AN MEAL BY OTHER PLANT PROTEIN SOURCES IN NILE TILAPIA (*OREOCHROMIS NILOTICUS*) DIETS ON DIGESTIBILITY OF NUTRIENTS USING FIBER OR ASH AS MARKERS

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Abstract

A total number of 64 monosex Nile tilapia with an average body weight of 150±1.85g were exposed to digestibility trial using insoluble ash or crude fiber as inert markers .The experimental fish represented four dietary treatments (16 fish each in replicates). The four dietary treatments were control soybean meal diet (T1), T2 where 30% of soybean protein (SBMP) was replaced by dried rumen contents, T3 where 30% of (SBMP) was replaced by sunflower meal and T4 where (SBMP) was replaced by 30% of sesame seed cake. Results obtained are summarized as follow:

- The tested diets affected significantly ($P < 0.05$) the digestibility coefficients of DM, CP, EE, NFE and energy as determined by using insoluble ash as internal marker, while using the crude fibers as indicator the applied treatments affected significantly the digestibility coefficients of DM, EE, ash, NFE and energy except CP.

Key words: Nile tilapia monosex, Growth performance, dried rumen contents, Sunflower meal, Sesame seed cake, Soybean meal protein, Digestibility.

INTRODUCTION

The composition of non traditional plant feed stuffs used in fish diets determines its quality and accordingly its digestibility by fish .Also the methods used in processing these plant originated feed stuffs determines it quality and the digestibility of nutrients included in such feeds. Hanley (1987) reported that the tilapia (*Oreochromis niloticus*) was able to digest the crude protein and gross energy of the animal, based feedstuffs more efficiently than those the plant bossed feedstuffs.

Plant oilseeds and their by products usually constitute a major source of dietary protein within aqua feeds for warm water omnivorous/ herbivorous fish species (Akiyama, 1991, Lim and Dominy, 1991). Some factors limit incorporation of these ingredients at high levels in fish feed are low protein content, amino acid imbalance and presence of anit-nutritional factors (Wee, 1991). Moreover, the lack of information on their digestibility in feed formulation and manufacture may limit its use in aquatic feeds. It is essential to have digestibility knowledge of the main ingredients, as well as of the whole diet (Desilva and Anderson, 1995). In India, very few studies have been conducted on the digestibility of locally available feed ingredients for carps (Jayaram

and shetty 1980, Nandeesha *et al.* 1991, Ray and Das 1994, Mukhopadhyay and Ray 1997). Hossain and Jauncey (1989) evaluated three oilseed (mustard, linseed and sesame) of Bangladeshi origin were as fish meal substitutes in diets of common carp (*Cyorinus carpio* L.) at levels of 25.5 and 75% of dietary protein. They reported that apparent protein digestibilities (APDs) for all diets were fairly high, ranging from 77.72% to 89.80%. The same authors added that APD values decreased with increasing the plant protein levels. Jackson *et al.* (1982) incorporated sunflower seed in tilapia diets at high level with addition of methionine. They reported that there is a paucity of information on the nutrient digestibility of dehulled sunflower meal as potential feed ingredient for Nile tilapia.

The present study aimed to determine the digestibility of nutrients of Nile tilapia fed diets containing rumen contents, sunflower meal and sesame seed cake to replace 30% of soybean meal protein using the fiber and ash methods as indicators.

MATERIALS AND METHODS

A digestibility trial was carried out and the apparent digestibility coefficients of nutrients (ADC) were determined using ash or fibers as an inert marker according to Jones and De Silva (1998). Apparent digestibility coefficients (ADC %) of nutrients was calculated according to the following equation:

$$ADC\ (\%) = 100 - [100 \frac{\%\ Marker\ in\ feed}{\%\ Marker\ in\ feces} \times \frac{\%\ Nutrient\ in\ feces}{\%\ Nutrient\ in\ feed}]$$

A total number of 64 mono sex Nile tilapia of an average body weight of 150±1.85g were taken randomly from a previous feeding trial where dried rumen contents (RC), sunflower meal (SFM) or sesame seed cake (SSC) were incorporated in the diet to replace 30% of soybean meal in the control diet and were fed for 18 weeks. Each diet was represented in two replicates (8 fish each) and tested for nutrient digestibility in glass aquaria of a total volume 216 *L* each .The glass aquaria containing dechloronated tap water supplied with air stones for aeration. The fish were fed on the experimental diets at daily rate of 1% of aquarium fish biomass. The experimental diets were offered once daily at 11^{00} am. The experimental diets are presented in Table (1).

