EVALUATION OF SOME ALTERNATIVE SOURCES OF ENERGY IN NILE TILAPIA *OREOCHROMIS NILOTICUS* DIETS.

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ABSTRACT

The study investigated the effect of replacing the yellow corn energy with potato processing by-product (PPB) and broken rice meal (BRM) at 20, 40 and 60% levels on growth performance of Nile tilapia. Results revealed no significant differences in total body weight gain, relative growth rate and specific growth rate in fish fed diets containing PPB up to 40% and BRM up to 60% in replacement of corn which recorded better values compared to control group. On the other hand there were significant differences in liver weight, hepato-somatic index and liver glycogen between control and all tested treatments. Body dry matter content was higher in control group than in all PPB treatments while DM content was lower in the control group than the all BRM treatments, with no significant differences. Crude protein contents decreased significantly by the increasing the level of PPB more than 40%, but the opposite trend occurred with BRM. Ether extract contents increased significantly by increasing PPB level, while increased by the increasing BRM level in the diet with no significant differences. There were significant decreases in ash content by increasing PPB or BRM levels. Based on the results of growth performance of fish, the substituting of yellow corn by either PPB of BRM at levels of 40 and 60%, respectively, gave the lowest feed cost to obtain one kg gain in live weight.

Keywords: *O. niloticus,* broken rice, potato, energy, growth performance.

INTRODUCTION

In Egypt, the high price of animal protein created a great demand towards fishes; it is well known that feeding costs in fish production represent about 50% or more of the total production costs (Collins and Delmendo, 1979). Therefore, emphasis is being laid on research into the use of novel sources as agricultural wastes as well as to reduce hazard pollution resulting from these wastes (Steffens, 1994) and the partial replacing of yellow corn in fish feed by potato processing by-product and broken rice meal as unconventional energy sources in order to prepare relatively cheap and balanced diets for feeding Nile tilapia fish.

Osman *et al.* (2004) observed significant improvement in feed intake of fish fed diets containing 25, 50, 75 and 100% broken rice meal (BRM) compared to the control diet. Also, Ghazalah *et al.* (2002) found that yellow corn energy can be substituted up to 50% by potato by-product meal (PPB) without harmful effects on the performance and feed utilization of fish. Moreover, Mostafa (2003) reported that *O. niloticus* grew well when potato peel meal represents only 23% of the diet or 50% of yellow corn energy in the control diet.

The current study aimed at evaluating the effects of incorporation of different levels of PPB or BRM (20, 40 and 60%), as replacement of yellow corn (on gross energy basis), on growth performance parameters of *Oreochromis niloticus* fingerlings.

MATERIALS AND METHODS

The present study was carried out in Fish Research Laboratory, Department of Animal Production, Faculty of Agriculture, Kafr El-Sheikh University during the period from April until July 2006 for 98 days.

Fish and experimental groups:

Total of 140 *O. niloticus* fingerlings with average live body weight of 11.32$\pm$2.0 g and body length of 8.93$\pm$0.10 cm were randomly stocked in 14 glass aquaria (80 x 35 x 40 cm) at a rate of 10 fish/aquarium.

Experimental fish were distributed to seven dietary treatments, in duplicates for each treatment as shown in Table (1). Fish in the control group (T1) were fed the control diet containing yellow corn and considered 100% of yellow corn. In treatments T2, T3 and T4, 20, 40 and 60 of the total gross energy of yellow corn was replaced by potato processing by-product meal (PPB) on the basis of gross energy, respectively. While in T5, T6 and T7, the same energy levels of the yellow corn were replaced by broken rice meal (BRM).

Table (1): Ingredients and chemical composition of the experimental diets used in feeding fish in different experimental groups.

