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Full Length Research Paper

Effect of dietary protein, lipid and carbohydrate contents on the carcass composition of *Cyprinus carpio communis* fingerlings

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Fingerlings having average weight of 1.64 ± 0.13 g and length 5.26 ± 0.10 cm were fed on four different formulated feeds and a control feed (each in a triplicate set), 6% of their body weight, three times a day, during 90 days. Feeds were formulated using groundnut oil cake, mustard oil cake, rice bran, wheat bran, fish meal and soybean meal in order to suffice the balanced need of protein and energy of the Common carp. Carcass composition was determined initially, at the end of 30 days and at the end of the study. At the end of 30 days, carcass composition of fingerlings was not affected significantly (P>0.05) with protein, lipid and carbohydrate contents in the feeds. At the end of the study, carcass composition of fingerlings was affected significantly (P<0.05) with protein, lipid and carbohydrate contents in the feeds. Highest carcass dry matter, crude protein, crude lipid, ash and energy content, lowest moisture content and carbohydrate content were observed in fingerlings fed with Feed B which contained 40 ± 0.21% protein, 9.31 ± 0.25% lipid and 10.08 ± 0.10% carbohydrate. The fingerlings fed with Feed C which contained 25.98 ± 0.19% protein, 5.49 ± 0.18% lipid and 34.63 ± 0.19% carbohydrate showed least carcass dry matter, crude protein, crude lipid, ash and energy content, highest moisture content and carbohydrate content. This study concluded that Feed B containing 40% protein, 9.31% lipid and 10.08% carbohydrate is the best one in terms of carcass composition for a more profitable and successful culture of the common carp.

Key words: *Cyprinus carpio communis,* fingerlings, carcass composition.

INTRODUCTION

Proteins are the major organic materials in most fish tissue, and form an important component of the diet. One of the major requirements of fish culture is the efficient transformation of dietary protein into tissue protein (Webster and Lim, 2002). However, protein is essential for normal tissue function, for the maintenance and renewal of fish body protein and for growth. Because of the cost of the protein, the feed will be more cost effective if all the protein is used for tissue repair and growth and little catabolized for energy (Gauquelin et al., 2007). From a practical point of view, the ideal situation should tend to maximize the use of dietary protein for growth, minimizing the use of proteins for functional protein synthesis, gluconeogenesis, lipogenesis and energy (Jamabo and Alfred, 2008). If adequate protein is not provided in the diet, there is a rapid reduction or cessation of growth and a loss of weight due to withdrawal of protein from less vital tissues to maintain the functions of more vital tissues. On the other hand, if too much protein is supplied in the diet, only part of it will be used to make new proteins and the remainder will be catabolized to produce energy (Alatise et al., 2006). Although the utilization of proteins for basal energy metabolism is a well-established phenomenon, conventional “energy- yielding” nutrients like fats and carbohydrates can reduce the oxidation of protein to satisfy the energy needs of fish and thus improve the utilization of dietary protein (Kim et al., 2004).

Lipids are an extremely diverse group of compounds

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many of which function as important sources of metabolic energy. Among the various types of lipid it is the simple, glycerol based, fats and oils that are of most interest in terms of general nutrition (Du et al., 2008). Lipids normally occur in foodstuffs and in the fat deposits of most animals in the form of triglycerides, which are esters of fatty acids and glycerol (Kiessling et al., 2001). Thus, dietary lipids provide a source of indispensable nutrients, the essential fatty acids. In addition, they also act as carriers of certain non-fat nutrients, notably the fat-soluble vitamins A, D, E and K and they are also an important source of energy (Storebakken, 2002). Lipids contain more energy per unit weight than any other biological compound. For example, one gram of lipid contains almost twice, as much total energy as either one gram of carbohydrate or one gram of protein (Gullaine et al, 2001). Dietary lipids, mainly in the form of triglycerides, are hydrolyzed to free fatty acids and glycerol by pancreatic lipase, aided by the saponifying and emulsifying action of bile acids in the digestive tract. Absorption generally occurs primarily in the anterior ileum including the caecum (Subhadra et al., 2006). Energy that is not utilized immediately is stored for future use as glycogen and carcass fat. Since glycogen reserves in fish are usually low, the main energy stored is fat. Experiments show that during starvation or food restriction in fish most of the metabolic energy is derived from lipid and, to a more limited degree from protein and carbohydrate (Kikuchi et al., 2002). Lipid is digested and metabolized with greater relative ease and so serves as a much better source of energy for protein sparing than carbohydrate.

