ISSN 1110-0419

Annals Of Agric. Sc., Moshtohor,
Vol. 40(4):2081-2096, (2002)

USING OF TOMATO AND POTATO BY-PRODUCTS AS NON-CONVENTIONAL INGREDIENTS IN NILE TILAPIA, *OREOCHROMIS NILOTICUS* DIETS

BY

SOLTAN, M. A.

Faculty of Agriculture, Moshtohor, Zagazig University, Banha branch

ABSTRACT

The present study was designed to evaluate the effect of replacing the protein source of soybean meal (SBM) by tomato by-product meal (TBM) and replacing yellow corn (YC) by potato by-product meal (PBM) on growth performance and feed utilization of Nile tilapia, *O. niloticus*. Therefore, two experiments were conducted, in the first experiment nine experimental diets were formulated to contains 0 to 80% replacing levels of SBM by TBM in 10% increments. In the second experiment another nine experimental diets were formulated to contains 0 to 80% replacing levels of YC by PBM in 10% increments and each diet was fed to two replicates. Experimental diets of the two experiments were formulated to be isonitrogenous (30% CP) and isocaloric (3300 ME/kg diet) and P/E ratio of 90 mg protein/kcal (ME). During the two experimental periods diets were fed to Nile tilapia (*O. niloticus*) 6 days/week at 4% of live body weight through 10 weeks experimental period. Results of the first experiment showed that:

Replacement of SBM by TBM up to 50% did not affect fish body weight (BW), body length (BL) weight gain (WG), specific growth rate (SGR), feed intake (FI), feed conversion ratio (FCR) and protein efficiency ratio (PER). Also, replacing 50% of SBM by TBM did not exert significant effect on the dress-out, by-products, flesh, moisture and protein content in fish bodies.

Results of the second experiment showed that replacing YC in tilapia diets by PBM up to 40% did not significantly affect all growth parameters (BW, BL, WG and SGR), feed utilization (FI, FCR and PER) and the same trend was also observed for flesh, moisture, protein, fat and ash contents in fish bodies.

From economic view, it was observed that replacing 50% of SBM by TBM in tilapia diets reduces feed costs by 10.93% while replacing 40% of YC by PBM reduced feed costs by 7.53%.

INTRODUCTION

In Egypt, it is commonly known that, there is an observed shortage in the traditional feedstuffs rather than the continuous increase in their prices from time to time. Also, the high costs and/or fluctuating quality of soybean meal lead to identify alternative protein sources for use in fish feed formulation. Therefore, attempts have been carried out to search for alternative untraditional low price by-products which could be used in fish diets. Hassanen (1991) demonstrated that, the Nile catfish (*Clarias lazera*) was able to utilize a diet containing 66%

unconventional protein supplement (tomato, brewers dried grain and bean haulms).

Tomato waste is one of the canning wastes which tried by many workers (Khadzhinikolova and Tomasyan, 1983 and 1984; Hassanen, 1986; Hassanen et al., 1995; El-Shamma et al., 1997 and Saad, 1998). The processing of tomatoes yields several by-products such as seeds and peels which are mostly classified as tomato pomace, tomato seed meal, tomato seed cake and tomato seed oil. The total waste produced from tomato from world production was estimated roughly to be 3.7 million tons/year (FAO, 1991). According to the informations released by "Kaha" and "Edfina" companies, the two companies produce not less than 1080 tons of tomato waste/year (Saad, 1998).

In Egypt, the yield of potatoes crop was 1984013 tons in 1999 and the waste was determined by 12.2% (Ghazalah et al., 2002). The metabolizable energy content of PBM is 3.2 kcal/g which is comparable with that of corn being 3.47 kcal/g (NRC, 1993). Potato processing is a very specialized field which can not be described briefly. The potato processing industry produces several products and by-products. The main aspects are dealing with the following; peeling potatoes for processing, processing of potato chips, frozen French fries, dehydrated mashed potatoes as granules or flaks and potato starch flour. Potato waste meal (potatoes, potato pulp and peeling) is a product produced by drying and grinding of culls of potatoes, potato trimming, pulp, peeling and off-colour parts of French fries and potato chips.

The present study aimed to investigate the possibility of using the low price tomato and potato by-products as unconventional protein and energy sources instead of the high piece common sources, soybean and yellow corn in Nile tilapia diets.

MATERIALS AND METHODS

The experimental work of the present study was carried out at the Laboratory of Aquaculture Research, Faculty of Agriculture, Moshtohor, Zagazig University (Banha branch). Two experiments were conducted to evaluate the effect of replacing the protein source of SBM by TBM (Exp. 1) and replacing the energy source of YC by PBM (Exp. 2) in tilapia diets.

Preparation of tomato and potato by-products:

Tomato by-product was obtained from Kaha factory, located in Kaha, Kalubia Governorate while potato by-product obtained from chippsy factory, 10^{th} of Ramadan City. Tomato and potato by-products were sun-dried and the resulting residues were ground to meal and incorporated in the experimental diets after the chemical analysis.

Nine experimental diets were formulated to contains 0 to 80% (10% increment) TBM as a partial replacement of SBM (Exp. 1). Another nine experimental diets were also formulated by the same substitution levels (0 to 80%) but containing PBM (Exp. 2) as a partial replacement of YC. Composition and proximate analysis of the experimental diets used in the two experiments are presented in Tables (1 and 2).

Eighteen rectangular aquaria 100 × 40 × 50 cm (200 liter for each) were used in each experiment (2 replicates for each treatment), and each aquarium was stocked with 25 fish. The average body weights were 7.93±0.23 and 4.94±0.15 g for fish used in the first and the second experiments, respectively. Fish were given the pelleted diets (3 mm in diameter) at a daily rate of 4% of total biomass during the experimental period 6 day/week (twice daily at 9.00 am and 3.00 pm) and the amount of feed was bi-weekly adjusted according to the changes in body weight throughout the experimental period (10 weeks).

Table (1): Composition and proximate analysis of the experimental diets (Exp. 1).

