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THE EFFECT OF PROTEIN AND CARBOHYDRATE OF DIETS ON THE BODY COMPOSITION OF HETEROBRANCHUS LOGIFILIS FINGERLINGS

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ABSTRACT

There was no significant difference (P>0.05) in the nutrient composition of the fish fed various diets in the two experiments. The lower levels of protein (10 to 24%) and higher levels of carbohydrates (58 to 76%) in the diets presented to H. longifilis fingerlings resulted in the fish not growing beyond the size at stocking that is maintenance level. The body composition of fish fed various diets showed lower levels of nutrient than the nutrients supplied through the diets. There was no specific trend of the influence of the protein and lipid content of the diet on the body composition. The body protein did not increase with dietary protein. Higher carbohydrate levels in the diets at levels of 58 to 76% did not contribute positively to the growth of the fish.

KEYWORDS: Protein, Carbohydrate, body composition, Heterobranchus longifilis

INTRODUCTION

Proteins are major component of fish tissues consisting about 65 – 75 % of the total on a dry weight basis. Proteins constitute the most expensive item of fish diets. Aquaculture nutrition research starts with the determination of gross protein requirement (Benitez 1989). According to Lim and Dominy (1989) fish does not have an absolute requirement for protein but require a well balanced mixture of EAA and non – EAA. The level of dietary crude protein required by warm water fish range from 30% to 56%. These variations probably reflect differences in species, size of fish, water temperature, culture management, daily feed allowance, amount of non - protein energy quality of the dietary protein and availability of natural food. (Lim and Dominy 1989) Research shows that fish have a much higher dietary protein requirement than other domestic animals but requires lower dietary energy. High production levels in aquaculture depend on good nutrition. The quality and quantity of feed used determine the amount of flesh and production limits. As the quality of the feed is being considered in formulation so is the economy of the use of a combination of feed stuffs. The least – cost nutritionally balanced diet, the minimum amount of dietary protein needed for optimum growth of fish are naturally selected for production purpose. According to NRC (1983) when protein is consumed, it is digested or hydrolyzed to release free amino acids that are absorbed from the intestinal tract of the fish and distributed by the blood to the various organs and tissues. The amino acids are used to synthesize new protein to build new tissues during growth, reproduction or to repair worn tissues. NRC (1983) further stated that if protein is inadequate there will be a rapid reduction or cessation of growth or a loss of weight because the animal withdraws protein from some tissues to maintain the functions of more vital ones. If too much protein is supplied the excess will be metabolized to produce energy. The amount of carbohydrates in fish diet is also important as its availability in sufficient quantities prevents disproportionate catabolism of proteins and lipids for energy and metabolic intermediates for the synthesis of other biologically important compounds (Steffens 1989; Shiau and Huang 1990; Wilson 1994). Wilson (1994) observed that levels of carbohydrates higher than 20% is used by fresh or warm water fishes. Shiau and Lin (1993) also reported that fish utilize complex carbohydrates such dextrin and starch better than simple sugars. Although the protein requirement of H. longifilis has been reported (Eyo, 1995; Olufeagba, 1999; Ovie, 2003) it is pertinent to know how the fish responds to lower levels of protein and other nutrients in the diet. This study therefore compares the effect of varying levels protein and other nutrients on the body composition of two sizes of H. longifilis.

MATERIALS AND METHODS:

Two sets of sizes H. longifilis of mean weight 0.84 ± 0.01g and 0.97 ± 0.01g in experiment I and 2.2 ±0.01g and 2.83 ± 0.02g in experiment II were collected from the National Institute for Freshwater fisheries Research hatchery complex, New Bussa, Nigeria. The experiment was conducted in a mini – flow through system consisting of 39 plastic troughs. Each trough measures 25cm in depth and 55cm in diameter. Each trough was supplied with an outlet pipe which is covered with a sleeve borne with holes for overflow. A rubber hose of 2mm diameter served as the inlet pipe. This is connected to a biological sedimentation tank linked with overflow tank. The water is sprinkled into each trough through tiny holes borne on the hose. The flow-through was run for 15hours daily. Fifteen fingerlings were stocked into each of the troughs and each treatment was replicated thrice. The fingerlings were acclimatized for three days. Ten fingerlings were randomly selected and frozen immediately for proximate analysis. Sampling was done by bulk weighing of the fish biweekly and feeding rates were adjusted to new weights. The number of fish in each trough was counted. Some water quality parameters were monitored for temperature, pH, dissolved oxygen and conductivity.

