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RESPONSE OF FLORIDA RED TILAPIA (OREOCHROMIS UROLEPIA HORNORUM VS O. MOSSAMBICUS HYBRID) FINGERLINGS TO DIFFERENT DIETARY OIL LEVELS

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Key Words: Lipid utilization; growth performance;Haematological responses; Red Tilapia Hybrid.

ABSTRACT

The present study was conducted to study the effects of different levels of lipid supplement to diets on growth performance, feed and nutrient utilization, body composition as well as some hematological parameters of red tilapia fingerlings. Five isonitrogenous diets (30% protein) contained (0.0; 3.0; 6.0; 9.0 and 12.0%) lipid supplement from a mixture of soybean oil and cod liver oil were fed to triplicate groups of red tilapia for 12 weeks. Results of the experiments showed that plasma cholesterol and glucose levels as well as haemoglobin content were affected significantly with the dietary energy levels. Changes of plasma total protein as well as sodium and potassium ions were all insignificant. On the other hand, fish fed low energy levels exhibited extremely poor growth performance and feed utilization compared to those fed moderate or high-energy diets. The best growth performance was achieved with the diet containing 9% oil supplement (467.3 Kcal/100 g), while the optimal protein utilization was achieved with the diet containing 6% oil supplement (449.8 Kcal/ 100 g). Body composition was also significantly affected by diet energy. It was concluded that, red tilapia was able to utilize these sources of energy to improve growth and food utilization efficiency.

INTRODUCTION

Tilapias are among the most successful cultured fish in the world (Balarin & Hatton, 1979). Furthermore, red tilapia has several characters which make it an important farm fish i. e. the fast growth rate, good conversion and ability to grow in fresh, brackish and salt waters and low susceptibility to diseases (Liao and Chang, 1983). Most tilapias are known to accept artificial feeds immediately after yolk-sac absorption. Therefore, determination of dietary protein and energy requirements for maximum growth and survival of cultured tilapia is essential.

Protein is the most expensive source of energy and thus the major aim of fish feeds is to maximize the utilization of protein for growth by supplying adequate amounts of alternative dietary energy sources. The design of practical feeds is therefore a compromise between a protein level that produces good growth with little conversion to energy and an energy level that gives high rates of protein synthesis but that does not result in undesirably high levels of carcass lipid (Jauncey ***et al.***, 1983; Desilva & Perera, 1985 and Siddiqui ***et al.***, 1988).

Several studies have been sought to substitute expensive protein sources with lower-cost protein sources and by-product materials (Jackson ***et al.***, 1982; Viola and Arieli, 1983; Ofojekwu and Ejike, 1984), while others have investigated the ability of tilapia to utilize carbohydrates and lipids as energy sources (El-Sayed and Garling, 1988, Ellis and Reigh, 1991).

The present study was undertaken to investigate the effects of various levels of lipid within the diets on growth, feed utilization, body composition and some hematological parameters of Florida red tilapia fingerlings.

MATERIALS AND METHODS

The present study was conducted at Fish Rearing Laboratory, Aquaculture Division in the National Institute of Oceanography & Fisheries, Alexandria in June 1997. Florida red tilapia hybrid (***Oreochromis urolepia*** hornorum X ***O. mossambicus*** hybrid) fingerlings were obtained from Mariut Fish Farm, 21 Km west Alexandria. The fingerlings weighing 0.73 ± 0.01 g were brought to

the laboratory and acclimated under appropriate experimental conditions in brackish water (salinity = 17.8‰) for two weeks. Ten fish were randomly distributed in 15 glass aquaria (105L capacity/unit). Five isonitrogenous diets (30% crude protein) varying in oil supplement (0, 3, 6, 9 and 12%) were prepared (Table 1). The lipid source was a mixture of soybean oil and cod liver oil. Dry dietary ingredients were mixed in a plastic container. The oil was added a few drops at a time, during mixing warm distilled water (45 °C) was slowly added under continuous mixing, until the diets began to clump, then passed through a commercial meat grinder to produce spaghetti-like strands. The strands were air-dried and broken into pellet size particles. Each treatment consisted of three aquaria. Fish were fed two times daily (9.00 am and 14.00 pm) for six days a week at a rate of 4% of their wet biomass per day and readjusted bi-weekly after the biomass of fish in each aquarium was determined. Water in each aquarium was partially changed once every three days using brackish water (17.8‰). Brackish water was prepared using 50% tap water + 50% seawater. Accumulated wastes were removed by siphoning and a fixed amount of water (1/3 of aquaria water) was exchanged daily over the experimental period (12 weeks). Oxygen levels were kept close to saturation value by vigorous aeration.