Ingredient (%)	Control (T_1)	Potato processing by-product meal			Broken rice meal (BRM)		
		As (%) of yellow corn gross energy					
		20% (T_2)	40% (T_3)	60% (T_4)	20% (T_5)	40% (T_6)	60% (T_7)
Fish meal	10	10	10	10	10	10	10
Soybean meal	45.00	45.00	45.00	45.00	45.50	46.00	46.00
Yellow corn	34.00	27.20	20.40	13.60	27.20	20.40	13.60
PPB	-	4.97	9.95	14.93	-	-	-
BRM	-	-	-	-	7.07	14.15	21.23
Wheat bran	5.20	8.13	11.15	14.17	4.23	3.35	2.97
Corn oil	5.00	3.90	2.70	1.50	5.20	5.30	5.40
Vitamin mixture	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Mineral mixture	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Total	100	100	100	100	100	100	100
Chemical analysis (%) on DM basis							
DM %	91.15	91.09	90.14	90.81	91.63	90.56	91.48
CP %	31.80	31.98	32.32	32.21	31.92	31.85	32.09
EE%	8.45	8.71	8.85	9.23	8.14	8.03	7.56
CF %	5.53	5.72	6.15	6.54	4.41	4.20	3.69
Ash %	5.16	5.34	5.52	5.39	4.70	4.48	4.15
NFE* %	49.06	48.25	47.16	46.63	50.83	51.44	52.51
GE** Kcal/kg	4779	4788	4795	48.19	4782	4784	4778
P/E ratio (mg/Kcal)	66.5	66.8	67.4	66.84	61.75	66.58	67.16

* Calculate by difference = 100-+ (CP + EE + CF Ash)

** Calculated using the factors (5.65, 9.45, 4.0 and 4.0 Kcal/g) of CP, EE, CF and NFE according to NRC (1993).

E = Gross energy Kcal P = Crude protein (mg)

PPB = Potato processing by-product BRM = Broken rice meal.

DM % = Dry Matter CP % = Crude Protein EE% = Ether Extract

CF % = Crude Fat NFE* % = Nitrogen Free Extract

Fish were fed the tested diets for six days/week at a rate of 3% of fish live body weight for 98 days.

Experimental procedures:

At the end of the experimental period, final weight, feed intake and final length was recorded and then total weight gain, average daily gain, length gain, relative growth rate and specific growth rate were calculated. Also, survival rate, feed conversion ratio, retained nutrients, protein and fat efficiency ratios, protein and fat productive values, hepato-somatic index and condition factor were calculated according to the following equations:

Total weight gain (TWG, g) = Final weight (g.)-Initial weight (g)

Length gain (LG, cm) = Final length (cm)-Initial length (cm.

Average daily gain (ADG, g/d) = TWG (g)/ experimental period (d).

Specific growth rate (SGR, %/d) = (Ln Wt_1-Ln Wt_0/T) x 100.

Where: Ln is the natural logarithm, Wt1= final weigh, Wt_0 = initial weight and T = experimental period according to Pouomogne and Mbongblang (1993).

Relative growth rate (RGR, %) = (Wt_1-Wt_0/Wt_0) x 100.

Survival rate: SR %

$$(SR,\%)=\left[\frac{\text{(Total number of fish at the end of the experiment)}}{\text{(Total number of fish at the start of the experiment)}}\right]\times 100$$

Feed conversion ratio (FCR) = Feed intake (g)/weight gain (g)

Retained Nutrients RN = B - A

Where: A = Nutrient content of carcass at the start (on DM basis)

= Body weight at the start x DM % x nutrient % at the start.

B = Nutrient content of carcass at the end (on DM basis)

= Body weight at the end x DM % x nutrient % at the end.

Protein efficiency ratio (PER, %)=(TWG (g)/protein intake (g) x 100. according to Davis and Morries (1997).

Protein productive value (PPV, %) = [Retained protein (g)/protein intake (g)] x 100 according to Maries and Kissil (1979).

Fat productive value (FPV, %) = [Retained fat (g)/fat intake (g) x 100.

Condition factor (K, %) = [Live body weight (g)/total length (cm^3) x 100.

Hepato-somatic index (HSI) = [Liver wet weight (g)/body weight (g)] x 100.

Liver glycogen was determined according (Handel, 1965).

The chemical analysis of the experimental diets and the carcass at the end of experiment were carried out using the methods of A.O.A.C. (1990).

Statistical analysis:

The data obtained were analyzed by F-test using SAS (1996) procedure for personal computer. Least significant difference according to Duncan (1955) was used for the comparison among the significant group means at level of $P<0.05$.