Ingredients	Diets								
	TBM0	TBM10	TBM20	TBM30	TBM40	TBM50	TBM60	TBM70	TBM80
Fish meal (65%)	28	28	28	28	28	28	28	28	28
Soybean meal (40%)	20	18	16	14	12	10	8	6	4
Yellow corn	45	43	41	39	37	35	33	31	29
Tomato by-product	0	4	8	12	16	20	24	28	32
Corn oil	2	2	2	2	2	2	2	2	2
Cr_2O_3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Bone meal	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Vit. & Min. Mixture[1]	3	3	3	3	3	3	3	3	3
Sum	100	100	100	100	100	100	100	100	100
Proximate analysis	*(determined on dry matter basis)*								
Moisture	5.71	5.14	5.11	4.99	5.27	4.80	4.89	4.85	4.58
Crude protein (CP)	30.05	30.02	30.09	30.50	30.03	30.10	30.20	30.11	30.01
Ether extract (EE)	4.80	4.90	4.95	4.83	4.96	5.50	5.58	5.32	5.49
Crude fiber (CF)	9.50	9.66	10.03	10.29	10.68	11.00	11.57	11.73	11.80
Ash	10.13	10.61	10.88	10.76	10.91	11.23	10.56	10.60	10.70
NFE[2]	45.52	44.81	44.05	43.62	43.42	42.17	42.09	42.24	42.00
ME (Kcal/kg diet)[3]	3393	3332	3313	3306	3289	3294	3303	3282	3283
P/E ratio	89.74	90.10	90.82	92.26	91.30	91.38	90.43	91.74	91.41

Digestibility study:

A chromic oxide marker was included in all experimental diets (of the two experiments) at a rate of 0.5%. During the last three weeks of each experiment, fish provided the diets and feces were collected daily from each tank as described by Hajen et al., (1993). Feeds and collected feces were dried to a constant weight. Proximate analysis of diets and feces were conducted in duplicates for dry matter (DM) crude protein (CP), ether extract (EE), crude fiber (CF) and ash. Chromic oxide levels were determined in diets and feces (Fenton and Fenton, 1979) and apparent digestibility coefficients for DM, CP, EE and NFE were calculated (NRC, 1993). Records of live body weight (g) and body length (cm) of individual fish were measured at the start and the end of the two experimental periods for each aquarium. Growth performance parameters were measured by using the following equations:

Specific growth rate (SGR) = $\frac{LnW2 - LnW1}{t}$ x 100

Where:- Ln = the natural log, W1 = initial fish weight; W2 = the final fish weight in "grams" and t = period in days.

Weight gain (WG) = final weight (g) – initial weight (g)

Feed conversion ratio (FCR) = feed ingested (g)/weight gain (g)

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

Table (2): Composition and proximate analysis of the experimental diets (Exp. 2).

Ingredients	Diets								
	PBM0	PBM10	PBM20	PBM30	PBM40	PBM50	PBM60	PBM70	PBM80
Fish meal	28	28	28	28	28	28	28	28	28
Soybean meal	20	20	20	20	20	20	20	20	20
Yellow corn	45.0	40.5	36.0	31.5	27.0	22.5	18.0	13.5	9.0
Potato by-product	0	4.5	9.0	13.5	18.0	22.5	27.0	31.5	36.0
Corn oil	2	2	2	2	2	2	2	2	2
Vit.& min. Mixture[1]	3	3	3	3	3	3	3	3	3
Bone meal	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Cr_2O_3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sum	100	100	100	100	100	100	100	100	100
Proximate analysis *(determined on dry matter basis)*									
Moisture	5.03	5.28	5.58	5.80	5.34	5.70	5.40	5.23	5.80
Crude protein (CP)	30.11	30.14	30.17	30.40	30.32	30.25	30.18	30.11	30.00
Ether extract (EE)	4.69	4.77	4.19	4.56	4.82	4.96	4.27	4.59	4.92
Crude fiber (CF)	9.45	9.87	10.20	9.88	9.39	9.65	9.33	9.71	9.87
Ash	8.79	9.03	8.97	9.11	9.56	9.87	10.27	10.64	10.55
NFE[2]	46.96	46.19	46.47	46.05	45.91	45.27	45.95	44.95	44.66
ME (Kcal/kg diet)[3]	3394	3374	3336	3363	3377	3363	3325	3314	3327
P/E ratio	88.71	89.33	90.44	90.40	89.78	89.95	90.77	90.86	90.17

[1]Vitamin & mineral mixture/kg premix : Vitamin D_3, 0.8 million IU; A, 4.8 million IU; E, 4 g; K, 0.8 g; B1, 0.4 g; Riboflavin, 1.6 g; B6, 0.6 g, B12, 4 mg; Pantothenic acid, 4 g; Nicotinic acid, 8 g; Folic acid, 0.4 g Biotin,20 mg , Mn, 22 g; Zn, 22 g; Fe, 12 g; Cu, 4 g; I, 0.4 g, Selenium, 0.4 g and Co, 4.8 mg.

[2]Nitrogen free extract (NFE) =100-(CP+EE+CF+Ash)

[3]Based on kilocalorie values of 4.50 g^{-1} protein, 8.51 g^{-1} lipid and 3.49 g^{-1} NFE (Jauncy, 1982).

At the end of each experiment, five fish were randomly sampled from each aquarium and slaughtered. The weight of head, viscera, flesh, carcass and total by-products were recorded. All carcass components were measured according to Lovell (1981). Another five fish were also chosen at random and exposed to the proximate analysis of whole fish body according to the methods of AOAC (1990).

The statistical analysis of data was carried out by applying the computer program, SAS (1996) by adopting the following model:-

$Y_{ijk} = \mu + R_i + \alpha_j + E_{ijk}$

Where, Y_{ijk} = the observation on the ijkth fish eaten the jth diet for the ith replicate; μ = overall mean, R_i = the effect of ith replicate; α_j = the effect of jth diet and E_{ijk} = random error.

