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INCLUSION OF A COMMERCIAL POULTRY BY-PRODUCTS MEAL OR FISH WASTES MEAL AS A PROTEIN REPLACEMENT OF FISH MEAL IN PRACTICAL DIETS FOR NILE TILAPIA (*Oreochromis niloticus*).

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SUMMARY

Poultry by-product meal (PBM) and fish wastes meal (FWM) were substituted each alone for fish meal protein in eight experimental diets for Nile tilapia fingerlings (*Oreochromis niloticus*) at 25%, 50%, 75% and 100% substitution levels which were compared with the control diet (10% fish meal).Ten fish were stocked in triplicate groups with a mean initial body weight of 6.4 g which were fed nine isonitrogenous(30.29% CP) and isocaloric (438.81Kca GE/ 100 g diet) diets at 3% of wet body weight for a period of 98days. Results showed that final weight gains (g), weight gain (g or %) of fish fed poultry-by product and fish waste meal at the tested substitution levels were lower ($P < 0.05$) than those fed on the commercial control diet (10% fish meal) except T_3 which recorded values similar to the control group with insignificant differences. Fish fed on diet with 75% PBM showed generally the highest protein retention value (2.55g/fish) compared with the control diet (2.35 g/fish). Both ADP and protein retention value were observed insignificant differences of the control group as compared to the diets containing FWM up to the 75% substitution level of FM protein. The results of this study indicated that PBM and FWM were acceptable ingredients for the partial replacement of fish meal protein in practical diets for tilapia up to75% substitution level of fish meal protein, without adverse effects on growth performance.

Keywords: poultry by-products meal, fish waste meal, growth performance, tilapia feeding.

INTRODUCTION

Protein is the most expensive nutrient in prepared diet, and protein is essential for soft tissue growth (Fleming *et al.*, 1996). Feed costs make up the highest proportion (Approximately 60%) of an intensive aquaculture production regimen. Fish meal has traditionally been used as a major ingredient in commercial aquatic feeds as the most important source of protein. However; the increasing cost of fish meal has restricted its use as a protein source for Nile tilapia. Tilapia is the third most important cultured fish group in the world, after carps and salmonids. They are widely cultured in about 100 countries in the tropical and subtropical regions (FAO, 2004).

However, animal by-products unsuitable for human consumption are good alternative protein sources to use as ingredients in fish diets and they are in general much less expensive than fish meal (Steffens, 1994).

Partial or complete replacement of fish meal with alternative sources of protein could be of considerable economic advantage (Hajen *et al.*, 1993) like poultry by-product (Abdel Wraith *et al.*, 2001) and fish carcass wastes (Balarin and Hatton, 1979) could contribute to a substantial reduction of feed cost (Fagbenro and Jauncey, 1994) and the pollution.

Poultry by-product meals are waste material of the poultry industry, which may be used as a valuable animal protein source in diets for fish. The standard poultry by-product meal (PBM) can be used as partial replacement for fish meal in pacific salmon diets (Fowler, 1991) it contains about 58-60% crude protein and 16-22% ash and can use PBM in Chinook salmon diets to reduce the percentage of fish meal by 50% without impairing growth.

Also, fish waste meals produced from commercial markets of fish processing such as skeleton, head, swim bladder and viscera (about 50% of the raw material volume) which have almost a high protein content as the fillet and considered as a good source of low-cost nutrients (Oetterer, 2002). These products have good nutritive quality and can, therefore, be very useful in animal feeding. The accumulation of FW can lead to cause serious environmental pollution problems (Nunes, 1999). However, using the by-products wastes could be the ideal solution to avoid waste pollution (Maia *et al.*, 1998).

Therefore, the present investigation was conducted to determine the level of poultry by-product meal and fish waste meal that could be used to replace fish meal protein as well as their advantages and disadvantages when used in commercial Nile tilapia (*Oreochromis niloticus*) diets.

