EFFECT OF VARIOUS DIETS ON GROWTH AND BODY COMPOSITION OF TILAPIA

BY

ASGHAR ALI

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF PHILOSOPHY
IN
BIOLOGY
(ANIMAL PHYSIOLOGY)

DEPARTMENT OF BIOLOGICAL SCIENCES
QUAID-I-AZAM UNIVERSITY
ISLAMABAD
1989

This thesis by Asghar Ali is accepted in its present form by the Department of Biological Sciences as satisfying the thesis requirements for the degree of Master of Philosophy in Biology (animal Physiology).

Internal
Examiner ____________

External
Examiner ____________

Chairman ____________

Dated: 20/2/92

DEDICATED

TO MY NATION

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

I feel actuated from within to offer my humblest and sincerest thanks to **Almighty Allah,** Who is merciful and benevolent and Whose bounteous blessings enabled me to perceive and persue higher ideals of life. Special praise to His last Messanger, **Hazrat Muhammad** (Peace be upon him) who is forever a torch of knowledge and guidance for huminity as a whole.

I feel highly privileged to avail this opportunity to express the deep sense of gratitute to my reverened supervisor **Dr. M.A. Hafeez,** Professor and Chairman, Department of Biological Sciences under whose dynamic supervision, propitious guidance, illustrative advise, keen intrest, philanthropic attitude, and encouragement, the research work presented in this dessertation, even in the midst of his multiferious duties.

My special regards are offered to my reverened Research colleague **Shamsuddin Ahmed** for his meticulous encouragement and ingenuous cooperation which he extended during the research work.

I especially wish to acknowledge to **Mr. Arshad Mahmmod** my roommate, for his candid cooperation, encouragement and immaculate moral support.

I would take this oppurtunity to extend my admiration and appreciation to my friends and colleagues especially M/S **Azhar Javed, Hamid Ratyal** and **Zubair Ahmad** and all other well wishers for their constant support and encouragement during my studies.

Mention should be made of the National Agriculture Research Centre, Islamabad, for providing feed formulation and proximate analytical facilities and for computer based statistical analysis of the data.

I am greatly indebted to my parents, brothers and sisters for their love, immense orision, relucent and mellifluous affections, which hearten me to achieve success in every sphere of life, without whose encouragement and moral support the present study would have a mere dream.

Asghar Ali

ABSTRACT

CHAPTER I

ABSTRACT

The effects of varying dietary protein level on several nutritional parameters of Tilapia nilotica were studied. Four approximately isonitrogeneous diets were formulated with protein levels ranging from 24 % to 33%.

The specific growth rate increased as protein concentration increased in the diet while diet 2 (25% protein) and 3 (29% protein) were comparable in effect, a significant rise was noted with diet 4(33% protein). A consistent increase in FCR was evident in relation to increasing dietary protein. A significant high FCR resulted with diet 4. Protein efficiency ratio varied inconsistently, highest value was noted with diet 2. Generally there appeared to be an inverse relationship between the FCR and PER with increasing FCR and PER decreasing in relation to protein level increments.

Dry matter, crude protein, crude fat, total ash and carbohydrate (N.F.E) of fish varied with diets. Maximum values of both dry matter and protein occured with diet 4. Crude fat in the experimental groups increased above the control (fish analysed at start of experiments). Total ash droped below control level in all experimental groups. Carbohydrate level in the control and experimental fish were nominal and although it increased in experimental fish, an inconsistent trend was evident in relation to dietary protein.

INTRODUCTION

CHAPTER II

INTRODUCTION

Aquacultural techniques and fish farming have become an important means of enhancing production of a variety of economically important fish species. There has been a growing interest in this approach in Pakistan as is also true of many other parts of the world there is lack of availability of suitable fish feeds which can be used to ensure optimal growth of fish espeacially in an intensive culture system. It is important that the cost of maintaining fish be such that fish farming becomes an economically productive enterprise. Even in situations where fish, at various stages of their life, are being cultured in the presence of naturally available food, periodical replenishment of the environment with supplementary feed is essential to make sure that the fish are growing at the desired rate.

The group of tilapias has attracted attention in many countries, particularly the developing ones, especially because these fish are prolific breeders and hold strong promise as table fish. Consequently, many studies have been done on this group of fish including their dietary and nutritional requirements. First attempts to develop suitable protien diets with optimum rates of growth were made on chinook salmon (Oncorhynchus tshawytscha, Delong et al ., 1958). Numerous other studies along these lines have been conducted using various other species of fish (Ogino and Saito, 1970; Cowey et al., 1972; Zeitoun et al., 1974 and Dabrowski, 1977). Some investigations on artificial feeding have been carried out in India (Lakshmanan et al., 1976; Singh, 1970; Singh and Bhanot, 1970; Mahajan and Yadave, 1974; Sin, 1973 a and b; Chakrabarty, 1973) and in Pakistan (Butt et al., 1988; Jafri and Ali, 1984; Nazneen and Begum, 1985).

The present work was designed to study effect of four different supplementary fish feed formulation with variable protein levels on growth, specific growth rate, feed conversion ratio, protein efficiency ratio, and fish composition. Several studies have been carried out on different tilapias in the past to understand the effects of varying dietary protein levels on various growth parameters (Cruz and Laudencia, 1977; Davis and Stickney, 1978; Mazid et al., 1979). A review of culture practices concerning tilapias in Pakistan (Jafri and Ali; 1984) and observation on effects of natural food on growth (Nazneen and Begum, 1985) are also available.

REVIEW OF LITERATURE

CHAPTER III

REVIEW OF LITERATURE

Artificial feeding is one of the necessary requirements in fish culture programs as a means of ensuring enhanced production. Supplementary feeding becomes essential particularly in intensive culture programs because natural food in the ponds may not be sufficient to maximise production rates; artificial feeding can double or even triple the production. The importance of artificial feeding varies according to intensity of cultivation. As already stated above, the practice of intensive fish culture aims at production of a large economically profitable crop of marketable fish. Supplementary (artificial) feed allows culturists to maintain a higher density of fish per unit area than is possible merely with natural fertility of ponds (Devaraj and Krishna, 1981).

It has been argued by several workers (Erokhina, 1959; Hepher and Chervinski, 1965; Merla and Kulow, 1967) that the yield of corps can be increased substantially by use of protien-rich diets. Since the feed formulations are mixtures of various ingredients, the composition of these mixtures is important from the stand point of achieving the desired increase in fish yields. Shell (1967) conducted experiments to determine the ecomomical feed rate in relation to growth and feed conversion rates. According to him favourable increases in growth rate of Tilapia mossambica occur when the feeding rate is 1-2 percent of live body weight. This observation has also been confirmed by Chervinski et al (1968) who also found that in field trials protein-rich diets can increase the yield of fish.

Chakrabarty (1973) used a supplementary feed with a 1:1 mixture of ground nut oil (about 40% protein) and good quality de-oiled rice polishing (about 10-20% protein) and reported that the conversion of feed to fish flesh was 2.3:1 and 3.3:1 in two different ponds. The best conversion (1.6:1) was obtained for gran carps in ponds where both silver grass carps and common carps were cultured in an envoirnment enriched with fertilizer, supplementary feed and weeds. Ufodike and Matty (1981) showed that fish grew best on 45% protein-rich feed. Marian et al (1982) advocated the use of protein rich diet for carp and recommended application of ration once a day. Allen and Wooton (1982) studied the effect of ration on the growth of three-spined stickleback.

Akiyama et al (1982) has studied effects of various dietary carbohydrates on growth, feeding efficiency and body composition of chum salmon fry. Wang and Song (1984) conducted experiments to see the effect of protein and carbohydrate contents in feeds on the growth of black carp fingerlings. Diets with different contents of protein and carbohydrate were of casein, dextrin, fish-liver oil, carboxymethyl cellulose, minerals and vitamins. They were given for 8 weeks to black carp fingerlings. The optimum protein content of the diets ranged between 29.54 to 40.85%. There was interaction between protein and carbohydrate. The fish grew rapidly when fed on 37 to 43.3% protein and 9.5 to 18.6% carbohydrate. About 20% carbohydrate in diet seemed suitable for black carp.

