DRIED EARTHWORM MEAL AS A SOURCE OF ANIMAL PROTEIN IN NILE TILAPIA FINGERLINGS DIETS

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SUMMARY

Five experimental diets were formulated to contain dried earthworm meal (DEM) which were grown in the lab. to substitute 0, 25, 50, 75 and 100% of the diet fish meal protein (20%), and biologically evaluated through 8 weeks of experimental period. All formulated diets were isocaloric (4800 kcal/kg DM) and isonitrogenous (33% CP). The results showed that tilapia fingerlings received diets containing 100% (DEM) showed the best results in growth parameters, feed efficiency, chemical composition of whole fish body and economic efficiency.

Keywords: *earthworm meal, fish meal, substitution, tilapia, feeding experiment.*

INTRODUCTION

Tacon *et al.*, (1983) concluded that fish fed frozen *Allolobophora longa* and *Lumbricus terrestris* grew as well as or better than fish fed on commercial trout pellets. However trout did not grow so well on a diet of whole freeze-dried *Eisenia. fetida.* Moreover, Guerrero (1983) reported that tilapia grew better on a diet containing earthworm protein supplements from *(Perionyx excavatus)* than those fed with other fish meal supplementation. Baskaran, *et al.*, (1990) investigated the influence of several diets (earthworms, fish meal, goat liver, egg white and oil cake) on protein metabolism in two fresh water fish species *Mystus vitttatus* and *Channa striatus* over a period of 21 days. The study revealed that among 5 experimental diets (earthworms, fish meal, goat liver, egg white and oil cake) earthworm led to the highest growth rate and highest protein efficiency in the two fish species. They also revealed that the levels of intestinal protease activity in fish fed with animal protein diets (earthworm, fish meal goat liver and egg white) were higher than in fish fed plant protein (oil cake) diet. The intestinal protease activity did not differ significantly in both fish species when they were fed different diets. Mangala (1990) examined different alternative feeds to *Channa striatus* and concluded that aquatic *Tubicid oligachaetes* and Caridina shrimps both were suitable for growing small fingerlings. In addition he also postulated that earthworms were suitable for all stages especially for fingerlings. Knights (1996) examined olfactory attractiveness and gustatory palatability of different potential material in first feeding of young eels, *Anguilla (L.).* Preparations of tubificed worms, earthworms (*Eisenia foetida*), cod roe, beef liver and potentially stimulatory chemicals were tested. They reported that invertebrate derived foodstuffs and combinations of amino acids, (ionosine 5- mono-phosphate and glycine betaine) were more attractive than vertebrate foodstuffs.

Allolobophora calignosa is the most commen speices in Egypt (El-Duweini and Ghabbour 1965)

The objective of the present study aimed to evaluate the effect of replacing fish meal in fish feed by Dried earthworm meal (DEM) on growth performance and body composition of Nile tilapia fingerlings to reduce the cost of the ration.

MATERIALS AND METHODS

This study has been carried out at the closed system laboratory, Faculty of Agriculture, Ain Shams University. Fish meal was substituted by dried earthworm meal DEM at 25, 50, 75 and 100% level of dietary fish meal protein. Dried earthworm meal (DEM) was produced in the laboratory between September 1997 and October 1998 on 3 stages.

1st stage: Testing the bedding materials, Five types of bedding materials have been tested, these included, Bagasse, corn stalk, buffalo manure, grass and soil. These organic wastes were composed before their use.

2nd stage, growing earthworms on bench scale. The best bedding material were chosen (100% bagasse) from stage2, due to its high production of earthworm.

3rd stage, growing earthworms on pilot scale to produce enough worms for the feeding experiment was accomplished during third stage, utilizing the bedding materials that exhibited the best performance.

Harvested earthworms *Allolobophora calignosa* were washed thoroughly and left in water for 2 hours to evacuate their guts from wastes. Worms were then blanched in boiling water for one minute, and were dried in an electric oven at 75 °C for 6 hours to produce a dry powder (Edwards and Niederer 1988). The dried earthworm meal (DEM) was kept in plastic bag and stored in a deep freezer at (-20°C) until being analyzed in triplicate samples. Table (1) shows the chemical composition of DEM that were utilized in the feeding experiment.