Unlike protein and fat, carbohydrate as a nutrient was not considered essential to fish because of their ability to synthesize carbohydrate metabolites (glucose, glycogen etc.) from excess dietary protein and fat. Compared to the farmed terrestrial animals, the utilization of dietary carbohydrates in fish is limited, but the inclusion of carbohydrate in fish feeds has certain beneficial effects (Shiau and Lin, 2001). The utilization of carbohydrate in fish varies depending on its complexity, source, level in the diet, pre-treatment and degree of gelatinization. The ability of fish to utilize carbohydrate also differs greatly between species and life stage as a consequence of the marked variations in the anatomy of the digestive tract and in the food habits (Mustafizur et al., 2008). It is also thought that herbivorous and omnivorous fish species utilize carbohydrate better than carnivorous fishes (Hamre et al., 2002). The inability of fish to utilize dietary carbohydrate has been illustrated by glucose tolerance tests. Oral administration of glucose to different fish species led to linear increase of blood glucose concentration, with a poor response of plasma insulin levels. This implies that glucose levels in blood are poorly regulated by fish, their response being frequently similar to diabetic mammals (Stone, 2003; Amoah et al., 2008; Tian et al., 2010). Other carbohydrates such as fibres, hemicellulose, lignin and pentosans generally form indigestible fractions in the feed, often act as pellet binders. Some fish species can tolerate up to 8% of dietary fibre and depressed growth may occur when the fibre content reaches 20% (NRC, 1993; Amoah et al., 2008; Jesu et al., 2008).

The aim of the present study was to carry out orderly nutritional research with Common carp by using different dietary protein, lipid and carbohydrate contents for determination of a feed formulation with optimum protein to energy ratio (P/E ratio) which would result in better carcass composition so as to make production of Common carp economical.

MATERIALS AND METHODS

Four feeds (Feed A, B, C and D) were formulated using the ingredients like ground nut oil cake, mustard oil cake, rice bran, wheat bran, fish meal and soybean meal. The ingredients were selected so as to suffice the balanced need of protein and energy of the Common carp. Feeds were formulated using "Pearson-Square method" with different protein, carbohydrate and lipid contents. Control feed consisted of 50% mustard oil cake and 50% rice bran. Vegetable oil (1.5 ml per 100 g of feed) and cod liver oil (1.5 ml per 100 g of feed) were incorporated in each formulated feed to ensure adequate supply of fatty acids of both n - 6 and n - 3 series, assumed to be essential for Common carp. Vitamin-mineral mixture (2 g per 100 g of feed) was added to each formulated feed for the maintenance of fish health. Sodium alginate (5 g per 100 g of feed) was used as binder and oxytetracycline (500 mg per 100 g of feed) as antibiotic for control and formulated feeds.

A pelleting machine (Hobart, model, A 200) was used to pellet the feeds. An appropriate die was used to form pellets of desired sizes (1.0 to 3.0 mm). Pellets were oven dried and fed to the fishes at 6% of the body weight, three times a day at 10 A.M., 2.0 and 5.0 P.M. every day.

Cyprinus carpio communis fingerlings having average weight 1.64 ± 0.13 g and length 5.26 ± 0.10 cm were used for the experiment. Prior to the initiation of the feeding trail, fingerlings were acclimatized for one week. During this period, traditional mixture of mustard oil cake and rice bran (1:1) was fed to the fingerlings. Each formulated feed and control feed was fed to triplicate group of fingerlings for 90 days.