Markh 1983 studied the effect of dietary protein (37, 47, or 57%) and lipid (7, 12, 17%) on growth of striped bass in their first year of age. It was concluded that increasing dietary protein concentration generally improves weight gain. Striped bass fed diets containing 37% crude protein plus 7% lipid had lower weight gain than fish fed 47% crude protein plus 12% lipid or 57% protein plus 17% lipid. Whole body protein concentrations increased with higher dietary protein and lower dietary lipid concentrations. The lowest whole body protein concentration occured in fish fed 37% crude protein plus 17% lipid. The whole body lipid concentrations increased with higher dietary lipid concentrations and lower dietary protein concentrations. Feed efficiency and protein efficency ratio increased as dietary lipid concentration increased. Feed efficiency also increased as dietary protein increased. Jauncey (1982) conducted experiment to see the effect of varying dietary protein level (0 to 56%) on the growth, feed conversion, protein utilization and body composition of juvenile tilapia (Sarotherodon mossambicus). Specific growth rates (%/day) were: were higher the greater the protein level in the diet. The minimum dietary protein level producing maximum growth of S. mossambicus was found to be 40%, with a dietary protein to energy ratio (P.E) of 116.6 mg protein per kilocalorie of metabolizable energy.

Degani and Viola (1987) studied the effect of partially replacing protein by carbohydrates in the diet of the eel (Anguilla anguilla). The body fat of eels fed a high carbohydrate diet were greater (weight/weight) than the body fat of eels fed a low carbohydrate diet. The food conversion value was lower in eels fed 40% protein than eels fed 30% or 50% protein. However, the protein efficiency ratio was lower in eels fed a low percentage of protein (30%) than that of eels fed a high percentage of protein (40% or 50%). Wee and Ng (1986) made an assessment of the nutritive value of cassava as an energy source in a pelleted tilapia diet. Four isonitrogeneous diets containing 15%, 30%, 45% and 60% cassava was formulated and fed to groups of Oreochromis niloticus L. for 10 weeks. Good growth and food utilization efficiencies were obtained with all diets. There was a trend for improved growth and food utilization with increased cassava incorporation in the diet although there was no significant differences in food conversion ratio, protein efficiency ratio or apparent net protein utilization between the experimental diets.

The importance of proper protein nutrition and its interrelation with dietary energy has been reviewed by Winfree and Stickney (1981). Dupree and Sneed (1966) and Niles (1982) reported requirements of young channel catfish for protein through feeding trials utilizing semipurified diets that contained casein as the primary protein source. Levels of dietry crude protein supporting maximal growth were similar in both studies when water temperature averaged about 25^0c. Dupree and Sneed (1966) reported that weight gains, over a three week experimental period, increased linearly with increased dietary protein upto 40% (dry matter basis) but were reduced at 53%. Niles (1982) determined the protein requirement between

40 and 80% over a 12 week culture period. High levels of energy (4090 Kcal GE/kg) characterized the diets which supported maximal growth in the study by Niles. Lower water temperature 21.6^{0}c reduced growth rates and tended to equalize effects of 35, 40 and 53% protein diets in the study by Dupree and Sneed (1966). The results of studies utilizing semipurified diets have been reviewed by the National Research Council (NRC 1977) which recommended that the dietary protein levels for catfish should be between 35 and 40% in starter feeds. Lovel (1977) has also recommended that the protein content of catfish starter be above 36%. Brandt (1980) reported that commercial diets containing 48% protein significantly outperformed multicomponent test diets containing 40 or 42% protein. Arai and Nose (1983) examined the dietary protein requirement of young ayu by feeding dry diets with eight protein levels ranging from 11 to 51%, using a white fish meal as a dietary protein source at a water temperature of 16^{0}c for six weeks. The growth performance was examined at each protein level in terms of weight gain, feed intake, daily specific growth rate, feed efficiency, protein efficiency ratio and body protein increase. The daily protein level of 11% was found to be necessary for maintenance of body weight. The optimum level of dietary protein for growth was estimated to be 37% on dry basis. The daily protein requirement for optimum growth was about 14g/kg fish/day. The protein was utilized most efficiently at dietary protein levels of 22-42% and at 7-14 gm protein /kg fish /day.

Kanazawa et al. (1980) have studied the effects of various levels of dietary protein (casein), lipid (pollack liver oil), minerals and vitamins on growth of puffer fish, Fugu rubripes. The growth response was examined in terms of weight gain, feed conversion efficiency, protein efficiency ratio and net protein utilization in 3 week/- feeding experiments at 25-26^{0}C. The results of these studies indicate that the optimum protein level in the diet for the puffer fish is about 50% when casein was used as a protein source. Also the optimum level of lipids, minerals and vitamins were estimated to be about 6% (or less), 4% and 3% in the diet, respectively. Margitt et al. (1984) has noted that protein content of diet very strongly influenced the nutrients of carp. The highest rate of growth (of juvinile common carp) was observed at ration size of approximately 7.0% of body weight per day and at higher rations a slight decrease was seen (Huisman et al., 1979).

Akiyama et al. (1981) conducted experiment on chum salmon fingerlings for 6 weeks to determine the optimum levels of dietary protein and fat. The growth rate and feed efficiency increased as the dietary protein level increased from 23 to 47%. As dietary fat level (5, 10 and 14%) increased, the feed efficiency improved. Suitable dietary fat requirements were taken to be 5 and 10% at 9.4 and 16.3^{0}C, respectively. The protein requirement was estimated to be 43% with 5% fat and 38% with 10% fat, based on the body protein gain. Winfree and Stickney (1981) reported a diet providing roughly 56% protein and 4600 kcal/kg digestible energy with a P:E ratio of 123 mg protein/kcal produced highest gains in weight of fry over a 5-week period. Larger fish (7.5g) grew most rapidly when fed a 34% protein, 3200 Kcal/kg with protein to energy ratio of 108. Apparent feed conversion was superior on diets having lower P:E ratios and was best on the 34% protein, 3200 kcal/kg diet.

Jeyachandran and Paulraj (1976) reported that four feeds silkworm pupae, silk worm litter, maiz cob and pellet at 5% body weight for 6 days a week have significant effects on Cyprinus Carpio. There is a positive correlation between the protein content of the feed and the daily increment in the weight of fish and also between the fat content of the feed and the daily weight increment of the fish. Shiau et al. (1987) conducted experiments on hybrids of tilapia (Oreochromis niloticus X O. aureus) to determine whether commercial hexane-extracted soybean meal could be used as a partial replacement for fish meal at two dietary protein, levels, 24% and 32%. At each protein level, 30% of fish meal protein was replaced by soybean meal with and without methionine suplementation. They suggested that without methionine supplementation, fish meal can be replaced partially by commercial hexane-extracted soybean meal when dietary protein level is sub-optimal for tilapia growth. However, at the optimal dietary protein level (32%), partial replacement of fish meal protein with protein from soybean meal depresses both growth and feed conversion in tilapia.

Eckmann (1987) reported that blood meal can be incorporated in a diet together with fish meal but it was inadequate as the only source of animal protein for young Colossoma macropomum. Growth rates from 1.1 to 2.5% dry weight/ day were proportional to dietary protein levels (25-37%) while dry matter content of whole fish bodies was inversely proportional to growth rate. Body composition on a dry matter basis shows highest protein (53%) and lowest fat level (26%) for the fastest growing fish. Otubusin (1987) has reported results of preliminary studies on Oreochromis (=Tilapia) niloticus fingerlings. He evaluated the effect of varying levells of blood meal (50%, 25% and 10%) in feeds. The pelleted feeds were fed at rates of 10%, 5% and 3% of the fish biomass during the Ist, 2nd and 3rd plus 4th months of the experiment respectively. The feed containing 10% blood meal was the most efficient in terms of total fish production, average weight gain and average final fish weight.

MATERIALS AND METHODS

CHAPTER IV

MATERIALS AND METHODS

The experimental work on the effects of feeds on growth and body composition of tilapia was carried out in the Fish Laboratory of the Departmnent of Biological Sciences.

Four different supplementary feeds were formulated with varying proportions of fifteen different ingredients (Table-1). The proximate analysis of the various ingredients used in formulating diets is shown in Table 2.

Diet Formulation:

The relative proportion of the ingredients in the formulae were determined by computer utilizing a Least Cost Nutrient Procedure. The minimum and maximum nutrient restrictions were set for crude protein and digestible energy.

Diet Processing:

Feed ingredients were generously provided by Feed Mill, National Agriculture Research Council, Islamabad. Other ingredients needed were purchased from the local suppliers. The test diets were prepared as follows:

Dry ingredients were combined and minced in a grinder to a fine powder before adding oil and molases cane. An antifungal agent propionic acid, was added at a level of 0.25% of the ration water. The ingredients were blended in water in to form a dough-like consistency. Pelleting of the feeds was done by passing the dough repeatedly through a motor driven meat mincer. All diets were dried by

Table 1: Relative proportions (%) of various ingredients in various feed formulation diets (1-4). Analytical data are means of duplicate analysis.