Five experimental diets were formulated and biologically evaluated through 8 weeks of experimental period. Dried earthworm meal (DEM) substituted 0, 25, 50, 75 and 100% of the fish meal protein (20%) in the diet, which represented 0, 5.2, 10.45, 15.67 and 20.9% of the diets as fed, respectively. All the formulated diets were isocaloric (4800 kcal/g DM) and isonitrogenous (33% CP) and were supplied with 1.5% vitamin – mineral premix and were formulated to cover the nutrient requirements of tilapia according to NRC (1993). Corn oil was used as a source of essential fatty acids and to adjust the energy content. Composition of the experimental diets and their chemical analyses are shown in Tables (2,3).

Feed ingredients were grounded to fine particles and were blended with approximately 10% water. A steam-pelleting machine (California mill Co.) was used to prepare the pelleted diets, which were air dried after being pelletized. The experimental diets were kept in plastic bag and stored in deep freezer (-20 °C) and were utilized through the experimental period (8 weeks).

Ten fiber glass tanks of (60 x 60 x 25 cm.) joined to a large recirculated water system were used. Water turn over was 53 min./tank. Water temperature was maintained at 26 – 27°C, using a thermostatic heater. A photoperiod of 12h light: 12h dark was operated throughout the eight weeks experimental period. The tanks were cleaned every week to avoid microbial development.

A total number of 150 fingerlings with an average initial weight of 4.7g/fish were used in the present experiment. Five fish groups were randomly distributed among the five treatments employed in the study.

Table (1) : Chemical analyses of dried earthworm meal (%on DM basis).

Item	%
Dry matter (DM)	87.31
Crude protein (CP)	68.26
Ether extract (EE)	5.2
Crude fiber (CF)	0.10
Ash	4.52
Nitrogen free extract (NFE)*	21.92
Energy kcal GE/kg**	5226.29

*Calculated by difference, ** Estimated (5.65, 9.4, 4.0 and 4.0 kcal GE/g dry matter for CP, EE, CF and NFE, respectively, Jobiling, 1983).

Table (2) : Composition of the experimental diets as feed.

Ingredients	T_0 Control	T_1 25%DEM	T_2 50%DEM	T_3 75%DEM	T_4 100%DEM
Fish meal. [a]	20	15	10	5	0
DEM. [b]	0	5.2	10.45	15.67	20.9
Soybean meal[c]	30	30	30	30	30
Yellow corn	31.50	31.30	31.05	30.33	30.00
Wheat bran	10	10	10	10	9
Corn gluten meal	1	1	1	1	1.3
Corn oil	6	6	6	6	6
Vit. & Min. premix*	1.5	1.5	1.5	1.5	1.5
$CaCo_3$	0	0	0	0.5	1.3
Calculated analysis					
CP %	30.49	30.47	30.42	30.41	30.42
G.E. kcal/g	4692.7	4725.3	47757.6	4789.7	4824.8
Methionine	0.758	0.759	0.81	0.9	1.01
Lysine	1.91	2.05	2.2	2.34	2.48
E:P ratio	153	155	156	157	156

*Vit. A 150,000 IU, Vit. D_3 25000IU, Vit. E 36 mg, Vit.K30 mg, Vit.B_1 70 mg, Vit. B_2 200 mg, Vit. B_6 75 mg, Vit.B_{12} 0.48 mg, Pantothenic Acid 300 mg, Niacin 300 mg, Folic Acid 375 mg, Choline Chloride 20 mg, Copper 120 mg, Iodine 1.2 mg, Iron 1,500 mg, Manganese 3,600 mg, Zinc 2,400 mg, Selenium 0.6 mg.

a: 62.3% protein. b: 59.6% protein (as feed) c: 44% protein.