RESULTS AND DISCUSSION

Body weight and growth performance:

Data of growth performance parameters of fish as affected by replacing yellow corn energy with different PPB or BRM at 20, 40 and 60% levels presented in Table (2) show that BRM levels increased final body weight, total weight gain, average daily gain, relative growth rate and specific growth rate as compared to the control (T1), being the highest ($P<0.05$) with 60% BRM (T7). However, PPB levels decreased the previous traits as compared to the control (T1), being the lowest ($P<0.05$) with 60% PPB (T4).

It is of interest to note that, survival rate did not differ in T3 and T7 than that in the control (T1), being 95%, but improved to 100% in T5 and impaired to be 90% in T2, T4 and T6 (Table 2).

According to growth performance parameters of fish in different treatments, yellow corn as the main energy source in fish diet could be replaced successfully by 60% BRM. However, increasing PPB levels up to 60% had eversible effects on growth performance of fish. Such differences in the present results between PPB and BRM may be attributed to the utilization of different types and sources of carbohydrates as a source of energy for fish. Carbohydrate of the broken rice is mostly dextrin and only starch and is starch in PPB and yellow corn.

In comparable with the present results, Ghazalah et al. (2002) found that yellow corn energy can be substituted up to 50% by potato by-product meal without harmful effects on the performance and feed utilization of fish.

To the same results Mostafa (2003) reported that *O. niloticus* grew well when potato peel meal represents only 23% of the diet or 50% of yellow corn in the control diet. While the higher levels of substitution (75% and 100%) showed negative effects on performance of tilapia.

Table 2. Growth performance parameters of Nile tilapia (*O. niloticus*) fed the experimental diets.

Treat. No.	Treat.	Initial weight (g)	Final weight (g)	Total weight gain (g)	Average daily gain (g)	RGR (%)	SGR (g/fish/day)	SR (%)
T_1	Control	11.30 ±0.015	39.22^{ab} ± 0.59	27.92^{ab} ± 0.61	0.284^{ab} ± 0.006	246.97^{ab} ± 5.72	1.269^{ab} ± 0.017	95 ±5.11
T_2	PPB 20%	11.49 ±0.015	38.65^{abc} ± 0.47	27.16^{bc} ± 0.46	0.276^{bc} ± 0.004	236.26^{bc} ± 3.69	1.237^{bc} ± 0.011	90 ±0.00
T_3	PPB 40%	11.22 ±0.005	37.78^{bc} ± 0.36	26.56^{bc} ± 0.37	0.270^{bc} ± 0.003	236.61^{bc} ± 3.40	1.238^{bc} ± 0.010	95 ±5.00
T_4	PPB 60%	11.42 ± 0.01	37.06^{c} ± 0.94	25.64^{c} ± 0.93	0.261^{c} ± 0.009	224.55^{c} ± 7.99	1.200^{c} ± 0.025	90 ±10.00
T_5	BRM 20%	11.23 ± 0.01	39.64^{ab} ± 0.22	28.41^{ab} ± 0.21	0.289^{ab} ± 0.002	253.02^{a} ± 1.69	1.286^{ab} ± 0.004	100 ± 0.00
T_6	BRM 40%	11.33 ± 0.02	39.91^{a} ± 0.71	28.58^{ab} ± 0.69	0.291^{ab} ± 0.007	252.28^{ab} ± 5.69	1.284^{ab} ± 0.016	90 ±10.00
T_7	BRM 60%	11.34 ± 0.02	40.66^{a} ± 0.52	29.32^{a} ± 0.50	0.299^{a} ± 0.005	258.58^{a} ± 3.99	1.302^{a} ± 0.011	95 ± 5.00

a, b and c: Means in the same column with different letters are significantly different at $P < 0.05$. RGR: relative growth rate SGR: Specific growth rate
SR: Survival rate.

Feed and nutrients consumption:

Data in Table (3) show no significant differences in feed intake between the control diet (T_1) and other treatments. The highest value of feed intake was obtained by T_7 (60% BRM) and the lowest one was observed by T_4 (60% PPB). Intake from CP was not affected significantly by treatments, ranging between 18.98 and 19.56 g/fish in all treatments.