Table 1. Composition of the experimental Diets (on DM basis)

Ingredients in percentage	Experiment Diets			
	Control	T_1	T_2	T_3
Fish meal herring	11.00	11.00	11.00	11.00
Corn gluten	14.00	16.22	14.00	14.00
Soybean meal	25.00	17.50	17.50	17.50
Dried rumen contents	-	29.46	-	-
Sunflower meal	-	-	9.71	-
Sesame seed cake	-	-	-	10
Yellow corn	41.30	17.20	42.07	42.10
Rice bran	3.00	3.00	3.00	3.00
Corn oil	3.10	4.62	1.40	1.40
Celluose powder	1.60	-	0.32	-
Vitamine & Mineral premix*	1.00	1.00	1.00	1.00
Total	100	100	100	100
Chemical analysis of the experimental diets (on DM basis)				
Dry matter%	90.78	92.10	91.35	91.26
Crude protein %	30.88	30.36	30.91	30.94
Ether extract %	8.15	9.58	7.87	8.61
Crude fiber %	6.02	8.24	5.90	5.13
Ash %	7.69	11.45	7.94	8.37
NFE** %	47.26	40.37	47.38	46.95
Grass Energy*** (Kcal/ kg)	4646.10	4565.05	4621.33	4644.96

* Each kg premix contains: vitamin A, 2.5 m.i.u., vitamin D_3, 1.25 m.i.u., vitamin E. 125000 mg, vitamin K, 5000 mg, vitamin B_1, 7500mg, vitamin B_2, 5000 mg, vitamin B_6, 25000 mg, vitamin B_{12}, 10 mg, pantothenic acid, 10000 mg, Nicotinic acid, 100000, folic acid, 5000 mg, biotin, 750 mg, choline chloride, 2000000mg, copper, 3000 mg, Iodine, 125 mg, Iron, 75000 mg, Manganese, 6000 mg, Zinc, 65000 mg, Selenium, 150 mg).

** Calculated by differences

*** Estimated according to Jobiling (1983). Using the factor 5.65, 9.45 and 4 for crude protein, ether extract and carbohydrate, respectively.

Feces were collected by siphoning one time daily before feeding, and were kept in a deep freezer at -4°C after collection to avoid the fermentation according to the method of A.O.A.C. (1990). The digestion trial lasted 21 days after start.

One half of the experimental aquaria (16 aquaria) were exchanged daily with new dechloronated water during the course of the digestibility trial. The diets tested were control deit containing 30% soybean meal protein and fish meal (T1), T2 containing dried rumen contents to replace 30% soybean meal protein, T3 containing

sesame seed cake to replace 30% of soybean meal protein and T4 containing sunflower meal to replace 30% of soybean meal protein. All diets tested in the digestibility trial were previously fed to the corresponding fish in the digestibility trial for 18 weeks in a growth trial. Experimental diets and feces were chemically analyzed for crude protein, fat, ash and fiber contents according to the methods described by A.O.A.C. (1990).

Statistical Analysis

The data were analyzed using the SAS computer program (1996). Comparison between treatments was conduct according to Duncan (1955).