Fifty fingerlings were reared in each fiber glass tank. Water analysis of the experimental tanks was done regularly to monitor any unusual changes. The tanks were aerated throughout the experiments with aquarium air pumps (RS-180, Zhongshan Risheng Co. Ltd., China).

Biochemical analysis (dry matter, moisture, crude protein, crude lipid, carbohydrate and ash of feed ingredients, feeds and carcass) was determined by using standard procedures (AOAC, 1995). The energy content of feed ingredients, feeds and carcass were calculated calorimetically.

RESULTS

Biochemical composition of fish feed ingredients

Biochemical composition of fish feed ingredients (% in dry weight basis) used for the present study is given in Table 1. The dry matter content of fish feed ingredients is the highest (95.37 ± 0.17%) in mustard oil cake and the

Table 1. Biochemical composition of fish feed ingredients (% in dry weight basis).

S/N	Ingredient	Dry matter	Moisture	Crude protein	Crude lipid	Carbohydrate	Ash	Energy (Kcal/g)
1	Ground nut oil cake	95.09^{c} ± 0.21	4.91^{a} ± 0.18	42.21^{b} ± 0.17	9.05^{c} ± 0.28	8.62^{b} ± 0.13	4.62^{a} ± 0.21	4.74^{b} ± 0.13
2	Mustard oil cake	95.37^{c} ± 0.17	4.63^{a} ± 0.13	39.56^{b} ± 0.18	9.73^{c} ± 0.19	7.32^{b} ± 0.12	4.12^{a} ± 0.17	4.92^{b} ± 0.21
3	Rice bran	91.55^{a} ± 0.28	8.45^{c} ± 0.21	13.45^{a} ± 0.13	3.37^{a} ± 0.17	19.61^{c} ± 0.17	12.50^{c} ± 0.16	1.86^{a} ± 0.22
4	Wheat bran	91.84^{a} ± 0.23	8.16^{c} ± 0.26	16.10^{a} ± 0.12	4.58^{a} ± 0.13	16.26^{c} ± 0.19	11.92^{c} ± 0.21	1.99^{a} ± 0.26
5	Fish meal	93.82^{b} ± 0.19	6.18^{b} ± 0.16	53.60^{c} ± 0.21	7.78^{b} ± 0.26	4.33^{a} ± 0.14	10.60 ^{b} ± 0.20	3.92^{c} ± 0.23
6	Soybean meal	93.63^{b} ± 0.12	6.37^{b} ± 0.15	50.12^{c} ± 0.17	7.56^{b} ± 0.24	4.72^{a} ± 0.10	10.05 ^{b} ± 0.18	3.63^{c} ± 0.13

Values are means ± SD. Means in the same column having different superscripts are significantly different (P<0.05) and means in the same column with same superscript are not significantly different (P>0.05).

least (91.55 ± 0.28%) in rice bran. The moisture content of fish feed ingredients is the highest (8.45 ± 0.21%) in rice bran and the least (4.63 ± 0.13%) in mustard oil cake. The crude protein of fish feed ingredients is the highest (53.60 ± 0.21%) in fish meal and the least (13.45 ± 0.13%) in rice bran. The crude lipid of fish feed ingredients is the highest (9.73% ± 0.19) in mustard oil cake and the least (3.37 ± 0.17%) in rice bran. The carbohydrate content of fish feed ingredients is the highest (19.61 ± 0.17%) in rice bran and the least (4.33 ± 0.14%) in fish meal. The ash content of fish feed ingredients is the highest (12.50% ± 0.16) in rice bran and the least (4.12 ± 0.17%) in mustard oil cake. The energy content of fish feed ingredients is the highest (4.92 Kcal/g ± 0.21) in mustard oil cake and the least (1.86 ± 0.22 Kcal/g) in rice bran. Out of six ingredients, ground nut oil cake and mustard oil cake were used as the source of lipid to provide energy of 4.74 ± 0.13 and 4.92 ± 0.21 Kcal/g, respectively. Fish meal and soybean meal were used as protein source, providing 53.60 ± 0.21% and 50.12 ± 0.17% crude protein, respectively. Rice bran and wheat bran were used as the source of carbohydrate to provide instant energy of 1.86 ± 0.22 and 1.99 ± 0.26 Kcal/g, respectively. There is no significant difference (P>0.05) in the biochemical composition of ground nut oil cake and mustard oil cake; rice bran and wheat bran; fish meal and soybean meal.

