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EFFECT OF PARTIAL REPLACEMENT OF FISH MEAL WITH SOME ANIMAL BY- PRODUCT MEALS ON DIGESTIBILITY AND PERFORMANCE OF NILE TILAPIA *OREOCHROMIS NILOTICAS* (L.)

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ABSTRACT: *Nine feeding and digestibility trials were carried out to evaluate the potential of replacing fish meal with nine experimental diets included different sources and levels of four animals by – product meals: hatchery dried poultry waste, poultry by- product meal, fish viscera meal and feather meal. All diets were formulated to be approximately isonitrogenous, isocalloric and were dedecated to replace 25% and 50% of fish meal.*

Throughout the digestibility trials period (4 weeks), fish were fed once per day at morning at a daily feeding rate 1% of biomass. After a preliminary period extended for seven days, feces were collected daily from each tank for three weeks by siphon method. In the feeding trials, fish were fed on the experimental diets along period of ten weeks.

The results reveiled significant differences (P<0.05) in apparent protein digestibility. The highest coefficient values of 91.9, 91.8 and 90.8% were obtained when using the control, poultry by – product meal 50% and fish viscera meal 50% respectively.

No significant differences (P<0.05) were observed among hatchery dried poultry waste 25%, 50% in apparent fat digestibility.

The results reveiled significant differences in the average final body weights, average body weight gain values among experimental diets compared to that of the control were not observed.

Fish fed on the feather meal 25%,50% diets showed significantly lower condition factors (1.49 and 1.55, respectively) than fish fed on the other diets (P <0.05). Best feed conversion ratios (FCR) were obtained with poultry by – product meal 50% (1.7) followed by the control diet (2.04) and fish viscera meal 50% (2.08) compared with the other diets (2.2 -2.6).

Key words: *Nile tilapia, growth performance, digestibility, fish meal.*

INTRODUCTION

Feeds for tilapia (*Oreochromis niloticas)* generally contain high levels of fish meal which may represent 40–60% of total operational costs (El- Sayed, 1999).So, in tilapia aquaculture there is a need for more rational use of fish meal to improve economic sustainability.

Steffens, (1994) found that Animal by – product meals are in general much less expensive than fish meal when used as a complete or partial replacement for fish meal in practical fish feeds. The experimental by – products meals can be mixed to produce a balanced nutritional diet (Hegedus et al., 1990).

The present study was conducted to evaluate hatchery dried poultry waste , poultry by – product meal, fish viscera meal and feather meal when included in the formulation of tilapia (0-25% -50%)diets as partial replacement for fish meal protein in practical diets for tilapia on its performance and the digestibility of these by – products .

MATERIALS AND METHODS

1-Experimental diets and their preparation:

The experimental animal by-products were collected from Giza markets places and the nine diets were formulated to be pelleted and approximately isonitrogenous with a crude protein content of 30% and approximately isocalloric with metabolizable energy content of 3300 K Cal /Kg as fed basis. Two partial replacement levels (25% and 50%) of the fish meal protein by hatchery dried poultry waste, poultry by – product meal, fish viscera meal and feather meal as illustrated in Table (1) which Identify the experimental design of work. The proximate composition of the tested ingredients is presented in Table (2).The formulation and a proximate composition experimental diet is presented in Table (3).

Table (1) : The experimental design of work.

Design	Treatments								
	Control	Hatchery dried poultry waste		Poultry by-product meal		Fish viscera meal		Feather meal	
	F_{100}-O	F_{75}-H_{25}	F_{50}-H_{50}	F_{75}-P_{25}	F_{50}-P_{50}	F_{75}-S_{25}	F_{50}-S_{50}	F_{75}-FZ_{25}	F_{50}-FZ_{50}
System/ replication	concrete tanks / duplicate per treatment								
Major animal protein sources	Fish meal	hatchery dried poultry waste	hatchery dried poultry waste	Poultry by product	Poultry by product	Fish by product	Fish by product	Feather meal	Feather meal
Partial replacement of fish meal protein	0	25%	50%	25%	50%	25%	50%	25%	50%
Water replacement	Complete replacement once every 15 days								
Initial weight of fish	20.71	21.52	21.80	20.0	14.22	20.72	19.75	20.35	19.80
Fish density / tank	15	15	15	15	15	15	15	15	15
Feed level	3%	3%	3%	3%	3%	3%	3%	3%	3%