Table 1 shows the proximate composition of the ingredients used for the formulation of the diets.

For the first experiment 13 diets containing varying levels of crude protein ranging from 10.74% to 40.87%, carbohydrates ranging from 27.99% to 76.15% and other nutrients.(Table 2 and 3) These feed were prepared and dried. Feeding was done at 5% of the body weight of fish thrice daily (8hrs, 13hrs and18hrs) for 56 days. The flow-through system is self cleansing although, not all faecal materials and feed remnants were removed and so whatever was not removed as the water flowed was siphoned out. At the end of the experimental period ten fish each was taken from each feeding treatment and frozen for proximate analysis (AOAC 1990).

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In the second experiment twelve feeding treatments of crude protein levels ranging from 20.76% to 49.60% and carbohydrate levels of 28.24% to 76.15% were fed in triplicates to the fish. They were fed at the same rate and number of days as the fish in experiment I.

The growth parameters measured were Food Conversion Ratio (FCR), Specific Growth Rate (SGR), Protein Efficiency Ratio (PER), Percentage Protein Deposited (PPD) and Food Conversion Efficiency (FCE). The growth parameters were calculated as follows:

FCR=Feed consumed/weight gain
SGR=100 x (In final weight (g) – In initial weight)/time (days)
PER=Weight gain/ Protein consumed
FCE=Weight gain (g)/dry feed intake

$$PPD=\frac{\text{Final body protein(g)} - \text{initial body(g)}}{\text{Protein intake}}$$

All the growth parameters were analyzed using one-way ANOVA. The significance of differences among diets within the experiments were determined by Student's Newman Keul (SNK), Least Significant Difference (LSD), Tukey – test and Duncan multiple range test.

RESULTS

The results of growth and nutrient utilization are presented in Tables 4 and 5.

Experiment I

The fish fed crude protein level of 41.8% showed the best growth having the maximum MWG, SGR, PER and FCE. The lowest MWG, SGR, PER and FCE was observed with fish fed 20.76% crude protein. The highest PPD was observed with diet III while the least was with diet II (Table 4). In subjecting the result to statistical multiple comparisons using LSD, SNK and Tukey the following results were obtained. There was significant difference in the FCR (P<0.05). The source of the significant difference was from diets I, III, and VIII. There was significant difference (P<0.05) in the MWG, and the sources of the significant difference was from diets VI, IX, XI, XII and XIII.

There was significant difference (P<0.05) in the PER. It showed overlapping results although the major source of difference was from diet XII. The SGR varied significantly (P<0.05) and the source of the difference is from diet I. There are several degrees of overlapping among the SGR observed with fish fed the diets. There was no significant difference (P>0.05) in the percentage survival of fish fed all the varying diets. Although the fish that had the best growth had the lowest percentage survival while fish fed diet II had the best percentage survival.

The body composition shows that the crude protein, lipid, ash , crude fibre and moisture were not significantly different (P>0.05). The crude protein, lipid and crude fibre content was highest with fish fed diet X. The crude protein content was lowest with fish fed diet II. The ash content was highest with fish fed diet IV while the lipid and ash content were lowest with fish fed diet V. The crude fibre content was lowest with fish fed diet XI. The moisture content was highest with fish fed diet XII and lowest with fish fed diet VII.

Experiment II

The fish fed diet X showed the highest MWG, PER and FCE. The fish fed diet II had the lowest MWG, PER and FCE. The fish fed diet IX had the highest SGR while fish fed diet I had the lowest SGR. (Table 5) The fish fed diet XII had the highest PPD while that fed diet I had the lowest. There was no significant difference (P>0.05) in the FCR of all the fish fed the varying diets. The percentage survival does not differ significantly (P>0.05) and the sources of variation were diets V, VI, XI and XII as shown by Duncan multiple range test. There was significant difference in the MWG, PER, SGR and FCE (P<0.05). The sources of variation in the FCE were from diets V and XI.

