ISSN 110-2047 ALEX. J. VET. Med. SCIENCE 2009 VOL. 28 NO. 1: (103-115)

POTENTIAL OF USING UNCONVENTIONAL ANIMAL PROTEIN INGREDIENTS TO REPLACE FISH MEAL IN NILE TILAPIA DIETS

Hoda, A.Ali, Maha, M. Hady, E.Y. Ismail and E.H. Salloum

Dept. of Nutrition and Clinical Nutrition, Fac. of Veterinary Medicine, Cairo Univ.

ABSTRACT

The study was performed to evaluate the partial replacement of fish meal by unconventional animal protein ingredients; feather meal (FM) and/or rabbit manure (RM) in Nile tilapia diets. Fish were fed for 15 weeks on six isonitrogenous and isocaloric experimental diets. The control group diet contained fish meal, whereas the other five groups received diets in which fish meal was partially replaced by incorporation of (7.5-15 %) FM or (7.5-15%) RM or (7.5 and 7.5%) FM and RM respectively.

Incorporation of FM at both levels (7.5-15%) in Nile tilapia diets decreased body weight gain, feed intake and reduced the digestibility of DM and CP. RM at levels of (7.5-15)% increased fish body weight gain, feed intake, protein intake and improved digestibility of DM and CP. Feed conversion ratio (FCR), specific growth rate (SGR), protein intake and protein efficiency ratio (PER) were decreased by incorporation of 7.5 % FM in fish diet. Meanwhile 7.5 % RM resulted in an increase of FCR and improve PCR, while 15 % RM increased SGR. A combination of 7.5% FM and 7.5%RM achieved best DM and CP retention and highest CP content in body composition. The lowest nutrient retention, CP content of fish body and dressing % were recorded in groups fed FM containing diets.

Conclusively, the present results suggested that FM and RM could be included safely in Nile tilapia diets to reduce feed cost. Partial replacement of fish meal by incorporation of RM in the diet of Nile tilapia achieved the best growth performance.

INTRODUCTION

Fish are practically valuable food for human, being high in protein with balanced amino acids, high in polyunsaturated fats and vitamin B_{12}, low in cholsterol and saturated fats **(El-Garhy ,1977).**

Feeding of fish represents over 50 % of the operation costs in intensive aquaculture. Fish meal is considered as the main protein source for fish due to its high protein content, essential fatty acids and is claimed to have unidentified growth factor **(De Silva and Anderson, 1995).**

It is evident that our developed country will be unable to depend on fish meal as a major protein source in aqua feeds due to its high cost. Therefore, several attempts have been made to replace fish meal partially with less expensive locally available unconventional protein sources.

Feather meal is the product resulting from the treatment of clean undecomposod feathers from slaughtered poultry. The chemical composition of feather meal was varies according to many factors; approximatly 10.67 % moisture, 77.59 % CP; 11.90 % EE and 2.01 % ash **(McDonald et al. ,1995; Abdel-Hakim, 1998 and Nengas et al., 1999).**

Ismail and El-Katch (1988) found that the best performance was achieved in fish fed diet containing 10 % feather meal while the poorest performance was for those fed diet containing 40% feather meal. Nevertheless **Fowler (1990)** reported that body weight gain and condition factor of fish did not differ when fed on 0, 5 or 15 % feather meal in their diets. **Bureau et al. (2000)** concluded that incorporation of up to 15 % feather meal in the diet of fish was possible without affecting growth feed efficiency, nitrogen or energy gains of that fish.. However **El-Kholy (1993) and Hassan et al. (1997)** stated that the highest levels of feather meal in the diet of fish caused lowest fish performance. **Yan Wang et al. (2006)** reported that there were no significant differences in feed intake, feed conversion ratio and chemical composition of whole body among fish fed feather meal, meat meal or poultry by product meal. Meanwhile, feather meal incorporation in the feeds resulted in lower specific growth rate and final body weight compared to those of fish fed the control feed. **Yan Wang et al. (2008)** stated that fish fed 10 % feather meal in their diet had higher feed intake, feed conversion ratio but had lower final body weight gain nitrogen retention efficiency, energy retention efficiency than fish fed control diet. They also showed no significant differences in condition factor and fish body composition including moisture, CP, EE and ash.

