EFFECT OF SOURCES AND LEVELS OF PROTEIN IN DIETS OF TILAPIA *(SAROTHERODON GALILAEUS)* FINGERLINGS ON THE DIGESTIBILITY OF NUTRIENTS

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Abstract

This study was planned to investigate the effect of three sources and levels of protein in fish diets on the digestibility coefficients on Tilapia galilae (average body weight 4.7g) reared in aquarium under laboratory condition. Nine diets representing three protein sources, animal, plant and mixture of animal and plant protein sources at three protein levels 22, 27 and 32% within each source were tested.

The obtained results revealed that:

1-Fish fed on plant protein source as a sole source resulted in the significant (P<0.05) higher value of digestion coefficient of dry matter (91.93%) , nitrogen free extract (75.12%) and energy (75.88%), while, fish fed on animal plus plant protein source showed the best significant (p< 0.05) values of digestibility of crude protein (87.18%) and ether extract (90.55%).

2-Level of 22% crude protein resulted in the best significant (p<0.05) values of digestion coefficient of dry matter (91.12%), ether extract (90.75%), nitrogen free extract (71.64%), energy (76.67%), and resulted in significant lower (p< 0.05) values of crude protein digestion (81.14%), comparative to 32% protein level, while, a level of 27% crude protein improved significantly (p< 0.05) the digestion coefficient of dry matter (90.05%), ether extract (87.28%), nitrogen free extract (75.12%) and energy (75.19%) comparative to 32% dietary protein .

3-Within any dietary protein source, tested increasing the level of protein from 22 to 27 or 32% lowered significantly the digestion coefficient of dry matter, nitrogen free extract, energy and (p< 0.05) the digestion coefficient of ether extract, while, the digestion of crude protein increased insignificantly. Fish fed on plant protein source at level of 22% showed higher insignificant value of digestion coefficient of dry matter (92.85%),nitrogen free extract (75.74%) and energy (77.54%), while, 22% protein level from animal plus plant protein source showed significantly the highest value (p< 0.05) of digestion coefficient of ether extract (92.88%) .

INTRODUCTION

The major components which affect water quality are: temperature, dissolved oxygen, pH and NH_3. Failure to maintain adequate water quality in aquaria may cause poor growth or death of fish (Boyd, 1992). He added that tilapia *(S. galilaeus)* can tolerate high water temperatures about 30°C. Aquaculture is now recognized as a viable and profitable enterprise world wide, and considered an important animal protein source for increasing demand on animal protein .

Protein is the major organic material in fish tissue making up about 65 – 75 % of the total dry weight basis (Halver,1989). Muscle protein is highly digestible and has high nutritional value. Fish use protein efficiently as a source of energy.

Cho, *et al* .(1974) found that ,the apparent dry matter digestibility for rainbow trout (97g) was increased by removing the fermentation and plant products with both the high and low levels of herring meal in the diet. The apparent digestibility of the protein and fat differed little between soybean meal and herring meal protein. Hanley (1987) studied the digestibility of foodstuffs for Tilapia, *Oreochromis niloticus* (33.7 g) received essentially single ingredient diets containing approximately 80% of the test fed stuff. It was found that , the digestibility coefficients for protein were: soybean meal (91%), fish meal (86%), ground corn (83%), wheat middling (75 %), poultry-offal meal (74%), and brewers grain (63%). In regard to gross energy, the digestibility were: animal oil (93%), fish meal (80 %), ground corn (76%), poultry-offal meal (59%), wheat middling (58%), soybean meal (56%), ad brewers grains (30%). It was apparent that the protein and energy of the animal – based foodstuffs were more digestible in *O. niloticus* than those of the plan-based foodstuffs .

Hasan, *et al.* (1994) found that, apparent protein digestibility decreased with increasing Soaked leucaena leaf meal protein level in the diet for Indian major carp fingerlings .