	Diets			
Ingredients	1	2	3	4
Maize	30.88	54.26	8.65	28.28
Rice broken	4.38	-	28.36	-
Wheat bran	39.32	9.56	-	-
Sesame meal	6.81	-	5.58	5.01
Rapeseed meal	6.82	-	-	-
Fish, 56%	5.77	5.62	9.53	11.91
Blood meal	2.56	6.23	4.94	5.28
Molasses cane	2.25	1.09	1.17	1.15
Cotton seed meal 37%	1.16	-	7.67	4.86
Ground Nut 41%	-	9.75	10.45	16.53
Meat Meal	-	2.87	-	-
Soyabean meal	-	10.16	8.65	10.05
Vitamin	-	0.43	0.46	0.46
Guar seed meal	-	-	9.52	11.50
Sunflower oil	-	-	4.97	4.91

Table: 2: Proximate Analysis of Ingredients used in diets.

	Ingredients	Moisture %	Dry Matter %	Crude Protein %	Crude Fat %	Crude Fiber %	Ash %	Nitroge Free Extract %
1	Maize	6.63	93.37	13.56	4.40	4.66	5.62	65.13
2	Rice broken	7.69	92.31	11.41	5.69	4.37	4.68	66.16
3	Wheat bran	10.71	89.29	14.70	1.73	4.78	3.18	64.9
4	Sesamo meal	9.84	90.16	49.77	14.54	5.14	13.07	7.64
5	Rape seed meal	9.97	90.03	49.71	9.53	15.39	8.21	7.1
6	Fish, 56%	8.84	91.16	51.47	1.21	1.04	33.28	4.16
7	Blood meal	9.5	90.5	62.73	2.05	2.34	2.73	20.65
8	Molasses cane	22.22	77.78	-	-	-	9.78	68.0
9	Cotton seed meal 37%	6.9	93.10	22.34	8.9	12.93	7.76	41.17
10	Ground Nut 41%	12.51	87.49	45.64	10.26	5.03	5.23	21.33
11	Meat meal	10.8	89.20	52.26	9.0	2.3	18.12	7.52
12	Soyabean meal	10.04	89.96	46.36	0.59	7.92	7.08	28.01
13	Vitamin	2.33	97.67	-	-	-	97.67	-
14	Guar seed meal	3.89	96.11	41.49	4.20	11.87	7.77	30.78
15	Sunflower oil	-	91.95	-	1,00	-	-	-

forced air at room temperature. The diets were sealed in double plastic bags and refrigerated. The dried diets were brought to room temperature before use. Required portions were ground and sieved to sizes which could be consumed by the fish.

Experimental Fish:

Fingerlings of Tilapia nilotica were obtained from the Fish Hatchery, Rawalpindi Division, Islamabad. Immediately after transport to the laboratory, the fish were placed in a large cemented tank and allowed to acclimate for about a week before start of experiments. Feeding was started gradually depending on acceptability of artificial feed. The fish were acclimated to 29^0c as recommende for optimal growth (Welcome 1964, Donnelly 1969, Fryer and Iles 1972, Bruton and Boltt 1975, Caulton 1975 a). The pH of the aquarium water during the experiment was recorded as 7.6 ± 0.09. Water temperature was controlled by thermostatic aquarium heaters. During this time the fish were slowly adapted to the pellatized feeds. The fish were starved overnight before starting feeding experiment.

Experimental Facilities and Procedure:

Experiments were conducted in 50 L fiber glass aquaria measuring 30 cm X 30 cm X 60 cm. The aquaria were filled with aged tap water which was changed twice daily without disturbing the required water temperature (29 ± 20^0C). The tanks were aerated continuously using air pumps. The fingerlings were randomly distributed between the tanks at a stocking density of 10 fish per tank. Experiments for each of the four diets were conducted in triplicate. At the start of the feeding trials, 20 fish were sacrified by a sharp blow to the head, and weighed to the nearest mg (wet weight), and dried in an oven. Following drying they were brought to room temperature weighed again (dry weight) and stored for caracass analysis.

Feeding Method:

The experimental fish were fed twice daily (8.00 a.m and 4.00 p.m) 6 days a week, at a fixed feeding rate of 5% wet body weight per day (Wee and Ng, 1986). The feeding rates were adjusted accordingly at 1-week intervals. The experimental fish were weighed individually at the beginning and the end of the feeding trial (end of the experiment). Batch weighing, however, was done at 1-week intervals in order to calculate the feeeding rate. The standard length (S.L.) of the fish was also recorded on weekly basis.

Growth:

Growth performance of Tilapia nilotica was monitored as weekly increase in average body weight and length. Following termination of the feeding trials all fish were sundried for proximate analysis.

Specific Growth Rate (SGR):

Specific growth rate was calculated according to the formula (Nicolaides et al., 1985, and Wee and NG, L.T. 1986):

Specific Growth Rate (%/day) = 100 [final weight(g) - In initial weight (g) / time

(days)

Daily Weight Gain:

Daily weight gain was calculated according to the following formula (Wee and Ng, 1986):

Daily Weight Gain (g/24h) = Final Weight(g) - Initial Weight (g) / time (days).

Proximate Analytical Procedures:

Feed ingredients, experimental diets and samples of the experimental fish were subjected to proximate analysis. Each analysis was performed in duplicate. This procedure was repeated for fish from each of the three replicates for the various diets. Proximate analysis was done by the following methods.

1) Determination of Moisture::

Moisture content of samples was determined by drying the sample in an oven at 105^0c. The loss in weight after drying (wet weight minus dry weight) yielded moisture (A 0 A C 1975).

2) Determination of Crude Protein:

Crude protein was determined indirectly from the analysis of total nitrogen (crude protein = N 6.25) by Kjeldahl method (A 0 A C 1980).

3) Determination of Crude Fat:

Crude fat was determined by extraction with diethyl or petroleum ether for six hours in a Soxhlet apparatus (A 0 A C 1975).

4) Determination of Crude Fiber:

Crude fiber is defined as organic residue that remains after digestion sequentially in a weak acid solution and a weak alkaline solution, the residue collected after digestion was ignited. The loss in weight on ignition was registered as crude fiber (A O A C 1980, Matyka and Adamezyk 1979).

5) Determination of Ash:

Ash was determined in weighed samples in a porcelain crucible placed in a muffle furnace at 600^0C for four hours. This burned off all organic matter. The inorganic carbon-free substance which remained at that temperature was ash.

6) Determination of Nitrogen Free Extract (NFE):

Nitrogen free extract was calculated as % NFE by difference from the sum of all other items (i.e. crude protein, crude fat, crude fiber, moisture and ash) using the following formula (Hastings, 1976):

NFE(%) = 100 - (%moisture + % Crude Protein + % ether extract + % Crude fiber + % ash)

7) Determination of Gross Energy:

The gross energy content was determined by combustion of 0.9 g of material in a Ballistic Bomb Calorimeter (Miller and Payne, 1959).

8) Other Growth Parameters:

Feed conversion ratio (FCR), protein efficiency ratio (PER), specific growth rate (SGR), and daily weight gain (Gain over total period/No. of days) were calculated according to the formulae shown below.

Feed conversion Ratio (FCR):

Feed conversion ratio was calculated as mean values per aquarium basis according to the following relationship (Millikin, 1983).

Feed conversion Ratio (FCR) =Wet weight gain (g) / Dry weight feed offered (g)

Protein Efficiency Ratio (PER):

Protein efficiency ratio is expressed as quotient of growth increment and protein intake and was calculated according to the formulae (Steffens, 1981 and Millikin,1983):

Protein Efficiency Ratio (PER)=Wet weight gain (g)/Dry weight protein offered (g).

Statistical Analysis

Statistical analysis were performed using statistical analysis system SAS (Barr et al. 1976). Statistical comparisons of the results of the feed rations were made by using analysis of variance (ANOVA). Duncan's Multiple Range Test (Duncan 1955) was used to evaluate the differences between means for individual diets at 95% (0.05) and 99% (0.01) levels of significance.

RESULTS

CHAPTER V

RESULTS

The results of various tests are discribed below. It is to be noted that data for diet type 1 are not included in the results pertaining to weight gain and length, because the experiment testing the effect of this diet had to be terminated earlier owing to interruption in air supply and consequent mortalities in the experimental tanks.

Proximate Analysis of diet:

Results of proximate analysis of the diets and the experimental fish are shown in Table 3. Feeds 1, 2, 3 and 4 turned out to contain 20.47, 24.93, 28.63 and 32.75% protein levels repectively. The protein were of both animal and plant sorces. The protein to energy ratio of these feeds ranged from 48, 64, 66 to 75 mg protein/Kcal.