On the other hand, it is noticed that a small commercial herd with 12 breeding does could produce about 0.75 – 1.25 ton fresh manure per year. Recycling of these huge amount of rabbit manure through its use as unconventional animal protein ingredient and can also reduce environmental pollution. The chemical analysis of rabbit manure varies according to many factors: ranged 9.50 % moisture; 14.22 % CP, 2.00 % EE; 21.07 % CF and 14.37 % ash (**Mohamed, 1992 and Khayyal, 1997**).

Eleraky (1991) concluded that rabbit feaces was a satisfactory unconventional feedstuff and can be included in tilapia diet at 8 % to reduce feed costs. **Zaza (1993)** reported that both 10 % and 20 % dried poultry manure had significantly superior final weights of catfish compared to control. However, **Hussein (1998)** found that body weight gain and body length did not differ significantly in Nile tilapia fed diets containing 10, 20, 20 and 40 % poultry dropping in comparison with those fed control diet. On the contrary, **Zayed (1995)** found that body weight, specfic growth rate and digestibility coefficients of DM were decreasing with increasing the level of dried poultry manure in the diets of blue tilapia. **Omar et al. (1999)** found that inclusion of more than 10 % dried poultry manure in Nile tilapia diets significantly decreased body weight gain, specific growth rate, feed utilization and survival rate comparable to control.

Therefore, the present study was performed to formulate economic practical fish diets using cheap unconventional animal protein ingredients (feather meal – rabbit manure) to replace partically the expensive fish meal in Nile tilapia diets. Also to study the effect of the selected unconventional animal protein ingredients on the growth performance of Nile tilapia and their body composition. Digestibility trail was performed to evaluate both feather meal and rabbit manure inclusion in Nile tilapia diets.

MATERIALS AND METHODS

- Experimental fish

Two hundred and seventy Nile tilapia (Oreochromis niloticus) fingerlings with an average body weight 3.94 g and average body length of 6.0 cm were used in this experiment. They were obtained from Abou-shady farm, Wady El-Natron , Behera governorate, Egypt.

- Acclimatization and environmental conditions

At the beginning of the adaptation period (10 days), the fish were stocked in eighteen clean glass aquaria (80 x 30 x 40 cm). Each aquarium was supplied with an air pump and tap water which was previously treated with sodium thiosulphate as an antichlorine agent at the rate of 6.99 mg/liter **(Boyed, 1979).** During the adaptation period all fish were fed daily on the control diet at a rate of approximately 3 % of their average body weight to be adapted to pelleted feeds **(Soltan ,1990 and Zayed, 1995).** Water was changed in each aquarium at weekly intervals to maintain good water quality according to **Hassan et al. (1997).** Water pH value was measured every week by using electric digital pH-meter. Water temperature in degree centigrade was recorded by using a mercury thermometer. Dissolved oxygen, ammonia (NH_3), nitrite (NO_2) and nitrate (NO_3) contents were determined according to the procedures stated by the American Public Health Association **(APHA, 1992).**

- Sources, treatments and nutritive value of the used unconventional animal protein ingredients:

Two different unconventional animal protein ingredients origin were used in formulating the experimental diets.

- Feather meal (FM):

Feathers of broiler chicks were obtained from a local poultry dressing plant approximately 1 hours after plucking. Feathers were cleaned, freed from foreign matter, and then processed in an autoclave (at 145°C and 345 K Pa) for 20-30 minutes. The treated feathers were dried in a hot air oven adjusted at 60°C and then ground in a mill **(Papadopoulos et al., 1985**). The nutritive chemical composition of FM is given in table (1).

- Rabbit manure :

Rabbit manure was collected from apparently healthy rabbits reared in batteries belonging to the Faculty of Veterinary Medicine, Cairo University. It was nearly free from urine, hair and other debris. It was dried in a hot air

oven at 45°C and then ground in a mill **(Elemele et al., 1980).** The nutritive chemical composition of RM is included in table (1).