The MWG, PER and percentage survival showed several overlapping results as shown in Table 5.

The body composition showed that the crude protein, lipid, crude fibre, ash and moisture content of all the fish fed varying diets were not significantly different from one another (P>0.05). The fish fed diet XI had the highest crude protein and crude fibre while that fed diet VI and IX had the lowest crude protein and crude fibre respectively. The lipid content of the fish fed diet X was highest while that fed diet III was lowest. The fish fed diets III and IX had the highest ash content while the lowest was recorded with fish fed diet XII. The highest moisture content was observed with fish fed diet I while the lowest was in diet IX. The Nitrogen Free Extract (NFE) was very negligible in most of the body content of the fish in all treatments although the highest was observed with fish fed diet IV.

Table 1: Chemical Composition of feedstuffs used in formulation of diets

Proximate Composition %	Ingredients			
	Soyabean meal	Groundnut cake	Fish meal	Guinea corn
Protein	48.13±0.04	40.59±3.05	71.33±3.16	11.22±2.18
Lipid	23.93±1.73	23.39±3.90	7.97±1.00	2.48±0.66
Crude fibre	4.12±0.04	6.03±1.49	1.08±1.10	2.32±0.22
Ash	7.88±1.30	6.20±1.18	20.22±3.44	1.77±0.04
NFE	20.65±5.00	19.01±5.56	-	74.06±7.12
Dry matter	92.08±0.31	92.41±1.61	90.22±0.89	88.84±2.94
Essential Amino Acids				
Arginine	2.91	7.95	5.51	2.33
Methionine	1.06	0.87	2.21	0.85
Leucine	4.42	5.15	8.31	14.14
Isoleucine	2.13	2.91	2.62	2.97
Threonine	2.59	3.30	5.50	3.54
Phenylalanine	4.35	5.20	5.50	5.18
Histidine	2.55	3.99	4.28	2.11
Lysine	3.72	4.18	11.09	1.90
Valine	2.20	2.77	5.83	3.71

Adapted from Eyo 1990

Table 2: Proximate composition of feed in experiment I

Nutirents	Crude Protein	Lipid	Ash	Crude Fibre	Moisture	Nitrogen Free Extract	Total Carbohydrate
Diets							
I	20.76	7.7	6.62	3.3	7.5	59.12	62.42
II	24.09	6.55	5.4	2.00	8.35	50.61	52.61
III	26.88	14.65	6.48	2.2	8.2	41.59	43.79
IV	27.82	15.2	5.91	2.3	7.75	41.02	48.32
V	29.05	12.25	3.06	2.2	8.6	55.16	57.36
VI	30.47	8.75	7.06	2.7	11.5	39.52	42.22
VII	31.88	15.05	5.61	2.7	7.3	37.56	40.26
VIII	34.72	18.25	6.17	3.5	7.55	29.81	33.31
IX	36.84	15.25	5.48	2.5	5.95	33.9	36.4
X	39.28	14.1	7.35	3.00	4.80	41.47	44.47
XI	40.39	12.9	8.08	2.8	6.7	29.13	31.93
XII	41.8	10	8.86	2.7	11.35	25.29	27.99
XIII	49.6	12.4	9.48	1.2	9.8	27.52	28.72

Table 3: Proximate composition of experimental diets in experiment II

Nutrients	Crude protein	Lipid	Ash	Crude Fibre	Moisture	Nitrogen Free Extract	Total Carbohydrate
Diets							
I	10.74	4.45	10.46	1.6	7.2	74.55	76.15
II	14.67	5.2	10.87	1.7	8.9	58.66	60.36
III	19.68	7.15	5.55	2.6	7.25	57.77	60.37
IV	20.48	10.75	4.15	2.0	5.9	56.72	58.72
V	21.3	8.05	6.39	1.9	7.7	54.66	56.56
VI	22.55	14.00	6.73	1.9	6.25	51.57	53.47
VII	26.13	12.05	6.14	2.4	7.55	45.73	48.13
VIII	30.88	11.85	6.25	2.4	6.45	42.17	44.57
IX	32.57	14.25	6.45	2.8	7.28	36.65	39.45
X	34.89	15.5	6.87	1.9	6.15	34.69	36.59
XI	35.5	14.25	6.85	3.7	6.55	33.15	36.85
XII	40.87	16.65	6.86	2.9	7.38	25.34	28.24