Table (3) : Chemical analyses and energy content of the experimental diets (on DM basis):

Treatment	Moist.%	CP	EE	CF	Ash	NFE*	Energy* Kcal/kg DM
T_0	7.6	33.11	8.80	4.48	7.11	46.5	4737
T_1	7.84	33.06	8.75	4.46	6.78	46.95	4747
T_2	7.81	33.00	8.72	4.41	5.84	48.03	4782
T_3	7.72	32.95	8.71	4.39	4.94	49.01	4816
T_4	7.66	32.94	8.66	4.23	3.92	50.25	4854

* Calculated by difference.

Each group was represented by two replicate tanks (15 fish/ tank). Fifty tilapia fingerlings were killed at the beginning of the experiment to provide initial carcass analyses. Fish were acclimatized to the experimental condition and feeding regime for two weeks prior to the experiment. Fish in each tank were fed the experimental diets at 5% of their total body weights 3 times a day for 8 weeks (NRC, 1993) at 09.00, 13.00 and 17.00. The amount of diet given was progressively changed and adjusted every two weeks according to the change in fish biomass. Experimental fish were individually weighted and their lengths were measured at the beginning and at the end of the experiment to calculate the condition factor (K). Additionally, fish from each tank were weighed every two weeks to evaluate growth and survival. Moisture, crude protein (CP), ether extract (EE), crude fiber (CF) and ash content of dried earthworm meal, diets and fish carcasses were determined according to the methods of AOAC (1984), while nitrogen free extract (NFE) was calculated by difference. Gross energy of feeds and fish carcasses were calculated from their chemical composition, using the factors 5.65, 9.40, 4.00 and 4.00 (kcal/g) for protein, fat, fiber and carbohydrate, respectively (Jobiling, 1983).

Water samples were taken each week for ammonia, nitrite and pH analyses. Analytical methods were done according to the American Public Health Association (APHA, 1985). The pH values were determined by digital pH meter Mod. 821 NEL ELEKTRONIK.

Water temperature and oxygen level were measured daily at 8.00 o'clock by oxygen meter WPA20WAP scientific instrument.

Data were analyzed using SAS (1995) program according to the following model.

$$Yij = \mu + t_i + eij$$

Where: Yij : is the observation in the ith combination of source of protein and level of replacement, ti : is the effect of the combination of source of protein and level of replacement where i= 1, 2.......13, e : is the randomize error.

RESULTS AND DISCUSSION

Water quality:

It is well known that fish are cold-blooded animals, therefore, environment has more effect on fish compared to other livestock animals. As given in Table (4), the averages of water temperature, pH, dissolved oxygen and water ammonia content were suitable for growth of tilapia, *Oreochromis niloticus*. In this respect, Degani *et al.*, (1988) observed that the optimum water temperature for *O. aureus* was ranged between 24 and 31°C. Reite *et al.*, (1974) indicated that tilapia tolerated a range of pH between 5-11 which had no ill effect in 24 hour test period, while, at pH lower than 3-5 or above 12 caused 100% mortality within 2-6 hours for brackish water. Boyd (1984) revealed level of dissolved oxygen above 4 ppm, which is considered a limiting level since below 4 ppm dissolved oxygen, fish may live but can not feed or grow. European Inland Fisheries Advisory Commission (1973) reported that the toxic level of ammonia to fish is 2 mg/L.

Growth performance:

Average initial live body weight of tilapia among the different experimental treatments ranged between 4.63 and 4.71g (Table 5). Statistical analysis showed that no significant differences (P>0.05) in initial body weight among

Table (4) : Average of water quality parameters through the experimental period

Treatment	Water temperature °C	pH	DO_2* (mg/L)	NH_3** (mg/L)
T0 (control)	26.5	8.05	6.5	0.13
T1 (25%D.E.M.)	26.5	8.03	6.4	0.12
T2 (50%D.E.M.)	26.5	8.04	6.5	0.14
T3 (75%D.E.M.)	26.5	8.05	6.6	0.13
T4 (100%D.E.M.)	26.5	8.06	6.5	0.15

*DO_2 : Dissolved oxygen. **NH_3 : Ammonia.