- Experimental design:

Fish were randomly allocated into six equal groups, each group of 3 replicates (15 fish/replicate). The experiment was conducted for 15 weeks. The experimental design can be summarized as follows:

Group (1) was considered as control and fed on the basal diet. Group (2) was fed on the diet containing 7.5 % feather meal (FM). Group (3) was fed on the diet containing 15 % feather meal. Group (4) was fed on the experimental diet containing 7.5% rabbit manure (RM). Group (5) was offered the experimental diet containing 15 % rabbit manure. Group (6) was fed on the diet that contained a combination of 7.5 % feather meal and 7.5 % rabbit manure. The six experimental diets were formulated to be nearly isocaloric and isonitrogenous (Table 2) and to fulfill Nile tilapia requirements **(NRC, 1993).**

- Measurements

At the start of the experiment the average initial weight and average initial length of fish were recorded. Five fish were randomly collected and minced. Also at the end of the experiment, 5 fish from each group were randomly collected and minced and kept for subsequent chemical analysis according to **AOAC (1980).**

The fish were weighed weekly, and body weight gain calculated. Fish body length and feed conversion ratio were recorded weekly while specific growth rate (SGR) was calculated according to **DeSilva and Anderson (1995).** Protein efficiency ratio was calculated according to **DeSilva and Anderson (1995).**

Retention of nutrients was calculated according to **El-Kholy (1999).** Digestibility coefficient of the experimental diets was determined using internal indicator (crude fiber) according to **Jones and DeSilva (1989)**. Survival rate was calculated as described by **Shepherd and Bromage (1995).** Dressing percentage was performed following to **Hardy and Sullivan (1983).** The statistical analysis of the recorded data was done according to **Snedecor and Cochran (1969).**

Table (1): Proximate chemical analysis (%) of feather meal and rabbit manure

Analysis / Ingredients	Moisture %	CP %	EE %	CF %	Ash %
Feather meal	8.00 ± 0.60	81.50 ± 2.50	4.00 ± 0.15	1.00 ± .05	3.00 ± .09
Rabbit manure	9.50 ± .73	17.50 ± 1.1	8.30 ± .53	21.00 ± .66	8.00 ± .41

Chemical analysis was done according to the methods of the Association of Official Analystical Chemists, AOAC, (1980).

Table (2): Ingredient composition (%) and calculated analysis of the experimental diets

Group No. / Ingredient	1	2	3	4	5	6
Fish meal	24.00	18.00	10.00	20.00	22.00	17.00
Soybean meal	23.00	20.00	18.50	30.75	25.00	19.00
Yellow corn	20.50	30.10	30.50	20.10	15.20	20.25
Wheat bran	26.75	19.00	20.50	16.00	17.30	23.25
Feather meal	00	7.50	15.00	00	00	7.50
Rabbit manure	00	00	00	7.50	15.00	7.50
Linseed oil	1.75	1.40	1.50	1.65	1.50	1.50
Mineral mix. *	2.00	2.00	2.00	2.00	2.00	2.00
Vitamin mix. **	2.00	2.00	2.00	2.00	2.00	2.00
Calculated analysis CP %	33.63	33.64	33.63	33.63	33.64	33.64
EE %	5.29	4.83	4.49	5.38	5.82	5.28
Ash %	7.64	6.81	6.17	7.87	8.27	7.28
CF %	5.09	4.28	4.24	6.10	7.25	5.97
NFE %	37.99	39.94	40.73	36.69	34.63	37.28
Ca %	1.13	0.76	0.60	0.99	1.09	0.86
P %	1.10	0.93	0.90	1.02	1.10	1.03
ME kcal/kg diet ***	3462.7	3463.7	3460.1	3460.6	3468.0	3461.4
P/E ratio ****	97.1	97.1	97.2	97.2	97.0	97.2

* This permix was prepared by mixing 27% limestone (38% Ca), 41.5% disodium phosphate (21.8 % P and 32.4 % Na), 25 % Ramical trace mineral (made in Western Germany) and 6.5% sodium chloride. Each Kg. of mineral premix contains Ca 102.6 g, P 90.5 g, Fe 25 g, Cu 2 g, Mn 6 g, 10.2 g, Se 0.1 g, Zn 40 g, and Nacl 65 g.