It is of interest to note that EE intake was not affected (P<0.05) by all PPB levels (T2, T3 and T4), and decreased (P<0.05) in all BRM treatments (T5, T6 and T7) compared with the control (T1). However, high PPB levels in T3 and T4 and all BRM levels increased (P<0.05) NFE intake as compared to the control (T_1), being the highest (P<0.05) in T_7.

Table 3. Intake of feed, CP, EE and NFE of the experimental diets.

Treat. No.	Treatment	Total feed intake (g/fish)	Nutrient intake on DM basis (g/fish)		
			CP	EE	NFE
T_1	Control	60.70^{ab}+0.69	19.30+0.22	5.12^{a}+ 0.05	29.96^{c}+ 0.34
T_2	PPB 20%	60.09^{ab}+0.67	19.21+0.21	5.22^{a}+0.05	29.17^{c}+0.33
T_3	PPB 40%	59.70^{ab}+0.23	19.29+0.07	5.26^{a}+0.02	28.15^{d}+0.11
T_4	PPB 60%	58.95^{b}+0.59	18.98+0.19	5.28^{a}+0.05	27.40^{d}+0.27
T_5	BRM 20%	60.89^{ab}+0.69	19.31+0.22	4.95^{b}+0.05	30.95^{b}+0.35
T_6	BRM 40%	61.20^{a}+0.57	19.37+0.18	4.91^{b}+0.05	31.38^{ab}+0.29
T_7	BRM 60%	61.34^{a}+0.51	19.56+0.16	4.63^{c}+0.04	32.12^{a}+0.27

a, b and c: Means in the same column with different letters are significantly different at P < 0.05.

The present results indicated that both PPB and BRM levels could be used in feeding fish as alternative sources of energy instead of yellow corn up to 40%-60% levels without any effects on total feed intake. Yet, Osman *et al.* (2004) observed significant improvement in feed intake of fish fed diets containing 25, 50, 75 and 100% BRM compared to the control diet of Nile Tilapia .

Body length and condition factor:

Data in Table (4) show that final body length did not differ significantly (P > 0.05) in all treatment groups from that in the control group, being the highest in T7 and the lowest in T4. However, length gain decreased (P<0.05) in T2 and T4 and did not differ significantly in the other groups as compared to the control group. The highest length gain value was obtained in T_5.

Final condition factor (K) values were not affected by dietary treatments as compared to the control group, ranging from 1.598 in T_4 to 1.653 in T_6. These results are generally similar to those obtained by Al-Ogaily *et al.* (1996) and Ghazalah *et al.* (2002).

Table 4. Body length, length gain and condition factor of Nile tilapia (*O. niloticus*) fed the experimental diets.

Tre. No.	Treatment	Body length (cm)		Length gain (cm)	Condition factor (K)	
		Initial	Final		Initial	Final
T_1	Control	8.90±0.10	13.39^{ab}±0.01	4.49^{ab}±0.09	1.605±0.05	1.634±0.03
T_2	PPB 20%	9.05±0.05	13.30^{ab}±0.11	4.25^{c}±0.06	1.551±0.02	1.643±0.02
T_3	PPB 40%	8.90±0.00	13.24^{b}± 0.05	4.34^{bc}±0.05	1.592±0.001	1.628±0.03
T_4	PPB 60%	9.00±0.10	13.23^{b}±0.09	4.23^{c}±0.01	1.568±0.05	1.598±0.01
T_5	BRM 20%	8.85±0.05	13.44^{ab}±0.05	4.59^{a}±0.10	1.621±0.03	1.633±0.03
T_6	BRM 40%	8.90±0.10	13.41^{ab}±0.05	4.51^{ab}±0.04	1.608±0.05	1.653±0.01
T_7	BRM60%	8.95±0.05	13.53^{a}±0.03	4.58^{a}±0.02	1.582±0.02	1.642±0.01

a, b and c: Means in the same column with different letters are significantly different at $P < 0.05$.

Hepato somatic index (HSI) and liver glycogen:

As shown in Table (5), liver weight, hepato-somatic index (HSI) and liver glycogen content significantly ($P<0.05$) increased by the highest level of PPB (60%, T_4) or by 40 and 60% from BRM (T_6 and T_7, respectively) as compared to the control. However, incorporation of 20% either from PPB or BRM or 40% PPB to diet of fish did affect liver traits compared with the control diet.