* F = fish meal, H = hatchery dried poultry waste, P = poultry by – product meal, S = fish viscera meal and FZ = feather meal

Table (2) : Formulation (air dry weight) and proximate composition of experimental diets.

Treatment / Ingredient	Treatments								
	Control	Hatchery dried poultry waste		Poultry by- product meal		Fish viscera meal		Feather meal	
	F_{100}-O	F_{75}-H_{25}	F_{50}-H_{50}	F_{75}-P_{25}	F_{50}-P_{50}	F_{75}-S_{25}	F_{50}-S_{50}	F_{75}-FZ_{25}	F_{50}-FZ_{50}
Fish meal	8.36	6.47	4.32	6.47	4.32	6.47	4.32	6.47	4.32
Hatchery dried poultry waste	-	3.93	7.89	-	-	-	-	-	-
Poultry by-product meal	-	-	-	2.95	5.92	-	-	-	-
Fish viscera meal	-	-	-	-	-	2.43	4.86	-	-
Feather meal	-	-	-	-	-	-	-	1.71	3.43
Soybean meal	46.0	46.0	47.0	46.0	46.0	46.0	46.0	46.0	46.0
Corn	26.07	23.09	24.09	18.18	12.16	24.11	22.12	26.12	26.15
Wheat bran	12.30	13.5	9.7	19.4	24.6	14.0	15.7	12.7	13.1
Starch	5	5	5	5	5	5	5	5	5
Vitamin- mineral mixture	2	2	2	2	2	2	2	2	2
Proximate composition									
Crude protein	30.56	30.17	30.54	30.38	30.15	30.0	30.61	30.11	30.12
Fat	1.19	2.77	3.04	2.53	2.50	2.12	2.67	1.47	1.18
Ash	6.32	6.33	8.07	5.84	6.06	6.29	6.18	5.35	5.49
Carbohydrate	51.34	50.31	49.15	49.06	50.57	51.16	49.95	49.32	51.97
Crude fiber	4.19	3.92	3.66	3.95	3.16	4.39	3.72	4.18	4.47
Moisture	6.40	6.50	5.54	8.24	7.56	6.04	6.87	9.57	6.77
Metabolizable energy (Kcal/g)	3.283	3.367	3.367	3.300	3.385	3.323	3.368	3.203	3.280

Table (3) : Proximate composition (%) of test ingredients.

Ingredient	*Dry matter*	Crude protein	*Fat*	Ash	NFE	Crude fiber	*Moisture*
Fish meal	93.8	69.5	10.2	11.4	1.8	0.9	6.2
Hatchery dried poultry waste	97.1	38.0	18.9	27.02	11.5	1.5	2.9
Poultry by-product meal	98.4	50.7	19.7	10.8	15.1	2.1	1.6
Fish viscera meal	94.8	61.7	15.5	14.2	3.0	0.4	5.2
feather meal	95.7	87.5	3.4	1.9	2.4	0.5	4.3
Soybean meal	88.5	44.7	2.7	6.1	28.8	6.2	11.5
Corn	86.6	9.9	4.2	1.2	67.9	3.4	13.4
Wheat bran	88.7	12.9	3.7	3.96	61.74	6.4	11.3

2-The experimental fish:

Fish used in feeding trial were Nile tilapia juveniles (*Oreochromis niloticus*) with an average weight of 19.98 -21.8 g /fish and were randomly distributed among 18 outdoor concrete tanks at intitial stocking density of 15 juveniles per tank (2.0 x 1.2 x 1.0 m) .The water was changed in each tank at two week intervals for ten weeks (the experimental period) .The feed was administered by hand, once daily at the rate of 3% of total fish biomass per tank per day and all fish in each tank were individually weighed. Fish in digestibility trial were Nile tilapia (*Oreochromis niloticus*) fingerlings (22.0 g) were stocked in 70 liter glass aquaria for a one week preliminary period to adapt them to the test diets with density 10 per tank.