** Each kg of Vitamin premix (made in Italy) contains Vit. A 6.750.000 I.U., Vit. D_3 1.500.000 I.U., Vit. E 2.000 I.U., Vit. K 1 g, Vit. B_1 1 g, Vit. B_2 2 g, Vit. B_6 1g, Vit. B_{12} 5g, Vit. C, 10g, d-Ca-pantothenate 5g, Nicotinic acid 10g, Folic acid 0.15 g, Biotine 5mg, Sodium 825 g, Mangnesium 10g, Potassium 10g and Calcium 20g.

*** ME was calculated using a value of 4.5 kcal/g protein, 8.51 kcal/g fat and 3.48 kcal/g CHO, according to Soltan (1990).

**** P/E ratio was calculated as mg of protein/Kilocalorie ME according to Soltan (1990)

RESULTS AND DISCUSSION

The data in table (3) showed an increase in the body weight gain of fish fed diets supplemented by RM at both levels as compared to control group. These results may be attributed to the chemical composition and presence of vitamin B-complex in RM (**Zaza, 1993**). However, **Eleraky (1991)** found that body weight was decreased by feeding fish diets contaning RM. This conflict may be due to the variation in fish species or the difference in RM levels used.

There was a significantly decrease in body weight gain of fish in group 2 (7.5% FM) and was non significant in group 3 (15 % FM) compared to control group. The decrease in body weight gain due to feeding of both levels of FM was in agreement with the result obtained **by El-Kholy (1993).** Whereas **Bureau et al. (2000)** concluded that incorporation of up to 15% FM in the diet of fish was possible without affecting growth performance. The present results showed that body weight gain of fish fed diet containing combination of FM and RM (group 6) was slightly lower than control group.

- Body length

It is clear that there was a positive correlation between fish weight and the data of body length (Table 3).

- Specific growth rate:

Group 4 which received 15% RM in the diet showed insignificant increase in SGR than control (Table 3). The finding is agree with those of **Zaza (1993)** and may be attributed to the fact that RM contains high amounts of Vit. B complex and it is rich in true proteins and unidentified growth factor. Group 2 which fed 7.5 % FM showed significant low in SGR as compared to control. This results support the work of **El-Kholy (1993)** who found that the SGR of Nile tilapia fed FM was lower than those of control. This may be due to improper essential amino acid composition in FM **(El-Boushy and Van Der Poel, 1994)**

- Feed Intake:

The highest significant feed consumption was recorded by the fish fed RM at both levels used (Table 3). This increase in feed intake may be reflected to the increase in body weight obtained by those fish. However, **Eleraky (1991)** found that feed intake decreased as the level of rabbit faeces in Nile tilapia diet was increased.

The data also revealed that a marked decrease in total feed intake of fish fed diets containg FM at both levels. This may be due to low body gain recorded in those groups. The finding confirm the work of **El-Kholy (1993).**

Table (3): Effect of feeding different levels of feather meal and/or rabbit manure on Nile tilapia performance