Composition of control and formulated feeds experimented

Four feeds (Feed A, B, C and D) were formulated using the ingredients like groundnut oil cake, mustard oil cake, rice bran, wheat bran, fish meal and soybean meal. The ingredients were selected so as to suffice the balanced need of protein and energy of the Common carp. Feeds were formulated using “Pearson-Square method” with different protein, carbohydrate and lipid contents in order to ascertain their effect on growth parameters. Control feed consisted of 50% mustard oil cake and 50% rice bran. Feed A consisted of groundnut oil cake (15%), mustard oil cake (15%), rice bran (10%), wheat bran (10%), fish meal (25%) and soybean meal (25%). The combination aimed at the supply of maximum protein component than the energy. Feed B consisted of ground nut oil cake (18%), mustard oil cake (60%), rice bran (2%), wheat bran (8%), fish meal (4%) and soybean meal (8%). This combination, instead of having fish meal as a source of protein had mustard oil cake. Feed C consisted of ground nut oil cake (8%), mustard oil cake (12%), rice bran (40%), wheat bran (30%), fish meal (6%) and soybean meal (4%). This combination aimed at the use of carbohydrate rich diet for the growth. Feed D consisted of the mixture of equal quantity (16.66%) of all the ingredients. Vegetable oil (1.5 ml per 100 g of feed) and cod liver oil (1.5 ml per 100 g of feed) were incorporated in each formulated feed to ensure adequate supply of fatty acids of both n-6 and n-3 series, assumed to be essential for Common carp. Vitamin-mineral mixture (2 g per 100 g of feed) was added to each formulated feed for the maintenance of fish health. Sodium alginate (5 g per 100 g of feed) was used as binder and oxytetracycline (500 mg per 100 g of feed) as antibiotic for control and formulated feeds. Composition of control and formulated feeds (% in dry weight basis) experimented is given in Table 2.

Biochemical composition of control and formulated feeds experimented

Biochemical composition of control and formulated feeds experimented (% in dry weight basis) is given in table 3.

Table 2. Composition of control and formulated feeds experimented (% in dry weight basis).

Ingredients	Control	Feed A	Feed B	Feed C	Feed D
Ground nut oil cake	Nil	15	18	8	16.66
Mustard oil cake	50	15	60	12	16.66
Rice bran	50	10	2	40	16.66
Wheat bran	Nil	10	8	30	16.66
Fish meal	Nil	25	4	6	16.66
Soybean meal	Nil	25	8	4	16.66
Sodium alginate (g)	5	5	5	5	5
Vitamin[1] mineral mixture (g)	Nil	2	2	2	2
Vegetable oil (ml)	Nil	1.5	1.5	1.5	1.5
Cod liver oil[2] (ml)	Nil	1.5	1.5	1.5	1.5
Oxytetracycline (mg)	500	500	500	500	500

[1]Supplevite – M (Sarabhai Chemicals India); [2]Cod liver oil (Sea cod, M/S Universal Medicare Ltd. Mumbai).

Table 3. Biochemical composition of control and formulated feeds experimented (% in dry weight basis).