Robaina, *et al.* (1995) reported that, the observed protein digestibility in gilthead sea bream for lupine seed meal diets
were similar to the control diet (100 % fish meal) and 10% higher than those for the soybean meal diets .

Nengas, *et al.* (1995) investigated the digestibility coefficients of various raw materials in diets for gilthead sea bream (45 g). They found that, the lowest protein digestibility coefficients were obtained for feather meal, in the animal by-product group, and tomato pulp within the plant by- product group. The highest coefficient was obtained using herring meal and skimmed milk powder. However, corn glutin meal and soybean meal gave results which were only slightly inferior. The differences in lipid digestibility did not appear to be correlated either with the origin of the raw materials, plant or animal, or with the lipid level of the diet tested. The same authors added that the lower energy digestibility value was observed for feather meal and the higher for herring meal. Poultry by-product meal, corn glutin meal, meat and bone meal, poultry meat meal and fullfat soya meal, performed well. Wee and Tuan (1988) reported that, protein and dry matter digestibility were increased as dietary protein level increased up to 50 % .

Shiau and Huang (1989) stated that, the protein digestibility was not affected by the protein content in the diet. They found that the protein digestibility ranged from 80.89 to 87.85 % for fish fed diet containing dietary protein levels ranging from 8 to 56 % with Tilapia *(O. niloticus × O. aureus)* of average weight 2.88 g.

De Silva, *et al.* (1991) indicated that, lipid digestibility of red Tilapia (1.18g), increased significantly (p> 0.05) with increasing dietary lipid content at the studied dietary protein levels (15, 20 and 30 %). The trends of influence of dietary protein content on protein digestibility, at comparable dietary lipid levels, were not clear-cut. The same was true with the apparent dry matter digestibility estimates of the test diets .

Smith *et al.* (2000) reported that digestible energy (DE) values for different fish species vary depending on the nature of the digestive tract and the type of digestive enzymes secreted. The tilapia *(S. galilaeus)* has a digestive tract with a relatively long, herbivorous type of intestine with a series of mulliple loops and coils in a unique arrangement.

David *et al.* (2004) reported that, for tilapia *(Oreochromis nitoticus × Oreochromis aureus)* 100g, digestibilities of crude protein (CP) were in general high and over 90% for soybean meal, sunflower meal and corn glutin meal. Corn and wheat protein had the lowest (CP) digestibilities ranging between 75% and 80%. They added that lipid digestiblitities were above 90% for corn glutin and rapeseed meal and were lower for corn and wheat bran at 72-76%. Carbohydrate digestibility was the highest at 80% for corn glutin meal and the lowest for wheat bran at 32.5%. Gross energy (GE) digestibility was the highest for fish meal at 89% and the lowest for wheat bran at 39%.

The objective of this the study was to investigate the effect of protein sources and levels as well as their interaction on digestibility coefficient of *Tilapia galelea.*

MATERIALS AND METHODS

Experimental procedure

Twenty – seven glass aquaria of (60× 40× 50 cm) were used in this experiment(3 a quaria for each treatment). The aquaria were supplied with tap water which were previously aerated in fiber glass tank by compressed air for two days before use. The experiment was conducted using *Tilapia galilaeus* fingerlings with an initial body weight of 4.7±0.2g. The fish were acclimatized to laboratory conditions for nearly two week in a fiber tank. At the begining of the experiment, 25 fish were stocked in each experimental aquarium. Water temperature was maintained at 25±2 °C. The fish were fed in three equal portions the tested diets at a rate of 3% of body weight daily. The daily ration fed was at three times daily at 8.00, 12.00 and 16.00 h, fish were weighed biweekly and the daily ration was adjusted accordingly. Water quality properties (temperature, dissolved oxygen. PH and NH_3) of aquaria were carried out according to Boyd (1992).

Diet preparation

Before formulating the experimental diets, the animal and plant protein sources were chemically analyzed according to methods of AOAC (1995) (Table I).