Group No.	1 control	2 7.5%FM	3 15%FM	4 7.5%RM	5 15%RM	6 7.5%FM 7.5%RM
Initial weight (g)	3.82 ± 0.29 a	3.98 ± 0.24 a	4.00 ± 0.20 a	4.04 ± 0.22 a	4.04 ± 0.30 a	3.75 ± 0.23 a
Final Weight (g)	11.17±1.07 ab	9.25± 0.52 b	9.67± 0.74 b	12.71± 1.04 a	11.90± 0.62 a	10.68± 0.82 ab
Total gain (g)	7.34± 0.541 a	5.27± 0.440 b	5.67± 0.510 ab	8.70± 0.501 a	7.86± 0.294 a	6.89± 0.432 a
Initial length (cm)	5.94± 0.13 a	6.05± 0.13 a	6.07± 0.11 a	6.12± 0.10 a	6.00± 0.15 a	5.91± 0.13 a
Final length (cm)	8.86± 0.27 a	8.37± 0.15 b	8.52± 0.21 b	9.21± 0.22 a	9.16± 0.16 a	8.75± 0.22 ab
Increase in length (cm)	2.92	2.32	2.45	3.09	3.16	2.84
Average SGR	0.44± 0.03 ab	0.35± 0.01 c	0.37± 0.01 b	0.47± 0.01 a	0.43± 0.01 ab	0.43± 0.01 ab
Total feed intake (g)	17.65± 0.49 b	15.37± 0.53 b	15.97± 0.86 b	20.39± 0.41 a	20.06± 0.27 a	17.37± 0.36 b
Average feed conversion ratio	2.40± 0.05 c	2.96± 0.29 a	2.82± 0.03 ab	2.34± 0.05 c	2.55± 0.04 b	2.51± 0.02 b
Total protein intake (g)	5.91± 0.14 ab	5.17± 0.18 c	5.38± 0.11 b	6.79± 0.15 a	6.75± 0.09 a	5.84± 0.12 ab
Average protein efficiency ratio	1.24± 0.02 ab	1.02± 0.09 c	1.05± 0.01 bc	1.28± 0.03 a	1.16± 0.02 b	1.19± 0.01 b

- Values are mean, ± standard error (SE) a,b,c..et.: Means in the same raw with different superscripts are significantly different ($P < 0.05$).

- Feed conversion ratio:

It is noticed from table (3) that average FCR was the best (improved) in fish fed 7.5 % RM and the poorest one was recorded in those fish fed 7.5 % FM. Several factors may be responsible for the improved FCR by feeding RM, among them its high contents of vitamins, digestible protein and gross energy which leads to increase in the body gain of fish **(Zaza, 1993).** Improving FCR by feeding diets containg RM was also reported by **Eleraky (1991).** The poor FCR recorded by feeding FM may be attributed to poor digestibility and amino acids imbalance which reflects poor growth. These findings are in agreement with those recorded by **El-Kholy (1993).**

- Protein intake:

Data of total protein intake table (3) showed a significant increase for fish in groups 4 and 5 which fed diet containing RM compared to control. The findings reflects the increase in feed intake of fish recorded in those groups. These finding did not coincide with those obtained by **Eleraky (1991).** The same table showed a significant decrease in total protein intake of fish in group 2 (7.5% FM) compared to control. The results also reflects the decrease of feed intake of that group. Similar results were reported by **El-Kholy (1993).**

- Protein efficiency ratio (PER):

Table (3) showed that the highest PER values recorded in group 4 (7.5 % RM), while group 5 (15 % RM) showed significant decrease in PER comparable to group 4. These findings indicated that as the level of RM in Nile tilapia fish diet increased, PER was significant decreased **Eleraky (1991)**. The lowering in PER in fish fed high level of RM may be due to the high contents of CF in RM.

Meanwhile, feeding of FM significantly decreased the PER as compared to the control. This may be attributed to the particular methionine deficiency which is the most limiting amino acid found in FM. These results were in accordance with that reported by **El-Kholy (1993)** who fed FM to Nile tilapia and **Hassan et al. (1997)** who fed FM to mirror carp.

- Body compostion:

A general view on body composition figures (Table 4) indicated a clear increase in final DM content of all groups compared to initial one. These findings confirm the work of **Fowler (1990)** who found an increase in body DM content with advancing age.

The highest body CP content was observed in group 6 (7.5% FM and 7.5% RM) while the lowest body CP content was recorded in group 3 (15 % FM). Similar results were found by **El-Kholy (1993)** who found that fish body CP % was decreased as the FM content of the fish diet increased. EE content of fish body was higher in all treated groups except group 6 as compared to control. These findings are in agreement with those obtained by **Ismail and El-Katcha (1988)** who studied FM in tilapia and **Eleraky (1991)** who tested RM in tilapia. Concerning the ash body content, it is noticed that the ash decreased in groups fed FM **(Ismail and El-Katcha 1988).** While increase in groups received RM **(Eleraky, 1991).**

