
<td>3.10 ± 0.11a</td>
<td>3.20 ± 0.17a</td>
<td>2.95 ± 0.21a</td>
<td>2.96 ± 0.41a</td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>48.85 ± 0.36a</td>
<td>47.98 ± 0.26a</td>
<td>48.10 ± 0.26a</td>
<td>48.30 ± 0.31a</td>
<td>48.90 ± 0.35a</td>
<td>48.85 ± 0.24a</td>
</tr>
</tbody>
</table>

Figures bearing common letter(s) in a row as superscript do not differ significantly (P<0.05).

**Table 6:** Monthly variations in nutrient (protein, lipid and carbohydrate) contents with treatment T6 (Leaf of banana, Musa acuminata).  

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (%)</td>
<td>14.60 ± 0.32a</td>
<td>13.92 ± 0.19a</td>
<td>14.65 ± 0.19a</td>
<td>14.50 ± 0.36a</td>
<td>14.22 ± 0.28a</td>
<td>14.50 ± 0.24a</td>
</tr>
<tr>
<td>Lipid (%)</td>
<td>10.42 ± 0.31a</td>
<td>10.50 ± 0.25a</td>
<td>10.64 ± 0.25a</td>
<td>10.20 ± 0.21a</td>
<td>10.24 ± 0.15a</td>
<td>10.45 ± 0.26a</td>
</tr>
<tr>
<td>Carbohydrate (%)</td>
<td>44.25 ± 0.41a</td>
<td>43.72 ± 0.19a</td>
<td>43.85 ± 0.19a</td>
<td>44.20 ± 0.24a</td>
<td>44.32 ± 0.20a</td>
<td>44.20 ± 0.16a</td>
</tr>
</tbody>
</table>

Figures bearing common letter(s) in a row as superscript do not differ significantly (P<0.05).

**Table 7:** Variations in the mean values of protein, lipid and carbohydrate contents in different fish feed items.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Nutrient content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (%)</td>
<td>Lipid (%)</td>
</tr>
<tr>
<td>T1 (Rice bran)</td>
<td>14.40 ± 0.32a</td>
</tr>
<tr>
<td>T2 (Wheat bran)</td>
<td>17.13 ± 0.07a</td>
</tr>
<tr>
<td>T3 (Oilcake)</td>
<td>30.53 ± 0.40a</td>
</tr>
<tr>
<td>T4 (Azolla pinnata)</td>
<td>18.58 ± 0.09a</td>
</tr>
<tr>
<td>T5 (Grass- Cynodon dactylon)</td>
<td>7.26 ± 0.18a</td>
</tr>
<tr>
<td>T6 (Leaf of Musa acuminata- Banana leaf)</td>
<td>6.18 ± 0.13a</td>
</tr>
<tr>
<td>F value</td>
<td>16.42</td>
</tr>
<tr>
<td>P value</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Figures bearing common letter(s) in a column as superscript do not differ significantly (P<0.05).
and with the ecological conditions and the phase of growth. The crude protein content is about 19-30 percent dry matter basis during the optimum conditions for growth [25,26]. The protein contents of Azolla species are comparable to or higher than that of most other aquatic macrophytes. Aquatic weeds are highly nutritious with protein content of 20-30%, when cultivated in nutrient rich waters [27]. Importantly, they are preferred food of a wide range of herbivorous fish such as grass carp (Ctenopharyngodon idella), silver barb (Barbonymus gonionotus, Puntius jerdoni), tilapias (Oreochromis niloticus, Tilapia rendalli, Tilapia zillii) and rohu (Labeo rohita) [28,29].

Overall findings indicated that inspite of having variations in nutrient contents, monthly supply of nutrients was almost same respective feed item under non-conventional feeds as with conventional feeds. Mean values of the nutrient contents under non-conventional feed items are found potentials for the development of low cost aquaculture.

Fish feed generally constitutes 60-70% of the operational cost in intensive and semi-intensive aquaculture system [30]. The fish feed used in aquaculture is quite expensive, irregular and short in supply in many third world countries. These feeds are sometimes adulterated, contaminated with pathogen as well as containing harmful chemicals for human health. Naturally there is a need for the development of healthy, hygienic fish feed which influences the production as well as determines the quality of cultured fish. Considering the importance of nutritionally balanced and cost-effective alternative diets for fish, almost similar expression to evaluate the nutritive value of different non-conventional feed resources, including terrestrial and aquatic macrophytes was found with Wee and Wang [10,31]. However potentials roles of aquatic and terrestrial macrophytes as supplementary feeds in fish farming were also found to be expressed with Bardach [32] and Edwards [33].

Conclusion

In case of conventional feed items, protein, lipid and carbohydrate varied from 14.40 ± 0.32% to 30.53 ± 0.40%, 6.69 ± 0.30% to 13.33 ± 0.10% and 32.95 ± 0.29% to 66.12 ± 0.47%. In case of non-conventional feed items, protein, lipid and carbohydrate varied from 6.18 ± 0.13% to 18.58 ± 0.09%, 3.06 ± 0.09% to 6.31 ± 0.13% and 46.36 ± 0.16% to 50.21 ± 0.54%. Inspite of variations weeds are moderately nutritious and low cost effective diets for fish. However, the present study did not evaluate the fish production and economics of feed and weed based systems.

Recommendation

Present findings explored the nutritive aspects of both conventional and non-conventional feed items and question raised about the response of utilizing the feed specially of aquatic weeds to fish growth and economics. Therefore, it is recommended to conduct further study on the evaluation of fish production and economics under different feed and weed based systems in polyculture ponds.

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References