Table (5) : Effect of protein source and its replacement level on growth parameters of *O. niloticus* fingerlings.

	Initial weight g/fish	Final weight g/fish	Gain g/fish	A.D.G. mg/d/fish	S.G.R.. %/d.	feed fed g/fish	F.C.R. g DM /g gain	P.E.R.	P.P.V. %	Energy utili-zation
T_0 (control)	4.65	17.6^{a} ± 0.8	13.0^{a} ±0.8	231.4^{a} ±13.8	2.38^{a} ± 0.08	22.0^{ab} ± 1.1	1.7^{f} ± 0.0	1.79^{a} ± 0.02	28.00^{a} ±0.28	24.20^{a} ± 1.27
T_1 (25% DEM.)	4.63	15.49^{bc} ± 1.0	10.9^{bc} ±1.1	193.9^{bc} ±18.7	2.15^{bcd} ± 0.13	21.1^{ab} ± 0.4	2.0^{def} ± 0.2	1.56^{bcd} ± 0.18	24.35^{bcd} ±1.8	21.05^{bc} ± 0.92
T_2 (50% DEM)	4.71	14.6^{cd} ± 1.0	9.9^{cd} ± 1.0	176.1^{cd} ±18.5	2.01^{de} ± 0.13	20.8^{abc} ± 0.6	2.1^{cd} ± 0.2	1.44^{de} ± 0.11	23.00^{cd} ± .84	18.85^{c} ± 1.91
T_3 (75% DEM)	4.70	13.3^{de} ± 0.5	8.7^{de} ± 0.5	154.4^{de} ± 8.7	1.87^{cf} ± 0.06	19.5^{cd} ± 0.5	2.3^{bc} ± 0.2	1.35^{cf} ± 0.11	22.50^{de} ± 2.55	15.70^{d} ± 0.85
T_4 (100% DEM)	4.69	17.1^{ab} ± 1.4	12.4^{ab} ± 1.3	221.4^{ab} ± 23.8	2.31^{ab} ± 0.13	22.2^{a} ± 1.1	1.8^{cf} ± 0.1	1.70^{ab} ± 0.09	27.85^{a} ± 1.48	20.85^{bc} ± 1.20

Means with the same superscript letters, in the same column, are not significantly different ($P>0.05$),
gain = W_{t1} - W_{t0} , ADG = Average weight gain (g) / Experimental\ period (d),
(i) SGR = $\{(L_n W_{t1} - Ln W_{t0}) / T\}$ x 100 ,
FCR = Feed intake (g)/ weight gain (g), PER = Weight gain (g) / protein intake (g), PPV % = Retained protein (g) / protein intake (g) x 100 , EU % = (Retained energy (kcal) / energy intake (kcal)) x 100

the experimental treatments were observed, indicating the accuracy of randomization process between the experimental treatments.

It is clearly shown (Table 5) that although averages of initial weight of fish for the different experimental groups were the same, however, all the tested growth parameters (gain, ADG, SGR) showed that the group fed diet containing 100% substitution of fish meal protein by dried earthworm meal (DEM) protein (T_4) surpassed all other groups fed DEM (T_1,T_2 and T_3). On the other hand, the group of fish fed diet containing 75% DEM substitution of fish meal (T_3) exhibited the lowest final body weight. Statistical analysis showed that the group of fish fed diet containing 100% substitution of fish meal with DEM (T_4) had significantly ($P<0.05$) higher value than those of 50 and 75% levels of substitution, but not significantly higher than 25% level of substitution (T_1). Also no significant difference was observed between fish group fed diet containing 100% fish meal (T_0) and group of 100% DEM (T_4).