The used model was: $Xi = \mu + Ti + Ei$

Where: Xi is the observation on i treatment

μ is the overall mean

Ti is the effect of i treatment

Ei is the experimental error

RESULTS AND DISCUSSION

Effect of the dietary treatments on nutrient apparent digestibility by using the ash method as internal indicator

Averages of nutrient digestibility using ash as indicator for dry matter (DM), crude protein (CP), ether extract (EE), nitrogen free extract (NFE) and energy, are presented in Table (2). Concerning DM digestibility%, averages were found to be 90.73, 88.89, 89.92 and 87.91% for the treatment groups, C, RC, SFM and SSC groups, respectively. Results revealed that the highest DM digestibility coefficient ($P<0.05$) was recorded by the control diet and the lowest (87.91%) $P<0.05$ was recorded by SSC group and both RC and SFM groups showed DM digestibilities between both of C and SSC groups. Concerning CP digestibility coefficient group fed on the diet containing sesame seed cake (SSC) showed the highest ($P<0.05$) value (75.05) followed by the other groups. Results of table (2) revealed that SSC group showed significantly ($P<0.05$) the highest EE digestibility coefficient 91.25% followed in a significant decreasing order by SFM, RC and C groups, respectively. Results of EE digestibility revealed that SSC group showed significantly ($P<0.05$), the highest values (91.25%) followed in a decreasing order by SFM group and RC and C groups, respectively. On the other hand, the RC group showed the highest ($P<0.05$) NFE digestibility coefficient (46.49) followed in a significant ($P<0.05$) decreasing order by both SFM and C groups and the lower values were recorded by the SSC group. As presented in table (2).

Averages of energy digestibility coefficients for the C, RC, SFM and SSC groups were found to be 58.95, 59.78, 59.67 and 61.18%, respectively and the highest value ($P<0.05$) was recorded by the SSC group and the lowest by the control group. These results may indicated that incorporation of sesame seed cake into diets of Nile tilapia resulted in pronounced improvement in digestibility of CP, EE and energy, compared to the other groups.

Table 2. Apparent nutrient digestibility coefficient (ADC%) of the experimental diets by using an ash as internal digestive indicator (mean ± S.E.)

Treatments	ADC%				
	DM	CP	EE	NFE	Energy*
Control diet	90.73^{a} ± 0.13	72.98^{b} ± 0.60	86.15^{c} ± 0.28	44.46^{b} ± 0.37	58.95^{b} ± 0.39
RC	88.89^{b} ± 0.30	72.24^{b} ± 1.06	87.03^{c} ± 0.16	46.49^{a} ± 0.43	59.78^{ab} ± 0.53
SFM	89.92^{ab} ± 0.43	73.65^{ab} ± 0.68	88.76^{b} ± 0.36	44.72^{b} ± 1.33	59.67^{ab} ± 0.94
SSC	87.91^{b} ± 0.18	75.05^{a} ± 0.10	91.25^{a} ± 0.11	43.06^{c} ± 0.70	61.18 ± 0.49

* Estimated according to Jobiling (1983). Using the factor 5.65, 9.45 and 4 for crude protein, ether extract and carbohydrate, respectively.

**a, b, c: meaning the same column with different superscripts are significantly different ($P<0.05$).

Using Crude fiber as internal indicator

The results of nutrients digestibility coefficients using (CF) as internal indicators are presented in Table (3). Results of this table revealed that the fish fed on the Control and SFM diets showed significantly ($P<0.05$) the highest DM digestibility coefficient followed in a significant ($P<0.05$) decreasing order by the RC and SSC groups, respectively. Concerning the CP digestibility coefficient, dietary treatments had no significant effect on this trial, however group SSC showed the highest value followed in a descending order by SFM, C and RC groups, respectively. Results of the same table revealed that the highest EE ($P<0.05$) digestibility coefficient was recorded by the SSC group followed in a significant ($P<0.05$) decreasing order by SFM group and both C and RC groups, respectively. As presented in Table (3) digestibility coefficient of ash for the Control, RC and SFM groups were significantly ($P<0.05$) higher than that of the SSC group.

Concerning NEF digestibility coefficient, results of Table (3),revealed that RC group showed the highest ($P<0.05$) value followed in a significant ($P<0.05$) decreasing order by C and SFM groups and the lowest value was recorded by the SSC group, respectively. Results of the same table revealed that energy digestibility coefficients of tilapia had ranged between 67.37 and 68.06% with insignificant differences among groups. In this connection, Ibrahim (1997) reported that the

highest CP digestibility coefficient was obtained with tilapia diets containing 75% of concentrated rumen liquor in replacement for fish meal protein followed in a decreasing order by diets where fish meal was replaced by 100, 50, 10 and 25% of concentrated rumen liquor, respectively.