RESULTS AND DISCUSSION

Results of feeding Nile tilapia, *Oreochromis niloticus* on the different experimental diets containing the different levels of tomato or potato by-product during the feeding trials are going to be discussed under three points: a) proximate analysis of tomato and potato by-products , b) effect of tomato or potato by-products on nutrients digestibility of different experimental diets, and c) effect of tomato or potato by-products on growth performance, feed utilization, carcass and proximate analysis of whole body of Nile tilapia, *O. niloticus.*

First experiment:

a) Proximate analysis of tomato by-product meal (TBM):

As described in Table (3) TBM contained 91.72 DM, 20.13% CP, 7.92% EE, 29.33% CF, 11.11% ash and 31.51% NFE. The high protein content (20.13%) in TBM show the possibility of incorporation this cheap industrial by-product in fish diets, moreover the EE content is high compared with SBM being 7.92 and 2.31%, respectively. Alicata et al., (1988) found that, tomato waste contained 22.0 CP, 32.8 CF and 19.5% EE. El-Sayed (1994) demonstrated that, the chemical composition of tomato by-product was 93.96 DM, 16.11 CP, 5.49 EE, 44.18 CF, 28.73 NFE, and 5.49% ash. Hassanen (1986) reported that, the proximate analysis of tomato pulp was 95.61 DM, 24.38 CP, 6.43 EE, 25.94 CF, 31.50 NFE and 7.30% ash. Saad (1998) found that, the average values of moisture, CP, EE, CF, ash and NFE in tomato waste were 7.44, 28.08, 11.92, 31.36, 9.53 and 11.67%, respectively.

Table (3): Proximate analysis of tomato by-product meal (TBM) and soybean meal (SBM).

Item	TBM	SBM
Dry matter (DM)	91.72±2.14	91.00±1.50
Crude protein (CP)	20.13±0.11	40.21±0.23
Ether extract (EE)	7.92±0.33	2.31±0.26
Crude fiber (CF)	29.33±0.41	6.50±0.32
Ash	11.11±0.10	6.16±0.27
NFE*	31.51±0.10	44.82±0.45

*Nitrogen free extract (NFE) =100-(CP+EE+CF+Ash)

b) Nutrient digestibility:

Results of Table (4) show that, apparent digestibility coefficient (ADC) for DM ranged between 78.26 and 82.30% with insignificant differences between experimental diets attributed to replacing levels 0 to 70% of SBM by TBM, but incorporation of 80% of TBM in fish diets as partial replacement of SBM significantly (P<0.05) decreased ADC of DM to 75.26%. Saad (1998) found that, replacing 44.40% of SBM by TBM improved ADC for DM. With respect to CP it is clear that ADC lie in three clusters, the first one includes two diets (TBM0 and TBM10), the second cluster includes another three diets (TBM20, TBM30 and TBM40) and the third one includes four diets (TBM50, TBM60, TBM70 and TBM80). Statistical analysis indicated that, the differences between the first and the third clusters are significant while differences between the second and each of the first and the third clusters are not significant, therefore we can concluded that, replacing up to 40% of SBM by TBM did not significantly changed ADC for CP but the higher replacing levels 50 to 80% significantly decreased ADC for CP. It was also observed that, replacing up to 60% of SBM by TBM had no significant effect on the ADC of EE and NFE.

Table (4): Apparent digestibility coefficients (ADC) for different nutrients in experimental diets contained TBM.

Diets	DM	CP	EE	NFE
TBM0	82.30±1.99 a	77.85±1.10 a	90.96±0.78 a	71.72±1.19 abc
TBM10	81.84±1.99 a	78.35±1.10 a	91.05±0.78 a	73.39±1.19 ab
TBM20	80.76±1.99 a	76.86±1.10 ab	91.71±0.78 a	71.14±1.19 abc
TBM30	79.85±1.99 ab	77.10±1.10 ab	90.05±0.78 a	71.76±1.19 abc
TBM40	78.85±1.99 ab	77.36±1.10 ab	91.11±0.78 a	74.23±1.19 a
TBM50	79.86±1.99 ab	74.46±1.10 b	89.31±0.78 ab	70.65±1.19 abc
TBM60	78.26±1.99 ab	74.76±1.10 b	91.21±0.78 a	71.64±1.19 abc
TBM70	78.41±1.99 ab	74.07±1.10 b	87.92±0.78 b	68.64±1.19 c
TBM80	75.26±1.99 b	74.50±1.10 b	87.68±0.78 b	69.63±1.19 bc
Probability	0.0401	0.0423	0.0410	0.0510

Means with the same letters in each column are not significantly different (P<0.05).

c) Growth performance:

Data presented in Table (5) show that, the initial body weight and body length were nearly similar and ranged between 7.86-7.99 g for body weight (BW), 7.79-8.07 cm for body length (BL) with insignificant differences between fish groups for both traits. Final body weight and length ranged between 23.66 to 30.70 g and 11.48 to 12.09 cm with significant differences between fish groups for body weight (P<0.001) and body length (P<0.01), respectively. From results obtained it is observed that, the higher BW (30.70 g) was recorded for the group fed TBM10 diet (replacing level of 10%) however there were insignificant differences in body weight for fish fed the experimental diets contained 0, 10, 20, 30, 40 and 50% of TBM. These results revealed the possibility of replacing 50% of the high cost SBM by the low cost TBM in tilapia diets but increasing the level of TBM in the experimental diets above this level (50%) significantly (P<0.001) decreased BW of Nile tilapia, *O. niloticus*. Saad (1998) found that, replacement of SBM by TBM up to 88.9% increased the final BW of Nile tilapia fry while the complete replacement decreased the final body weight.

Final BL did not significantly affected by replacing of SBM by TBM up to 70% but the high replacing level (80%) significantly decreased the final BL (Table 5).

Table (5): Growth performance and feed utilization of Nile tilapia as affected by replacing of SBM with TBM.