Biochemical composition	Control	Feed A	Feed B	Feed C	Feed D
Dry Matter	92.89^{a}± 0.17	93.77^{b}± 0.21	94.01^{b}± 0.19	92.73^{a}± 0.28	93.44^{b}± 0.16
Moisture	7.11^{b}± 0.21	6.23^{a}± 0.16	5.99^{a}± 0.17	7.27 ^{b}± 0.23	6.56^{a}± 0.19
Crude Protein	26.50^{a}± 0.31	42.00^{c}± 0.26	40.00^{b}± 0.21	25.98^{a}± 0.19	34.75^{ab}±0.17
Crude Lipid	5.80^{a}± 0.26	8.94^{b}± 0.19	9.31^{b}± 0.25	5.49^{a}± 0.18	8.22^{b}± 0.16
Carbohydrate	32.95^{b}± 0.18	12.92^{a}± 0.16	10.08^{a}± 0.10	34.63^{b}± 0.19	15.07^{a}± 0.22
Ash	8.68^{a}± 0.21	9.39^{b}± 0.19	9.45^{b}± 0.16	8.59^{a}± 0.26	9.15^{b}± 0.15
Energy (Kcal/g)	3.66^{a}± 0.15	4.44^{b}± 0.11	4.65^{b}± 0.13	3.48^{a}± 0.16	4.26^{b}± 0.19
P/E (mg protein/Kj)	17.33^{a}± 0.22	22.64^{c}± 0.36	20.54^{b}± 0.21	17.18^{a}± 0.19	19.53^{ab}±0.15

Values are means ± SD. Means in the same row having different superscripts are significantly different (P<0.05) and means in the same row with same superscript are not significantly different (P>0.05).

The highest dry matter content (94.01% ± 0.19) was recorded in Feed B and the least (92.73 ± 0.28%) in Feed C. The highest moisture content (7.27 ± 0.23%) was recorded in Feed C and the least (5.99 ± 0.17%) in Feed B. The highest crude protein (42 ± 0.26%) was recorded in Feed A and the least (25.98 ± 0.19%) in Feed C. The highest crude lipid (9.31 ± 0.25%) was recorded in Feed B and the least (5.49 ± 0.18%) in Feed C. The highest carbohydrate content (34.63 ± 0.19%) was recorded in Feed C and the least (10.08 ± 0.10%) in Feed B. The highest ash content (9.45% ± 0.16) was recorded in Feed B and the least (8.59 ± 0.26%) in Feed C. The highest energy content (4.65 ± 0.13 Kcal/g) was recorded in Feed B and the least (3.48 ± 0.16 Kcal/g) in Feed C. The highest P/E ratio (22.64 ± 0.36 mg protein/Kj) was recorded in Feed A and the least (17.18 ± 0.19 mg protein/Kj) in Feed C.

Carcass composition

Carcass composition (% mean wet weight basis) of the fingerlings fed on control and formulated feeds after 30 and 90 days of experiment is given in Table 4.

Dry matter

The initial carcass dry matter content of the fingerlings was recorded 24.18% ± 0.19. After 30 days, there was no significant difference (P>0.05) in the carcass dry matter content of the fingerlings fed on control feed, Feed A, Feed B, Feed C and Feed D. After 90 days, the carcass dry matter content was recorded the highest (29.35±0.14%) in the fingerlings fed on Feed B and the least (28.18 ± 0.19%) in the fingerlings fed on Feed C. There was no significant difference (P > 0.05) in the carcass dry matter content of the fingerlings fed on control feed and Feed C; Feed A, B and D.

Moisture

The initial carcass moisture content of the fingerlings was recorded 75.82 ± 0.31%. After 30 days, there was no significant difference (P>0.05) in the carcass moisture content of the fingerlings fed on control feed, Feed A, Feed B, Feed C and Feed D. After 90 days, the carcass moisture content was recorded the highest (71.82 ± 0.13%) in the fingerlings fed on Feed C and the least (70.65 ±

Table 4. Carcass composition (% mean wet weight basis) of fingerlings fed on control and formulated feeds after 30 and 90 days of experiment