Table 4: Growth, nutritional indices and survival of H. longifilis fed varying levels of protein and carbohydrates in experiment I adequate

Nutritional Indices	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
Initial Mean weight	0.98± 0.01	0.98± 0.02	0.96± 0.01	0.84± 0.00	0.82± 0.01	0.95± 0.01	0.84± 0.01	0.84±0.01	0.86± 0.01	0.85± 0.01	0.96± 0.01	0.96± 0.02	0.98± 0.02
Final mean weight	1.64± 0.20	2.33±0.10	1.84±0.2	2.00±0.23	2.35± 0.30	3.31± 0.17	2.25± 0.01	1.97± 0.20	2.59± 0.06	2.22± 0.10	3.87± 0.58	4.93± 0.77	4.16 ±0.67
MWG	0.66± 0.19^{a}	1.35± 0.10^{ab}	0.88± 0.23^{ab}	1.16± 0.08^{ab}	1.53± 0.30^{ab}	2.36± 0.17^{cd}	1.41± 0.09^{ab}	1.13± 0.19^{ab}	1.74± 0.07^{bc}	1.37± 0.10^{ab}	2.91± 0.58^{de}	3.97± 0.78^{f}	3.18± 0.71^{e}
SGR	0.92^{a}	1.55^{b}	1.16^{bc}	1.55^{bc}	1.88^{c}	2.23^{bc}	1.76^{c}	1.53	1.97^{c}	1.72^{bc}	2.49^{d}	2.92^{d}	2.58^{d}
FCR	8.54± 0.21^{c}	3.14± 0.69^{ab}	4.77± 0.92^{b}	3.67± 0.97^{ab}	3.21± 0.46^{ab}	2.49± 0.44^{a}	3.44± 0.29^{ab}	4.12± 1.62^{b}	2.78± 0.27^{ab}	3.25± 0.65^{ab}	1.99± 0.44^{a}	1.99± 0.42^{a}	2.12± 0.23^{a}
PER	0.032^{ab}	0.06^{ab}	0.033	0.042^{abc}	0.053^{bc}	0.077^{abc}	0.044	0.033^{ab}	0.047	0.035^{ab}	0.07^{bc}	0.10^{c}	0.08^{abc}
PPD	-0.77	-6.43	5.13	0.05	0.01	-0.03	0.04	-0.05	0.06	0.05	0.01	0.02	0.01
FCE	0.014^{a}	0.024^{a}	0.018^{a}	0.022^{a}	0.028^{a}	0.042^{a}	0.026^{a}	0.021^{a}	0.032^{a}	0.026^{a}	0.036^{a}	0.051^{a}	0.04^{a}
%survival	80± 11.55	95.56± 7.7	91.11± 7.7	91.11± 3.85	86.67± 3.85	80± 17.64	88.89± 10.18	91.11± 10.18	86.67± 17.64	88.89± 10.18	93.33± 6.67	75.56± 20.37	86.67± 13.34
Feed consumed	47.1	57.28	49.8	51.8	54.83	56.84	53.79	53.64	54.8	53.72	80.73	77.52	80.83

MWG=Mean Weight Gain
SGR=Specific Growth Rate
FCR=Food Conversion Ratio
PER=Protein Efficiency Ratio
PPD=Percent Protein Deposited
FCE=Food Conversion Efficiency

Table 5: Effect of varying levels of protein on the growth, nutritional indices and survival of H. longifilis

