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THE EFFECTS OF PARTIAL REPLACEMENT OF FISH MEAL BY PEAS (*Pisum sativum*) AND TOMATO POMACE BY-PRODUCT AS NON- CONVENTIONAL INGREDIENTS IN DIETS FED TO NILE TILAPIA (*Oreochromis niloticus*) JUVENILE.

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ABSTRACT

The current general economic and food crises have generated an unsettled future for food and feed production and prices in general . Increasing demand , prices and fluctuations in supply in world markets for fish meal , fish oil, soybean meal and maize emphasize the need to reduce the dependence of the fish feed industry on these ingredients by increasing choices among a wider range of raw materials .The objective of the present study was to investigate the effects of partial replacement three different levels (25%, 50% and 75%) of the crude protein as fish meal (FM) protein in a reference (control) diet by peas waste protein (PW) and Tomato pomace (TP) protein as plant protein sources incorporated into the balanced diets on growth performance, feed utilization,body composition and economic efficiency of sex-reversal juvenile male Nile tilapia (Oreochromis niloticus), for 14 weeks experimental period . Groups of experimental fish (initial average weight 2.99 ±0.48g) were fed one of 7 isonitrogenous (30% crude protein) and isocaloric (4200 kcal Gross energy /kg dry matter).Test diets, with two replicates (20 fish / aquarium). The present results showed that replacement of FM by Pw and TP did not significantly affect difference for all growth performance (BW, BL, ADG,SR,SGR , K), feed utilization (FI,FCR ,FE , PER , PPV , ER, EU.) between feeding diet control (D1) and the other six diets. Also economic efficiency showed that the reduction of feed costs was easily observed for the feed costs per Kg weight gain which decreased with increasing incorporation levels of PW and TP. This study concluded that partial replacement of fish meal protein with peas waste protein or tomato pomace protein as plant protein sources in tilapia diets resulted in better growth and feed performance . From the all aforementioned results, it could be detected that PW or TP could be utilized by Nile tilapia safely and efficiently as alternative protein instead of 50% of FM without adverse effects on the growth performance of Nile tilapia. In addition , these plant protein sources are locally available at much lower prices than imported fish meal.

INTRODUCTION

Egypt is the leading aquaculture country, especially fresh water aquaculture in Africa . The national government aims to increase the animal per capita consumption of fish and to ensure the availability of low-priced fish to the consumer by increasing national production . Increasing demand, prices and fluctuations in supply in the world markets for fishmeal, fish oil, soybean meal, maize and wheat meal, emphasize the need to reduce their incorporation in feeds and at the same time increase the range of raw material sources.

Pea waste and tomato pomace was selected as the best candidates for the production of protein candidates for the production of protein

concentrates and local byproducts. The plant ingredients were include at three levels to replace 25%, 50% and75% of the protein supplied by fish meal in order to provide an indication of their potential in Nile tilapia as feeds. Field or feed or green pea (*Pisum sativum* L.) is a legume with potential due to the fact that it has been used in livestock feeds for a long time as a source of energy and protein, but has only recently been evaluated in feed for aquatic species (Davis, *et al*., 2002). The average protein content of whole peas is around 21% which is low compared to soybean, but it is high compared to cereals, and it is rich in starch (around 45%) and has an energy content of 15.8kJg^{-1} (Sauvant *et al*., 2004).

Field peas have been evaluated as potential feed ingredients, whole or dehulled, raw or processed, for several aquatic species including European seabass (Gouveia and Davies, 1998; 2000), , Atlantic salmon (Carter and Hauler, 2000), rainbow trout, turbot (Burel *et al*., 2000).In general most studies indicated that dehulled peas and extruded pea seed meal have higher Apparent Digestibility Coefficients (ADCs) for energy and crude protein than whole or raw peas respectively (Davis *et al*., 2002; Thiessen *et al*., 2003). Tomato waste is one of the canning waste which tried by many workers could be used in fish diets, Hassanan *et al*.,1995, Saad 1998and Soltan, 2002).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 (soltan, 2002).

According to Ministry of Agriculture Reports during years 1985-1987 the average annual production of tomato in Egypt was about 2 million tons.

Also Khadzhnikolova 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.The present study aimed to investigate the effects of partial substitution of the dietary fish meal protein with incorporation of Peas waste (PW) and Tomato Pomace (By-product) (TP) as agro-industrial by-products protein obtained from canning industry on the growth performance, utilization of nutrients, whole body composition, and economical efficiency of juvenile male Nile tilapia (*Oreochromis niloticus*) reared in glass aquaria.

MATERIALS AND METHODS

The experimental in of the present study was performed at the experimental fish culture in glass aquaria system with closed water recirculation belonging to the fish production section, Animal production department, faculty of agriculture, Al-azhar university, Cairo, Egypt The experiment started on the 20th of July, and lasted at 4th of November, 2009 for 14 week.