Table (4): Chemical composition (% on DM basis) of Nile tilapia fish carcass at the start and at the end of the experiment

Composition	Group No. / Average Initial Composition	Average final composition					
		1	2	3	4	5	6
DM	18.54 ± 0.6	25.36 ± .89	24.88 ±.90	20.62 ±.92	22.52 ±.87	23.14 ±0.98	30.03 ±1.00
CP	60.00 ± 1.2	56.06 ± 1.2	57.85 ±1.1	54.00 ±1.0	61.02 ±0.98	60.62 ±1.10	61.34 ±1.50
EE	13.20 ± 0.7	16.50 ± .82	18.00 ±.88	19.85 ±.9	17.30 ±.92	17.04 ±0.94	14.20 ± .8
Ash	22.06 ± 1.5	20.06 ± 1.8	17.90 ±1.6	14.58 ±1. 2	20.38 ±1.4	20.53 ±1. 8	17.50 ±1.2

Value are means ± SE

Nutrient retention:

The highest retention values of DM and CP in fish (Table 5) were recorded in group 6 (combination of 7.5 % FM and 7.5 % RM). On the contrary, the lowest retention of DM, CP, EE and ash was recorded for fish in group 3 (15 % FM). The highest EE retention was observed in fish of group 4 (7.5 % RM). Similar results were obtained by **El-Kholy (1993)** who found that the Nile tilapia fishes fed diet containing 9.98 % FM exhibited a lower retention of CP, EE and ash compared to the control fish.

Table (5): Nutrient retention in Nile tilapia fish of different groups

Item \ Group No.	1 control	2 7.5%FM	3 15%FM	4 7.5%RM	5 15%RM	6 7.5%FM 7.5%RM
DM Retained (g)	2.14	1.56	1.19	2.11	2.00	2.51
%	100	72.90	55.60	98.60	93.46	117.29
CP Retained (g)	1.17	0.89	0.60	1.30	1.22	1.55
%	100	76.07	51.28	111.11	104.27	132.48
EE Retained (g)	0.38	0.31	0.28	0.39	0.35	0.36
%	100	81.58	73.68	102.63	92.10	94.74
Ash	0.41	0.25	0.12	0.42	0.40	0.41

Retained (g)						
%	100	60.97	29.27	102.43	97.67	100

- Values are mean, ± standard error (SE)

Nutrients digestibility:

The results of digestibility trials (Table 6) indicated that digestiblity of DM and CP were higher in groups fed RM as compared to control group. This may be due to the presence of vitamin B complex and true protein in RM **(Zaza 1993).** Whereas the digestibilty of DM and CP were low in groups fed on FM as compared to control group. This may be attributed to the FM protein which is composed of keratin known to be low in digestion. The same findings were obtained by **El-Kholy (1993)** and **Sang-Min Lee (2002).** The digestibility of EE was highest in group 4 followed by group 2 and 3 and was lowest in group 5 and 6 as compared to control group. **El-Kholy, (1993)** found that EE digestibility was low in fish fed diets containing FM in comparison to control. However the improvement in growth performance obtained in the current study (Table 3) as a result of feeding RM may be explained by the results of digestiblity trials.

Table (6): Nutrient digestibility (%) of Nile tilapia fish in different experimental groups

Group No. / Item	1 control	2 7.5%FM	3 15%FM	4 7.5%RM	5 15%RM	6 7.5%FM 7.5%RM
DM	97.30	94.38	93.64	97.82	97.22	96.75
CP	87.60	82.52	85.00	90.91	88.61	83.78
EE	95.11	96.49	95.84	96.74	93.99	92.40

Table (7): Survival rate % and dressing percentage of Nile tilapia fish in different experimental groups

Group No. / Item	1 control	2 7.5%FM	3 15%FM	4 7.5%RM	5 15%RM	6 7.5%FM 7.5%RM
Dead fish No.	3	4	5	2	2	1
Survival Rate %	93.30	91.10	88.90	95.50	95.50	97.80
Dressing %	87.84^{a} ± 1.09	84.61^{b} ± 0.77	85.79^{ab} ± 0.18	88.45^{a} ± 0.42	87.93^{a} ± 0.369	86.39^{a} ± 0.41

- Values are mean, ± standard error (SE)

a,b,c..et.: Means in the same row with different superscripts are significantly different ($P < 0.05$).