The same authors reported that incorporation of concentrated rumen liquor at 75% to replace fish meal protein improved EE digestibility and these results are in accordance with the results of Tables (2) and (3). Results of the present study are also in accordance with those reported for CP and EE digestibility coefficient by Shiau and Huang (1989) in tilapia (81.5 to 87.86%), (Mahdy, 1989) in Nile tilapia (74.37 to 86.65) and (Antongiovanni *et al.,* 1973) recorded CP% and EE% of rumen content were 70.81, 80.95 and 64.80% when dried by heat and freezing. Also, these values were ranged the values obtained by (El Deek *et al.,* 1984).

Concerning sesame seed cake (Tables 2 and 3) results obtained in the present study are in partial agreement with the findings of Mukhopadhyay and Ray (2001) who incorporated raw and fermented sesame seed meal in rohu (*Labeo rohita*) fingerlings diets at 20, 30 and 40% levels and found that digestibility coefficients of crude protein improved from 68.7 to 97.60% and from 71.06 to 98.36% and from 72.57 to 98.15% in raw and fermented sesame seed meal containing diet at 20, 30 and 40% incorporation levels. They also reported that fermentation of sesame seed meal improved significantly the digestibility of fat. Furthermore results of Hossain and Jauncey (1989) revealed that incorporation of sesame seed meal at 25, 50 and 75% of the dietary protein in common carp diets decreased the apparent digestibility of dry matter, crude protein, lipids and energy compared to the control diet containing 52.50% fish meal. On the other hand, results of El- Said and Gaber (2003) incorporated a plant protein mixture ppm (25% soybean meal + 25% cotton seed meal + 25% sunflower meal + 25% linseed meal) to replace 0, 25, 50, 75 and 100% of fish meal protein in juvenile Nile tilapia diets and found that ppm (ppm 0, ppm 25, ppm 50, ppm 75 or ppm 100, respectively). The ppm consisted of 25% soybean meal, 25% cottonseed meal, 25% sunflower meal and 25% linseed meal and 0.5% of both methionine and lysine were added to each diet except for the control, after 16 weeks of feeding, the fish fed diets ppm 75 and ppm 100 exhibited growth performance not differing significantly from the fish fed control diet ppm substitution of up to 75% of the fish meal protein did not results in differences in the apparent protein digestibility compared with the control, where as in the ppm 100 group digestibility was significantly lower than in the other groups, except for fish fed the ppm 75 diet.

In general results of digestibility coefficients obtained for DM in the present study using the ash (Table, 2) or fibers (Table, 3) as internal indicators were found to lay between 87.91 to 90.73% (for insoluble ash) and 89.95 to 92.63% (for crude fibers) methods which are matched with the results reported by Saleh (2001) who showed that DM digestibility coefficients of Nile tilapia ranged between 92.21 to

87.55% using the ash as internal indicator and between 80.04 to 95.09% using fibers as internal indicator. Also, CP digestibility reported in the present study had ranged between 72.24 to 75.05% (ash method) and between 77.94 and 79.27% (fibers method) which is almost in the same range reported by Saleh (2001) who reported CP digestibility coefficient of 60.30 to 85.53% (crude fibers method) and 56.33 to 85.40% (ash method). Also, digestibility coefficients of EE and NFE obtained by both methods in the present study are almost matching with those reported by the same author and differences may due to the differences in the ingredients tested.