Diets	Body weight (g)		Body length (cm)		Weigh gain(g) /fish	Specific growth rate	Feed intake (g)/fish	FCR	PER
	Initial	Final	Initial	Final					
TBM0	7.90	30.29 a	8.07	12.09 a	22.40 a	1.92 a	49.65 a	2.22 c	1.50 a
TBM10	7.89	30.70 a	7.88	11.90 a	22.82 a	1.95 a	50.31 a	2.21 c	1.51 a
TBM20	7.99	28.89 ab	7.95	11.70 a	20.91 ab	1.85 ab	48.62 a	2.28 c	1.46 a
TBM30	7.86	28.87 ab	7.84	12.02 a	21.01 ab	1.86 ab	47.50 a	2.26 c	1.47 a
TBM40	7.96	28.90 ab	7.87	11.73 ab	20.94 ab	1.84 ab	47.47 a	2.27 c	1.47 a
TBM50	7.93	28.55 ab	7.90	11.95 a	20.62 ab	1.83 ab	48.48 a	2.35 bc	1.42 ab
TBM60	7.93	27.10 b	7.79	11.89 a	19.17 b	1.76 b	48.63 a	2.54 b	1.31 b
TBM70	7.94	27.03 b	7.81	11.64 ab	19.09 b	1.75 b	48.90 a	2.56 b	1.30 b
TBM80	7.87	23.66 c	7.88	11.48 b	15.79 c	1.57 c	44.06 b	2.79 a	1.19 c
St. error	0.23	0.10	1.01	0.007	0.030	0.007	0.250	0.020	0.010
Prob.	0.999	0.0001	0.67	0.0061	0.0001	0.0001	0.0001	0.0091	0.0077

Means with the same letters in each column are not significantly different (P<0.05).

Results of Table (5) also show that, weight gain (WG) of *O. niloticus* insignificantly changed until the replacing level of SBM by TBM reached 50%, after this replacing level (50%) WG was significantly decreased and these results indicated the possibility of replacing 50% of SBM by TBM without any adverse effect on WG of *O. niloticus.* Hassanen et al., (1995) showed that, the highest WG and specific growth rate were obtained at 20% tomato pulp silage on the total dietary protein. On the other hand, Khadzhinikolova and Tomasyan (1984) found that, partial or complete replacement of sunflower meal by tomato waste showed an improvement in WG of carp fish. Saad (1998) found that the higher WG was obtained for fish fed the diet contained 20% (substitution level of 88.8%) tomato waste meal with soybean meal followed by fish fed the diet contained 10% (substitution level of 44.4%) tomato waste meal with soybean meal followed by fish fed diet contained 10% (substitution level of 44.4%) tomato waste meal with cotton seed meal and these diets gained higher WG compared with fish fed the control diet (containing soybean meal only).

Specific growth rate (SGR) values ranged between 1.57 and 1.95 and the differences between SGR values were significant (P<0.001). The higher SGR value (1.95) was obtained with fish fed the diet contained 10% of TBM and the lowest one (1.57) was obtained when fish fed the diet contained 80% of SBM was replaced by TBM. Table (5) also showed that, increasing the inclusion level of TBM as a partial replacement of SBM in the experimental diets up to 50% insignificantly changed SGR but the higher inclusion levels (60 to 80%), decreased SGR values. These results agreed with those observed by Saad (1998) who found insignificant differences of SGR for tilapia when 44.40% of SBM was replaced by TBM.

It is noteworthy to state that, increasing the replacing levels of SBM by TBM (0 to 50%) did not significantly affect all growth parameters (BW, BL, WG, and SGR) but the higher replacing levels (60 to 80%) significantly decreased these parameters. TBM contains considerably amounts of Crude fiber (29.33%) compared to 6.5% in SBM (Table, 3) and methionine and lysine are limiting essential amino acids in this by-product as reported by Hassanen et al., (1995). For these reasons the higher replacing levels (60 to 80%) of SBM by TBM decreased all growth parameters of Nile tilapia (Table, 5).

d) Feed utilization:

As described in Table (5), feed intake in the present experiment lie in two clusters, the first one includes fish groups fed the diets contained 0 to 70% of TBM and the second one include fish fed the diet contained 80% of TBM as a partial replacement of SBM. These results indicated that, replacing SBM by TBM from 0 to 70% had no significant effect on feed intake but the following replacing level (80%) significantly decreased feed intake.

Feed conversion ratio (FCR) ranged from 2.21 to 2.79 (Table, 5). The best rate was obtained when fish fed the TBM10 diet (10% of SBM replaced by TBM) where only 2.21 kg of feed was required to produce one kilogram of live fish. Table (5) also indicated that, increasing replacing level of SBM by TBM from 0 to 40% (with an increment of 10%) in *O. niloticus* diets did not significantly affect the FCR but the higher replacing levels (50 to 80%) significantly adverse the FCR. These results are in agreement with those obtained by Saad (1998), who found that, replacing 44.4% of SBM by TBM improved the FCR but the higher replacing levels (66.7, 88.9 and 100%) adverse FCR for Nile tilapia. Table (5) also showed that, the best (1.51) protein efficiency ratio (PER) was obtained when 10% of SBM protein was replaced by TBM but the high levels of replacement (80%) decreased PER to 1.19 and the differences between PER's were significant ($P<0.01$). The lower PER percentages obtained for the higher replacing levels (60 to 80% of SBM by TBM) indicating progressive reduction in nutritional value compared to the lower inclusion levels (0 to 50%). This effect may be due to the reduced efficiency in protein utilization leading to a depression in feed intake (Dabrowski, 1986 and Hilton, 1983). Saad (1998) found that, the best FCR and PER for *O. niloticus* when 44.4% of SBM or cotton seed meal were replaced by tomato waste and the worst FCR and PER were obtained when soybean meal and cotton seed meal were replaced by 66.7, 88.9 and 100% tomato waste. Also, Khadzhinikolova and Tomasyan (1984) found that, carp fish fed a control diet containing sunflower oil meal partially or completely replaced by tomato waste showed an improved feed efficiency.

e) Carcass and proximate analysis:

As described in Table (6) replacement of SBM by TBM in an increasing levels ranged from 0 to 70% did not significantly changed the percentages of dress-out, flesh and by-products but the higher replacing level (80%) significantly decreased the percentages of dress-out and flesh and increased the percentage of by-products but the percentage of viscera had no clear trend for *O. niloticus.* Saad (1988) found that, the higher dressing percentage was recorded for *O. niloticus* fed the diet contained 44.4% TBM as replacement for SMB compared to that of fish fed the control group.