Fish were fed their respective diets once each morning at a fixed rate of 1% of body weight per day. Feces were collected daily from each tank for three weeks by siphon method and daily faecal samples from each tank were pooled over the experiment until sufficient sample for chemical analysis. The fiber content in diet was used as digestion indicator.

3- Chemical analysis:

Diets, feces, whole fish and fillet were analysed for dry matter, crude protein, lipid and total ash according to the methods of AOAC, (1990). Organic matter was calculated by subtracting the total ash value from dry matter and total carbohydrates was estimated by subtracting crude protein and lipid values from organic matter.

4- Statistical Analysis :

The experiment was designed and statistically analyzed as completely randomized design consisting of nine dietary treatments (Middleton et al., 2001). Duncan multiple range tests were used to determine significant differences between treatments means (Duncan, 1955).

RESULTS AND DISCUSSION:

Data in Table (4) summarises the mean values of digestibility coefficients of the experimented diets. The apparent crude protein digestibility coefficient were relatively high for all diets tested and ranged 87.62 – 91.93 % among them , with significant differences among treatments ($P< 0.05$) .The fish on the control diet showed highest crude protein digestibility coefficient value when using the poultry by – product meal 50% and fish viscera meal 50% values being 91.93 ,91.88 and 90.81 respectively . While the lowest protein digestibility coefficients was obtained when using hatchery dried poultry waste 25%diet 87.62%).The apparent fat digestibility of poultry by – product meal 25% (88.75%) and 50 %(89.23%) were significant higher compared to all treatments ($P< 0.05$).

Cho et al., 1982 ;Sargent et al., 1989; Sullivan and Rright (1995) reported for Nile tilapia that energy from lipids in the fish meal , hatchery dried poultry waste, poultry by product meal and fish viscera meal diets were well digested.

The high lipid digestibility coefficients for all the diets may be attributed to high lipase activity in tilapia and fish generally (Sadiku and Jauncy, 1995). Apparent digestibility (%) values of organic matter were high (80.05 – 85.23 %) for all treatment. Significant differences in apparent digestibilites of carbohydrate among experimental diets and ranged from 83.17 to 88.25 % among treatment. The apparent digestibility values of dry matter showed little variation among the experimental diets (83.17 – 88.28 %) and were comparable to that of the control diet (85.84%).

The growth performance:

The average final weights and daily weight gain of Nile tilapia Table (5) did not differ significantly ($P<0.05$) among the experimental diets compared to that of the control. Such results are in agreement with those obtained by Fowler, (1982) and Watanabe; Pongmaneerat, (1991) and Kureshy et al (2000)., Kikuchi et al., (1994); Conrad et al., (1988). The average body weight gains showed no significant differences in weight gain of fish fed any of

Table (4) : Average apparent digestibility coefficients ± S.D. of experimental diets fed to Nile tilapia .