Body Weight and Length:

A statistically significant effect ($P < 0.01$) on body weight was noted with all of the diets tested (Table 4 Fig. 1). Body weight increased with increasing protein in the diets with maximum the value being observed with diet 4. Similarly, significant effects were observed on body length. It increased with increasing concentration of protein in the diet. Maximum length was achieved with diet 4 (Table 4) Fig 2. It should also be noted that the results showed a similar relationship with protein / energy ratio in diet, body weight and length (Table 4). Lowest body weight and length corresponded with the lowest P:E ratio where as highest with the highest P:E ratio.

The data were also analysed for weekly gains in body weight and length in relation

Table 3: Proximate analysis of diets.

Proximate analysis	Diets			
	1	2	3	4
Dry Matter %	93.42	92.82	94.4	91.8
Moisture %	6.58	7.18	5.6	8.2
Crude Protein %	20.47	24.93	28.63	32.75
Crude Fat %	16.66	13.65	13.4	15.01
Crude Fiber %	1.96	1.54	5.08	5.35
Total Ash %	5.13	6.26	7.35	5.62
Nitrogen Free Extract %	49.2	46.4	39.9	33.1
Protein Energy Ratio (mg/Kcal)	48	64	66	75
Gross Energy (Kcal/g diet)	4.5	5.2	4.5	4.6
Metabolizable Energy (Kcal/g diet)	3.99	3.90	3.98	3.95
Digestable Energy (Kcal/g diet)	4.2	4.9	4.3	4.4

Table 4: Average body weight (g) and body length (cm) in relation to protein concentration and protein/ energy ratio (mg/Kcal) of diets 2, 3, and 4. Values are means (± S.E) of three replicates. Statistical analysis of the data is shown in Table 5.

Diet	Crude Protein	Protein : Energy Ratio	0 Week		1 Week		2 Week		3 Week		4 Week	
			Weight	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length
2	24.93	64	10.5	6.2±0.1	13.5± 0.2	7.1±0.2	16.6±0.2	7.6±0.1	19.5±0.3	8.0±0.1	22.2±0.4	8.7±0.2
3	28.63	66	14.1	7.5±0.1	18.3±0.1	7.9±0.4	22.2±0.2	8.6±0.5	26.4±0.4	9.5±0.4	30.3±0.4	10.3±0.4
4	32.75	75	13.0	7.4±0.1	17.6±0.1	8.0±0.3	22.0±0.3	9.0±0.2	26.8±0.2	10.0±0.3	30.9±0.1	11.1±0.2

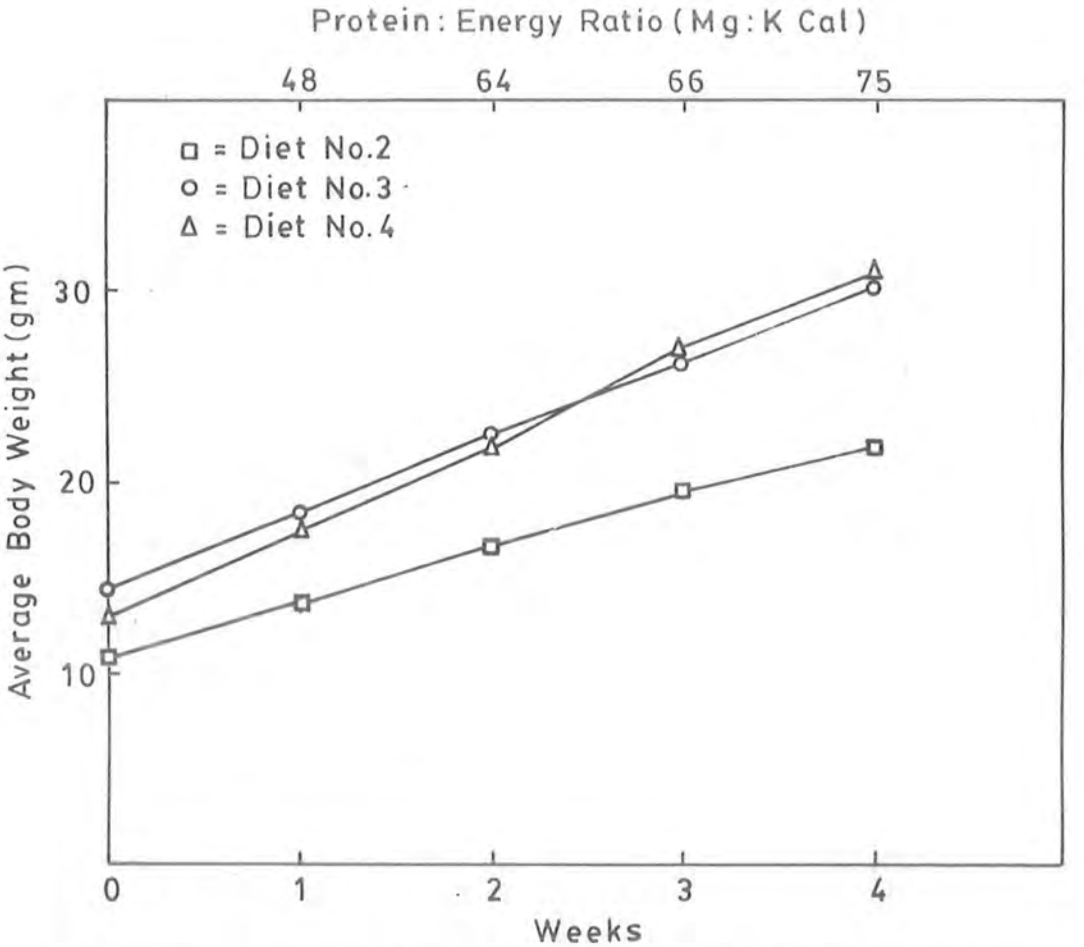

Fig.1. Average body weight of Tilapia nilotica at weekly intervals maintained on diets 2,3 and 4 and its relationship to P:E ratio.

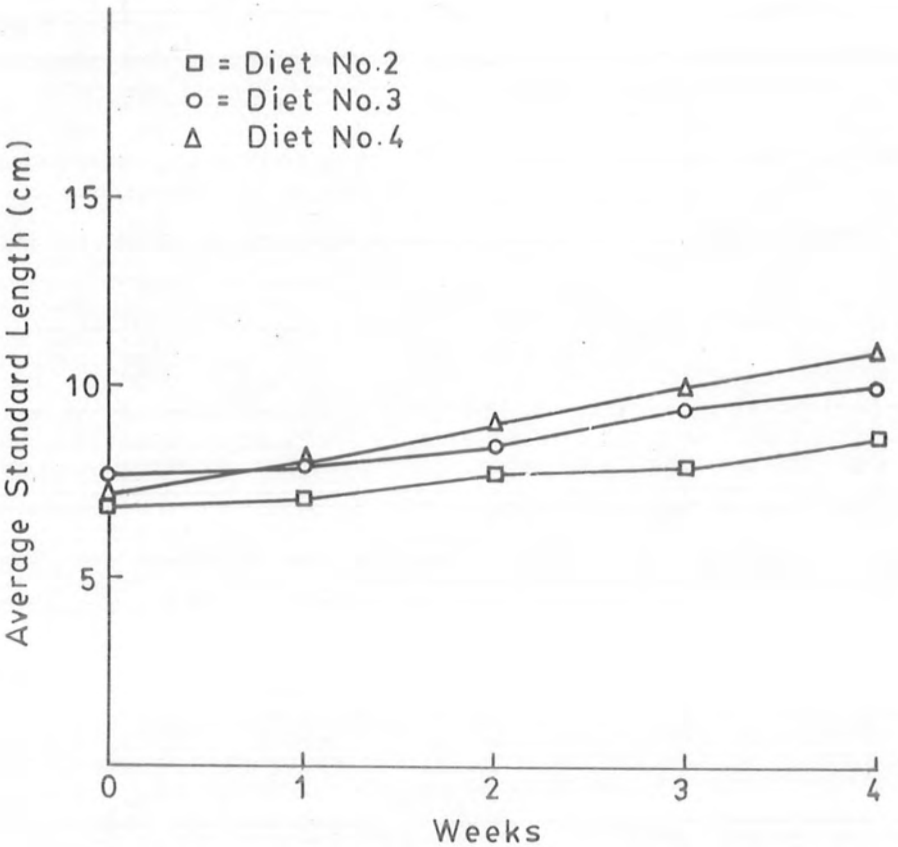

Fig.2 . Average standard length of Tiplapia nilotica at weekly interval maintained on diets 2,3 & 4.

to the types of diets used. Figure 3 shows that weekly gain in weight per diet showed a more or less inconsistent trend. Inconsistency was evident in regard to length as well altough maximum gain in length occured at the end of 4 weeks (Fig 4) with diets 2 and 4. Where there was a clear effect of increasing amount of protein in the diet on weights and length increments, no statistical correlation was evident between duration (number of weeks) for which the diets were fed and weekly weight gain (Table 5) only a marginal correlation between duration and diets was evident in respect to weekly length increments (Table 5). These results by and large suggest that increase in body weight as well as length is a function mainly of dietary protein concentration and the period for which the fish are kept (at least in the present experiment) is without meaningful effect.