Nutritional Indices	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
MIW	2.18± 0.03	2.20± 0.03	2.20± 0.03	2.81± 0.03	2.20± 0.03	2.84± 0.01	2.85± 0.02	2.85± 0.01	2.82± 0.01	2.84± 0.01	2.21±0.01	2.83±0.02
MFW	2.07±0.13	2.19±0.06	2.87±0.12	4.61±0.26	3.15±0.22	4.11±0.48	4.81± 0.23	4.74± 0.98	5.2± 0.64	6.35± 0.53	4.97± 2.69	6.28±0.30
MWG	0.15± 0.13^{a}	0.01± 0.00^{a}	0.67± 0.12^{ab}	1.77± 0.24^{cd}	1.32± 0.25^{bc}	1.27± 0.48^{bc}	1.97± 0.24^{cd}	2.91± 0.96^{d}	2.37± 0.65^{d}	3.50± 0.42^{e}	2.76± 0.45^{de}	3.45± 0.28^{e}
SGR	0.01^{a}	0.03^{a}	0.47^{a}	0.88^{bc}	0.63^{a}	0.66^{a}	0.90^{bc}	0.92^{bc}	1.09^{c}	0.78^{b}	1.47^{c}	1.42^{c}
FCR	72.32± 69.68^{a}	147.32± 0.00^{a}	1.930± 2.67^{a}	5.07± 0.01^{a}	5.67± 0.98^{a}	9.47± 2.56^{a}	5.31± 1.33^{a}	6.42± 2.26^{a}	5.03± 1.95^{a}	3.42± 0.22^{a}	3.28± 0.53^{a}	3.31± 0.27^{a}
PER	0.014^{ab}	0.001^{a}	0.03^{bc}	0.09^{d}	0.06^{cd}	0.06^{cd}	0.08^{d}	0.094^{cd}	0.073^{d}	0.10^{d}	0.08^{d}	0.084^{d}
FCE	0.0001^{a}	0.0001^{a}	0.007^{ab}	0.013^{a}	0.016^{b}	0.01^{a}	0.014^{a}	0.021^{a}	0.016^{a}	0.022^{a}	0.021^{c}	0.02^{a}
PPD	0.093	4.84	3.66	14.7	0.141	4.7	7.88	2.66	8.04	6.07	4.48	10.86
%Survival	84.44± 10.18^{ab}	86.67± 0.00^{ab}	84.44± 10.18^{ab}	86.67± 6.67^{ab}	77.78± 7.7^{a}	91.11± 10.18^{ab}	91.11± 10.18^{ab}	86.67± 6.67^{ab}	93.33± 6.67^{ab}	88.89± 13.88^{ab}	97.78± 3.85^{b}	97.78± 3.85^{b}
Total Feed	76.6	82.5	97.23	141.04	109.59	130.38	138.59	139.47	153.37	159.3	130.38	170.03

Table 6: Proximate composition of whole – body of H. longifilis fed varying diets in experiment I

Nutrients	Crude Protein	Lipid	Ash	Crude Fibre	Moisture
Diets					
I	13.59	3.75	2.45	0.60	76.1
II	12.2	2.75	2.3	1.2	77.45
III	15.4	4.7	2.5	0.5	73.65
IV	15.4	4.7	2.5	0.5	73.65
V	14.41	2.45	1.45	0.8	77.6
VI	12.83	6.45	2.00	1.00	80.95
VII	15.34	3.75	2.00	1.4	72.65
VIII	12.44	5.6	1.55	0.7	74.95
IX	16.34	6.0	2.0	0.8	74.05
X	15.96	5.75	1.8	1.2	76.7
XI	14.1	3.05	1.9	0.5	81.2
XII	14.56	4.1	1.8	0.8	82.2
XIII	14.21	2.95	1.5	0.8	82.3
Initial I	14.02	2.3	1.55	1.09	79.1
Initial 2	13.75	2.7	1.55	0.9	81.2

Initial 1 = 0.84 ± 0.01g, Initial 2 = 0.97 ± 0.01g

Table 7: Whole- body composition of H. longifilis fed varying diets in experiment II