The results obtained from the present study showed that partial replacement (about 25%) of fish meal could be replaced by dried earthworm meal (DEM), without deleterious effect on growth, and when the level of substitution was increased to 50 or 75% there was a reduction in fish growth. The results are fully in agreement with that of Hilton (1983) who reported that there was a significant growth depression in the trout as the level of worm meal increased and the level of fish meal decreased in the test diet. Stafford and Tacon (1984) resulted that worm meal of *Dendrodrilus subrubicundus* at 71% led to significant decrease in growth and feed utilization in rainbow trout, while levels of 7 and 36% gave growth almost comparable to the fish meal-based control diet. Nandeesha *et al.* (1988) indicated the possibility of using earthworm meal at low levels in common carp diets. None the less, it is necessary to further evaluate its influence on fish growth parameters at different levels of incorporation. In this connection Pereira and Gomes (1995) revealed that growth rate and feed utilization efficiency of fish fed diets containing high levels of whole frozen worms suggested an adverse effect of worm incorporation, probably due to dietary energy/protein imbalance. In the present study, results showed highest growth rate when 100% of fish meal were replaced by dried earthworm meal (DEM) indicating its high utilization by tilapia that may be due to antagonistic effect of amino acids of both fish meal and DEM at levels of 50 and 75% of replacement whereas at levels of 25 and 100% replacement there is little or no antagonistic effects on growth performances. Tacon *et al.* (1983) revealed that the result obtained with trout fed frozen slices of *A. longa* and *L. terrestis* were encouraging. Fish fed these worm species grew as well or better than fish fed a commercial trout ration, with no detrimental effect on the health of the fish. Baskaran *et al.* (1990) studied the influence of earthworm, fish meal, goat liver, egg white and oil cake on protein metabolism in two fresh water fishes *Mystus vittatus* and *Channa striatus*. The study revealed that among the 5 diets, earthworm led to the highest growth of the two fishes.

Feed conversion:

Replacing fish meal by dried earthworm meal (DEM) at the different levels (Table 5) showed that the group of fish fed diet containing 100% substitution of fish meal with DEM (T_4) exhibited significantly ($P<0.05$) better FCR (1.79) than those of 50 and 75% level of substitution (2.12 and 2.26, respectively) but not significantly better than the groups of 25% level of substitution (1.95). There were no significant differences (P>0.05) among T_4, T_1 and control. The same trend was observed for feed intake, PER, PPV and EU. These results are in accordance with that of Hilton (1983) who found that the feed: gain ratio was not significantly different (P>0.05) in the trout reared on the high worm meal diets as compared to the trout reared on the high fish meal diets. In this connection, Tacon *et al.*, (1983) reported that fish fed frozen *L. terrestis* and *A. longa* exhibiting the best food conversion efficiency. Moreover, Baskaran *et al.*, (1990) concluded that the protein conversion efficiency was highest in both the *Mystus vittatus* and *Channa striatus* fish fed with earthworm. They also added that the levels of intestinal protease activity in fish fed animal protein diets (earthworm, fish meal, goat liver and egg white) was higher than that in fish fed plant protein (oil cake) diet. In contrast, Cardenete *et al.*, (1993) revealed that values of feed intake and nutritive utilization of protein for rainbow trout fed on diet containing 50% of dietary protein earthworm meal (*Eisenia foetida*) were lower than those obtained when fishes were fed on an earthworm meal-free diet. They added also that a reduction of proteolitic activity in the digestive tract of fish fed on earthworm meal was observed, positively correlated to total feed intake, that suggests in inhibitory effect of some earthworm meal components on digestive enzymes activity. In this respect, Pereira and Gomes (1995) resulted that feed utilization efficiency of rainbow trout fed diets containing high levels of whole frozen worms had an adverse effect of worm incorporation, probably due to dietary energy/protein imbalance.