Table 6 summarises various parameters of performance of the fish in respect to the different diets used in the study. Final weights at the end of the experimental period increased in response to all form diets. Analysis of the data on the basis of daily gain in weight (gain / 24 hr) revealed that diets 1 and 2 (protein 20.47% and 24.93%) had a similar effect (no statistical difference in daily gain). On the other hand a pronounced effects on daily gain was evident with diets 3 and4 having heigher protein concentration (Table 6). Maximum gain occured with diet 4. However, the maximum effective level of protein in the diet which appears to be 28.63% (diet 3).

Feed Conversion Ratio (FCR):

When the various diets are compared for feed conversion ratio, a consistent increase in FCR was evident in relation to increasing dietary protein (Table 6). Diets 2 and 3

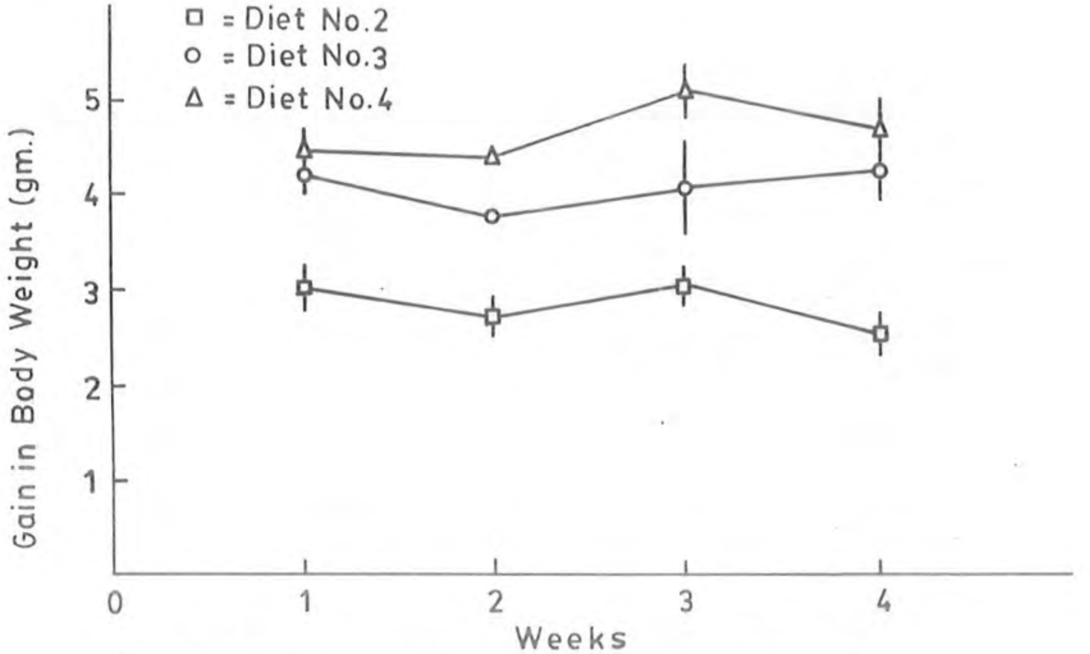

Fig.3. Average weekly gain in body weight of <u>Tilapia nilotica</u> maintained on diets 2 (24·93% protein), 3 (28·63% protein) and 4 (32·75% protein).

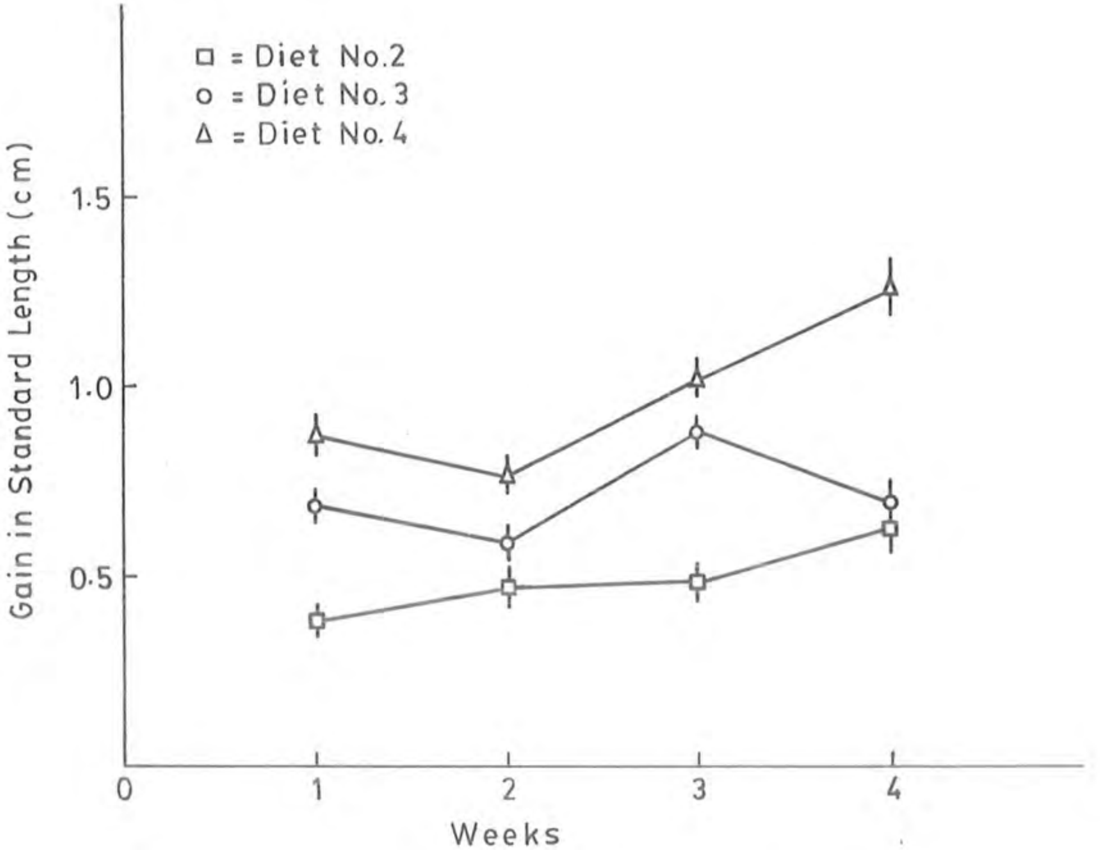

Fig. 4. Average weekly gain in standard length of Tilapia, nilotica maintained on diets 2,3 & 4.

Table 5: Mean squares from the analysis of variance based on data shown in Table 4.

	Degrees of freedom	Gain in body weight	Gain in standard length
Diets (A)	02	7.90 **	0.63 **
Weeks (B)	03	0.22	0.14 *
A X B	06	0.08	0.04
Error	22	0.14	0.05

* $p < 0.05$
** $p < 0.01$

Table 6: Growth, feed conversion ratio, protien efficiency ratio, spacific growth rate and protein : energy ratio of *Tilapia nilotica* maintained on four diets. Data are means of triplicate determination (mean + S.E). The final weight for fish kept on diet is at the end of 2 weeks whereas those for diets 2,3 and 4 are for a total period of 4 weeks.

Diets →	1 (20.47% Protein)	2 (24.93% Protein)	3 (28.63% Protein)	4 (32.75% Protein)
Initial Wt. (gm)	17.6 ± 0.0	10.5 ± 0.0	14.1 ± 0.0	13.0 ± 0.0
Final Wt. (gm)	22.6 ± 0.2	22.2 ± 0.4	30.33 ± 0.4	31.3 ± 0.2
Weight gain (g/24h)	00.33 ± 0.01^{c}	00.39 ± 0.01^{c}	00.54 ± 0.01^{b}	00.61 ± 0.01^{a}
Feed Conversion Ratio	00.44 ± 0.01^{c}	00.65 ± 0.01^{b}	00.66 ± 0.01^{b}	00.75 ± 0.01^{a}
Protein Efficiency Ratio	02.22 ± 0.06^{b}	02.71 ± 0.07^{a}	02.37 ± 0.04^{b}	02.63 ± 0.2^{a}
Daily Specific Growth Rate(%)	01.66 ± 0.05^{c}	02.49 ± 0.1^{b}	02.47 ± 0.1^{b}	02.93 ± 0.02^{a}
Protein/energy ratio (mg/Kcal)	48^{a}	64^{b}	66^{c}	75^{d}

Means bearing different superscripts are significantly ($p < 0.01$) different, in the same row.

were similar in effect. Since the FCR for the two diets did not differ significantly. A significant high FCR resulted with diet 4. The relationship between FCR and P:E ratio (Table 6) are shown in fig 5.