Survival rate:

The survival rate was 93.3 %, 91.1 %, 88.9 %, 95.5 %, 95.5 % and 97.8 % in groups 1 to 6, respectively (Table 7). The reason for death in the present work may be attributed to some uncontrolled sudden changes in the environmental condition to which fish in certain aquarium were subjected.

Dressing percentage:

Table (7) showed that there is no significant difference between groups fed on RM and control one in the dressing percentage. These results confirm the work of **Hardy and Sullivan (1983), Asgard and Austreny (1985 a,b) and Soltan (1990)** who found no difference in the dressing percentage between the control group and the others groups fed on diets containing other protein sources. Neverthless, group 2 (7.5 % FM) was significantly low in dressing percentage compared to control group.

Conclusively, based on the collective results, it seems that the two tested unconventional animal protein ingredients could be included safely in Nile tilapia diets aiming to reduce feed cost. Rabbit manure at both levels used achieved best growth performance in Nile tilapia in the present study.

REFERENCES

Abdel-Hakim, N.F., Amer, A.A., El-Naggar, N.M., Ismail, M.F. and Dessouky, M.S. (1992): Chemical composition and nutritive value of different animal manures as non-traditional feedstuffs in poultry rations. Egypt. J. Agric. Res., 70 (3): 951-963.

American Public Health Association APHA, (1992): Standard method for the examination of water and waste water. Washington, DC.

Asgard, T. and Austreng, E. (1985 a): Casein silage as feed for salmonids. Aquac., 48: 233-252.

Asgard, T. and Austreng, E. (1985 b): Dog fish offal, ensiled or frozen as feed for salmonids. Aquac., 49: 289-305.

Association of Official Analystical Chemists, AOAC, (1980): Official method of analysis of the association of analytical chemists. 13th Ed., Washington, DC.

Boyed, C.E. (1979): Water quality in warm water fish ponds. Auburn Univ. Agric. Exp. Station Aburn, Alabama.

Bureau, D.P., A.M. Harris, D.J. Bevan, L.A. Simmons, P.A. Azevedo, C.Y., Cho (2000): Feather meals and meat and bone meals from different origin as protein sources in rainbow trout concorhynchus mykiss diet Aqua Vol. 181 (2000) 281-291.

De Silva, S.A. and Anderson, T.A. (1995): Fish nutrition in aquaculture. Chapman and Hall, 2-6 Boundary Row, London SEI 8 HN, UK.

El-Boushy, A.R.Y. and Van Der Poel, A.F.B. (1994): Poultry feed from waste. Wageningen Agricultural Univ., The Netherland.

Elemele, H.O., Rao, D.R. and Chawan, C.B. (1980): Evaluation of rabbit excreta as an ingredient in broiler diets. Brit. Poultry Sci., 21: 345-349.

Eleraky, W.A. (1991): Evaluation effects of rumen contents and rabbit faeces in fish diets on growth performance and body composition of tilapia *Oreochromis niloticus*. J. Egypt. Vet. Med. Ass., 51 (1,2): 71-82.

El-Garhy, M.A.M. (1997): Using unclassical feedstuffs in fish nutrition. M.Sc. Thesis, Fac. Agric., Cairo Univ.

El-Kholy, K.F.(1993): Use of non-conventional feed ingredients in fish diets. M.Sc. Thesis, Fac. Agric., Ain Shams Univ.

El-Kholy, K.F.(1999): The use of some non-conventional feed sources in fish nutrition. PH.D. Thesis, Fac., Agric., Cairo Univ.

Fowler, L.G. (1990): Feather meal as a dietary protein sources during parr-smolt transformation in fall chinook salmon. Aquac., 89: 301-314.

Hardy, R.W. and Sullivan, C.V. (1983): Canola meal in rainbow trout *Salmo gairdneri* production diets. Can., J. Fish Aquat. Sci., 40: 281-286.