MATERIALS AND METHODS

Ingredients and diets:

Poultry by-product meal obtained from chicken slaughter house at -El sharkia governorate while fish waste meals were obtained from Cairo local markets which were dried in a forced – air drier at 65°C for 24 hours grounded in a laboratory hammer mill and stored in a freezer until required.

The experimental protein sources were mixed thoroughly with other components and pressed to formulate 2mm diameter pellets by using a meat mincer machine. The feed pellets were subsequently sun dried for 24 hours, sieved and stored at 4°C.

Nine practical tilapia diets were formulated: a control diet in which fish meal was used at 10% level (control diet); the eight tested diets in which 25, 50, 75 and 100% of the fish meal protein was replaced by protein from poultry by-products meals (T_1, T2, T3 and T_4) and from fish wastes meals (T5, T6, T7 and T_8), respectively were also formulated. All nine diets were maintained isonitrogenous (30.29% CP) and isocaloric (438.81Kca GE/ 100 g diet)

Fish, feeding and collection:

The experiment was carried out in Animal Production Research Institute, By-Products Utilization Dept. Agriculture Research center, Dokki, Giza, Egypt. Monosix Nile tilapia (*Oreochromis niloticus*) fingerlings were obtained from the Central Laboratory for Aquaculture Research, Abbassa, Abou Hammad, Sharkia Governorate, Egypt.

Three replicate groups of ten Nile tilapia each treatment group (initial mean body weight, 6.48g) were randomly stocked in 27 glass aquariums (60 x 40 x 30 cm) and weighted in bulk at the start of experiment.

The fish were fed by hand three times daily (at 09:00, 12:00 and 15:00 h) at a rate of 3% body weight per day during the experimental period (98 days). Fish were bulk weighed, counted and the quantity of food was adjusted accordingly recorded every 2 weeks. However, at the day of weighing, the feeding of the experimental fish was stopped for 24 hours.

At the beginning and end of the experiment, a sub-sample of fish were sacrificed for whole body analysis.

At the end of the experimental period, digestibility trail was carried out to evaluate the protein utilization of the tested diets. Therefore, fish were adapted for 7 days at a fixed rate of 1% of body weight to each diet before the starting of fecal collection period. Daily, feces were collected quantitatively by siphon method, once each morning for 3 weeks for nine groups in triplicate measurements per treatment.

Each fecal collection sample was dried at 105°C for 24 hours and then stored in airtight containers under refrigeration for analysis.

Chemical analysis and calculations:

The proximate chemical composition of the ingredients and the finished diets are shown in Tables 1 and 2. Standard AOAC methods (1990) were used to determine the proximate analysis of the diets, raw materials, fecal samples and initial and final body composition of experimental fish. The apparent digestibility coefficients for crude protein (ADP %) for each diet were calculated by crude fiber (as indicator) method as an inert indicator (Tacon and Rodrigues, 1984).

The parameters were calculated as follows:-

Weight Gain (WG, g) = final weight (g) - initial weight (g)

Weight Gain (WG, %) = [final weight (g) - initial weight (g)] / initial weight (g) x100

Average daily gain= {final weight (g) - initial weight (g)}/ experimental period

Specific growth rate (SGR) = 100 x [(ln final fish weight) - (ln initial fish weight)]/ experimental period.

FCR = feed intake (g) / weight gain (g)

Protein efficiency ratio (PER) = weight gain (g)/protein intake (g)

Protein retained (g) = final body protein – initial body protein

Productive protein value (PPV %) = {Protein retained /protein intake (g)} x 100

Apparent digestibility coefficients (ADP %) = 100 – 100 {(% indicator in feed/% indicator in feces) x (%nutrient in feces /%nutrient in feed)}.

Table (1): Proximate analysis of feed ingredients.