Protein Efficiency Ratio (PER):

Protein efficiency ratio of the various dietary groups varied inconsistently (Table 6). The highest PER occured with diet 2 (24.93%). The PER for diet 1 and 3 did not differ significantly but the PER for diets 2 and 4 did. Generally there appeared to be an increase relationship between the FCR and PER with FCR increasing and PER decreasing in relation to protein level increments.

Daily Specific Growth Rate (SGR):

The specific growth rate increased as protein conceentration increased in the diet (Table 6 and Fig 6) while diet 2 and 3 were comarable in effects, a significant six was noted with diet 4.

Proximate analysis of fish:

Dry matter of crude protein crude fat total ash and Carbohydrate (N.F.E) of fish varried with diets Table 7. Both dry matter and protein were lower in the experimental groups as compared to the initial control (fish analysed as short of experiments).

Maximum values of both dry matter and protein occured with diet 4. Crude fat in the experimental group increased abôve the control value. Total ash dropped below control level in all experimental groups. Carbohydrate levels in the control and experimental fish were nominal and altough it increased in the experimental fish, an inconsistent trend was evident in relation to dietary protein.

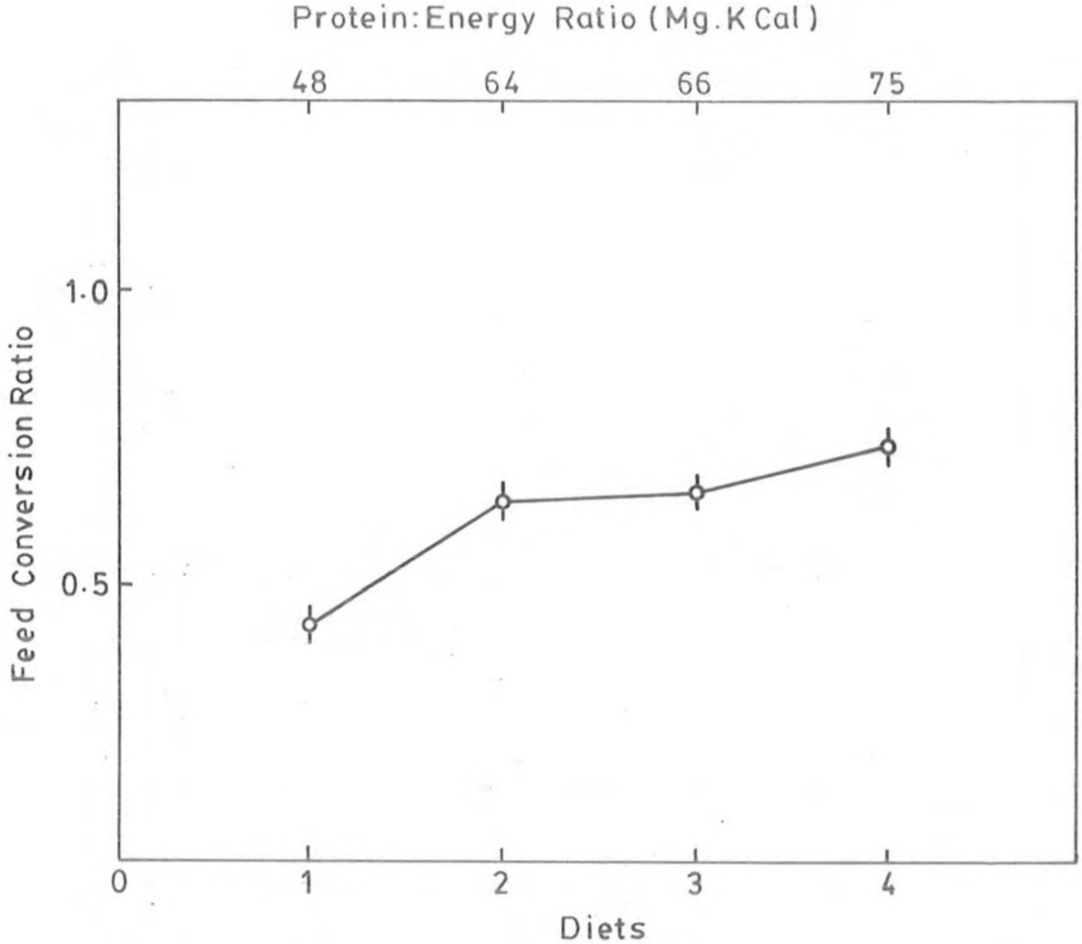

Fig.5. Feed conversion ratio for *Tilapia nilotica* maintained on diets 1,2,3 and 4 and its relationship to P.E ratio.

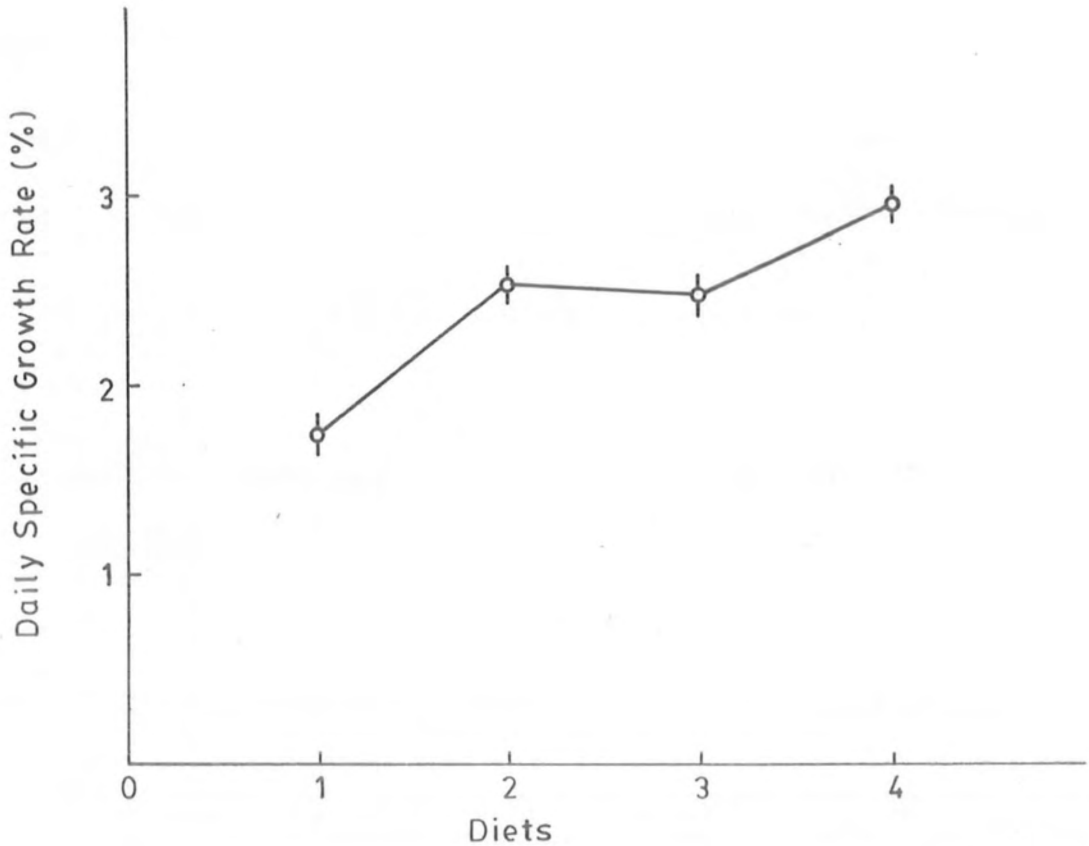

Fig. 6. Daily specific growth rate of Tilapia nilotica maintained on diets 1,2,3,and 4.

Table 7: Proximate Analysis (%) of experimental fish (fed four diets) on dry weight-basis. Number of fish per replicate is 6 (for diet types 1 & 2) and 10 (for diet types 3 & 4). Data for treated groups are based on means (±S.E.) of triplicate determinations (n=3). Data for the initial (control) are based on single determination (n=1).