The dry ingredients of each diet were ground through a feed grinder to very small particle sizes (0.15 mm mesh). The ingredients were weighed and mixed by a dough mixer for 20 minutes to ensure homogeneity of the ingredients. The estimated amount of oil components (fish and plant oil) were gradually added and the mixing operation continued for 20 minutes. After homogeneous mixture was obtained, 40ml water per 100 g diet were slowly added to the mixture according to Shimeino *et al.* (1985). The mixing speed was increased as the water was added. The diet was cooked on the water evaporator for 20 minuets. As the diet began to clump, it was pelleted through fodder machine (model D45 T. E Parmigiana), dried in a drying oven overnight at 65 °C, then, cooled and saved in plastic bags and stored in refrigerator at 4°C during the experimental period to avoid the nutrients deterioration. The formulation and chemical analysis of the experimental diets are presented in Tables 2 and 3.

Experimental design

A3 × 3 factorial design was used which contained 3 sources of dietary protein (animal source, plant source and animal plus plant protein source) each with three levels of protein (22 ,27 and 32 %) as shown in Table 4.

Determination of nutrients digestibility (the digestion trial procedure)

The digestion trial was carried out at the end of the feeding trial (after 90 days) in the same aquaria (27 aquaria), to determine the digestibility, coefficient of the experimental diets, and consequently their nutritive value to be estimated. Fish were starved for 72 h to ensure that alimentary tract was empty. The fish were fed the same experimental diets mixed with chromic oxide at a concentration of 0.5 % of the diet because chromic oxide is the best external marker which is not affected with enzymes and increase efficiency of digestibility coefficients. The fish were fed at 1 % of their total biomass at 9.00 and 14.00 o'clock. Feces were collected for 14 days by siphoning one time daily before the next morning meal and filtered through 3 layers nylon cloth, then, kept in the refrigerator at 4 °C. The total collection of samples were oven dried at 65 overnight and finally stored in containers for chemical analysis. The apparent digestibility were determined by the following equation:

Apparent digestibility coefficient (ADC) :

$$100 - [\, 100 \times \frac{\%\ \text{Indicator in feed}}{\%\ \text{Indicator in feces}} \times \frac{\%\ \text{Nutrient in feces}}{\%\ \text{Nutrient in feed}} \,]$$

according to AOAC (1995)

Statistical analysis

Data were collected and tabulated, then, subjected to statistical analysis. Means, standard error and analysis of variance were calculated according to Snedecor and Cochran

(1982) by using factorial design 3 × 3 (3 protein sources × 3 protein levels) with the following model:

$X_{ijk} = U + S_i + L_j + SL_{ij} + e_{ijk}$

Where

U = overall mean

S_i = Effect of protein source (i = 1.2 and 3)

L_j = Effect of protein levels (j = 1.2 and 3)

SL_{ij}= Effect of interaction between sources and levels of protein.

eijk = Random error.

Differences among means within the same factor were tested by using.

Duncan new multiple range test (1955).

RESULTS AND DISCUSSION

Digestibility coefficient

1- Effect of dietary protein sources

The average values of digestibility coefficient of nutrients of Tilapia galelea as affected by dietary protein sources are presented in Table 5. Result indicated that, inclusion of plant protein source in the diet of Tilapia galelea resulted in the significant (P< 0.05) higher value of digestibility coefficients of DM (91.93%), NFE (75.12%) and energy (75.88%). However, the animal plus plant protein source in the diet showed the best significant (P<0.05) values of digestibility of CP (87.18% and EE (90.55%). In fish, the determination of digestibility coefficient of dietary nutrients is complicated because the nutrient in feed and feces may have disappeared and dissolved in water. An error is caused in digestibility coefficients based towards higher values, according to losses of nutrients in water (Hepher, 1988). Results presented in this study are similar with those obtained by Cho, *et al.* (1974) who found that, the apparent digestibility of dry matter for Rainbow trout was increased by removing the fermentation and plant products with both the high and low levels of herring meal in the diet. Also, the apparent digestibility of the protein and fat were different little between soybean and herring meal protein. Also, Hanley (1987) reported that, it was apparent that protein and energy of the animal-based foodstuff were more available to *O. niloticus* than those of the plant-based foodstuff. On the other hand, Hasan, *et al* (1994) reported that, apparent protein digestibility values of mustard and linseed were similar to those of the fish meal