Item	Crude protein	Ether extract	Crude fiber	Moisture	Ash	NFE
Fish meal	65.00	9.30	1.0	8.30	14.1	2.30
Soybean meal	43.80	2.20	4.80	9.70	6.80	32.70
Poultry by-product	60.20	17.70	1.60	7.30	8.30	4.90
Fish waste meal	58.50	13.90	0.4	6.10	14.50	6.60
Corn starch	8.25	3.20	2.60	10.0	3.40	72.60
Wheat bran	13.60	2.90	7.60	12.20	3.60	60.10

Table (2): Formulations and proximate composition of the tested diets fed to the tilapia fingerlings.

Item	Diets								
	T0	T1	T2	T3	T4	T5	T6	T7	T8
Fish meal	10.0	7.5	5.0	2.5	-	7.5	5.0	2.5	-
Poultry by-product meal (PPM)	-	2.69	5.40	8.11	10.80	-	-	-	-
Fish waste meal (FWM)	-	-	-	-	-	2.77	5.56	8.34	11.11
Soybean meal	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0	47.0
Corn starch	20.5	20.31	20.1	19.89	19.70	20.23	19.94	19.66	19.39
What bran	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
starch	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Soybean oil	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vitamin and mineral mixture	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Dicalcium phosphate	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Total proximate composition (on DM basis):									
Crude protein (CP)	30.24	30.36	30.21	30.29	30.42	30.31	30.17	30.22	30.41
Ether extract (EE)	4.01	4.29	4.78	5.11	5.43	3.98	4.23	4.20	4.66
Crude fiber (CF)	3.69	3.73	3.81	3.76	3.84	3.65	3.55	3.63	3.60
Ash	6.61	6.63	7.42	6.82	6.35	6.42	6.75	6.28	6.81
moisture	6.40	6.31	6.54	6.34	5.66	8.45	6.50	6.10	7.32
NFE*	55.45	54.99	53.78	54.02	53.96	55.64	55.30	55.67	54.52
Gross energy (Kcal/Kg diet)**	436.30	437.74	436.54	441.1	444.61	437.2	437.37	438.89	439.58

NFE*(nitrogen free extract): 100- (protein + lipid + ash + fiber).

*GE (gross energy): Calculated by NRC (1993) as 5.64, 9.44 and 4.11 kcal/g for protein, lipid and NFE, respectively.

Statistical analysis:

Data was statistically analyzed by analysis of variance as two-way ANOVA using the general linear model procedure of SAS (1999). Differences among means were evaluated using Duncan's Multiple Range Test (1955).

RESULTS AND DISCUSSION

Growth performance:

Results of growth performance of Nile tilapia as affected by the dietary treatments are presented in Table (3). Results revealed that the initial weights of the experimental fish ranged between 63.97 and 65.66 g with insignificant differences among the treatment groups indicating the random distribution of individual fish at the experimental start. As presented in the same table the highest final weights were obtained by the control and T_3 ($P < 0.05$) as compared to the other treatment groups. Results of the same table showed that the lowest ($P < 0.05$) final weights were recorded by the T_4 which contained PBM at 100% substitution level of FM protein.

Whereas the control fish had insignificantly lower values of SGR than fish fed the all diets except T_2 and T_6 which had higher significant values as compared with the control group.

The highest final weight gain (WG, g), weight gain as % (WG, %) and average daily gain (ADG, g/d) values were observed in T_3 (161.88, 247.55 and 1.78, respectively) followed by the control diet (160.21, 246.77 and 1.77, respectively) with insignificantly differences and being least in T_4 (135.29, 210.75 and 1.49, respectively) and T_8 (146.01, 225.24 and 1.6, respectively)

Possible reasons for the reduced growth performance of fish at complete replacement of fish meal by PBM or FWM may be due to deficiencies in essential nutrient such as essential amino acids (methionine, lysine and isoleucine) whereas, fish meals in general have been reported to have good essential amino acid profiles for fish (**Guzon and** Guillaume, 1991; Steffens, 1994).

Table (3): Growth performance parameters of Nile tilapia (*O.niloticus*) as affected by dietary protein sources and substitution levels of fish meal.