	Initial (Control)	Diets			
		1	2	3	4
Dry matter	99.6	93.9 ± 0.33	95.6 ± 0.6	94.8 ± 0.6	96.6 ± 0.6
Crude Protein	57.1	52.6 ± 0.6	52.9 ± 0.1	55.0 ± 0.4	56.1 ± 0.2
Crude Fat	16.0	18.5 ± 0.4	22.5 ± 0.2	20.5 ± 0.7	22.3 ± 0.4
Total Ash	24.8	20.5 ± 0.7	19.8 ± 0.1	20.2 ± 0.2	18.9 ± 0.1
Carbohydrates (N.F.E.)	1.0	3.2 ± 0.6	1.7 ± 0.2	0.9 ± 0.2	0.3 ± 0.1

DISCUSSION

CHAPTER VI

DISCUSSION

The observations presented here indicate that growth of Tilapia nilotica a bears a positive relation with dietary protein increments. At least in the context of the present experimental conditions, the duration of the feeding does not influence fish growth. In studies where a greater range of dietary protein concentrations have been used and the experimental duration is longer, time dependent variation in growth (average weight) have been observed (Winfree and Stickney, 1981).

Over the 4-week period of study nearly consistent increase in body size (Weight and Length) as well as in specific growth rate occured with increasing protein levels. A direct relationship between average body weight and specific growth rate has been reported by Otubusin (1987, Oreochromis niloticus), Jauncy (1982, Sarotherodon mossambicaus), Kanazawa et al. (1980, Puffer fish) and Steffen (1981, Cyprinus carpio). However, generalizations in this respect are not always valid since the relationship may, infact, vary depending on the stage of development of the fish and the nutrient requirements at particular age (or size). The effects of dietary protein on growth may also vary depending on propositions of lipid and carbohydrate in the dietary formulations as has been demonstrated by several workers (Millikin, 1983; Degani and Viola, 1987; Wang and Song, 1984; Akiyama et al 1982) owing to their protein sparing action. An analysis of this aspect was not included in the present work, hence no meaningful comments are possible for Tilapia nilotica at this time. In this fish, average weekly gain in weight and length varied following treatment with the various dietary proteins. More consistent, however, was daily weight gain which showed a nearly linear trend as protein level increased from approximately 20 to 33%.

An inverse relationship between feed conversion and protein efficiency ratios (FCR, PER) would indicate optimal growth conditions since low FCR and high PER values reflect better utilization of food (winfree and stickney, 1981; Millikin, 1983; Janucy, 1982; Wee and Ng, 1986). In the present work an inverse inverse relationship has been observed with FCR increasing as protein concentration in diet increases. PER shows an opposite trend, the two low protein diets (20% and 24%) yielded better FCR ratios than the higher concentration diets. Diets with 24 and 32% protein produced better PER ratios. Since the range of protein concentration was narrow and a protein free diet (control) was not included in the experiments it is difficult to make valid judgements as to which of the protein concentrations provide optimal growth of fish. Notwithstanding the above limitation it would seem that 24% protein diet would represent the minimal level necessary for better growth in the context of FCR and PER relationship. Jauncy (1982) also considered 24% protein concentration as favourable for growth of a related tilapia Sarotheroadon mossambicus and Mazial et al., have provided similar results for Tilapia zilli. An increase in FCR with increasing protein has been reported in several other studies (Millikin, 1982, 1983, striped bass; Davis and Stickney, 1978, Tilapia aurea; Anderson et al., 1981, Micropterus dolomieui). Similarly, it has been observed by many workers that PER decreases with increasing dietary protein (Ogino and Saito, 1970; Jauncy, 1980, 1982). The importance of this parameter needs to be fully ascertained in respect to growth particularly since high PER have been obtained in situations where the protein concentrations in the diet are insufficient for maximal growth (Dabrowski, 1987, grass carp; Cowey et al. 1972, plaice; Ogino and Saito, 1970, common carp; Millikin, 1983, Striped bass). An instance of a different relationship between PER, growth and protein concentration is provided by the observation of Zaitoun et al., (1973) and Yue et al. (1977), who found that minimal dietary protein and high PER are associated with maximal growth.

Maximum growth of Tilapia nilotica in the present study occured with the diet containing 33 % protein and a protein to energy ratio of 75 mg protein per kcal of energy. In fact, final average weights of fish kept on diets increased consistently (Table 6) with increasing protein concentration and increasing protein to energy ratio. Changes in optimum protein to energy ratio are known to occur as growth of fish progresses (Winfree and Stickney, 1981). The range of protein concentrations, the duration of the experiments as well as the size of the fish were too narrow in the present study to allow an assesment of this aspect.

Data on composition of fish have relevance to not only in terms of species to species comparisions but also in judging quality of the fish as food (Winfree and Stickney, 1981; Salman and Salama, 1983). No particular trends in regard to any of the body constituents were evident in response to the feeds tested. Although the protein concentration of fish was highest in the 33% protein group, the values ranged within narrow limits. Fet content showed definite increase in fish over the control level in all experimental groups. Increasing fat levels are indicator of healthiness of the fish and food reserves. The value of fat determined in the present study are much higher than those reported for T. nilotica by Salman and Salama (1983) while those for carbohydrate are nearly comparable. No inverse relationship between body protein and body fat as shown in other studies (Millikin, 1983; Janucy, 1982, Winfree and Stickney, 1981) could be discerned in the present work. From the stand point of body composition in relation to dietary protein levels all of the dietary protein concentrations appear satisfactory. There is, however, need to enlarge the scope of the study in the future involving long term tests with focus not only dietary protein but also on carbohydrate and fat. This would allow an understanding of intereactive effects of these ingredients in the context of optimal growth and suitability of given feed formulations.

LITERATURE CITED

LITERATURE CITED

Akiyma, T., Yaaisawa, I. and Nose, T. 1981. Optimum levels of dietary crude protein and fat for fingerling chum salamons. Bull. Natl. Res. Inst. Aquaculture No.2, 35-42.

Akiyma, T., T. Murai and Nose, T. 1982. Effects of various dietary carbohydrates on growth, feed efficiency and body composition of chum salamon fry. Bull. of the National Research Institute of Aquaculture 3:75-80.

Allen, J. R. M., and Wooton. 1982. Effect of ration and temp. on the growth of three spined stickle back. Gesterosteus aemleatus. J. Fish Biol. 20:409-422

Arai, S. and Nose, T. 1983. protein requirement of young Ayu, Plecoglossus altivelis. Natl. Res. Inst. Aquaculture No. 4, 99-105.

A O A C (Association of Official Analytical Chemists), 1975. Official methods of analysis, 12th edition Washington, DC.

A O A C (Association of Official Analytical Chemists), 1980. W. Horwitz (editor), official methods of analysis, 13th edition, Washington DC.

Bardach, J.E., Ryther, J. H. and McLarney, W.C., 1972. Aquaculture. Wiley Intersience, New York, NY, 868pp.

Bruton, M.N. and R. E. Bolt. 1975. Asspects of Biology of Tilapia mossanbica peters (pisces:Cichlitae) in a natural fresh water lake (Lake Sibaya, South Africa). J. Fish Biol. 7:423-446.

Butt, J.A.M. Iqbal, S.A. Shah, A. Latif and G. Khattak, 1988. studies on production of cheap fish feed through use of wastes as protein and energy sources in the diet of common carp (Cyprinus carpio). Pakistan J. Zool. 20(3),pp. 209-224.

Caulton, N. S. 1975a. Diurnal movement and temperature selection by Juvenile and sub-adult Tilapia rendalli Boulenger. Transc. Rhod. Sai. Assoc. 56: 51-56.

Cowey, C. B. and Sargent. J. R. 1972. Studies on nutrition of marine flat fish. The protein requirements of plaice (pleuronectes platessa). Br. J.Nutr., 28:447-56.

Chakrabarty, R. D. 1973. Observation on the relative usefulness of different feed for carps pawn and fry. J. Inland Fish. SOP. India. 5:182-188.

Chervinski, J., B. Hepher and A. Tagari. 1968. The nutritive value of various fodder plants for carp. Redligh. 29(1):6-15.

Chuapoehuk. W.1987. protein requirements of walking catfish, Clarias batrachus (linnaeus), fry. Aquaculture, I.L., 1977. Protein requirments of Tilapia mossambica fingerlings, Kalikasam Philipp. J. Biol., 6:177-182.

Dabrowski, K. 1977. Protein requirements of grass carp fry (Ctenopharyngobon idella val.). Aquaculture 12:63-73.

Degani, G. and Viola, S. 1987. The protein sparing of carbohydrates in the diet of eels (Anguilla anguilla). Aquaculture, 64:283-291.

DeLong, D. C., J.E. Halver, and E.T. Mertz 1958. Nutrition of Salmonoid fishes-vi. Protein requirements of chinook salmon at two water temperatures. J. Nutr. 65:589-599.

Devaraj, K. V., and D. S. Krishana. 1981. Utilization of duck weeds and waste cabbaga leaves in the formation of fish feeds Mysor. J. Agric. Sci., 15:132-135.