It was observed that the recorded increase in liver weight in T_4, T_6 and T_7 was associated with increasing HSI, which indicated more pronouncedly increase in liver weight than in body weight of fish in these groups, and such trend was mainly related to increasing glycogen contents in hepatic tissue of fish in T_4, T_6 and T_7 (Table 5).

Table 5. Liver weight, hepato-somatic index and liver glycogen of Nile tilapia (*O. niloticus*) fed the experimental diets.

Treat. No.	Treatment	Liver weight (g)	Hepato-somatic index	Glycogen content (mg/g liver tissue)
T_1	Control	0.73^{cd}+0.03	1.86^{d}+0.10	4.05^{d}+0.26
T_2	PPB 20%	0.70^{d}+0.03	1.81^{d}+0.09	4.24^{d}+0.46
T_3	PPB 40%	0.74^{cd}+0.04	1.96^{cd}+0.17	4.59^{d}+0.38
T_4	PPB 60%	0.91^{b}+0.01	2.45^{ab}+0.06	5.93^{bc}+0.40
T_5	BRM 20%	0.80^{c}+0.02	2.02^{bcd}+0.11	5.10^{cd}+0.18
T_6	BRM 40%	0.96^{b}+0.10	2.40^{abc}+0.03	6.52^{ab}+0.42
T_7	BRM 60%	1.09^{a}+0.035	2.68^{a}+0.21	7.66^{a}+0.15

a, b and c: Means in the same column with different letters are significantly different at $P < 0.05$.

The present results exhibited greater HSI values than those recorded in striped bass fingerlings (0.99-1.86 g) by Rawles and Gatlin (1998). Also, Hemre and Hansen (1998) reported relatively low HSI values of 0.83, 0.86 and 0.91 when they evaluated gelatinized wheat, corn and oats in diet of Atlantic salmon. Also, the present values are higher than those obtained by Kaushik *et al.* (1989) in rainbow trout fed low-protein diet containing high level (38%) of different carbohydrate sources (raw starch, extruded corn, extruded wheat, extruded corn starch or extruded wheat starch), which ranged between 1.5 to 2.1. Such differences may be attributed to fish species differences and/or feeding regime.

Increasing values of liver weight, HSI and liver glycogen in BRM compared to PPB treatments may be due to the higher values of NFE content in BRM diets, NFE intake, total feed intake, nutrients retained and nutrients utilization, in addition to the lower CF content in BRM diets. These results are in agreement with some pervious studies which exhibited that liver glycogen increases with elevated level of dietary carbohydrate (Buhler and Halver, 1961; Garling and Wilson, 1977). Also, Wilson (1994) showed that liver size and glycogen content tended to increase with elevated levels of dietary carbohydrates in several fish species.

Carcass composition:

Data concerning carcass composition of fish at the end of the experiment (Table 6) show that DM content decreased (P<0.0) only in T_2 as compared to the control (T_1), while DM content in carcass of fish in the other treatments (T_3-T_7) did not differ significantly from that of the control group.

It is of interest to note that CP content was not affected significantly by all PPB levels, but increased with BRM levels, being significantly (P<0.05) only with 40 and 60% BRM levels as compared to the controls. The opposite trend was observed with EE content, being higher with all PPB levels and was not affected significantly by RBM levels (Table 6). Such trend was associated with slightly higher CP intake and lower (P<0.05) EE intake of fish fed RBM than PPB (Table 2). Generally, in all PPB or RBM diets ash content decreased (P < 0.05) as compared to the control group (Table 6).

Table 6. Carcass composition (on DM basis) of Nile tilapia (*O. niloticus*) fed different levels of PPB or BRM.