Item	Diets							
	Control	Poultry by-product meal				Fish waste meal		
		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
IW*	64.92^{a} ±3.36	64.35^{a} ±3.23	63.97^{a} ±2.78	65.40^{a} ±1.53	64.20b^{a} ±3.13	65.28^{a} ±2.19	64.25^{a} ±2.35	65.66^{a} ±2.56	64.83^{a} ±3.31
FW*	225.13^{a} ±6.27	208.42^{e} ±8.38	218.09^{b} ±9.17	227.28^{a} ±7.59	199.49^{f} ±6.79	217.59^{b} ±7.47	214.75^{c} ±8.12	214.71^{c} ±8.11	210.84^{d} ±7.23
WG, g*	160.21^{a} ±٢.43	144.07^{e} ±2.18	154.12^{b} ±2.14	161.88^{a} ±٢.78	135.29^{f} ±2.36	152.31^{bc} ±٥.42	150.50^{cd} ±2.17	149.06^{d} ±٤.41	146.01^{e} ±٢.29
WG, %*	246.77^{a} ±9.08	223.91^{e} ±8.9	240.67^{b} ±8.32	247.55^{a} ±10.31	210.75^{f} ±8.57	233.29^{c} ±7.4	234.28^{c} ±9.19	227.04^{d} ±6.36	225.24^{e} ±7.64
ADG*	1.77^{a} ±0.41	1.58^{d} ±0.53	1.70^{b} ±0.53	1.78^{a} 0.41	1.49^{e} ±0.43	1.67^{b} ±0.33	1.65^{bc} ±0.21	1.64^{bc} ±0.41	1.60^{cd} ±0.31
SGR*	1.29^{d} ±0.12	1.34^{abd} ±0.08	1.37^{a} ±0.09	1.24^{cd} ±0.11	1.32^{bd} ±0.0^	1.32^{bd} ±0.0^	1.33^{ab} ±0.06	1.30^{bd} ±0.09	1.30^{bd} ±0.08

Values with the same superscript are not significantly different ($P < 0.05$).

* IW= initial weight; FW= final weight; WG =Weight gain (gram); WG, %=Weight gain %; ADG = Average daily gain; SGR= Specific growth rate

The present results are in agreement with these of Higgs *et al.* (1979) who found that up to 70% of fish meal could be replaced by defatted PBM in coho salmon *Oncorhynchus kisutch* diet without adverse effects on growth. Also, Webster *et al.* (1999) reported that sunshine bass fed a diet with PBM had similar growth to fish fed a control diet.

On the other hand, Alexis *et al.* (1985), working with rainbow trout, obtained very good results with a feed containing 25 % PBM with added methionine. Similar results were obtained by Fowler (1991) who reported that fish fed diets containing 10 and 20% PBM in replacement with fish meal protein in the basal diet had weight gain and SGR similar to fish fed the control diet which contained fish meal.

Feed consumption and feed utilization:

Table (4) shows the feed intake (FI), feed conversion ratio (FCR), protein utilization parameters as protein efficiency ratio (PER), protein productive value (PPV), and apparent digestibility coefficient of protein (ADP) of fingerling groups fed diets containing different PBM and FWM levels. The results indicated that an improvement ($P < 0.05$) of FI with fish fed T_3 which had the highest values followed by T_5, control and T_2 diets, respectively compared with than the other experimental groups.

The control group and T_3 group showed the highest ($P < 0.05$) value of FCR (2.0) followed by T_6, $T_5$and T_2 with insignificant differences. However, T_8 and T_4 groups had the lowest values of FCR with significant differences as compared to the control group and T_3 group.

Table (4): Feed and protein utilization parameters of Nile tilapia (*O.niloticus*) as affected by dietary protein sources and substitution levels of fish meal.