Parameters (%)	Initial	Control	Feed A	Feed B	Feed C	Feed D	± SEM
Observations after 30 days of experiment							
Dry matter	24.18± 0.19	25.22^{a}± 0.16	25.64^{a}± 0.12	25.79^{a}± 0.10	25.14^{a}± 0.24	25.57^{a}± 0.16	0.17
Moisture	75.82± 0.31	74.78^{a}± 0.23	74.36^{a}± 0.21	74.21^{a}± 0.19	74.86^{a}± 0.27	74.43^{a}± 0.22	0.22
Crude protein	18.43± 0.24	19.16^{a}± 0.17	19.76^{a}± 0.14	19.83^{a}± 0.16	19.06^{a}± 0.21	19.52^{a}± 0.19	0.19
Crude lipid	2.19± 0.12	2.83^{a}± 0.22	3.16^{a}± 0.26	3.21^{a}± 0.16	2.76^{a}± 0.24	3.06^{a}± 0.18	0.23
Carbohydrate	1.43± 0.10	1.71^{a}± 0.21	1.49^{a}± 0.16	1.46^{a}± 0.10	1.76^{a}± 0.19	1.54^{a}± 0.18	0.15
Ash	2.58± 0.16	2.86^{a}± 0.15	3.12^{a}± 0.21	3.18^{a}± 0.20	2.79^{a}± 0.19	3.04^{a}± 0.16	0.18
Energy (Kcal/g)	7.67± 0.26	8.15^{a}± 0.21	8.67^{a}± 0.18	8.76^{a}± 0.17	8.06^{a}± 0.20	8.53^{a}± 0.19	0.22
Observations after 90 days of experiment							
Dry matter		28.27^{a}± 0.17	29.26^{b}± 0.16	29.35^{b}± 0.14	28.18^{a}± 0.19	29.18^{b}± 0.22	0.18
Moisture		71.73^{b}± 0.12	70.74^{a}± 0.10	70.65^{a}± 0.11	71.82^{b}± 0.13	70.82^{a}± 0.14	0.11
Crude protein		21.63^{a}± 0.34	24.23^{b}± 0.16	25.03^{c}± 0.12	21.54^{a}± 0.29	23.92^{ab}± 0.16	0.20
Crude lipid		3.61^{a}± 0.20	4.23^{b}± 0.16	4.30^{b}± 0.22	3.53^{a}± 0.19	4.12^{b}± 0.17	0.18
Carbohydrate		2.79^{a}± 0.11	2.47^{a}± 0.12	2.42^{a}± 0.10	2.88^{a}± 0.13	2.56^{a}± 0.14	0.12
Ash		5.19^{a}± 0.16	5.53^{a}± 0.19	5.59^{a}± 0.18	5.12^{a}± 0.22	5.38^{a}± 0.15	0.18
Energy (Kcal/g)		10.36^{a}± 0.26	12.38^{b}± 0.22	12.47^{b}± 0.19	10.24^{a}± 0.20	12.13^{b}± 0.21	0.23

Values are means ± SD of five replications (d.f. 5, 35). Means in the same row in the same block having different superscripts are significantly different (P<0.05) and means in the same row in the same block with same superscript are not significantly different (P>0.05).

0.11%) in the fingerlings fed on Feed B. There was no significant difference (P>0.05) in the carcass moisture content of the fingerlings fed on control feed and Feed C; Feed A, B and D.

Crude protein

The initial carcass crude protein of the fingerlings was recorded 18.43 ± 0.24%. After 30 days, there was no significant difference (P>0.05) in the carcass crude protein of the fingerlings fed on control feed, Feed A, B, C and D. After 90 days, the carcass crude protein was recorded the highest (25.03 ± 0.12%) in the fingerlings fed on Feed B and the least (21.54 ± 0.29%) in the fingerlings fed on Feed C. There was no significant difference (P>0.05) in the carcass crude protein of the fingerlings fed on control feed and Feed C. The carcass crude protein of the fingerlings fed on Feed A was significantly lower (P<0.05) as compared to the carcass crude protein of the fingerlings fed on Feed B.

