Journal of Aquaculture
Research & Development

Islam, et al., J Aquac Res Development 2015, 6:2
DOI: 10.4172/2155-9546.1000301

Research Article Open Access

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

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Abstract

This study was conducted with a view to comparing 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. 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 T_1, T_2, T_3, T_4, T_5 and T_6, 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 T_4 (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]. 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. 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 [3]. 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. 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 [4].

Aquatic macrophytes have been known to have potential food value [5]. 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 [6-9]. Most of these nutritional studies were 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 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

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Received September 23, 2014; **Accepted** December 10, 2014; **Published** January 12, 2015

Citation: Islam MA, Asadujjaman M, Biswas S, Manirujjaman M, Rahman M, et al. (2015) Determination of Protein, Lipid and Carbohydrate Contents of Conventional and Non-Conventional Feed Items used in Carp Polyculture Pond. J Aquac Res Development 6: 301. doi:10.4172/2155-9546.1000301

of Bangladesh. Whereas nutrient analysis was done at the Protein and Enzyme Research Laboratory under the department of Biochemistry and Molecular Biology, Rajshahi University, Rajshahi, Bangladesh.

Experiment design

The current experiment was carried out under six treatments of feed items each with three replications. The treatment assignments were designated as T_1, T_2, T_3, T_4, T_5 and T_6 for rice bran, wheat bran, mustard oilcake, Azolla, 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 Azolla was collected from Azolla 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 throughout 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 [10,11] methods and Anthrone method [12] 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) [13].

Results

Monthly variations

Protein content significantly varied from 6.05 ± 0.45% with T_6 (banana leaf) at 6th month (September, 2010) to 31.20 ± 0.32% with treatment T_3 (mustard oilcake) at 2nd month (May, 2010). Lipid content significantly varied from 2.95 ± 0.21% with treatment T_6 (banana leaf) at 5th month (August, 2010) to 13.72 ± 0.36% with treatment T_3 (mustard oilcake) at 4th month (July, 2010). Carbohydrate significantly varied from 32.85 ± 0.14% with treatment T_3 (mustard oilcake) at 4th month (July, 2010) to 66.35 ± 0.32% with T_2 (wheat bran) at 3rd month (June, 2010). In the same feed item no significant difference in the nutrient content was found during the study period (Tables 1-6).

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 T_6 (banana leaf) to 30.53 ± 0.40% with treatment T_3 (mustard oilcake). Lipid content significantly varied from 3.06 ± 0.09% with treatment T_6 (banana leaf) to 13.33 ± 0.10% with treatment T_3 (mustard oilcake). Carbohydrate significantly varied from 32.95 ± 0.29% with treatment T_3 (mustard oilcake) to 66.12 ± 0.47% with treatment T_2 (wheat bran).

Discussion

Monthly variations of the nutrient contents

Protein content varied from 6.05 ± 0.45% with (T_6 at 6th month) to 31.20 ± 0.32% (T_3 at 2nd month). Lipid content ranged from 2.95 ± 0.21% (T_6 at 5th month) to 13.72 ± 0.36% (T_3 at 4th month). Carbohydrate content ranged from 32.85 ± 0.14% (T_3 at 4th month) to 66.35 ± 0.32% (T_2 at 3rd month). Suresh and Mandal 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 6.8%, respectively and in Azolla, crude protein and crude fibred was 26.5% and 20.4%, respectively. Sithara and Kamalaveni [14] worked on the formulation of low cost fish feed using Azolla as a protein supplement during September to March and reported 20-25.5% protein in Azolla. Ebrahim [15] used Azolla as tilapia diet for a period of 90 days in summer season and reported 20% protein in Azolla. Fasakin and Balogan [16] worked on the nutritional aspects of Azolla in August, 1997 and reported 20.9% protein in Azolla.

Present findings also indicated that in case of same feed item, no significant difference was found in the nutrient content at different months (Tables 1-6). This might be due to no major change in the temperature was found to affect the growth and composition of Azolla during the study period. This statement was almost agreed with Lumpkin and Plucknett [17] who reported that change in Azolla composition was subjected to change in environment. Statement also agreed with Van-Hove [18] and Ebrahim [15] who reported that change in Azolla composition was subjected to change in species.