Hassan, M.R., Haq, M.S., Das, P.M. and Mowlah, G. (1997): Evaluation of poultry-feather meal as a dietary protein source for Indian carp *Labeo rohita* fry. Aquac., 151: 47-54.

Hussein, S.Y. (1998): Impact of poultry dropping supplemented with ascorbic acid and live yeast on Nile tilapia *Oreochromis niloticus* performance. Assi. Vet. Med. J., 40 (79): 212-232.

Ismail, E.Y. and El-Katcha, M.I. (1988): Effects of partial and complete replacement of fish meal by feather meal in diets on the performance and body composition of tilapia nilotica *Oreochromis niloticus*. Alex. J. Vet. Sc., 4 (1): 159-173.

Jones, P.L. and De Silva, S.S. (1989): Comparison of internal and external markers in digestibility studies involving the Australian fresh water crayfish, cherax destructor clark *Decapoda, parastacidae*. Aquac. Res., 29: 487-493.

Khayyal, A.A.M. (1997): Nutritional effect of rabbit manure on the performance of growing rabbits. M.Sc., Thesis, Fac. Agric., Zag. Univ. Benha Branch.

McDonald, P., Edwards, R.A., Greenhalgh, J.F.D. and Morgan, C.A. (1995): Animal nutrition. Longman Scientific Tenchnical, New York pp. 550.

Mohamed. F.G.A. (1992): The use of non-conventional ingredients as feed for growing rabbits. M.Sc. Fac. Agric. Ain Shams Univ.

NRC, National Research Council. (1993): Nutrient requirements of fish. National Academy Press, Washington.

Nengas, I., Alexis, M.N. and Davies, S.J. (1999): High inclusion levels of poultry meals and related by products in diets for gilthead seabream *Sparus aurata* L. Aquac., 179: 13-23.

Omar, E., Zaki, M.A.A. and Abdel-Halim, A.M. (1999): Dried poultry manure as an unconventional protein

source in diet of Nile tilapia *Oreochromis niloticus* and Common carp *Cyrinus carpio* L. Egypt. J. Agric. Res., 76 (1): 433-446.

Papadopoulos, M.C., El-Boushy, A.R. and Ketelaars, E.H. (1985): Effect of different processing conditions on amino acid digestibility of feather meal determined by chicken assay. Poultry Sci., 64: 1729-1741.

Sang-Min Lee (2002): Apparent digestibility coefficients of various feed ingredients for juvenile and grower rockfish (Sebastes Schlegeli). Aquaculture 207 (2002) 79-95.

Shepherd, C.J. and Bromage, N.R. (1995): Intensive fish farming. U.K., Hartnolls LTD. Bodmin, Cornwall, pp. 154.

Snedecor, G.W. and Cochran, W.G. (1969): Statistical methods. The Iowa state Univ. Press. Iowa, U.S.A.

Soltan, M.A.A. (1990): Nutritive value of certain feeding stuffs incorporated in practical diets for Nile tilapia. M.V.Sc. Thesis. Fac. Vet. Med., Alex. Univ.

Yan Wang, Jin-Lu Guo, Dominque P. Bureaw, Zheng-he Cui (2006): Replacement of fish meal by rendered animal protein ingredients feeds for cuneate drum (Nibea miichthioides) Aquaculture 252 (2006) 476-483.

Yan Wang, Kaili, HuaHan, Zhou-Xin-Sheng, Dominique P. Bureaw (2008): Potential of using a blend of rendered fish meal in practical diets for malabar grouper (*Epinephelus malabricus*). Aqua. Vol. 281 issues 1-4 p 113-117.

Zayed, S.H.S. (1995): Partial replacement of soybean meal with poultry manure in diets for blue tilapia Oreochromis aureus. M.Sc. Thesis, Fac. Agric., Cairo Univ.

Zaza, G.H. (1993): Studies on nonconventional feedstuffs in feeding of Catfish *Clarias lazera*. M.Sc. Thesis, Fac. Agric., Al-Azhar Univ.