2- Effect of dietary proteins level

The average values of digestibility coefficient of nutrients of Tilapia galelea as affected by dietary protein level are presented in Table 6. From results presented in Table 6, it was noticed that, regardless of dietary protein source, level of 22% crude protein in the diet of Tilapia galelea resulted in the best significant (P<0.05) values of digestibility coefficient of DM (91.12), EE (90.75%), NFE (71.64%), energy (76.67%) and lower significant CP (81.14%) as compared to 32% protein level. Level of 27%

dietary protein improved significantly (P < 0.05) the digestion coefficient of DM (90.05%), energy (75.19%) and significantly decreased that of CP(84.54%) comparatively to 32% dietary protein. Generally. increasing dietary protein level from 22 to 32 in the diet of Tilapia galelea lowered the digestibility values of nutrient, except the digestibility of crude protein. These results are in partial agreement with those obtained by Wee and Tuan (1988) who reported that, protein and dry matter digestibility were increased as dietary protein increased up to 50%. On the other hand, Shiau and Huang (1989) stated that, the protein digestibility was not affected by the protein content in the diet and it ranged from 80.89 to 87.85% for fish fed diet containing dietary protein from 8 to 56% with hybrid Tilapia *(O. niloticus × O. aureus)*

3- Effect of interaction due to dietary protein sources and levels

The average value of digestibility coefficient to Tilapis galelea as affected by interaction due to dietary protein source and level are presented in Table 7 . Results obtained indicated that, at any dietary protein source (AP, PP and / or AP + PP), increasing the level of protein from 22 to 27 or 32% lowered insignificantly the digestion coefficient of DM, NFE, energy and significantly (P<0.05) the digestion coefficient of EE and improved significantly the digestion coefficient of CP. However, plant protein source at level of 22% showed the higher insignificant value of digestion coefficient of DM (29.85%), NFE (75.7%) and energy (77.54%), while, 22% protein level from animal plus plant protein sources showed higher significant value of digestion coefficient of EE (92.88%).

4- Water quality properties

Data collected on water quality are presented in Table 8 temperature, dissolved oxygen, pH and NH_3 values were in the tolerable range for fish (Boyd, 1992).

Table 1. Chemical composition of animal and plant protein sources tested.

%	Fish meal	Meat meal	Soybean meal	Cotton seed meal
Moisture	7.31	6.56	9.86	7.83
Crude protein	72.11	56.51	44.83	41.50
Ether extract	8.89	8.60	1.56	1.87
Crude fiber	-	1.13	7.10	10.92
Ash	10.27	24.12	6.25	6.58
N.F.E	1.42	3.08	30.40	31.30

Table 2. Percentage composition of the experimental diets of Tilapia galelea.

Protein source	Animal protein (AP)			Plant protein (PP)			Animal plus plant protein (AP+PP)		
Protein level %	22	27	32	22	27	32	22	27	32
Ingredients:									
Fish meal	15.26	18.65	22.22	-	-	-	7.63	9.36	11.09
Meat meal	19.47	23.89	28.32	-	-	-	9.73	11.95	14.16
Soybean meal	-	-	-	32.74	40.18	47.62	16.37	20.09	23.81
Cotton seed meal	-	-	-	17.67	21.69	25.70	8.83	10.84	12.85
Corn starch	51.52	42.77	35.37	36.62	28.62	17.33	44.64	33.71	26.55
Plant oil	2.50	2.00	1.00	4.00	2.50	2.00	3.00	3.00	1.50
Vit-and Min.mix.	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Methionine	0.30	0.20	0.10	0.47	0.41	0.35	0.40	0.32	0.24
Carboxy methyl cellulose (C M C)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Cellulose powder	3.95	4.49	5.99	1.50	1.00	-	2.40	3.73	2.80
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Each 100 gram of vitamin and mineral mixture contained:

0.55 Mineral : Zn; 2.50 mg; Mn; 16.00 mg; Fe; 31.50 mg; Cu; 5.50 mg; I; mg; Ca; 1.15 g; P; 450 mg; Se; 0.11 mg; and Nacl 2.18 mg .

Vitamins: Vit A; 7500000 IU; Vit B1 100mg; Vit B3; 500mg; Vit B6; 150mg; Vit; B12; 2.5 mg Vit. E; 100mg; Vit K; 100mg; Panthnic acid; 275mg; Folic acid; 100 mg and Vit. D3 75000 Iu .

Table 3. Proximate analysis of the experimental diets (as fed).

Diet No.	1	2	3	4	5	6	7	8	9
Compound:- Crude protein	22.10	27.01	32.09	22.07	27.05	32.03	22.08	27.05	32.04
Ither extract	5.51	5.69	5.36	4.81	3.49	3.17	4.91	5.35	4.28
Crude fiber	5.60	6.99	7.46	7.43	7.94	7.99	6.22	7.92	7.58
Ash	7.80	9.15	10.59	4.71	5.42	6.13	6.24	7.30	8.37
Moisture	10.53	9.93	9.51	10.90	9.53	10.47	10.77	10.33	10.12
Nitrogen free extract*	48.46	41.23	34.99	50.08	46.57	40.21	19.78	42.05	37.61
Gross energy (K.cal/100g)**	375.83	375.51	375.39	375.71	376.91	375.48	375.48	375.48	375.69

* Calculated by difference .

** Estimated according to NRC (1993).

Table 4. The experimental design .

Treatment No.	Protein source	Protein level
1	Animal protein (AP)	22
2		27
3		32
4	Plant protein (PP)	22
5		27
6		32
7	Animal plus plant	22
8	Protein (AP + PP)	27
9		32

Table 5. Digestibility coefficients($\bar{x}$ ± S.E) of Tilapia galelea as affected by different dietary protein source, at the end of the experimental period.

Protein source	D.M	C.P	E.E	NFE	Energy
A.P	88.87^{b} ± 0.62	82.61^{b} ± 0.57	88.61^{b} ± 0.57	66.68^{b} ± 0.71	73.22^{b} ±0.83
P.P	91.93^{a} ± 0.53	80.84^{b} ± 1.02	85.00^{c} ± 1.02	75.12^{a} ± 0.66	75.88^{a} ± 0.67
A.P+ P.P	88.98^{b} ± 0.54	87.19^{a} ± 1.05	90.55^{a} ± 0.61	67.10^{b} ±0.83	75.56^{a} ± 0.64

Means with different superscript letters within a column are significantly different($P< 0.05$).

A.P....... Animal protein .

P.P .... Plant protein .

D.M ......Dry matter.

C.P ....Crude protein .

E.E ....Ether extract .

N.F.E ... Nitrogen free extract .

Table 6. Digestibility coefficient ($\bar{x}$ ± S.E) of Tilapia galelea as affected by different dietary protein levels, at the end of the experimental period .

Protein level	D.M	C.P	E.E	NFE	Energy
22%	91.12^{a} ± 0.57	81.14^{b} ± 0.93	90.75^{a} ± 0.62	71.64^{a} ± 1.09	76.67^{a} ±0.60
27%	90.05^{ab} ± 0.78	84.45^{a} ± 1.14	87.20^{b}± 1.00	86.99^{b} ± 1.58	75.19^{a} ± 0.56
32%	88.62^{b} ± 0.59	85.34^{a} ± 1.18	68.22^{b} ± 0.91	68.27^{b} ±1.50	72.79^{b} ± 0.69

Means with different superscript letters within a column are significantly different ($P<0.05$)

D.M .... Dry matter.