At the termination of the study, fish in each aquarium were netted, counted and weighed. Body composition analyses were performed using standard AOAC (1980). Gross energy of the diets as well as carcass energy content was estimated according to NRC (1993).

To study the effects of different levels of lipid on some hematological parameters of red tilapia, blood was collected directly from the caudal artery into heparinized capillary tubes. Haemoglobin content was measured using Sahli haemometer. Plasma cholesterol, glucose and protein were measured using standard kits «Modern Laboratory Chemicals». Plasma ion concentrations of sodium and potassium were measured using flame analyzer «Gallen Kamp».

Statistical analysis of data was computed by the analysis of variance and the least significant differences (LSD) between means according to Snedecor and Cochran (1974).

Table (1): Composition (%) and chemical analyses of test diets containing Different levels of lipid, fed to red tilapia.

Feed Ingredients	Diet no				
	1*	2	3	4	5
Composition (%)					
Fish meal	40.0	40.0	40.0	40.0	40.0
Wheat bran	40.0	40.0	40.0	40.0	40.0
Soybean oil	0.0	1.5	3.0	4.5	6.0
Cod liver oil	0.0	1.5	3.0	4.5	6.0
Dextrin	18.0	15.0	12.0	9.0	6.0
Min. & Vita. Mix**	2.0	2.0	2.0	2.0	2.0
Chemical analyses (%)					
Dry matter	91.96	92.38	92.45	92.66	92.82
% on Dm basis					
Crude protein	30.09	30.21	30.48	30.54	30.59
Crude fat	3.03	7.26	10.66	13.59	18.04
Crude fiber	2.45	3.20	3.64	3.85	3.69
Ash	12.53	12.35	12.08	11.45	10.24
Nitrogen free extract	51.09	46.98	43.14	40.57	37.44
Gross energy*** (Kcal/100g diet)	408.29	432.01	449.84	467.28	496.70
P/GE ratio (Mg cp/Kcal GE)	73.70	69.72	67.76	65.36	61.59

* Control diet.

** Vitamins and minerals mixture/kg Premix containing the following: 3300 IU vitamin A, 3300 IU vitamin D_3, 410 IU vitamin E, 2660 mg vitamin B_1, 133 mg vitamin B_2, 580 mg vitamin B_6, 410 mg vitamin B_{12}, 50 mg biotin, 9330 mg coline chloride, 4000 mg vitamin C, 2660 mg inositol, 330 mg para-aminobenzoic acid, 93330 mg niacin, 26.60 mg pantothenic acid, 325 mg manganese, 200 mg iron, 25 mg copper, 5 mg iodine and 5 mg cobalt.

*** Gross energy (GE Kcal/g diet) calculated according to NRC (1993) using the following calorific values 5.64, 9.44 and 4.11 Kcal/g diet of protein, fat and carbohydrate, respectively.

RESULTS

The effect of different levels of energy on some hematological parameters of red tilapia are shown in Table (2). The main findings are, cholesterol values increased significantly ($p<0.01$) with increasing the levels of energy (70.7, 77.7, 82.5, 124.5 and 202.4 mg/100 ml), respectively. Plasma glucose as an indicator of fish metabolic rate increased also significantly ($p<0.05$) with the increase of energy levels (34.2, 36.2, 44.0, 46.7 and 49.7 mg/100ml), respectively. Haemoglobin content was significantly ($p<0.05$) affected by the levels of energy being higher for the fish maintained at diets containing 6% and 9% lipid supplement (449.8 and 467.3 Kcal/100 g diet). On the other hand, the concentrations of protein as well as sodium and potassium ions in the plasma of red tilapia changed insignificantly.

The present study revealed a significant ($p<0.01$) effect of energy levels on fish growth performance, feed utilization and body composition of red tilapia as shown in Table (3). At all energy levels, a diet containing low energy level (408.3 Kcal/100 g) produced extremely poor growth performance comparing to diets containing high levels of energy. The best growth was achieved at a diet containing 467.3 Kcal/100 g (9% lipid supplement). Growth performance started to decline in the fish fed diets containing beyond this level of energy (496.7 Kcal/100 g). Average daily gain (ADG) and specific growth rate (SGR%) showed the same trend of variation.