Results of proximate analysis (Table 6) showed also that, as the inclusion level of TBM in the experimental diets increased, protein and fat contents of whole fish significantly (P<0.05 and P<0.001) decreased and ash increased (P<0.001) but moisture content was not significantly changed. These results are in agreement with those reported by Hassanen et al., (1995).

Table (6): Carcass and proximate analysis of Nile tilapia as affected by replacing of SBM by TBM.

Diets	Carcass analysis (%)				Proximate analysis of whole fish (%)			
	Dress out	Viscera	Flesh	By-products	Moisture	Protein	Fat	Ash
TBM0	52.29 a	9.71 a	41.82 a	53.04 b	77.81	66.22 a	13.73 a	16.16 b
TBM10	52.61 a	7.29 c	41.68 a	52.25 b	76.61	64.46 a	11.43 b	16.78 b
TBM20	51.02 ab	9.12 ab	41.89 a	52.52 b	76.21	64.09 ab	11.22 b	17.66 ab
TBM30	51.31 ab	7.78 bc	40.79 a	52.45 b	77.89	63.89 ab	10.96 b	17.88 a
TBM40	52.94 a	7.54 c	41.27 a	52.22 b	76.08	63.75 ab	10.64 b	18.18 a
TBM50	52.61 a	7.43 c	39.93 a	53.35 b	76.59	63.70 ab	9.97 bc	18.23 a
TBM60	52.98 a	7.78 bc	40.14 a	51.83 c	75.98	63.52 ab	9.53 bc	18.22 a
TBM70	50.88 ab	9.12 ab	40.75 a	51.27 c	77.49	62.10 b	9.40 bc	18.61 a
TBM80	48.13 b	8.48 b	36.91 b	54.78 a	76.48	61.55 b	9.05 c	18.60 a
St. error	0.70	0.47	0.89	0.94	0.61	2.07	0.24	0.26
Prob.	0.0001	0.0014	0.0001	0.0031	0.0546	0.0258	0.0001	0.001

Means with the same letters in each column are not significantly different (P<0.05).

Second experiment:

a) Proximate analysis of potato by-product meal (PBM):

As shown in Table (7) PBM contained 94.12% DM. Based on DM, PBM contained 8.02 CP, 3.6 EE, 18.13 CF, 6.17 ash and 64.08% NFE. These results show that, PBM contain reasonable amount of NFE (64.08%) which is an indicator for its potential value as a source of energy, moreover EE (3.6%) and CP (8.02%) are nearly similar to those determined in Yellow corn (4.01% EE and 7.80% CP). Proximate analysis for PBM in the present experiment is relatively similar to that obtained by Ghazalah et al., (2002) except for EE. He found that, PBM contained 7.94% CP, 9.5% CF, 3.55% ash and 29.60% EE. In another study, El-Tawil (2001) showed that potato waste contained 8% CP, 6% EE, 4% CF and 4% ash.

Table (7): Proximate analysis of potato by-product meal (PBM) and yellow corn (YC).

Item	PBM	YC
Dry matter (DM)	94.12±2.14	92.00±1.51
Crude protein (CP)	8.02±0.11	7.80±0.26
Ether extract (EE)	3.60±0.15	4.01±0.31
Crude fiber (CF)	18.13±0.51	3.10±0.16
Ash	6.17±0.21	3.03±0.19
NFE*	64.08±0.11	82.06±1.10

*Nitrogen free extract (NFE) =100-(CP+EE+CF+Ash)

b) Nutrient digestibility:

Results presented in Table (8) showed that, ADC for DM did not significantly differ when replacing level of YC by PBM increased from 10 to 80% as compared to those of the control diet. However replacement of 40% decreased ADC for CP and the replacement level of 50% significantly decreased the ADC of EE and NFE. Ufodike and Matty (1988) found that, inclusion of potato waste in diets of mirror carp (*Cyprinus carpio* L.) fingerlings increased the digestibility of carbohydrate from 45% in corn to 53% in potato waste.

Table (8): Apparent digestibility coefficients (ADC) for different nutrients in experimental diets contained PBM.

Diets	DM	CP	EE	NFE
PBM0	90.25±1.36	80.86±1.01 a	85.86±1.40 b	62.21±2.40 a
PBM10	91.56±1.36	77.75±1.01 ab	87.75±1.40 ab	59.26±2.40 ab
PBM20	88.10±1.36	77.31±1.01 ab	84.75±1.40 ab	63.20±2.40 a
PBM30	92.20±1.36	77.28±1.01 ab	86.75±1.40 ab	60.41±2.40 ab
PBM40	87.91±1.36	75.80±1.01 b	88.35±1.40 a	60.72±2.40 ab
PBM50	89.91±1.36	76.89±1.01 b	84.25±1.40 b	58.67±2.40 b
PBM60	90.14±1.36	77.55±1.01 ab	89.30±1.40 a	57.75±2.40 b
PBM70	91.68±1.36	77.75±1.01 ab	88.26±1.40 a	60.70±2.40 ab
PBM80	90.70±1.36	76.66±1.01 ab	86.34±1.40 ab	60.45±2.40 ab
Probability	0.0611	0.0401	0.4503	0.0501

c) Growth performance:

Results of Table (9) showed that, the initial BW and BL ranged between 4.80 to 5.07 g and 6.48 to 6.71 cm, respectively with insignificant differences between fish groups in both traits indicating the random distribution of fish in the different treatments. Final BW and BL ranged between 18.62 to 24.83 g and 10.31 to 11.43 cm, respectively with significant ($P<0.001$) differences between fish groups for BW and BL, respectively. It could be seen that, increasing the replacing level of YC by PBM from 0 to 40% had no significant effect on BW and BL but the higher replacing levels (form 50 to 80%) significantly ($P<0.001$) decreased BW and BL and the same trend was also observed for WG and SGR. PBM contains considerably less of each amino acid compared to YC and it is limiting with respect to methionine, cystine, arginine and the aromatic amino acids (El-Tawil 2001). For this reason the higher replacing levels (50 to 80%) of YC by PBM decreased all growth parameters for Nile tilapia, *O. niloticus* (Table 9). Shouqi et al., (1997) found that, as dietary potato protein concentrate increased from 0 to 51% in rainbow trout (*Oncorhynchus mykiss*) diets final BW and SGR significantly decreased and mortality increased. In agreement with the obtained results, Ghazalah et al., (2002) found that, replacing 25 or 50% of YC with PBM did not significantly changed BW or WG of Nile tilapia, *O. niloticus*. Ufodike and Matty (1988) reported that, inclusion of potato waste in diets of mirror carp (*Cyprinus carpio* L.) fingerlings yielded greater WG.

d) Feed utilization:

Results of feed intake (Table 9) indicated that fish fed the control diet (PBM0) exhibited the highest feed intake (FI) compared to those fed the other experimental diets and fish fed the PBM30 diet exhibited the best FCR and PER.