C.P .... Crude protein .

E.E .... Ether extract .

N.F.E ..... Nitrogen free extract .

Table 7. Digestibility coefficients (x ±S.E) for Tilapia galelea as affected by the interaction due to protein source and level at the end of experimental period.

Protein source ,	Protein level	D.M	C.P	EE	NFE	Energy
A.P	22 %	$90.54^{ab}\pm0.51$	$79.98^{c}\pm1.03$	$90.25^{ab}\pm0.76$	$69.27^{b}\pm0.62$	$75.27^{a}\pm0.66$
	27 %	$88.69^{b}\pm1.05$	$83.98^{b}\pm0.91$	$88.73^{b}\pm0.47$	$65.68^{c}\pm0.53$	$73.79^{c}\pm1.09$
	32 %	$87.39^{c}\pm0.68$	$84.80^{b}\pm1.13$	$86.86^{b}\pm0.48$	$65.09^{c}\pm0.66$	$70.60^{d}\pm0.92$
P.P	22 %	$92.85^{a}\pm0.54$	$79.36^{c}\pm0.58$	$89.11^{b}\pm0.25$	$75.74^{a}\pm1.09$	$77.54^{a}\pm1.01$
	27 %	$92.31^{a}\pm1.08$	$81.11^{bc}\pm0.80$	$83.09^{c}\pm0.37$	$75.28^{a}\pm1.16$	$75.96^{ab}\pm0.60$
	32 %	$90.63^{ab}\pm0.46$	$82.04^{b}\pm1.18$	$82.80^{c}\pm0.66$	$74.33^{a}\pm1.01$	$74.16^{b}\pm0.86$
A.P+P.P	22 %	$89.96^{b}\pm0.89$	$84.09^{b}\pm1.43$	$92.88^{a}\pm0.42$	$69.90^{b}\pm0.80$	$77.27^{a}\pm0.89$
	27 %	$89.14^{b}\pm0.79$	$88.25^{a}\pm1.27$	$89.78^{ab}\pm0.54$	$66.00^{c}\pm1.00$	$75.81^{b}\pm0.57$
	32 %	$87.85^{c}\pm0.64$	$89.19^{a}\pm1.12$	$88.99^{b}\pm0.39$	$65.40^{c}\pm0.72$	$73.61^{c}\pm0.52$

Means with different superscript letters within a column are significantly different ($P< 0.05$).

AP.... Animal protein.

PP.... Plant protein.

DM.... Dry matter.

CP.... Crude protein.

EE.... Ether extract.

NFE.... Nitrogen free extract.

Table 8. Limnological characteristics of water in experimental aquarium.

Parameter / Treatment	Temperature (℃)	Dissolved oxygen (mg/l)	pH	NH_3(mg/l)
A . P	25.20 ± 0.66	3.50 ± 0.24	8.10 ± 0.17	0.012 ± 0.01
P.P	25.50 ± 0.72	3.35 ± 0.16	8.50 ± 0.14	0.015 ± 0.02
A.P + P.P	25.75 ± 0.80	3.15 ± 0.20	8.30 ± 0.15	0.011 ± 0.01