Treatments / Component	Control	Hatchery dried poultry waste		Poultry by- product meal		Fish viscera meal		Feather meal	
		25%	50%	25%	50%	25%	50%	25%	50%
Protein	91.93 ^{a} ± 0.16	87.62 ^{g} ± 0.19	89.75 ^{c} ± 0.39	88.27 ^{e} ± 0.22	91.88 ^{a} ± 0.19	89.28 ^{de} ± 0.34	90.81 ^{b} ± 0.12	89.40cd ± 0.29	88.91 ^{e} ± 0.05
Fat	80.09 ^{c} ± 0.91	87.89 ^{ab} ± 1.55	82.83 ^{bc} ± 0.48	88.75 ^{a} ± 1.57	89.23 ^{a} ± 1.35	82.87 ^{bc} ± 2.05	88.18 ^{ab} ± 0.36	77.34c ± 10.27	64.74 ^{d} ± 4.05
Carbohydrate	85.84 ^{c} ± 0.17	88.25 ^{a} ± 0.07	85.48 ^{cd} ± 0.32	83.17 ^{g} ± 0.47	87.85 ^{b} ± 0.01	83.46 ^{fg} ± 0.07	85.26 ^{d} ± 0.18	84.54 e ± 0.17	83.82 ^{f} ± 0.23
Organic matter	82.75 ^{c} ± 0.05	83.45 ^{b} ± 0.56	81.95 ^{d} ± 0.37	80.04 ^{f} ± 0.30	85.23 ^{a} ± 0.04	80.07 ^{f} ± 0.03	82.61 ^{c} ± 0.15	81.06e ± 0.08	80.05 ^{f} ± 0.09

* Means in the same row followed by different letters are significantly different (P<0.05).
* Levels of inclusion of animal by- product meals as partial replacement of fish meal are on equal protein basis.

Table (5) : Growth performance of Nile tilapia (*O . niloticus*) fed different sources and levels of animal by – product meals as partial replacement of fish meal in diet.

Parameters	Control	Hatchery Dried Poultry waste		Poultry by product meal		Fish viscera meal		Feather meal	
		25%	50%	25%	50%	25%	50%	25%	50%
AV. Initial. wt g /fish	20.71^{bc} +0.42	21.52^{ab} +0.30	$21..80^{a}$ +0.01	19.98^{cd} +0.81	14.22^{e} +0.22	20.72^{bc} +0.53	19.60^{d} +0.94	20.35^{cd} +0.70	19.80^{cd} +0.67
AV. Final. wt g/fish	$56..80^{abc}$ +1.83	60.50^{a} +3.46	55.76^{abc} +1.93	55.57^{abc} +5.90	59.34^{ab} +1.28	54.45^{bc} +2.07	57.50^{abc} +2.20	55.58^{abc} +2.33	53.17^{c} +2.29
AV. Wt. gain g/fish	36.10^{b} +1.14	38.98^{b} +3.76	33.96^{b} +1.93	35.59^{b} +6.70	45.12^{a} +1.49	33.73^{b} +2.6	37.74^{b} +3.02	35.23^{b} +3.03	33.37^{b} +1.62
AV. Wt. gain%	174.26	181.13	155.77	178.12	317.29	162.8	193.36	173.12	168.53
AV. Wt. gain/day	0.47^{b} + 0.02	0.51^{b} + 0.05	0.44^{b} + 0.03	0.46^{b} + 0.09	0.59^{a} + 0.02	0.43^{b} + 0.04	0.49^{b} + 0.04	0.46^{b} + 0.04	0.43^{b} + 0.03
SGR (%/day)	1.32^{b} + 0.02	1.35^{b} + 0.10	1.23^{b} + 0.05	1.33^{b} + 0.20	1.87^{a} + 0.05	1.26^{b} + 0.09	1.40^{b} + 0.11	1.32^{b} + 0.10	1.29^{b} + 0.02

* Means in the same row followed by different letters are significantly different (P<0.05).
* Levels of inclusion of animal by- product meals as partial replacement of fish meal are on equal protein basis.

experimental diets (P<0.05) except that of the poultry by – product meal 50% which had significantly higher values . Similar results were obtained by Koops et al., (1982); Tiews et al., (1979); Higgs et al., (1979); Brannon et al., (1976) and Roley et al., (1977).

The specific growth rates(SGR) of Nile tilapia fingerlings had not significantly differences compared to those of the control except for that of the poultry by – product meal 50% which was significantly higher (P<0.05). Such results are in agreement with (Fowler, 1990; Conrad et al., 1995; Gallagher and Degani., 1988).