Item	Treatments								
	Control	Poultry by-product meal				Fish waste meal			
		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
FI[1]	319.64^{b} ±8.38	309.70^{e} ±7.23	319.59^{b} ±9.28	323.58^{a} ±9.26	297.92^{f} ±8.88	320.18^{b} ±10.29	314.61^{d} ±8.48	317.91^{c} ±9.47	314.67^{d} ±11.38
FCR[2]	2.0^{b} ±0.16	2.15^{a} ±0.11	2.12^{ab} ±0.12	2.0^{ab} ±0.16	2.21^{a} ±0.05	2.1^{ab} ±0.09	2.09^{ab} ±0.07	2.14^{a} ±0.10	2.16^{a} ±0.09
PER[3]	1.66^{a} ±0.09	1.55^{cd} ±0.11	1.61^{b} ±0.11	1.66^{a} ±0.15	1.51^{e} ±0.08	1.58^{c} ±0.09	1.57^{cd} ±0.05	1.56^{cd} ±0.09	1.54^{d} ±0.11
PPV[4]	24.40^{b} ±0.11	22.54^{d} ±0.35	23.99^{bc} ±0.08	26.21^{a} ±0.63	24.06^{bc} ±0.59	25.22^{ab} ±0.21	24.18^{bc} ±0.57	23.30^{cd} ±0.13	19.94^{e} ±1.28
Retained protein (g/fish)	2.35^{a} ±0.16	2.10^{bc} ±0.10	2.31^{ab} ±0.13	2.55^{a} ±0.15	2.16^{bc} ±0.09	2.43^{ab} ±0.08	2.29^{abc} ±0.22	2.23^{abc} ±0.25	1.89^{c} ±0.19
ADP[5]	92.65^{a} ±0.99	92.02^{a} ±0.86	91.59^{ab} ±0.78	90.48^{b} ±0.56	89.04^{c} ±0.92	92.10^{a} ±0.87	91.28^{ab} ±0.95	90.81^{ab} ±0.75	86.43^{d} ±0.88

Values with the same superscript are not significantly different ($P < 0.05$).

FI [1]= feed intake. FCR[2]=Feed conversion ratio. PER[3]=Protein efficiency ratio. PPV[4]= Protein productive values. ADP [5]= Apparent digestibility coefficient of protein.

The control group and T_3 had significant ($P < 0.05$) higher values of PER than the other groups. Values of PER were similar in the fish which received the control diet and T_3 diets. However, differences between the control group and the other treatment groups were significant ($P < 0.05$).

The improved performance (as FCR and PER) of fish fed the control diet and up to 75% PBM and FWM inclusion diets was probably due to a more favorable essential amino

acids (EAA) balance than fish meal alone. It should also be noted that several other amino acids became progressively reduced at high PBM inclusion level and may have contributed to the inferior protein utilization (PER) and growth performance of fish (Abdel Warith *et al.*, 2001).

PPV of fish fed 75% level of PBM inclusion was significantly ($P < 0.05$) higher (7.42%) than that of fish fed the control diet. However, PPV for fish fed the diet containing the highest amount (100%) of FWM was significantly($P < 0.05$) lower (18.28%) compared to fish fed the control diet but the fish fed diets including FWM level up to 50% was not significant different compared to fish fed the control diet.

Results in Table (4) showed that the protein retained (g/fish) was linearly decreased as FWM level increased up to 100% , but this trend was linearly increased with increasing PBM level up to 75% in replacement with fish meal protein. The maximum protein retained was obtained with T_3 diet followed by T_5, control diet, T_2, T_6 and T_7 with insignificant differences.

Results of apparent digestibility coefficient of protein (ADP) showed that the control group had the highest values (92.65%) while T_8 diet had the lowest (86.43%). However, differences between the control group and T_1, T_2, T_5, T_6 and T_7 were not significant. These results of ADP are close to that obtained by Hajen *et al.* (1993) who found that the ADC of protein of that particular PBM was 85% in Chinook salmon and with Sugiura *et al.* (1998) in rainbow trout and coho salmon who found that the ADC of protein was 96%.