Results in Table (9) also show that, replacing 40, 50 and 60% of YC with PBM did not significantly affected FCR, FI and PER, respectively but the higher replacing levels, 50, 60 and 70% significantly decreased the FCR, FI and PER, respectively. The obtained results are in agreement with those obtained by Ghazalah et al., (2002), who found no significant differences in FI, FCR ratio and protein utilization when YC replaced by PBM up to 50% in tilapia *O. niloticus* diets. For rainbow trout (*Oncorhynchus mykiss*), Shouqi et al., (1997) found that, as dietary potato protein concentrate increased from 0 to 51% in the diets, FCR and PER significantly decreased.

e) Carcass and proximate analysis:

As described in Table (10), it could be seen that, replacing YC with PBM up to 40 and 70% did not significantly affected the percentages of dress-out and flesh, respectively in tilapia carcass while viscera and by-products had no clear trend. With regard to the proximate analysis of fish bodies, moisture content did not affected by inclusion levels of PBM in the experimental diets. Table (10) also show that, increasing inclusion level of PBM up to 50% in tilapia diets did not significantly changed the protein and fat contents of tilapia fish but the higher inclusion levels (60 to 70%) significantly decreased protein and fat contents of tilapia bodies. Ash increased significantly with each increase of PBM in the experimental diets. These results are in agreement with those of Shouqi et al., (1997) who found that, DM, CP and fat content of the fish decreased and ash content increased ($P<0.05$) as dietary potato protein concentrate increased from 0 to 51% in rainbow trout (*Oncorhynchus mykiss*) diets. Also, Xie and Jokumsen (1997) found that, incorporation of potato protein concentrate in diets for rainbow trout significantly decreased fat and increased ash contents of fish body.

Economical efficiency:

The current investigation highlights the potential of using TBM for partial replacement of SBM and PBM for partial replacement of YC in Nile tilapia diets. Generally, results of the present study showed the possibility of replacing of SBM by TBM up to 50% (Exp. 1) and YC by PBM up to 40% (Exp. 2) with no adverse effect on growth performance and feed utilization. Feeding costs in fish production is about 50% of the total production costs (Collins and Delmendo, 1979). All other costs in the present study are constant, therefore, the feeding costs required to produce one kg gain in weight could be used to compare the different experimental treatments. The calculated figures showed that, the cost of one ton feed mixture was reduced in all replacing levels of SBM by TBM and replacing 50% of SBM by TBM could be reduce feeding costs by 10.93%.

With regard to PBM, results in Table (11) showed that, replacing YC by PBM up to 40% reduced the feeding costs/kg weight gain but the higher replacing levels (50 to 80%) seemed to be not economic. Accordingly, replacing 40% of YC by PBM reduce feeding costs by 7.53%.

Table (9): Growth performance and feed utilization of Nile tilapia as affected by replacing of yellow corn (YC) by potato by-product meal (PBM).

Diets	Body weight (g)		Body length (cm)		Weight gain(g)/ fish	Specific growth rate	Feed intake (g)/fish	FCR	PER
	Initial	Final	Initial	Final					
PBM0	4.86 a	24.83 a	6.54 a	11.43 a	19.97 a	2.33 a	42.8 a	2.14 b	1.56 a
PBM10	4.93 a	24.68 a	6.60 a	11.12 ab	19.75 a	2.30 a	41.9 a	2.12 b	1.54 a
PBM20	5.02 a	24.00 a	6.48 a	11.31 ab	18.98 ab	2.24 a	40.7 a	2.14 b	1.55 a
PBM30	4.95 a	23.20 a	6.57 a	10.95 ab	18.25 ab	2.51 a	38.6 ab	2.12 b	1.58 a
PBM40	5.00 a	22.56 a	6.62 a	11.06 ab	17.56 ab	2.16 ab	38.2 ab	2.18 b	1.53 a
PBM50	5.07 a	20.19 b	6.58 a	10.61 b	15.12 b	1.98 b	38.5 ab	2.55 a	1.31 ab
PBM60	4.84 a	20.15 b	6.59 a	10.51 b	15.31 b	2.04 ab	37.7 b	2.46 a	1.35 ab
PBM70	4.97 a	18.91 c	6.71 a	10.31 b	13.94 c	1.92 b	37.9 b	2.72 a	1.23 b
PBM80	4.80 a	18.62 c	6.70 a	10.48 b	13.84 c	1.95 b	38.2 b	2.76 a	1.21 b
St. error	0.15	0.80	0.07	0.15	0.006	0.005	0.01	0.002	0.003
Probability	0.9778	0.0001	0.1191	0.0001	0.0001	0.0001	0.0001	0.0013	0.0011

Table (10): Carcass and proximate analysis of Nile tilapia as affected by replacing of yellow corn (YC) by potato by-product meal (PBM).