Mean variation of the nutrient contents

In the present study the protein content varied from 6.18 ± 0.13% (T_6, banana leaf) to 30.53 ± 0.40% (T_3, mustard oilcake), lipid content varied from 3.06 ± 0.09% (T_6, banana leaf) to 13.33 ± 0.10% (T_3, mustard oilcake) and carbohydrate content varied from 32.95 ± 0.29% (T_3, mustard oilcake) to 66.12 ± 0.47% (T_2, wheat bran). The highest protein and lipid content was found in treatment T_3 (mustard oilcake) whereas the highest carbohydrate content was found in treatment T_2, wheat bran (66.12 ± 0.47%) followed by T_4, Azolla (50.21 ± 0.54%), T_6, banana leaf (48.50 ± 0.51%), T_5, grass (46.36 ± 0.16%), T_1, rice bran (44.09 ± 0.67%), T_3, mustard oilcake (32.95 ± 0.29%). Hepher [19] reported the protein content of ricebran, wheat bran, oil cake and Azolla as 11.88%, 14.57%, 30-33% and 19.27%, respectively. Banerjee and Matai [20] determined the nutritive status of *Azolla pinnata* and reported protein as 21.9% and Lipid as 3.8%. Gavina [21] reported crude protein of 20.98%, crude fat of 5.17% and crude fiber of 19.30% in Azolla. Tavares [22] observed 38.8% crude protein, 3.8% crude fat and 13.2% crude fiber in dried duck weed. They also reported that the protein content of duckweeds growing on nutrient poor and nutrient rich water varied between 15-25% and 35-45% (Dry matter basis), respectively. In case of conventional feed items the major nutrient like protein varied from 14.40 ± 0.32% (rice bran) to 30.53 ± 0.40% (mustard oilcake). Whereas in case of non-conventional feed items the protein varied from 6.18 ± 0.13% (banana leaf) to 18.58 ± 0.09% (Azolla). Being an omnivore, the fish can also feed on vegetation [23] and may be able to assimilate Azolla in the diets.

The chemical composition of Azolla species varies with ecotypes 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 [24,25]. 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 [26]. 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*) [27,28].

Nutrients	Months					
	April	May	June	July	August	September
Protein (%)	14.60 ± 0.22[a]	13.92 ± 0.19[a]	14.65 ± 0.19[a]	14.50 ± 0.36[a]	14.22 ± 0.28[a]	14.50 ± 0.24[a]
Lipid (%)	10.42 ± 0.31[a]	10.50 ± 0.25[a]	10.64 ± 0.25[a]	10.20 ± 0.21[a]	10.24 ± 0.15[a]	10.45 ± 0.26[a]
Carbohydrate (%)	44.25 ± 0.41[a]	43.72 ± 0.19[a]	43.85 ± 0.19[a]	44.20 ± 0.24[a]	44.32 ± 0.20[a]	44.20 ± 0.16[a]

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

Table 1: Monthly variations in nutrient (protein, lipid and carbohydrate) contents with treatment T_1 (Rice, *Oryza sativa* bran).

Nutrients	Months					
	April	May	June	July	August	September
Protein (%)	17.20 ± 0.05[a]	17.05 ± 0.12[a]	17.25 ± 0.12[a]	16.95 ± 0.24[a]	17.10 ± 0.34[a]	17.22 ± 0.18[a]
Lipid (%)	6.75 ± 0.41[a]	6.66 ± 0.69[a]	6.80 ± 0.69[a]	7.12 ± 0.46[a]	6.47 ± 0.32[a]	6.32 ± 0.38[a]
Carbohydrate (%)	66.20 ± 0.36[a]	65.75 ± 0.32[a]	66.35 ± 0.32[a]	66.32 ± 0.26[a]	66.12 ± 0.15[a]	65.99 ± 0.23[a]

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 T_2 (Wheat, *Trticum aestivum* bran).

Nutrients	Months					
	April	May	June	July	August	September
Protein (%)	30.65 ± 0.18[a]	31.20 ± 0.32[a]	30.50 ± 0.32[a]	30.25 ± 0.15[a]	30.15 ± 0.11[a]	30.45 ± 0.17[a]
Lipid (%)	13.34 ± 0.31[a]	13.24 ± 0.47[a]	13.25 ± 0.47[a]	13.72 ± 0.36[a]	13.22 ± 0.18[a]	13.20 ± 0.19[a]
Carbohydrate (%)	32.86 ± 0.18[a]	32.90 ± 0.25[a]	33.10 ± 0.25[a]	32.85 ± 0.14[a]	32.98 ± 0.31[a]	33.02 ± 0.46[a]

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 T_3 (Mustard, *Brassica napus* Oilcake).