The difference in ADC of protein obtained could be due to the different methods of fecal collection samples and different sources of animal by-product which may have varied in their nutrient composition, processing methods, different amounts of constituents (bone, offal, meat, blood, etc.) and digestibility (New, *et al.*, 1995). Also, high levels of ash have been found to correlate negatively with protein digestibility (Watanabe and Pongmaneerat, 1991).

Carcass composition:

The effect of replacement of fish meal by PBM and FWM as protein sources on whole fish body composition of tilapia is presented in Table (5). The highest ($P<0.05$) whole fish body protein content (59.01%) was obtained for fish fed the control diet and the lowest values ($P<0.05$) were obtained for fish fed T_4 diets for PBM at all level of FWM

The whole body lipid contents increased with increasing the dietary levels of PBM or FWM as replacement of fish meal. The lowest whole body lipid content was recorded with the control group (19.99%) followed by T_5 (20.11%) and T_6 (20.92%) with insignificant differences. While the highest whole body lipid content was recorded with T_4 (24.86%) and T_3 (23.85%) with insignificant differences.

The decrease in whole body protein and the increase in the whole body lipid content with increasing dietary PBM or FWM levels might be the result of low quality of protein in animal waste sources as good as that in fish meal and could be related to a dietary imbalance between saturated and unsaturated fatty acids as a consequence of the high ratio of saturated fatty acids presented in the ingredients.

Furthermore, there was a negative relationship between substitution level of FWM and carcass DM content while there was a positive correlation between DM content and PBM level in the diets. However, fish fed on the control diet had significantly lower ($P<0.05$) DM content than T_2, T_3, T_4 and T_5 diets with insignificant differences as compared to T_1 diet

On the other hand, the differences of whole body ash content of control fish as compared with all treatment groups were not significant($P>0.05$) .

Whole proximate composition of tilapia fed practical diets in the present study was in agreement with Rodriguez-Serna *et al.* (1996), who reported that carcass composition of tilapia was 72.4% moisture, 17.70% protein, 5.14% lipid and 4.31% ash.

Percentage protein, lipid, ash and DM content of fish whole body as affected by use of animal by-product as the protein source in replacement of fish meal in the tilapia diets in the present study were similar to those reported in other studies by Rodriguez-Serna *et al.* (1996); Reinitiz *et al*, 1978; Reinitz and Hitzel,1980; Reinitz, 1983.

On the other hand, Belal *et al.* (1995) showed that fish silage will not affect the percentages of CP, lipid, ash and moisture in whole *O. niloticus* bodies.

Table (5): Chemical composition of whole fish bodies of Nile tilapia (*O.niloticus*) as affected by dietary protein sources and substitution levels of fish meal.

Item	Treatments									Initial body composition
	Control	Poultry by-product meal				Fish waste meal				
		T1	T2	T3	T4	T5	T6	T7	T8	
CP*	59.01^{a} ±0.41	56.95^{b} ±0.26	55.26^{de} ±0.35	54.49^{ef} ±0.31	54.03^{f} ±0.86	56.12^{bcd} ±0.78	56.58^{bc} ±0.84	56.90^{b} ±0.93	55.69^{cd} ±0.73	52.83 ±0.66
Lipid	19.99^{e} ±0.71	21.78^{cd} ±0.62	22.91^{bc} ±0.98	23.85^{ab} ±0.89	24.86^{a} ±0.77	20.11^{e} ±0.52	20.92^{de} ±0.51	21.56^{cd} ±0.75	22.16^{cd} ±0.53	26.02 ±0.65
Ash	21.01^{a} ±0.69	21.11^{a} ±0.41	21.25^{a} ±0.53	21.37^{a} ±0.81	20.88^{a} ±0.94	22.20^{a} ±0.39	22.21^{a} ±0.72	21.22^{a} ±0.44	21.89^{a} ±0.81	14.36 ±0.87
DM*	24.61^{d} ±0.14	25.33^{d} ±0.59	26.68^{bc} ±0.45	28.06^{a} ±0.56	28.42^{a} ±0.31	27.48^{ab} ±0.29	26.34^{bcd} ±0.37	25.88^{cd} ±0.25	23.92^{e} ±0.85	26.84 ±0.30
TM*	75.39^{a} ±0.47	74.67^{ab} ±0.86	73.32^{bcd} ±0.73	71.94^{de} ±0.86	71.58^{e} ±0.62	72.52^{cde} ±0.96	7366^{bc} ±0.93	74.12^{b} ±0.83	76.08^{a} ±0.72	73.16 ±0.57