Crude lipid

The initial carcass crude lipid of the fingerlings was recorded 2.19 ± 0.12%. After 30 days, there was no significant difference (P>0.05) in the carcass crude lipid of the fingerlings fed on control feed, Feed A, Feed B, Feed C and Feed D. After 90 days, the carcass crude lipid was recorded the highest (4.30 ± 0.22%) in the fingerlings fed on Feed B and the least (3.53 ± 0.19%) in the fingerlings fed on Feed C. There was no significant difference (P>0.05) in the carcass crude lipid of the fingerlings fed on control feed and Feed C; Feed A, B and D.

Carbohydrate

The initial carcass carbohydrate content of the fingerlings was recorded 1.43 ± 0.10%. After 30 days, there was no significant difference (P>0.05) in the carcass carbohydrate content of the fingerlings fed on control feed, Feed A, Feed B, Feed C and Feed D. After 90 days, the carcass carbohydrate content was recorded the highest (2.88 ± 0.13%) in the fingerlings fed on Feed C and the least (2.42 ± 0.10%) in the fingerlings fed on Feed B. There was no significant difference (P>0.05) in the carcass carbohydrate content of the fingerlings fed on control feed, Feed A, B, C and D.

Ash

The initial carcass ash content of the fingerlings was recorded 2.58 ± 0.16%. After 30 days, there was no significant difference (P>0.05) in the carcass ash content of the fingerlings fed on control feed, Feed A, B, C and D. After 90 days, the carcass ash content was recorded the highest (5.59 ± 0.18%) in the fingerlings fed on Feed B and the least (5.12 ± 0.22%) in the fingerlings fed on Feed C. There was no significant difference (P>0.05) in the carcass ash content of the fingerlings fed on the control feed, Feed A, B, C and D.

Energy

The initial carcass energy content of the fingerlings was 7.67 ± 0.26 Kcal/g. After 30 days, there was no significant difference (P>0.05) in the carcass energy content of the fingerlings fed on control feed, Feed A, B, C and D. After 90 days, the carcass energy content was recorded the highest (12.47 ± 0.19 Kcal/g) in the fingerlings fed on Feed B and the least carcass energy content (10.24 ± 0.20 Kcal/g) was recorded in the fingerlings fed on Feed C. There was no significant difference (P>0.05) in the carcass energy content of the fingerlings fed on control feed and Feed C; Feed A, B and D.

DISCUSSION

The carcass dry matter content, moisture content, crude protein, crude lipid, carbohydrate content, ash content and energy content of the fingerlings fed on control and formulated feeds did not vary significantly (P>0.05) after 30 days of the experiment. After 90 days of experiment, the carcass dry matter content was recorded the highest (29.35 ± 0.14%) in the fingerlings fed on Feed B. The least carcass dry matter content (28.18 ± 0.19%) was recorded in the fingerlings fed on Feed C. There was no significant difference (P>0.05) in the carcass dry matter content of the fingerlings fed on control feed and Feed C; Feed A, B and D. Pedro et al. (2001) reported 30% carcass dry matter content in tench fed diets with 35% dietary protein level and Amoah et al. (2008) reported 31% carcass dry matter content in largemouth bass fed diets with 38% dietary protein level. Both the findings lend support to the present observation of highest carcass dry matter content in Feed B having 40% dietary protein level.

The carcass moisture content was recorded the highest (71.82 ± 0.13%) in the fingerlings fed on Feed C. The least carcass moisture content (70.65 ± 0.11%) was recorded in the fingerlings fed on Feed B. There was no significant difference (P>0.05) in the carcass moisture content of the fingerlings fed on control feed and Feed C; Feed A, Feed B and Feed D. The carcass moisture content exhibited inverse relationship with the carcass lipid and also with the dietary lipid level. The same observations have been reported in European white fish (Vielma et al., 2003) and largemouth bass (Tidwell et al., 2005).