Body composition:

The results obtained from the present study showed no significant differences (P>0.05) in moisture, protein (except T_3) and ash content (Table 6) of whole body of tilapia raised on diet containing dried earthworm meal (DEM) and the control group (100% fish meal). These results are in full agreement with that of Hilton (1983) who didn't detect any significant differences in carcass composition, indicating that earthworm meal diets produced no overt physiological abnormalities. The present study also showed that ether extract and consequently energy content (Table 6) of whole body of tilapia raised on diet containing dried earthworm meal (DEM) was lower than the control group (100% fish meal) this may be attributed to low fat content and energy utilization of earthworm meal. In this respect, Tacon *et al.* (1983) reported that fish fed 100% worm meal protein had a significantly lower (P<0.05) percentage liver weight ratio and carcass lipid content, compared with fish fed the control ration. In this connection, Pereira and Gomes (1995) concluded also that a significant decrease was found in the whole-carcass lipid content of fish fed diet containing 25%, 50% and 75% frozen earthworms. On contrast Stafford and Tacon (1984) recorded high fat content in rainbow trout fed on *Eisenia foetida* meal. Moreover, Nandeesha *et al.* (1988) showed that fish raised on diet partially supplemented with earthworm had higher muscle protein, ash and fat contents than fish fed control diet.

The results obtained from the present study showed that when replacing fish meal protein with DEM protein the highest retention of protein, ether extract, ash and energy (Table 6) was recorded for the fish group fed diet containing 100% substitution of fish meal by DEM (T_4) this may be attributed to its high growth rate and best feed efficiency.

Condition factor (K) is usually used to compare the condition, fatness or well

Table (6) : Effect of protein source and its replacement level on body composition, energy content of *O. niloticus* and their retention.

Treatment	Moisture %	CP %	EE %	Ash %	Energy* Cal/g	Nutrient retained g/fish Protein	Fat	Ash	Energy kcal/fish
Initial sample	78.28	59.43	14.57	23.10	4727				
T_0 (control)	73.01^{d} ± 1.22	55.55^{def} ± 3.32	33.70^{ab} ± 1.84	13.40^{de} ± 1.98	6306.50^{ab} ± 14.8	2.04^{a} ± 0.08	1.46^{a} ± 0.23	0.41^{a} ± 0.04	25210^{a} ± 2560
T_1(25%DEM)	72.92^{d} ± 1.36	54.70^{ef} ± 1.13	32.80^{ab} ± 0.42	13.00^{def} ± 0.85	6174.00^{abc} ± 24.0	1.70^{bcd} ± 0.09	1.22^{abc} ± 0.00	0.32^{bc} ± 0.05	21088^{bc} ± 527
T_2 (50%DEM)	73.27^{d} ± 0.06	56.05^{cdef} ± 0.35	30.75^{bc} ± 1.63	11.70^{ef} ± 0.00	6057.50^{bc} ± 173.2	1.58^{cde} ± 0.17	1.05^{c} ± 0.16	0.22^{bcde} ± 0.04	18796^{c} ± 2431
T_3 (75%DEM)	74.24^{bcd} ± 0.57	59.50^{ab} ± 0.14	24.50^{d} ± 2.40	14.40^{cd} ± 0.85	5664.50^{d} ± 234.1	1.44^{def} ± 0.13	0.69^{d} ± 0.03	0.27^{de} ± 0.06	14657^{d} ± 438
T_4 (100%DEM)	73.37^{cd} ± 0.30	58.00^{bcd} ± 0.57	29.00^{c} ± 0.28	12.65^{def} ± 0.07	6003.00^{c} ± 5.7	2.04^{a} ± 0.21	1.17^{abc} ± 0.13	034^{ab} ± 0.06	22514^{abc} ± 2470

Means with the same superscript letters, in each column, are not significantly different (P>0.05),
***Calculated by the factors of Jobiling (1983).**
Retained protein (g) = Final body protein- Initial body protein.
Retained Fat (g) = Final body Fat- Initial body Fat.
Retained Ash (g) = Final body Ash- Initial body Ash.
Retained Energy (kcal) = Final body Energy - Initial body Energy.

Table (7) : The effect of source of protein and its level of replacement on condition factor (K) of tilapia (*O. niloticus*).