Values with the same superscript are not significantly different ($P < 0.05$).

* TM= Total moisture. DM= Dry matter. CP= Crude protein.

CONCLUSION

In conclusion, the results of this study indicate that PBM and FWM are acceptable ingredients for the partial replacement of fish meal protein in practical diets for tilapia. PBM and FWM can be used in balanced diet formulations for this species with up to replace 75 % of fish meal protein without adverse effects on growth performance. Tilapia fed these diets grew as well as tilapia fed the control diet and this could be attributed to the complementary effects produced from combining two animal protein sources and could be due to essential fatty acids because both fish waste and poultry by-product meal have higher level of crude lipids than that in fish meal.

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استخدام مسحوق أحشاء الدواجن ومخلفات تنظيف الأسماك كمصادر بديلة لمسحوق السمك في علائق البلطي النيلي

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تم إجراء هذه الدراسة بهدف استخدام مسحوق أحشاء الدواجن ومخلفات تنظيف الأسماك كمصادر بروتين حيوانية بديلة لمسحوق الأسماك كلا منها منفردا ومدى تأثير هذاالاستخدام على أداء النمو و الكفاءة الغذائية ومعاملات الهضم والتحليل الكيميائى لأجسام أسماك البلطي النيلي .حيث تم تكوين ثمانية علائق تجريبية بمستويات إحلال ٢٥ ،٥٠، ٧٥، ١٠٠٪ من بروتين مسحوق السمك مقارنة بعليقه الكنترول (١٠٪ من البروتين الكلى بالعليقة من مسحوق السمك) وكانت العلائق متساوية في محتواها من البروتين (٣٠.٢٩٪) والطاقة (٤٣٨.٨١ك ك طاقة كلية/١٠٠ جرام عليقة) وتم إجراء التوزيع العشوائي لعدد عشرة أسماك في الحوض بمتوسط وزن البداية (٦.٤٨ جرام /سمكة) وأجريت كل معاملة فى ثلاث مكررات وكان معدل التغذية اليومي ٣٪ من وزن الكتلة الحية للأسماك طول فترة التجربة(٩٨ يوم).

ومن النتائج المتحصل عليها وجد أن الزيادة فى وزن الجسم و معدل النمو اليومى على جميع مستويات الاحلال المستخدمة كانتا أقل معنويا عن عليقة الكنترول (١٠ ٪ مسحوق سمك) ماعدا العليقة المحتوية على ٧٥٪ مسحوق أحشاء الدواجن . كما أوضحت النتائج أن أعلى قيم للبروتين المحتجز مع العليقة المحتوية على ٧٥٪ مسحوق أحشاء الدواجن (٢.٥٥ جرام /سمكة) مقارنة بالكنترول (٢.٣٥ جرام/سمكة) كما لم تظهر فروق معنوية فى معدل النمو اليومى بين عليقة الكنترول و العليقة المحتوية على ٧٥٪ مسحوق تنظيف الاسماك.

ومن هذه الدراسة توضح يمكن إدخال مسحوق أحشاء الدواجن ومسحوق مخلفات تنظيف الأسماك كمصادر بروتينية بديلة لبروتين مسحوق السمك في علائق البلطي النيلي حتى مستوي ٧٥٪ بدون أى تأثيرات عكسية على أداء النمو.