Treat. No.	Treatment	DM (%)	Chemical composition (%)		
			CP	EE	Ash
T_1	Control	$25.63^{ab}\pm0.13$	$61.90^{cd}\pm0.22$	$21.25^{c}\pm0.08$	$16.49^{a}\pm0.15$
T_2	PPB 20%	$24.92^{c}\pm0.19$	$62.34^{bc}\pm0.13$	$23.67^{b}\pm0.39$	$13.78^{b}\pm0.04$
T_3	PPB 40%	$25.18^{bc}\pm0.38$	$62.10^{bc}\pm0.28$	$24.31^{ab}\pm0.07$	$13.23^{d}\pm0.22$
T_4	PPB 60%	$25.60^{ab}\pm0.11$	$61.29^{d}\pm0.09$	$24.98^{a}\pm0.21$	$13.35^{d}\pm0.25$
T_5	BRM 20%	$25.76^{ab}\pm0.15$	$62.47^{bc}\pm0.19$	$21.73^{c}\pm0.33$	$15.66^{b}\pm0.08$
T_6	BRM 40%	$26.01^{a}\pm 0.11$	$62.80^{ab}\pm0.03$	$21.39^{c}\pm0.10$	$15.25^{b}\pm0.18$
T_7	BRM 60%	$25.87^{a}\pm0.09$	$63.35^{a}\pm0.25$	$22.02^{bc}\pm0.37$	$14.54^{c}\pm0.12$

a, b ...d: Means in the same column with different letters are significantly different at P < 0.05.

In this connection Anderson *et al.* (1984) found that as more energy was provided by carbohydrate in experimental diets (10, 25 and 40%) for *O. niloticus*, all the assimilable carbohydrates had a protein-sparing effect. They added that the proportion of protein energy in the diets decreased and this led to an increase in carcass protein retained per unit protein fed and at low carbohydrate inclusion levels when approximately 50% of the total energy was provided by protein. El-Sayed and Garling (1988) found that the fat content of the whole *O. niloticus* varied between 18.3 to 29.4% when tilapia fed diets were fed at variable levels of dextrin ranged from 12 to 41% as a source of carbohydrate at mixture of fish and soy bean oil.

Protein and fat retention:

Protein and fat retention of fish fed the experimental diets are presented in Table (7). The present data indicated that protein retention insignificantly decreased by increasing PPB levels and increased by increasing BRM level in fish diets. However, fat retention increased gradually with increasing level of PPB or RBM with no significant differences. Generally, fat retention was higher at the same levels of PPB than BRM, probably due to the higher EE content of PPB than that of BRM

These results may indicate that the inclusion of PPB and BRM in fish diets to replace up to 40 and 60% of yellow corn energy, respectively gave good values of nutrients retention. These findings confirm the results obtained for final body weight (Table 2) and feed intake (Table 3), in addition to carcass composition (Table 6).

Table 7. Protein and fat retention of Nile tilapia (*O. niloticus*) fed the experimental diets.

Treat. No.	Treatment	Retained protein		Retained fat	
		(g/fish)	%	(g/fish)	%
T_1	Control	$4.68^{abc}\pm0.15$	100	$1.61^{b}\pm0.03$	100
T_2	PPB 20%	$4.44^{bc}\pm0.13$	94.9	$1.75^{ab}\pm0.08$	108.69
T_3	PPB 40%	$4.38^{c}\pm0.05$	93.6	$1.79^{ab}\pm0.01$	111.18
T_4	PPB 60%	$4.26^{c}\pm0.18$	91.0	$1.84^{a}\pm0.09$	114.28
T_5	BRM 20%	$4.85^{ab}\pm0.01$	103.6	$1.69^{ab}\pm0.03$	104.96
T_6	BRM 40%	$4.98^{a}\pm0.14$	106.4	$1.70^{ab}\pm0.06$	105.59
T_7	BRM 60%	$5.12^{a}\pm0.13$	109.4	$1.79^{ab}\pm0.07$	111.18

a, b and c: Means in the same column with different letters are significantly different at $P < 0.05$.

Efficiency of feed, protein and fat utilization:

The present results in Table (8) show that the best feed conversion ratio (FCR) and the highest protein efficiency ratio (PER) were insignificantly recorded by fish in T_7. However, protein productive value (PPV) and fat utilization was higher (P<0.05) only in T_7 than the control (T_1). On the other hand the poorest traits were obtained by T_4. These results go parallel with all foregoing growth parameters.