Diet	Carcass analysis (%)				Proximate analysis of whole fish (%)			
	Dress out	Viscera	Flesh	By-products	Moisture	Protein	Fat	Ash
PBM0	56.61 a	11.51 a	42.90 a	55.83 bc	78.09 a	67.46 a	13.38 a	15.53 b
PBM10	55.01 ab	8.60 b	42.57 a	54.45 cd	77.11 abc	67.19 a	13.26 a	16.03 b
PBM20	54.46 ab	10.83 ab	41.80 a	55.34 bc	77.16 abc	67.16 a	13.22 a	16.10 b
PBM30	53.07 ab	8.00 b	39.07 ab	55.82 bc	76.72 abc	65.84 ab	12.22 ab	16.25 b
PBM40	54.07 ab	8.47 b	42.96 a	54.42 cd	77.92 a	65.82 ab	12.10 ab	16.98 b
PBM50	51.56 b	8.47 b	39.34 ab	56.70 abc	76.63 abc	65.00 ab	11.89 ab	17.28 a
PBM60	51.55 b	8.53 b	39.61 ab	56.70 abc	77.50 ab	63.31 b	11.13 b	17.30 a
PBM70	51.32 b	11.08 a	39.68 ab	52.67 d	78.27 a	63.56 b	11.39 b	17.33 a
PBM80	48.98 c	11.44 a	37.63 b	57.03 ab	76.40 abc	62.79 b	10.07 b	17.46 a
St. error	1.06	0.63	1.24	0.78	0.63	1.05	0.57	0.11
Probability	0.0010	0.0011	0.0032	0.0001	0.0060	0.001	0.0001	0.0001

Means with the same letters in each column are not significantly different (P<0.05).

Table (11): Feed costs (L.E) for producing one kg weight gain by fish fed the experimental diets.

Tomato by-product meal (TBM)						
Diets	Costs (L.E)/ ton	Relative to control %	Decrease in feed cost (%)	FCR	Feed costs (L.E)/kg weight gain	Relative to control %
TBM0	1647	100	0.00	2.22	3.66	100
TBM10	1611	97.81	2.19	2.21	3.56	97.27
TBM20	1575	95.63	4.37	2.28	3.59	98.09
TBM30	1539	93.44	6.56	2.26	3.48	95.08
TBM40	1503	91.26	8.74	2.27	3.41	93.17
TBM50	1467	89.07	10.93	2.35	3.45	94.26
TBM60	1431	86.89	13.11	2.54	3.63	99.18
TBM70	1395	84.70	15.30	2.56	3.57	97.54
TBM80	1359	82.51	17.49	2.79	3.79	103.55

Potato by-product meal (TBM)						
Diets	Costs (L.E)/ton	Relative to control %	Decrease in feed costs (%)	FCR	Feed costs (L.E.)/kg weight gain	Relative to control %
PBM0	1646.8	100	0.00	2.14	3.52	100
PBM10	1615.8	98.12	1.88	2.12	3.43	97.44
PBM20	1584.8	96.24	3.76	2.14	3.39	96.31
PBM30	1553.8	94.35	5.65	2.12	3.29	93.47
PBM40	1522.8	92.47	7.53	2.18	3.32	94.32
PBM50	1491.8	90.59	9.41	2.55	3.80	108.00
PBM60	1460.8	88.71	11.29	2.46	3.59	101.99
PBM70	1429.8	86.82	13.18	2.72	3.89	110.51
PBM80	1398.8	84.94	15.06	2.76	3.86	109.66

Local market price (L.E./ton) for feed ingredients used for formulating the experimental diets when the experiment was started.

Ingredients	Price (L.E.) / ton
Fish meal	3000 L.E.
Soybean meal	1200 L.E
Yellow corn	800 L.E.
Tomato by-product	100 L.E.
Potato by-product	110 L.E.
Bone meal	450 L.E.
Vegetable oil	2500 L.E.
Vit. & Min. mixture	5000 L.E.

REFERENCES

Alicata, M. L., Bonanno, A., Glaccone, P., Leto, G. and Battaglia, D. (1988): Use of tomato skins and seeds in the feeding of male rabbits. Rivista di congili, Coltura 25(1):33-36.

AOAC (1990): Official Methods of Analysis. 15th Ed. Published by the Association of Official Analytical Chemists. North Nineteen st. Auite 210 Arlingth, Virginia 2220/USA.

Collins, R. A. and Delmendo, M. N. (1979): Comparative economics of aquaculture in cages, race ways and enclosures. In: Advance in aquaculture, pp. 427-7. England, Fishing News Books.

Dabrowski, K. (1986): Ontogentical aspects of nutritional requirements in fish. Com. Biochem. Physiol. 85 p:639-655.

El-Shamma, A. A., Salman, A. H., Al-Ashabb, M. H., Ahmed, A. S. and Tchyad, I. S. (1997): The use of tomato processing wastes as a partial replacement for maize diets of common cap, *Cyprinus carpio* L. Dirasat. Agric. Sci., 24:69-72.

El-Sayed, A. M. (1994): Nutritive value evaluation of some crops, vegetable and fruit residues. M.Sc. Thesis, Fac. Agric. Cairo University.

El-Tawil, M. E. (2001): Studies on some nutritional and managerial trials to improve the growth capacity of broiler chickens. M.Sc. Thesis, Fac. Agric., Zagazig University.

FAO (1991): Production year book, Vol. 44. Food and Agricultural Organization of the United Nations. Rome.

Fenton, T. W. and Fenton, M. (1979): An improved procedure for the determination of chromic oxide in feed and feces. Can. J. Anim. Sci., 59:631-634.

Ghazalah, A. A., Gomaa, I. A. and Hyam D. Tonsy, D. (2002): The use of date stone meal (DSM) and potato by-product meal (PBM) as non-conventional energy feed sources in Nile tilapia (*Oreochromis niloticus*) diets. The 1st Scientific Conference of the Egyptian Aquaculture Society, El-Arish, North Sinai, Egypt, 13-15 December, 2002.

Hajen, W. E., Higgs, D. A., Beames, R. M. and Dosanjh, B. S. (1993): Digestibility of various feedstuffs by post-juvenile chinook salmon (*Oncorhynchus ishawytscha*) in sea water: I. Validation to technique. Aquaculture, 112:321-332.

Hassanen, G. D. I. (1986): Studies on some appropriate rations for reared fishes in Egyptian fish farms. Ph.D. Thesis, Fac. of Agric., Monofia University. Egypt.