Davis, A. T. and Stickney, R. R., 1978. Growth responses of Tilapia aurea to dietary protein quality and quantity. Trans. Am. Fish. Soc.,107-479-483.

Donnely, B. G. 1969. A primilinary survey of Tilapia nurseries on lake Kariva durin 1967/68. Hydrobiologia 34:195-207.

Duncan, D. B. 1955. Multiple range and Multilple F-tests. Biometric 11:1-42.

Dupree, H. K. and Halver, J. E. 1966. Responses of channel catfish fingerlings to different levels of major nutriants in purified diets. Tech. Pap. US. Bur. Support. Fish Wildl. 9:21.

Erokhina, L. 1959. Opyt. Primenena Gyranulirovanvo Korma. Rybovod. T. Rybobvo., 2 (4):8-10(vide FAO Symposium on new development in carp and trout nutrition, 1958).

Fryer, G. and D. Iles. 1972. The Cichlid fishes of the great lakes of Africa: Their Biology and evaluation. T. F. H. Publ.,Nepture City, New Jerasey. Also published by Oliver and Boyd, Edinburgh.

Hasting, W. H., 1976. Fish nutrition and fish feed manufacture. Paper presented at a FAO technical conference on Aquaculture, Kyoto, Japan, FIR:AQ/Conf/ 76/R.23, P. 13.

Hepher, B., and J. Chervinski. 1965. Studies on carp nutrition. The influence of protein rich diets on growth. Badmigch. 17(2):31-46.

Henken, A. M., Lucas, H., Pijssen, P. A. T. and Machiels, M. A. M. 1968. A comparison between methods used to determine the energy content of heat, fish and faeces samples. Aquaculture 58:195-201.

Huisman, E. A., Klein Breteler, J. G. P., Vismans, M. M. and Kanis, E. 1979. Retention of energy, protein, and ash in growing carp (Cyprinus carpio) under different feeding rates and tempaerature regimes. In: J. P. Halber and K. Tiews (Editor), finfish nutrition and fish feed technology, vol. 1, Heenemann, Berlin, pp.175-188.

Jaffri S. I. H. and Ali, S. S. 1984. Culture of Tilapia in Pakistan: a review. Pakistan Journal of Agriculture Research (Pakistan) V5 (4) p.269-276.

Jauncey, K., 1982. effects of variant dietary protein level on the growth, feed conversion, protein utilisation and body composition of Juvenile Tilapia (Sarothrodon mossambicus). Aquaculture, 27:43-54.

Jeyachandren, P. and Paulraj, S. 1976. Experiments with artificial feeds on Cyprinus carpio fingerlings. J. Inland Fish. Soc. India, 8:33-37.

Kanazawa, A., Teshima, S., Shakaneto, M. and Shinomiya, A. 1980. Nutritional requirements of puffer fish:purified test diet and the optimum protein level. Bull. of the Japenese Soc. of Scientific Fisheries 46(11),1357-1361.

Lakshmanan M.A.V., Sukumaran K.K., Murthy D.S., Chakraborth D.P. and Philipose M.T. 1971. Preliminary observations on intensive fish farming in fresh water ponds by the composite culture of Indian and exotic species. Journal of the Inland Fisheries Society of India 3,1-21.

Lovell, R.T., 1977. Digetibility of nutrients in feed stuffs for catfish. In:R.R. Stickney and R.T. Lovel (editors), Alabama Agric. Exp. Stn. Southern Coop. Ser. Bull. 218. Auburn University, AL, pp.33-37.

Mahajan, C.L. and J.S. Yadave, 1974. Experiments on a synthetic diet for carps. Some priliminary observations and their relevance to Aquaculture. J. Inland Fish. Soc. India, 6:178-84.

Marian, M.P., Ponniah, A. G. Pitchaairag and N. Narayanan. 1982. Effect of feeding frequency on surfacing activity and growth in the air-breathing fish, Heteropneustes fossilis. Aquaculture 26:237-244.

Margett, H. Zeitler, M. Kirchgessner and F. J. Sehwarz. 1984. Effect of different protein and energy supplies on caracas composition of carp (Cyprinus carpio) Aquaculture, 36:37-48.

Matyka, J. and M. Adamezyk. 1979. Estimation of crude fiber in fooder by use of the fibertec appratus and understandard condition of analysis. Biuletyn informacyjny przenyslu paszowego. 18(2):12-15.

Mazid, M. A., Tanaka, Y., Katayama, T., Asadur Rahman, M., Simpson, K.L. and Chicheister, C.O., 1979. Growth response of Tilapia zillii fingerlings fed isocaloric diets with variable protein levels. Aquaculture, 18:115-122.

Merla, G., and H. Kulow. 1967. Resultate. der Kar fenaufzucst in Strechteich als Folgevers chiedener Ernahrungsmolichkaiten Dt. Fisch. Ztg. Radebul 14 (6):168-176.

Millikin, M.R. 1982. Qualitative and quantitative nutrient requirements of fishes: A review. Fish Bull. 80:655-686.

Millikin, M.R. 1983. Interactive of dietary protein and lipid on growth and protein utilization of age-o-striped bass. Trans. Am. Fish. Soc. 112:185-193.

Nazneen, S. And Begum, F. 1985. Effects of various diets on the growth of Tilapia fish. Pakistan J. Agric. Res. Vol. 6, No.2.

National Research Council (NRC). 1977. Nutrient involvements of warm water fishes national academy of sciences Washington, DC. 78pp.

Niles, S.D. 1982. Effects of variation in dietary protein and energy on the growth and survival of channel catfish fry. Masters thesis Texas A and M university, college Station. TX.

Ogino, C. and Saito K. 1970 Protein nutrition in fish. I. The utilisation of dietary protein by young carp. Bull. of the Japanese Society of Scientific Fisheries 36, 250-254.

Otubusin, S.O. 1987. Effects of different levels of blood meal in pelleted feeds on Tilapia, Oreochromis nilotica, production of floating bamboo net-cages. Aq-culture 65:263-266.

Shell, E. W. 1967. Feeds and feeding of warm water fish in North America. Proc. Word Symp. warm -water pond fish culture. FAO Fisheries Report. 3(44):310-325.

Shiau, S. -y., Chuang, J,.-L. and Sun, C.-L. 1987. Inclusion of soyaban meal in Tilapia (Oreochromis niloticus x O.auracus) diets at two protein levels. Aquaculture, 65:251-261.

Singh, C.S. 1970. Fresh water alga Oedogonium obtruncatum Wittrock as a nutritive source to Cirrhimus mrigala (Ham.) Ind. J. Exp. Biol., 8(2): 153-54.

Sin, A.W., 1973a. The dietary protein requirements for growth of young carp (Cyprinus carpio). Hong Kong Fish. Bull., 3:77-81.

Sin, A.W. 1973b. The utilization of dietary protein for growth of young carp (Cyprinus carpio) in relation to variations in fat intake. Hong Kong Fish. Bull., 3:83-88.

Steffens, W. 1981. protein utilization by rainbow trout (Salmo gairalmeri) and carp (Cyprinus carpio): a brief review. Aquaculture, 23:337-345.

Wang, D.Z., and F.T. Song, 1984. The effects of protein and carbohydrate contents in the feeds on the growth of black carp fingerlings. Journal of Fisheries China 8(1):9-17.

Welcome, R.L. 1964. The habitats and habitat preferencesof the young of the lake Victoria Tilapia (piscas, cichlidae). Rev. Zool. Bot. Afr. 70:1-28.

Wee, K.L. and L.T.NG. 1986. Use of cassava as an energy source in a pelleted feed for the tilapia, Oreochromis nilotica L. Aquaculture and Fisheries Management 17: 129-138.

Winfree, R.A. and Stickney, R.R. 1981. Effects of dietary and energy on growth, feed conversion efficiency and body composition of Tilapia nilotica. J. Nutr., 6(3):1001-1012.

Ufodike, E.B.C and A.J. Matty. 1981. Growth responses and nutrient digestibility in major carp (Eyprinus carpio) feed diff. levels of Cassava and rice. Aquacultures 31:41-50.

YU, T.C., Sinnhuber, R.O. and putnam, C.B., 1977. Use of swine fat as an energy sourec in trout rations. prog. Fish cutt, 39:95-97.

Zeitoun, I.H., J.E. Halver, D. E. Ullery, and P.I. Tack. 1973. Influence of salinity on protein requirements of rainbow trout (Salmo gairdonera) fingerlings. J. Fish. Res. Board Can. 30:1867-1873.

Zeitoun, I. H., Ullrey, D.E. and Tack, P.I., 1974. Effects of water salinity and dietary protein levels on total serum protein and haematocrit of rainbow trout (Salmo gairdneri) fingerlings. J. Fish. Res. Board Can., 31: 1131-1134.