The lowest values of PER and PPV of fish fed 60% PPB diet (T_4) were expected mainly due to the significant decrease in retained protein and body weight gain. However, the improvement in FPV of T_7 may be attributed to increased retained fat and EE intake. In this respect, Ghazalah *et al.* (2002) reported that, yellow corn can be substituted by 50% potato by-product meal without negative effect on the performance of Nile tilapia. Osman *et al.* (2004) reported that increasing BRM level up to 75% instead of yellow corn increased the fish growth rate and improved feed utilization.

Table 8. Feed efficiency, and protein and fat utilization of Nile tilapia (*O. niloticus*) fed the experimental diets.

Treat. No.	Treatment	FCR	Protein utilization		Fat utilization
			PER	PPV %	FPV %
T_1	Control	$2.17^{bc}\pm0.02$	$1.44^{ab}\pm0.01$	$24.26^{bc}\pm0.52$	$31.50^{b}\pm0.3$
T_2	PPB 20%	$2.21^{ab}\pm0.01$	$1.41^{bc}\pm0.01$	$23.12^{cd}\pm0.44$	$33.48^{b}\pm1.1$
T_3	PPB 40%	$2.24^{ab}\pm0.025$	$1.37^{cd}\pm0.01$	$22.69^{cd}\pm0.34$	$34.03^{b}\pm0.3$
T_4	PPB 60%	$2.30^{a}\pm0.06$	$1.34^{d}\pm0.03$	$22.46^{d}\pm0.75$	$34.80^{b}\pm1.3$
T_5	BRM20%	$2.14^{bc}\pm0.01$	$1.46^{ab}\pm0.01$	$25.14^{ab}\pm0.21$	$34.20^{b}\pm0.3$
T_6	BRM40%	$2.14^{bc}\pm0.03$	$1.47^{ab}\pm0.02$	$525.70^{ab}\pm0.48$	$34.61^{b}\pm0.8$
T_7	BRM60%	$2.09^{c}\pm0.02$	$1.49^{a}\pm0.01$	$26.19^{a}\pm0.47$	$38.75^{a}\pm1.2$

a, b and c: Means in the same column with different letters are significantly different at P < 0.05.

Economical evaluation:

Results shown in Table (9) revealed that the cost of one ton of feed mixture reduced in all levels of yellow corn substitution either by PPB or BRM meal as alternative energy source. According to the growth performance of Nile tilapia, the calculated figures of feed cost/kg gain show different meanings. For PPB containing diets substitution up to 40% was better than 60%. While as BRM replaced yellow corn, the feed cost/kg gain in fish weight improved gradually by the increasing of the substitution levels. These findings indicated that PPB could replace yellow corn energy safely and economically up to 40% level. While BRM as alternative energy source could be used economically in a wide range up to 60% of yellow corn which was the best level of growth and utilization of nutrients.

Table 9. Economic efficiency for production of one (kg) gain of Nile tilapia (*O. niloticus*) fed different levels of potato processing by-product and broken rice meal.

Treat No.	Treatment	Feed intake (g/fish)	Cost/ton feed (L.E)	Reduction in feed cost (L.E/ton)	Total gain (g/fish)	Feed cost/kg fish gain (L.E.)
T_1	Control	60.70	2216.80	0.00	27.92	4.82
T_2	PPB 20%	60.09	2132.19	84.61	27.16	4.71
T_3	PPB 40%	59.70	2042.45	174.35	26.56	4.59
T_4	PPB 60%	58.95	1952.71	264.09	25.64	4.49
T_5	BRM 20%	60.89	2208.29	8.51	28.41	4.73
T_6	BRM 40%	61.20	2194.67	22.13	28.58	4.70
T_7	BRM 60%	61.34	2175.55	41.25	29.32	4.55

Ingredients prices at Local market **(L.E/ton) for the year 2006:**

Fishmeal	5000	Soy bean meal	2000
Yellow corn	1100	Potato processing by-product	600
Broken rice meal	750	Wheat bran	900
Corn oil	60000	Vitamin mixture	12000
Mineral mixture	12000		

CONCLUSION

The results of the present study revealed that 40 and 60% of yellow corn energy could be replaced by PPB or BRM, respectively without adverse effects on tilapia growth performance feed utilization, body composition and in addition improved the economical efficiency.