REFERENCES

1. AOAC (Association of Official Analytical Chemists). 1995. In: Cunniff. P. (ED). Official Methods of Analysis, 16^{th} edn. Arlington, VA. Index of.
2. Boyd, C.E. 1992 . Water quality in warm water fish ponds. Alabama Agric. Experiment Station, Auburn Univ., Alabama.
3. Cho, C. Y., H.S. Bayley, and S. J. Slinter.1974. Partial replacement of her ring meal with Soybean meal and other changes in a diet for rainbow trout (Salmo gairdneri). J. Fish. Board Con., 31: 1523-1528.
4. David S., P. Tal and L. Ingrid. 2004. Apparent digestibility coefficients of feed ingredients and their prediction in diets for tilapia (*Oreochromis niloticus* × *Oreochromis aureus*) Teleostei, chichlidae. Aqucaulture research, 35: 358 – 364.
5. De Silva, S. S., R.M. Gunasekera and K. F. Shim. 1991. Interactions of varying dietary protein and lipid levels in young red Tilapia. Aquaculture, 95: 305 – 318.
6. Duncan, D.B. 1955. Multiple range and Multiple F-Tests. Biometrics, 11 : 1- 42.
7. Halver, J.E., ed. 1989. Fish Nutrition. New York, Academic Press.
8. Hanley, F. 1987. The digestibility of foodstuffs and the effects of feeding selectivity on digestibility determination in Tilapia, *(Oreochromis niloticus*) (L). Aquaculture, 66: 163 – 179.
9. Hasan, M. R., P.K. Roy and A. M. Akond. 1994. Evaluation of Leucaena leaf meal as a dieatry protein source for Indian major carp (Labea rohita) fingerlings. Aquaculture, 124 (1-4): 65 – 66.
10. Hepher, B. 1988. Nutrition of fishes. Cambridge University Press New Your, New Rochell, Mellourne. Sydeny. PP. 45 – 63.
11. National Research Council (NRC). 1993. Nutrient equirements of fish National Academy Press, Washington D.C.
12. Nengas, I., M. N. Alexis, S. J. Davies and G. Petichakis. 1995. Investigation to determine digestibility coefficient of various row materials in diets for gilthead sea bream, (Sparus auratus L.). Aquaculture Research, 26 : 185 – 194.
13. Robaina, L., M. S. Lzquierdo, F. J. Moyano, J. Socorro, J. M. Vergaro, D. Montero and H. Fernandez Palacios. 1995. Soybean and lupine seed meals as protein sources in diets for gilthead sea bream (Sparus aureata): Nutritional and histological implications. Aquaculture, 130: 219 – 233 .

14. Snedecor, G. W. and W.C. Cochran. 1982. Statistical Methods. 6th Edition, Lowa State University, Press Ames, U.S.N.
15. Shiau, S. Y. and S. L. Huang. 1989. Optimal dietary protein level for hybrid (Oreochromis niloticus × O. aureus) reared in sea water. Aquaculture, 81 : 119 – 127 .
16. Shimeino, S., H. Hosokawa, M. Taked, S. Kajiyama and T. Kaisho. 1985. Effect of dietary lipid and carbohydrate on growth, feed conversion and body composition in Yellow tail. Bull. Jpn. Soc. Fish., 51 (II): 1893 – 1898.
17. Smith B. J., S. A. Smith, B. Tengiaroenkul and T.A. Lawrence. 2000. Gross morphology and topograph of the adult intestinal tract of the tilapian fish, *Oreochromis niloticus* L. Cells Tissues Organs, 166: 294- 303.
18. Wee, K. L. and N.A. Tuan. 1988. Effects of dietary protein level on growth and reproduction in Nile tilapia (*Oreochromis niloticus*) The second International Symposian on Tilapia in Aquaculture, ICLARM Conference, Bangkok, Thailand, p. 401 – 410.