Nutrients	Crude Protein	Lipid	Ash	Crude Fibre	Moisture	Nitrogen Free Extract
Diets						
I	15.64	4.7	1.3	2.15	79.55	
II	15.34	3.85	0.9	2.75	76.8	
III	14.35	2.35	1.2	3.2	76.75	2.15
IV	15.84	3.75	1.4	2.05	73.95	3.41
V	15.66	3.2	1.2	2.8	76.45	1.09
VI	13.49	8.0	1.3	2.15	78.9	
VII	14.49	7.75	0.8	1.75	79.8	
VIII	13.25	6.6	1.4	2.8	74.65	
IX	15.65	8.4	0.7	3.2	69.9	
X	14.55	10.10	0.9	0.95	70.35	3.17
XI	17.22	5.85	1.6	2.45	75.35	
XII	16.87	6.8	0.9	2.0	78.1	
Initial I	12.43	3.8	0.5	2.6	79.85	0.82
Initial 2	15.63	5.35	1.75	1.85	75.1	0.32

Initial 1 = 2.2 ± 0.01g
Initial 2 = 2.8 ± 0.02g

DISCUSSION

Generally there was acceptance of feed in both experiments as positive growth was observed. Although in experiment II diets I and II showed negative growth in some of the replicates indicating very poor acceptance of the diet which resulted in very minimal growth, examination of the fish did not show any abnormalities. In both experiment all fish fed below 32% crude protein and containing levels of total carbohydrate of 39.45% to 76.15% showed poor growth. This may be due to the inadequacy of the protein which resulted in reduction in growth because of withdrawal of protein from some tissue to maintain the function of vital ones (NRC 1983).

Al- Ogaily et al (1994) observed that an increase in the level of maize grain to 25 – 43% in O. niloticus feed decreased growth. Viola and Arieli (1983) also observed grain content of 65 – 75% decreased the growth performance of carp and tilapia. As the level of total carbohydrate of these diets fell within the ranges stated in these studies the poor growth may be attributed to the level of carbohydrate in the diets. The poorest here were fish fed diets containing 10.74% and 14.67% crude protein and 76.15% and 60.36% carbohydrate. In the two experiments the levels of total carbohydrates incorporated in the diets were all above 20% recommended by Wilson (1994). The diets also meet the recommendation of Shiau and Lin (1993) as the carbohydrates provided were all complex in nature and so they would have been better digested for energy needs of this fish during the experimental period. The sparing effect of carbohydrates was probably in place during this experiment especially in the diets that had good conversion ratios. The smaller fish in experiment I had a better FCE for diets VI, XII and XIII because smaller fish had a greater probability to grow and hence convert food nutrients. Feed composition seem to affect the body composition although there was no significant difference ($P > 0.05$) in the level of nutrients in the body of fish fed 10.74% crude protein and 49.6% crude protein. The levels of nutrients in the body were generally lower than that in the feed provided except for the moisture content. There is no specific trend in the influence of the protein and lipid content of the feed on the body composition. The maintenance of a high protein content of fish fed lower protein levels corroborates Shearer (1994), who reported that the effects of diet composition on body protein were caused by size differences between the fish. The smaller fish in experiment I fed slightly higher levels of protein had better SGR than the larger fish in experiment II. According to Tacon (1987) among omnivorous fishes 42% crude protein is fed to fry while growing adults are fed 35%. The lower protein fed the bigger fish in these experiments was adopted from the recommendation that protein requirement decreases 'with increasing fish size' (Pillay 1990) or ' from early to later phases of growth' (Lovell 1989). In this study the body content did not increase with dietary protein level and so it does not compare well with Van der Meer et al (1995).The feed conversion ratio in all diets except X, XI, XII in experiment II; and I, III and VIII in experiment I were not favourable. This may be due to the low quality of the feed, the inability to differentiate between feed ration and feed intake.

CONCLUSION

In this study protein levels that are below 24% showed maintenance level of feeding although body composition of the fish did not vary significantly from fish fed higher levels of protein. Among the fish fed higher levels of protein there were overlapping responses in the growth of the fish. Since significant variations were observed in the growth parameters adequacy or inadequacy of protein affected the body composition of fish either negatively or positively.

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