Feed performance of Nile tilapia fingerlings is shown in Table (6) .Feed conversion ratio (FCR)values differed significantly (P<0.05) among the

Table (6) : Feed performance of Nile tilapia (*O .niloticus*) fed different source and levels of animal by – product meals as partial replacement of fish meal in diet.

Parameters	Control	Hatchery dried poultry waste		Poultry by-product meal		Fish viscera meal		Feather meal	
		25%	50%	25%	50%	25%	50%	25%	50%
FCR	2.04^{c} ± 0.04	2.28^{bc} ± 0.11	2.60^{a} ± 0.08	2.38^{ab} ± 0.29	1.70^{d} ± 0.03	2.32^{abc} ± 0.22	2.08^{bc} ± 0.14	2.21^{bc} ± 0.26	2.30^{abc} ± 0.09
PER	1.60^{b} ± 0.03	1.45^{bcd} + 0.07	1.26^{d} ± 0.04	1.39^{cd} ± 0.16	1.95^{a} ± 0.04	1.44^{bcd} ± 0.14	1.57^{bc} ± 0.11	1.51^{bc} ± 0.18	1.44^{bcd} ± 0.06
PPV	23.49^{c} ± 0.55	21.09^{cd} ± 1.17	19.68^{d} ± 0.22	21.12^{cd} ± 2.53	33.69^{a} ± 0.77	23.51^{c} ± 2.08	27.07^{b} ± 1.60	23.98^{c} ± 3.66	22.47^{cd} ± 0.82
ERV	21.58^{cd} ± 0.37	20.02^{de} ± 0.99	19.19^{def} ± 0.59	17.04^{f} ± 0.02	29.19^{a} ± 0.72	17.82^{ef} ± 1.59	24.16^{b} ± 1.55	22.87^{b} ± 2.63	19.99^{be} ± 1.04

* Means in the same row followed by different letters are significantly different ($P<0.05$).

* Levels of inclusion of animal by- product meals as partial replacement of fish meal are on equal protein basis.

experimental groups values being the best with the control diet but the poorest values were obtained with diet of the hatchery dried poultry waste 50% similar results were obtained by Cisse et al ., (1995) and Henrichfreise (1989). This may be due to the high proportions of different animal by - product meals included in the diets which led to a decline in feed intake as well as to a reduction of feed conversion ratio and therefore results in slower growth (Steffens, 1994).

Protein efficiency ratio PER varied significantly (P < 0.05) among treatments from 1.26 to 1.95 .When increasing the level of hatchery dried poultry waste in the diet, a significant reduction in PER value that may be due to many antinutritional factors such as trypsin inhibitors strongly influence the suitability of egg white as protein source for lobsters however, appropriate denaturation techniques can minimize their effects (Norman Boudreau and Conklin., 1985). There were no significant differences in protein productive values (PPV) between fish fed all animal by product meal treatments with 25% of fish meal substitutions and the control treatment. In contrast, the PPV values were significantly higher in fish fed the poultry by-product meal 50% and fish viscera meal 50%.

Fish fed the poultry by product meal 50% and the fish viscera meal 50% diets had energy retention value (ERV) significantly better (P< 0.05) than those fed the control diets which indicate better utilization of energy in those diets.

From the economic standpoint, Table (7) showed that feed costs per kilogram animal by- product meal diets at 25% replacement level were higher than those at 50% replacement level. The feed costs for producing one kilogram of Nile tilapia was significantly lowest for poultry by- product meal diet 50%, followed by that of the control diet, with significantly differences among treatments.

Table (7) : cost – benefit analyses of different experimental diets fed to Nile tilapia.