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تقييم بعض البدائل لمصادر الطاقة فى عليقة الأسماك البلطى النيلى

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تم إجراء هذا البحث بمعمل بحوث الأسماك بقسم الإنتاج الحيواني بكلية الزراعة بكفر الشيخ وذلك من أجل دراسة واستخدام بعض المكونات الغير تقليدية الناتجة من بعض العمليات التصنيعة في بعض المصانع بغرض تصنيع علائق رخيصة الثمن اضافة إلى التخلص من هذه المخلفات بطريقة اقتصادية لذلك تم دراسة إحلال طاقة الذرة الصفراء بطاقة مخلفات تصنيع البطاطس أو كسر الأرز بمستويات (٠ ، ٢٠ % ، ٤٠ % ، ٦٠ %) وتم استخدام (٦) معاملات تجريبية بالإضافة إلى المعاملة القياسية (الكنترول) وكل معاملة في مكررتين واحتوت جميع العلائق التجريبية تقريباً على (٣٠ %) بروتين – (٤٣٠٠) كيلو كالوري طاقة كلية / كجم .

وتم دراسة تأثير ذلك على كفاءة النمو ، التركيب الكيماوي للجسم ، كفاءة التحويل الغذائي ، كفاءة استخدام البروتين والدهن في أسماك البلطي النيلي ، وتم استخدام (١٤٠) سمكة من إصبعيات البلطي النيلي بمتوسط وزن (١١,٣٢ جرام) تم توزيعها عشوائياً وبالتساوي بمعدل (١٠) سمكات / حوض ، وتم تقديم العلائق للأسماك بمعدل (٣ %) من وزن الجسم ثلاث مرات يومياً وتم وزن السمك وتعديل كمية العلائق المقدمة للأسماك تبعاً للتغير في الوزن خلال مدة التجربة (٩٨) يوماً .

وكانت أهم النتائج التي تم التوصل إليها من خلال هذا البحث أنه لا توجد اختلافات معنوية واضحة في الغذاء والبروتين المأكول وكل المعاملات التي تحتوي على مسحوق مخلفات البطاطس أو كسر الأرز ، والدهن المأكول قل معنوياً بزيادة مستوى الأرز حتى (٦٠ %) مقارنة بالكنترول ، بينما زاد زيادة غير معنوية بزيادة مستوى البطاطس ، كما أن المأكول من الكربوهيدرات الذائبة قل بزيادة البطاطس عن (٢٠ %) وزاد بزيادة مستوى كسر الأرز حتى (٦٠ %) ، كما لا توجد فروق معنوية واضحة بزيادة الوزن الكلي ومعدل النمو النسبي والنوعي في الأسماك المغذاة على علائق تحتوي على مخلفات تصنيع البطاطس حتى (٤٠ %) ، كما تبين أن الأسماك المغذاة على عليقة تحتوي على (٦٠ %) طاقة كسر الأرز بدلاً

من طاقة الذرة الصفراء اعطت أفضل قيم الزيادة في الوزن الكلي ومعدل النمو النسبي مقارنة بكل من الكنترول والمعاملات الأخرى .

كما تبين وجود اختلافات معنوية بالنسبة لوزن الكبد ودليل الكبد الجسمي وجليكوجين الكبد بين الكنترول وكل المعاملات (سواء البطاطس أو كسر الأرز) والتي كانت أعلى في الكنترول ماعدا المعاملات (٢ ، ٣ ، ٥) والتي لم تكن هناك اختلافات معنوية .

كما أوضحت النتائج أن محتوي المادة الجافة للجسم في الكنترول كان أعلى في كل معاملات البطاطس بينما قل في معاملات الأرز أما البروتين المحتجز فقد انخفض بزيادة مستوى مسحوق مخلفات البطاطس بينما تحسن بزيادة مستوى كسر الأرز ، الدهن تحسن بزيادة مستوى مسحوق مخلفات البطاطس أو كسر الأرز .

اتضح من نتائج هذه التجربة أنه مما سبق نستنتج أنه يمكن استخدام كل من مخلفات تصنيع البطاطس و كسر الأرز في علائق أسماك البلطي النيلي حتى مستوى استبدال (٤٠ %) ، (٦٠ %) من طاقة الذرة الصفراء على الترتيب.