Hassanen, G. D. I. (1991): The utilization of some unconventional protein by Nile catfish (*Clarias lazera*). J. Egypt. Ger. Soc. Zool., 6:49-62.

Hassanen, G. D. I. Sherif, M. A., Hashem, H. A. and Hanfy, M. A. (1995): Utilization of some fermented waste food as a protein source in pelleted feeds for Nile tilapia (*Oreochromis niloticus*) fingerlings. Proc. 5th Sci. Conf. Animal Nutrition, vol. 1 : 427-435, Ismailya, Dec., 1995.

Hilton, J. W. (1983): Potential of freeze-dried worm meal as a replacement for fish meal. Aquaculture, 32:277-283.

Jauncey, K., (1982): The effects of varying dietary protein level on the growth, feed conversion, protein utilization and body composition of juvenile tilapia (*Sarotherdon mossambicus*). Aquaculture, 27: 43-54.

Khadzhinikolova, L. and Tomasyan, K. H. (1983): Tomato and pepper waste as fodder in fish farming. Ribno-Stopanstvo, 28:10-12.
Khadzhinikolova, L. and Tomasyan, K. H. (1984): Tomato waste for feeding carp up to one year old. Ribno-Stopanstvo, 30:20-21.
Lovell, R. T. (1981): Laboratory manual for fish feed analysis and fish nutrition studies. Auburn Univ., Alabama.
NRC. (1993): Nutrient requirements of fish,114 pp. National Research Council,Washington, DC.
Saad, F. A. (1998): Some studies on fish nutrition. M. Sc. Thesis, Fac. Veterinary Medicine, Moshtohor, Zagazig University (Banha branch).
SAS (1996): SAS Procedure Guide "version 6.12 Ed" . SAS Institute Inc., Cary, NC, USA.
Shouqi, X., Jokumsen, A. and Sq, X. (1997): Replacement of fish meal by potato protein concentrate in diets for rainbow trout, *Oncorhynchus mykiss* (Walbaum): growth, feed utilization and body composition. Aquaculture Nutrition, 3:65-69.
Ufodike, E. B. C. and Matty, A. G. (1988): Growth responses and nutrient digestibility in mirror carp (*Cyprinus carpio*) fed different levels of cassava and rice. Aquaculture, 31:41-50.
Xie, S. and Jokumsen, A. (1997: Incorporation of potato protein concentrate in diets for rainbow trout: effect on feed intake, growth and feed utilization. Aquaculture Nutrition, 3(4):223-226.

الملخص العربى

إستخدام مخلفات الطماطم والبطاطس كمواد علفيه غير تقليدية فى علائق أسماك البلطى النيلى

مجدى عبدالحميد سلطان

قسم الإنتاج الحيوانى – كلية الزراعة بمشتهر – جامعة الزقازيق (فرع بنها)

أستهدفت هذه الدراسة تقييم تأثير إحلال بروتين كسب فول الصويا بمخلفات تصنيع الطماطم وكذلك إحلال الذره الصفراء بمخلفات تصنيع البطاطس (الشيبسى) على نموأسماك البلطى النيلى ودراسة مدى إستفادة هذه الأسماك من العلائق التجريبية ولذلك أقيمت تجربتان أستخدمت فى الأولى ٩ علائق تجريبية احتوت على نسب متزايده من مخلفات تصنيع الطماطم (صفر إلى٨٠%) كبديل لكسب فول الصويا وفى التجربة الثانية تم أيضاً تكوين ٩ علائق تجريبية احتوت على نسب متزايدة من مخلفات تصنيع البطاطس (الشيبسى) كبديل للذرة الصفراء بنسب تراوحت بين صفر إلى ٨٠% (بفاصل ١٠%) وكانت علائق التجربتين متماثلة فى محتواها من البروتين (٣٠% بروتين خام) والطاقة (٣٣٠٠ كيلو كالورى طاقة ممثلة/كجم عليقة) وكانت نسبة البروتين إلى الطاقة بها ٩٠ مجم بروتين / كيلو كالورى (طاقة ممثله). وتم تغذية أسماك البلطى فى كلا التجربتين على هذه

العلائق بمعدل ٤% من الكتلة الحية (ستة أيام فى الأسبوع) لمدة ١٠ أسابيع وكان من أهم النتائج المتحصل عليها مايلى:

أظهرت نتائج التجربة الأولى أن إحلال كسب فول الصويا بمخلفات تصنيع الطماطم بنسبة وصلت إلى ٥٠% لم يكن له تأثير معنوى على صفات النمو فى أسماك البلطى (وزن وطول الجسم ، الزيادة فى الوزن ومعدل النمو) وكذلك كمية الغذاء المستهلكة ومعدل تحويل الغذاء وكفاءة البروتين كما أن نسبة الإحلال هذه لم تؤثر معنوياً على نسبة بعض مكونات الذبيحة مثل نسبة الجزء المأكول ونسبة اللحم وكذلك نسبة المخلفات كما لم تؤثر على نسبة الرطوبة والبروتين فى أجسام الأسماك.

وقد أظهرت نتائج التجربة الثانية أن إحلال ٤٠% من الذرة الصفراء فى علائق أسماك البلطى بمخلفات تصنيع البطاطس لم يكن له تأثير معنوى على صفات النمو (وزن وطول الجسم ، الزيادة فى الوزن ومعدل النمو) وكذلك كمية الغذاء المستهلكة ومعدل تحويل الغذاء وكفاءة البروتين كما أن نسبة الإحلال هذه لم تؤثر معنوياً على نسبة بعض مكونات الذبيحة مثل نسبة الجزء المأكول وكذلك نسبة اللحم ومحتوى أجسام الأسماك من الرطوبة والبروتين والدهن والرماد.

من الناحية الإقتصادية وجد أن إحلال ٥٠% من بروتين كسب فول الصويا بمخلفات تصنيع الطماطم قد أدى إلى توفير٩٣ر١٠% من تكاليف التغذية كما أن إحلال ٤٠ من الذرة الصفراء فى العليقة قد أدى إلى تقليل تكاليف التغذية بنسبة ٥٣ر٧%.