Experimental design:

The experimental were designed using the complete randomized block design .The experimental rearing system consisted of a series 14th glass aquaria. Each glass aquaria containing 72 liters water volume were used. The water supply of these experimental aquaria was the drinking tap

water which derived the mechanical filter reservoir via a pump to another two fiberglass tanks 5 M3 capacity.

Experimental fish:

The fish used in this study were sex-reversal juvenile male Nile tilapia (Oreochromis niloticus), were purchased from a private tilapia hatchery in Abbassa, Sharkiya Governorate. There after the fish were randomly distributed into 7thgroups represented one of the dietary treatments and stocked randomly distributed in the experimental aquaria at a density of 10 fish/ glass aquaria,with an average of2.99 ± 0.48 g initial weight, and average initial length was 5.45± 0.16 cm.

Diets formulation:

Tomato pomace and peas waste were obtained from Edfina company of preservation feedstuffs Nutrient analysis of each ingredient used in the experimental diets are included in table (1). Seven experimental diets were formulated(table2) to be Isonitrogenous (30% crud protein)and isocaloric (4200 kcal kg).The experimental diets varied only in their protein sources. The first diet (control feed D1) contained fish meal as the main protein source which served as the major protein ingredient of the reference diet with a small amount of protein supplied by Wheat bran (7.7 % crude protein) and soybean meal (44% crude protein).The experiment was made up of two trials, the first feeds trial was formulated to contain a 25%(D2) , 50% (D3) and 75% (D4) replacement of fish meal protein from pea waste (PW). In the second feeds trial, 25%(D5) , 50%(D6) and 75% (D7) of the fish meal protein was replaced by protein from tomato pomace (TP). Substitution was made on the basis of fish meal as the main protein source content of the control diet (D1). The composition and nutrient analysis of the experimental diets are displayed below in table (2). Dry experimental ingredients diets were mixed and then prepared by fine grinding of the dietary ingredients. Thereafter all ingredients included in each experimental diet were mixed thoroughly and produced in a pelleted form (0.2 cm. in diameter) using mincing machine after mixing with 25% of water. The experimental pellets were sun dried and stored in good storage conditions till the experimental start.

Table (1): Nutrient analysis of the ingredients used in the experimental diets

Ingredient	DM%	CP%	EE%	CF%	Ash%	NFE*	GE**(Kcal/Kg DM)
Fish meal	92.21	64.5	8.6	0.4	14.8	11.7	488.687
Soybean meal	90.57	44.00	1.1	7.3	6.3	41.3	4282.87
Wheat bran	87.30	16.4	4	9.9	5.3	64.4	3949.4
Yellow Corn	91.26	8.5	3.6	2.3	1.3	72.6	3803.1
Tomato Pomace(TP)	92.45	20	5	25	5	45	3449.5
Peas waste (PW)	91.76	19.1	6.4	11.9	4.6	58	4065.2

*** Calculated by differences[Nitrogen free extract (NFE) =100-(CP +EE +CF +Ash)]**

**** Estimated according to NRC (1993). Using the factor 5.65, 9.45 and 4 for crude protein, ether extract and carbohydrate, respectively.**

The daily feeding rate was kept constant at near 5% of body weight per day, and were offered two times a day, at 8.00 am and 3.00 pm. The amounts of feed were bi-weekly adjusted according to the changes in body weight throughout the experimental period (14 weeks) after weighing.

Growth performance and feed utilization parameters:

The Fish in each aquaria were weighted individually at the beginning of the experiment (W1) and every week, and at the end of the trial they weighted final weight (W2) and counted .

Final weight gain (g)% = [final wt (g)- initial wt (g)/ initial wt (g)] X100
Average daily gain(ADG)=initial body Wt–final body Wt (g)/period (days)
Survival rate (SR%) =[Number of fish at final/Number of fish at start]X100
Specific growth rates(SGR%)=[ln∞final wt- ln∞ initial wt / period]/days X 100
condition factor (K) = [W (g) / L3 (cm)]× 100
Food conversion ratio (FCR)= food consumed (g) / Wet weight gain (g)
Food efficiency (FE) = [total gain (g) / feed consumed (g)] x 100
Protein efficiency ratio(PER)= wt gain (g)/protein consumed(intake) (g)
Protein productive value (PPV%) =[P-PO / PF X] 100
Where:
P = is the protein in fish carcass of the end of experiment.
PO= is the protein in fish carcass at start of the experiment.
PF= is the protein intake

Energy retention ((ER%) = [E-EO / EF X]100

Where:
E = is the energy in fish carcass (kcal) at the end of experiment.
EO= is the energy in fish carcass (kcal) at the start of experiment.
EF= is the energy (kcal) in feed intake. Energy utilization
EU) %= Energy retained(kcal)/Energy intake(kcal) x100
Relative growth rate (RGR) % = [Final weight (g) / Initial weight (g)]x 100

Analytical procedure:

Water quality:

Water temperatures were recoded daily in each glass a aquaria at 8.00 am and 2.00 pm using a mercury thermometer suspended at 10-cm water depth. Also pH was measured daily by pH meter. proximate chemical analysis of

Diets and body composition:

Proximate analyses of the experimental diets and fish carcasses were carried out according to the procedures described by A.O.A.C.(1995). At the start and end of the experimental period, four fish were taken randomly and exposed to whole body proximate composition (Dry matter, protein, fat, ash and fiber).