On the other hand, the best feed conversion ratio (FCR); efficiency of protein utilization in terms of protein productive value (PPV%) and protein efficiency ratio (PER) as well as the utilization of energy (EU%) were achieved in the diet containing 6% lipid supplement (449.8 Kcal/100 g).

As shown in Table (3), carcass lipid levels increasing as the dietary lipid levels increased. Also, there was an increase in the level of carcass crude protein as dietary lipid level increased, except in the case of fish receiving high level of lipid where an increase in dietary lipid produced fish with lower carcass protein. Finally, control fish contained greater level of moisture than fish fed the supplemental diets due to the displacement of moisture by lipid and protein in fish fed the supplemental diets.

Table (2): Changes in some haematological parameters of red tilapia at the end of the experiment.

Parameter	Level of lipid supplement %					LSD*	
	0	3	6	9	12	5%	1%
Cholesterol (mg/100 ml)	70.7±3.9	77.7±3.7	82.5±4.2	124.5±8.2	202.4±8.4	56.1	75.4
Haemoglobin (%)	50.1±4.0	51.3±3.9	55.4±6.3	55.0±4.8	52.1±3.8	4.47	5.98
Glucose (mg/100 ml)	34.2±0.9	36.2±0.7	44.0±1.0	46.7±1.6	49.7±1.5	10.06	13.44
Total protein (mg/100 ml)	4.75±0.04	4.80±0.04	4.66±0.03	4.61±0.03	4.47±0.04	NS	NS
Sodium (m mol/L)	170.0±3.2	172.9±3.7	171.1±3.0	172.4±3.8	178.7±3.0	NS	NS
Potassium (m mol/L)	16.4±0.4	16.8±0.3	16.8±0.3	16.6±0.4	18.2±0.4	NS	NS

NS: not significant.
* LSD: least significant differences.

Table (3): Effect of different levels of lipid on growth performance, feed utilization and carcass composition of Florida red tilapia.

Item	Level of lipid supplement (%)					LSD (P<0.01)
	0	3	6	9	12	
A) Growth performance						
Initial wt. (g/fish)	0.73	0.74	0.73	0.73	0.74	N.S.
Final wt. (g/fish)	10.83^{e}	14.30^{c}	15.70^{b}	16.28^{a}	12.71^{d}	0.2213
Gain (g/fish)	10.10^{e}	13.56^{c}	14.97^{b}	15.55^{a}	11.97^{d}	0.2213
ADG[1] (mg/day/fish)	120.24^{e}	161.43^{c}	178.21^{b}	185.12^{a}	142.50^{d}	2.612
SGR[2] (%/day)	3.21^{e}	3.53^{c}	3.65^{b}	3.70^{a}	3.39^{d}	0.0342
B) Feed utilization						
FCR[3]	1.29^{d}	1.18^{b}	1.13^{a}	1.18^{b}	1.20^{c}	0.0197
PER[4]	2.58^{d}	2.80^{b}	2.91^{a}	2.78^{b}	2.64^{c}	0.0483
PPV%[5]	14.03^{e}	21.86^{c}	25.10^{a}	24.11^{b}	18.10^{d}	0.5715
EU%[6]	16.67^{d}	20.32^{b}	21.53^{a}	19.90^{c}	16.28^{e}	0.3741
C) Carcass composition						
Dry matter %	23.02^{c}	23.39^{b}	23.58^{a}	23.51^{a}	23.33^{b}	0.0966
% On DM basis						
Crude protein	57.10^{b}	58.04^{a}	58.24^{a}	57.97^{a}	57.35^{b}	0.4453
Ether extract	25.58^{c}	26.71^{b}	26.78^{b}	26.86^{b}	27.28^{a}	0.4265
Ash	17.44^{a}	15.39^{b}	14.99^{c}	15.17^{b}	15.37^{b}	0.7259*

1. Average daily gain = Average body gain (mg)/Experimental period (day)
2. Specific growth rate = Ln final weight g. - Ln initial weight g. /time (day)
3. Feed conversion ratio = g. dry feed/ g. live body gain.
4. Protein efficiency ratio = g. live body gain/ g. protein intake.
5. Protein productive value = g. protein gain/ g. protein intake × 100.
6. Energy utilization = Energy gain (Kcal)/ energy intake (Kcal) × 100.