تأثير مصادر ومستويات بروتين الغذاء على هضم مركبات الغذاء في أصبعيات البلطي الجليلي

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المعمل المركزي لبحوث الثروة السمكية – العباسة – مركز البحوث الزراعية– وزارة الزراعة – الدقي – جيزة – مصر

أجري هذا البحث بغرض دراسة تأثير مصادر ومستويات بروتين الغذاء على معاملات هضم المواد الغذائية في أسماك البلطي الجليلي . تم تكوين عدد ٩ علائق من ثلاثة مصادر (بروتين حيواني – بروتين نباتي – خليط من البروتين الحيواني والنباتي) داخل كل مصدر من مصادر البروتين السابقة ثلاثة مستويات من البروتين (٢٢ ، ٢٧ ، ٣٢ ٪) في ٢٧ حوض زجاجي سعة الحوض (٦٠ × ٤٠ × ٥٠ سم) تم توزيع الأسماك التي متوسط وزنها ٤,٦ جرام بعد أقلمتها لمدة أسبوعين داخل المعمل ثم تم تغذيتها على العلائق التجريبية بمعدل ٣ ٪ من الوزن الحي يومياً على ثلاث مرات ٨ ، ١٢ صباحاً ، ٤ عصراً وتم وزن الأسماك كل ١٥ يوم مع تعديل كمية الغذاء طبقاً للتغير في وزن الأسماك. تم تزويد الأحواض الزجاجية بمصدر مياه خالي من الكلور ومصدر للأكسجين وتم ضبط درجة الحرارة عند ٢٥ْ م طوال فترة التجربة والتي استمرت ٩٠ يوماً وفي نهاية الدراسة تم إجراء تجارب الهضم وذلك لتقدير معامل الهضم للمواد الغذائية المختلفة وبعد تقدير معاملات الهضم تم عمل التحليل الإحصائي للنتائج حيث أوضحت نتائج الدراسة ما يلي :

١- أعطت الأسماك المغذاة على بروتين نباتي فقط زيادة معنوية في معامل هضم المادة الجافة(٩١,٩٣ ٪) والمستخلص الخالي من النيتروجين (٧٥,١٢ ٪) والطاقة (٧٥,٨٨ ٪) بينما الأسماك المغذاة على خليط من البروتين الحيواني والنباتي أعطت زيادة معنوية في معامل هضم البروتين الخام(٨٧,١٨ ٪) ومستخلص الإثير (٩٠,٥٥ ٪).

٢- أعطى المستوى ٢٢ ٪ بروتين خام زيادة معنوية في معامل هضم المادة الجافة(٩١,١٢ ٪) ومستخلص الإيثير (٩٠,٧٥ ٪) والمستخلص الخالي من النيتروجين (٧١,٦٤ ٪) والطاقة (٧٦,٦٧ ٪) بينما أعطى نفس المستوى انخفاضاً معنوياً في هضم البروتين(٨١,١٤ ٪) وذلك مقارناً مع المستوى ٣٢ ٪ بروتين خام ، بينما المستوى ٢٧٪ بروتين خام أعطى زيادة معنوية في معامل هضم المادة الجافة(٩٠,٠٥ ٪) ومستخلص الإيثير (٨٧,٢٠ ٪) والمستخلص الخالي من النيتروجين (٧٥,١٢ ٪) والطاقة (٧٥,١٩ ٪) مقارناً مع المستوى ٣٢ ٪ بروتين خام .

٣- داخل أي مصدر بروتين ، زيادة مستوى البروتين من ٢٢ إلى ٢٧ أو ٣٢ ٪ خفض وبنسبة غير معنوية معامل هضم المادة الجافة والمستخلص الخالي من النيتروجين والطاقة كما خفض أيضاً ولكن بنسبة معنوية معامل هضم مستخلص الإيثير بينما زاد بنسبة غير معنوية معامل هضم البروتين . أظهرت الأسماك المغذاة على بروتين نباتي في مستوى بروتين ٢٢ ٪ زيادة بنسبة غير معنوية في معامل هضم المادة الجافة (٩٢,٨٥ ٪) والمستخلص الخالي من النيتروجين(٧٥,٧٤ ٪) والطاقة (٧٧,٥٤ ٪) بينما المستوى ٢٢ ٪ بروتين خام من خليط البروتين النباتي والحيواني أعطى زيادة معنوية في معامل هضم مستخلص الإيثير (٩٢,٨٨ ٪).