Nutrients	Months					
	April	May	June	July	August	September
Protein (%)	18.65 ± 0.08[a]	18.45 ± 0.41[a]	18.35 ± 0.41[a]	18.45 ± 0.32[a]	18.75 ± 0.24[a]	18.80 ± 0.26[a]
Lipid (%)	3.25 ± 0.09[a]	3.15 ± 0.12[a]	3.12 ± 0.12[a]	3.35 ± 0.18[a]	3.14 ± 0.34[a]	3.10 ± 0.41[a]
Carbohydrate (%)	50.36 ± 0.75[a]	50.45 ± 0.61[a]	50.20 ± 0.61[a]	50.15 ± 0.54[a]	50.20 ± 0.17[a]	49.88 ± 0.27[a]

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 T_4 (*Azolla pinnata*).

Nutrients	Months					
	April	May	June	July	August	September
Protein (%)	7.28 ± 0.35[a]	7.32 ± 0.25[a]	7.45 ± 0.25[a]	7.15 ± 0.14[a]	7.25 ± 0.19[a]	7.12 ± 0.23[a]
Lipid (%)	6.35 ± 0.05[a]	6.28 ± 0.06[a]	6.45 ± 0.06[a]	6.23 ± 0.12[a]	6.21 ± 0.18[a]	6.32 ± 0.28[a]
Carbohydrate (%)	46.58 ± 0.12[a]	46.30 ± 0.41[a]	45.95 ± 0.41[a]	46.85 ± 0.38[a]	46.70 ± 0.19[a]	45.76 ± 0.14[a]

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 T_5 (Grass, *Cynodon dactylon*).

Nutrients	Months					
	April	May	June	July	August	September
Protein (%)	6.25 ± 0.11[a]	6.20 ± 0.21[a]	6.32 ± 0.21[a]	6.12 ± 0.31[a]	6.14 ± 0.36[a]	6.05 ± 0.45[a]
Lipid (%)	3.05 ± 0.04[a]	3.12 ± 0.11[a]	3.10 ± 0.11[a]	3.20 ± 0.17[a]	2.95 ± 0.21[a]	2.96 ± 0.41[a]
Carbohydrate (%)	48.85 ± 0.36[a]	47.98 ± 0.26[a]	48.10 ± 0.26[a]	48.30 ± 0.31[a]	48.90 ± 0.35[a]	48.85 ± 0.24[a]

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 T_6 (Leaf of banana, *Musa acuminata*).

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 [29]. 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 [9] and Mondal and Ray [30]. However potentials roles of aquatic and terrestrial macrophytes as supplementary feeds in fish farming were also found to be expressed with Bardach [31] and Edwards [32].

Treatments	Nutrient content		
	Protein (%)	Lipid (%)	Carbohydrate (%)
T_1 (Rice bran)	14.40 ± 0.32^d	10.41 ± 0.31^b	44.09 ± 0.67^e
T_2 (Wheat bran)	17.13 ± 0.07^c	6.69 ± 0.30^c	66.12 ± 0.47^a
T_3 (Oilcake)	30.53 ± 0.40^a	13.33 ± 0.10^a	32.95 ± 0.29^f
T_4 (*Azolla pinnata*)	18.58 ± 0.09^b	3.19 ± 0.10^d	50.21 ± 0.54^b
T_5 (Grass- *Cynodon dactylon*)	7.26 ± 0.18^e	6.31 ± 0.13^c	46.36 ± 0.16^d
T_6 (Leaf of *Musa acuminata*- Banana leaf)	6.18 ± 0.13^f	3.06 ± 0.09^d	48.50 ± 0.51^c
F value	16.42	13.88	114.85
P value	0.002	0.004	0.0000008

Figures bearing common letter(s) in a column 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.

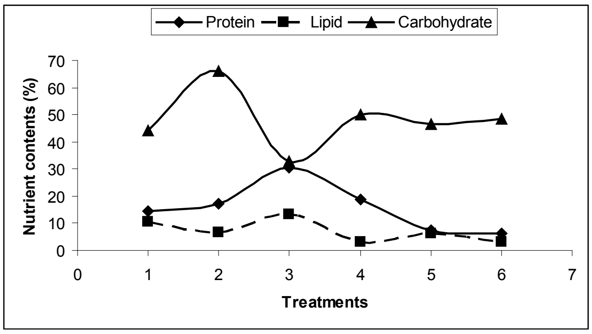

Figure 1: Variations in the mean values of nutrient contents under different fish feed items

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 nutritive and low cost effective diets for fish. However, the present study did not evaluate the fish production and economy 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 especially of aquatic weeds to fish growth and economy. Therefore, it is recommended to conduct further study on the evaluation of fish production and economy under different feed and weed based systems in polyculture ponds.

Acknowledgement

The research work was conducted under a financial support by the Ph. D. Fellowship Programme of Ministry of Science and Technology, Govt. of the People's Republic of Bangladesh which is gratefully acknowledged.

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