Tr. No.	Treatment	Condition factor (K) %
T_0	Control	2.13^{ab} ± 0.11
T_1	25% D.E.M.	2.09^{abc} ± 0.04
T_2	50% D.E.M.	2.08^{abc} ± 0.00
T_3	75% D.E.M.	1.92^{bcd} ± 0.13
T_4	100% D.E.M.	2.03^{abcd} ± 0.27

Table (8) : Economic efficiency for production of one kg gain of tilapia *O. niloticus* fed different treatments.

Tr. No.	Treatment	Cost/ton feed L.E.*	Reduction in feed cost %	Feed : gain Ratio	Feed cost /kg fish gain L.E.	% change in feed cost to produce kg fish gain
T0	Control	1427.2	0.00	1.69	2.42	100.00
T1	25%(DEM)	1325.6	7.11	1.95	2.59	107.02
T2	50%(DEM)	1228.2	13.94	2.12	2.61	107.85
T3	75%(DEM)	1142.5	19.95	2.26	2.58	106.61
T4	100%(DEM)	1057.5	25.90	1.79	1.97	81.40

***Based on the local market price of the following feed stuffs: (year 1998)**
Price (L.E./ ton): Fish meal 2700; Corn gluten 100; PBP 1000; Yellow corn 500; DEM 000; Corn oil 4000; Soybean meal 1000; Vit. Min. Mix 6500; LLM 100; L. methionine 20000; Wheat bran 500 and$CaCO_3$ 130 .

being of fish, and is based on the hypothesis that the heavier fish of a given length is in a better condition.

Data concerning the effect of replacing fish meal with dried earthworm meal (DEM) at the different levels (Table 7) on condition factor (K) of tilapia (*O. niloticus*) showed the similarity in the condition factor among all treatment groups, indicating the adequate feeding for such groups. Statistically, the differences between treatments were not significant. There were no significant differences between treatments and the control group (100% fish meal).

***Economic efficiency*:**

It is well known that feeding cost of fish production is about 50-60% of the total production costs (Collins and Delmendo, 1979). Under the present experimental conditions all other costs are constant, accordingly, the feeding costs to produce one kilogram of fish body weight gain could be used as a comparison parameter btween treatments.

The cost of producing one ton of mixed feed and the cost of producing one kg fish gain in LE from each diet are presented in Table (8). The calculated figures in this experiment showed that the inclusion of DEM in fish diets reduced the cost of producing one ton mixed feed. This reduction is dependent on the replacement level of DEM The results obtained from the present study showed that the cheapest diets for producing one kg fish gain was T_4 (100% level of replacement), which was 1.98 LE while, the control diet (100% fish meal) was 2.50 LE. The highest feed cost to produce one kg fish gain was T_2 (50% level of replacement) which was 2.72 LE

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مسحوق دودة الأرض الجاف كمصدر للبروتين الحيواني في علائق إصباعيات البلطي النيلي

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أجريت هذه الدراسة لبحث تأثير استبدال بروتين مسحوق السمك ببروتين مسحوق ديدان الأرض المجفف على أداء النمو و الاستفادة من الغذاء لإصباعيات البلطى النيلى بمتوسط وزن بداية ٤,٧ جم.

تم تكوين خمسة علائق تحتوى مسحوق ديدان الأرض المجففة والتى تم تربيتها بالمعمل لاستبدال صفر ، ٢٥، ٥٠، ٧٥ و ١٠٠% من بروتين مسحوق السمك والذى يمثل ٢٠% من العليقة و تم عمل تقييما حيويا خلال فترة التجربة التى امتدت لمدة ٨ أسابيع. كل العلائق كانت تحتوى على حوالي ٣٣% بروتين خام و ٤٨٠٠ ك كالورى طاقة كلية لتغطى احتياجات البلطى تبعا ل NRC (١٩٩٣) .أظهرت نتائج التجربة أن إصباعيات البلطى النيلى التى تغذت على عليقة تم استبدال ١٠٠% من مسحوق السمك بمسحوق ديدان الأرض المجففة أعطت أحسن النتائج فى قياسات النمو و كفاءة الاستفادة من الغذاء و كذلك التركيب الكيماوى لجسم السمكة والكفاءة الاقتصادية.