Treatments / Costs	Control	Hatchery dried poultry waste		Poultry by- product meal		Fish viscera meal		Feather meal	
		25%	50%	25%	50%	25%	50%	25%	50%
Price /kg (L.E)	1.42	1.35	1.28	1.35	1.28	1.36	1.30	1.35	1.27
Feed cost (L.E) Per kg of fish	2.90 a ± 0.05	3.07 a ± 0.14	3.32 a ± 0.11	3.22 a ± 0.39	2.17b ± 0.04	3.03a ± 0.30	2.7 a ± 0.66	2.98 a ± 0.35	2.92a ± 0.11

* Means in the same row followed by different letters are significantly different (P<0.05).
* Levels of inclusion of animal by- product meals as partial replacement of fish meal are on equal protein basis.

CONCLUSION

The results from this study suggest that there are possibilities for partial replacement of fish meal protein with much economic CP sources of animal by- product meals such as those proteins in hatchery dried poultry waste, fish viscera meal, poultry by - product meal and feather meal fed in mixtures for *Oreochromes niloticus*. These sources according to the obtained results could be used up to 50%except of hatchery dried poultry waste which could replace only up to 25% of fish meal protein without noticeable adverse affect on the nutrient digestibilities and consequently that allowed growth rates and feed efficiency to be similar to those of the control group.

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تأثير الإحلال الجزئي لمسحوق السمك ببعض المخلفات الحيوانية على الهضم و الأداء في البلطي النيلي

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٢- قسم الإنتاج الحيواني ، كلية الزراعة ، جامعة القاهرة .

الملخص العربى

في هذه الدراسة تم تقييم بعض المصادر البروتينية ذات الأصل الحيوانى وذلك من خلال إجراء تجارب هضم و نمو على اسماك البلطي النيلي و هذه المصادر (مسحوق مخلفات معامل التفريخ ، مسحوق أحشاء الدواجن ، مسحوق أحشاء الأسماك ، مسحوق الريش) وذلك بإحلالها جزئيا محل مسحوق السمك وكان مستوى الإحلال ٢٥% ، ٥٠% من بروتين مسحوق السمك وتم تكوين تسعة علائق مختبرة متماثلة في محتواها من البروتين والطاقة وتم إجراء تجربة هضم لمدة أربعة أسابيع لتقييم تلك العلائق وكان معدل التغذية اليومي حوالي ١% من وزن الجسم .

ومن النتائج المتحصل عليها كان أعلى معامل هضم ظاهري للبروتين معنويا في مجاميع الأسماك التي غذيت على عليقه الكنترول ، والعليقة التي تحتوى على ٥٠% مسحوق أحشاء الدواجن ، والعليقة التي تحتوى على ٥٠% مسحوق أحشاء الأسماك (٩١,٨ ، ٩١,٩ ، ٩٠,٨) على التوالي. ولوحظ أيضا عدم وجود فروق معنوية لمعامل هضم الدهن في العلائق المحتوية على ٢٥%، ٥٠% من مسحوق مخلفات معامل التفريخ.

وقد أوضحت النتائج أيضا وجود اختلافات معنوية عند مستوى ٥% في متوسط وزن الجسم النهائي ومتوسط الزيادة في وزن الجسم وذلك مقارنتا بالكنترول. ووجد أيضا انخفاض معنوي في معدل النمو النسبي (SGR) للأسماك المغذاة على علائق مسحوق الريش حيث كان (١,٤٩ ، ١,٥٥) على التوالي وذلك مقارنة بالأسماك المغذاة على باقي العلائق المختبرة . وجد

أيضا إن أفضل معامل تحويل غذائي كان في مجاميع الأسماك التي غذيت على العلائق المحتوية على مسحوق أحشاء الدواجن بنسبة إحلال ٥٠% حيث كان ١,٧ بينما عليقه الكنتـــرول كانــت ٢,٠٤ والعلائق المحتوية على مسحوق أحشاء الأسماك بنسبة إحلال ٥٠% كان ٢,٠٨ وذلــك مقارنة بباقي العلائق المختبرة حيث تراوحت بين ٢,٢ – ٢,٦ كجم عليقه /١ كجم نمو .