Table 3. Apparent nutrient digestibility coefficient (ADC%) of the experimental diets by using crude fibers as internal digestive indicator

Treatments	ADC%					
	DM	CP	EE	Ash	NFE	Energy*
Control diet	$92.63^{a} \pm 0.42$	$78.52^{a} \pm 0.43$	$88.99^{c} \pm 0.33$	$20.52^{a} \pm 0.65$	$56.85^{b} \pm 1.33$	$67.37^{a} \pm 0.87$
RC	$91.17^{b} \pm 0.23$	$77.94^{a} \pm 0.19$	$89.70^{c} \pm 0.32$	$20.54^{a} \pm 0.56$	$59.26^{a} \pm 1.56$	$68.04^{a} \pm 0.54$
SFM	$92.01^{a} \pm 0.11$	$79.13^{a} \pm 0.20$	$91.10^{b} \pm 0.24$	$20.81^{a} \pm 0.41$	$57.30^{b} \pm 0.73$	$68.06^{a} \pm 0.32$
SSC	$89.95^{c} \pm 0.69$	$79.27^{a} \pm 0.86$	$92.73^{a} \pm 0.40$	16.91 ± 0.21	$53.60^{c} \pm 1.80$	$67.75^{a} \pm 1.00$

* Estimated according to Jobiling (1983). Using the factor 5.65, 9.45 and 4 for crude protein, ether extract and carbohydrate, respectively.

**a, b, c: meaning the same column with different superscripts are significantly different ($P<0.05$).

Comparison between ash and fibers methods as internal indicator

The comparison between DM, CP, EE, NFE and energy digestibility coefficients determined using ash and fibers as internal indicator is presented in (Table, 4). In general results revealed that digestibility coefficients determined using the fibers as indicator for all nutrients cited above were significantly higher compared to the values determined using ash as indicator. In general, DM. CP, EE, NFE and energy digestibility coefficients determined by ash method represented 97.73, 93.34, 97.42, 75.72 and 88.32% of the corresponding values obtained using the fibers method, respectively, (Table 4). These results are in complete agreement with the findings of Saleh (2001) who noted that the digestibility coefficients of all nutrients were lower in most cases when ash was used as internal marker compared to the use of crude fibers as internal marker. Also, added that CF as internal marker gave misleading results and therefore (acid detergent fibers) ADF or ADL (acid detergent lignin) fractions could be more efficient to avoid over estimation.

Table 4. Comparison between ash and fibers methods as internal indicator (internal marker), (means ± S.E.)

ACD % methods	DM%	CP%	EE%	NFE%	Energy%
Ash method	89.36 ± 0.6	73.48 ± 0.59	88.29 ± 1.12	44.68 ± 0.71	59.89 ± 0.47
Fiber method	91.44* ±0.56	78.72* ± 0.3	90.63* ±0.89	59.01* ±2.56	67.81* ± 0.16
(Ash/fiber) X 100	97.73	93.34	97.42	75.72	88.32

* Significantly different using t-student test at (P <0.05)

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أثر احلال بروتين كسب فول الصويا بمصادر بروتين نباتية أخرى على قابلية هضم الغذاء باستخدام الألياف الخام أو الرماد الغير ذائب كمرقمات فى علائق أسماك البلطى النيلى

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تم استخدام عدد ٦٤ سمكة بلطى نيلى وحيد الجنس بوزن ١٥٠± ١,٨٥% جم لتقدير الهضم بها بطريقتى الرماد والألياف واستخدم عدد ١٦ سمكة من كل معاملة من المعاملات الأربعة وهى : عليقة الكنترول وتحتوى على بروتين كسب فول الصويا , عليقة محتويات الكرش الجافة، عليقة كسب عباد الشمس ، عليقة كسب بذرة السمسم والتى حل كل منها محل ٣٠% من بروتين كسب فول الصويا.

وتحصل على النتائج التالية:-

أدت المعاملات الغذائية المختبرة إلى اختلافات معنوية فى معاملات هضم كل من المادة الجافة والبروتين الخام والدهن الخام والكربوهيدرات الكلية والطاقة وذلك باستخدام الرماد الغير ذائب كدليل فى حين أن تقدير معاملات هضم مركبات الغذاء باستخدام الألياف الخام كدليل لم تكن هناك اختلافات معنوية فى معاملات هضم كل من المادة الجافة والدهن الخام والرماد والكربوهيدرات الكلية والطاقة ما عدا البروتين الخام.