The carcass crude protein was recorded the highest (25.03 ± 0.12%) in the fingerlings fed on Feed B. The least carcass crude protein (21.54 ± 0.29%) was recorded in the fingerlings fed on Feed C. There was no significant difference (P>0.05) in the carcass crude protein of the fingerlings fed on control feed and Feed C. The carcass crude protein of the fingerlings fed on Feed A was significantly lower (P<0.05) as compared to the carcass crude protein of the fingerlings fed on Feed B. The carcass protein content increased significantly (P<0.05) with the increase in dietary protein level up to 40% and above 40% of dietary protein level, the carcass protein content decreased significantly (P<0.05). The increase in carcass protein content with the increase in dietary protein level up to 40% is due to the increase in protein utilization and digestibility with the increase in dietary protein level up to 40%. The decrease in the carcass protein above 40% dietary protein level is due to the decrease in protein utilization and digestibility above 40% dietary protein level. Pedro et al. (2001) and Tidwell et al. (2005) reported the increase in carcass protein content with the increase in dietary protein level.

The carcass crude lipid was recorded the highest (4.30 ± 0.22%) in the fingerlings fed on Feed B. The least carcass crude lipid (3.53 ± 0.19%) was recorded in the fingerlings fed on Feed C. There was no significant difference (P>0.05) in the carcass crude lipid of the fingerlings fed on control feed and Feed C; Feed A, B and D. The carcass lipid content exhibited positive relationship with the dietary lipid level which is in agreement with the results reported by Yamamoto et al. (2000) in rainbow trout and Gumus and Ikiz (2009) in rainbow trout. The carcass lipid content and the carcass energy content exhibited direct relationship. It is a finding comparable with the observations of Gumus and Ikiz (2009) in rainbow trout. The carcass lipid content decreased significantly (P<0.05) with the increase in dietary carbohydrate level. The decrease in lipid digestibility and lipid utilization with the increase in dietary carbohydrate level resulted in the decrease in carcass lipid with the increase in dietary carbohydrate level. Morais et al. (2001) reported the decrease in carcass lipid with the increase in dietary carbohydrate level.

The carcass carbohydrate content was recorded the highest (2.88 ± 0.13%) in the fingerlings fed on Feed C. The least carcass carbohydrate content (2.42 ± 0.10%) was recorded in the fingerlings fed on Feed B. There was no significant difference (P>0.05) in the carcass carbohydrate content of the fingerlings fed on control feed, Feed A, B, C and D. The carcass carbohydrate content did not show significant difference (P>0.05) with the increase in dietary carbohydrate level from 10.08 to 34.63%. This is in conformation to the results reported in European white fish (Vielma et al., 2003) and largemouth bass (Amoah et al., 2008).

The carcass ash content was recorded the highest (5.59 ± 0.18%) in the fingerlings fed on Feed B. The least carcass ash content (5.12 ± 0.22%) was recorded in the fingerlings fed on Feed C. The carcass ash content did not vary significantly (P>0.05) among the fingerlings fed on control and formulated feeds. The same trend has been reported in grass carp by Du et al. (2008) and Atlantic halibut by Hamre et al. (2003).

The carcass energy content was recorded the highest (12.47 ± 0.19 Kcal/g) in the fingerlings fed on Feed B. The least carcass energy content (10.24 ± 0.20 Kcal/g) was recorded in the fingerlings fed on Feed C. There was no significant difference (P>0.05) in the carcass energy content of the fingerlings fed on control feed and Feed C; Feed A, B and D. Yamamoto et al. (2000) reported 12 Kcal/g carcass energy content in rainbow trout fed diets with 37% crude protein. Pedro et al. (2001) reported 13 Kcal/g carcass energy content in tench fed diets with 40% crude protein. Both the findings lend support to present observation of the highest carcass energy content in Feed B having 40% dietary protein level.

Based on carcass composition this work concludes that Feed B containing 40% protein, 9.31% lipid, 10.08% carbohydrate and having P/E ratio 20.54 mg protein/Kj is the best one for a more profitable and successful culture of the common carp.

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