* LSD P<0.05

DISCUSSION

The most prominent feature of the physiological response of red tilapia fed different levels of lipid inclusions was a significant increase in cholesterol level with increasing diet energy. This extreme variability no doubt reflects dietary input, which contain more level of lipid (soybean oil and cod liver oil). Barnhardt (1969), showed that soybean meal raised cholesterol levels of rainbow trout beyond those in fish fed on other diets. The increase of plasma glucose levels as an indicator of fish metabolic rate with increasing energy levels may be due to the increased metabolic requirement of the fish or decreased metabolic turnover rate. Haemoglobin content for red tilapia was significantly higher in fish maintained at diets containing 6% and 9% lipid supplement. Decreasing of haemoglobin in other diets might be ascribed to a decrease in the general condition of the fish or a deficiency in some essential fatty acid (Castell ***et al.***, 1972). Changes in plasma protein levels of red tilapia with different diets of energy were insignificant. This is normally due to the using of one isonitrogenous diets (30% protein) in this experiment. This is in contrast to a previous experiment (Sweilum, 1995) where tilapia and carp fed different dietary protein levels which resulted in a significant increase of plasma protein. Sodium and potassium ions in the plasma of red tilapia were also increased insignificantly which may be reflects a slight increase in drinking rate of water by the fish (Kirsch ***et al.***, 1985).

It is well known that, the ratio between protein and energy (P/E ratio) in fish diets is of great importance for the determination of their protein and energy requirements (El-Sayed, 1992). At inadequate energy levels, dietary protein will be used as an energy source (Cowey, 1980). The more protein is used for energy, the more ammonia produced and the more energy is lost as heat (Cho and kaushik, 1985). Consequently, less protein will be retained in the fish body. An excessive energy intake at moderate protein levels will lead to fat deposition (Jauncey and Ross, 1982). Therefore, the proper balance between dietary protein and energy is essential in fish feed formulation.

The present study revealed that at low energy level (408.3 Kcal/100 g), fish exhibited extremely poor growth performance compared to those fed moderate and high energy diets. This indicates that protein may have been used for energy, as has been demonstrated by many authors (Cowey, 1980, El-Sayed,

1992). The best fish growth was achieved on diets containing 9% oil supplement (467.3 K cal/100 g). This diet presumably contained the most appropriate P/E ratio (65.4 mg protein/K cal). Increasing dietary energy beyond this level did not further improve fish growth performance. Similar results have been obtained with O. ***aureus*** (Winfree and Stickney, 1981; ***O. niloticus*** (Teshima ***et al.***, 1985) and ***Tilapia zillii*** (El-Sayed, 1987). On the other hand, the best feed conversion ratio; protein and energy utilization was obtained in diet containing 6% oil supplement (449.8 K cal/100 g). When dietary energy increased above 6% dietary lipid, food conversion ratio (FCR), protien and energy utilization (PER, PPV and EU) decreased. This indicates that at a constant protein level, protein can be spared by increasing the non-protein energy sources. The same results were observed by Ringrose, (1971) for brook trout (***Salvelinus fotinalis***), Andron ***et al.***, (1976) for trout (***Salmo gairdnerii***), and Takeda ***et al.***, (1975) in yellow tail fish (***Seriola quinqueradiata***).

The positive relationship between dietary lipid content and whole-body lipid levels of fish in this study follows similar observations reported for rainbow trout (Lee and Putnam, 1973) and red drum (Williams and Robinson, 1988). The increase of body protein with increasing dietary energy level may indicate a protein-sparing effect by dietary energy as has been demonstrated by Le Grow and Beamish (1986). On the other side, the apparent decrease in body protein of fish fed high lipid diet (12% lipid supplement) may be due to a proportional decrease in the percentage of protein present in tissue as a result of increased tissue lipid levels. Therefore, excessive energy can produce a poor fish quality which can lead to increase lipid deposition and produced fatty fish. This can be undesirable, especially if it reduces the dress-out yield and decrease the durability of the frozen fish (Lovell, 1989).

It was concluded that red tilapia was able to store significant quantities of lipid in their carcass and was able to utilize this energy source to improve growth and food utilization efficiency. Moreover, diet containing 9% oil supplement was superior to growth performance while diet containing 6% oil supplement was optimal for maximum utilization of protein. These results are in accordance with those of Jauncey and Ross (1982) who suggested that 6-10% lipid to be included in the diet of tilapias.

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