Statistical analysis:

The influence of experimental diets on the growth response and body composition of fish form different feeding groups (in duplicate =2 replicates for each treatment=2n) was tested by one-way analysis of variance (ANOVA) using the general linear methods procedure of (SAS ,1998) .Differences of means were evaluated for significance by the multiple range tests of Tukey's-karmer HSD(P≤0.05) for homogenous variances Duncan's multiple range test

(Duncan, 1955) was used to resolve differences among treatment mean at 5% significant level using the following mode:

$$Yij=\mu+Ti+Eij$$

Where:
Yij=the observation of the individual from T treatment,μ=over all mean,Ti=the fixed effect of diet and Eij=the experimental random error associated with individual.

Table (2):Ingredients and nutrients composition of the experimental diets.

Ingredients	Experiment Diets						
	100%FM	25%Pw	50% Pw	75% Pw	25%TP	50%TP	75% TP
Fish meal	16	12	8	4	12	8	4
Soybean meal	33	33	33	40	33	33	40
Wheat bran	35	25.4	27.8	9.2	26	22	11
Corn	15.7	15.7	3.7	5.7	15.7	10.7	5.7
Vitamin & minerals mixture	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Tomato Pomace	-	-	-	-	13	26	39
Peas waste	-	13.6	27.2	40.8	-	-	-
Total	100	100	100	100	100	100	100
Chemical analysis of the experimental diets (on DM basis)							
Dry matter% (DM)	90.78	92.10	91.35	90.6	91.8	91.7	91.26
Crude protein % (CP)	30.4	30.9	29.8	30.6	30.8	30.1	30.3
Ether extract % (EE)	3.5	3.5	3.5	3.3	3.7	4.0	3.9
Crude fiber % (CF)	8.4	8.7	11.4	13.9	7.0	8.6	8.9
Ash %	8.3	7.9	7.1	6.4	7.8	6.4	6.2
*NFE %	49.4	49.0	48.2	45.8	50.7	50.9	50.7
**Gross Energy (Kcal/ kg)	4174.62	4072.14	3976.97	3905.14	4152.87	4152.87	4147

**** Calculated by differences[Nitrogen free extract (NFE) =100-(CP +EE +CF Ash)]**
***** Estimated according to NRC (1993). Using the factor 5.65, 9.45 and 4 for crude protein, ether extract and carbohydrate, respectively**

RESULTS AND DISCUSSION

Water quality parameters:

The average values of water quality criteria (water temperature (Co) and pH) in glass aquaria during the whole experimental period are shown in table (3).

Table (3): Average values of water quality criteria parameters of all experimental glass aquaria during the experimental period (14 weeks).

Parameter	Rang	Means ± SE
water temperature (C^{O})	20.8-28.6	25± 0.28
pH	7.1 -8.3	7.4± 0.212

No water quality problems were observed during the trial period. These means indicating that water quality parameters tested were within the acceptable range for monosex male OF Nile tilapia juvenile growth (El-Sayd, 2006).

Evaluation of partial replacement of fish meal by peas waste and tomato pomace on growth performance of Nile tilapia juveniles:

The effects of partial replacement of fish meal by peas waste and tomato pomace in experimental diets on live body weights and lengths were illustrated in table (4).Results revealed that averages of initial weights and lengths of the experiment start had ranged between 2.96±0.48 and 2.995±0.48 for weight and 5.25±0.16 and 5.5±0.16 for length, with insignificant differences among the experimental indicating that the complete randomization of individual fish among the experimental trials at the start of the experiment and were homogenous.

Table (4) : Evaluation of partial replacement of fish meal by peas waste and tomato pomace in feeds of Nile tilapia juvenile during the experimental period reared in aquaria (14 weeks).

Treatments	D1	D2	D3	D4	D5	D6	D7
Initial fish weight (g)	2.995 ± 0.48 a	2.995 ±0.48 a	2.98 ±0.48 a	2.96 ±0.48 a	2.99 ±0.48 a	2.988 ±0.48 a	2.995 ±0.48 a
Final fish weight (g)	9.738 ± 0.48a	10.85 ± 0.48c	12.078 ± 0.48b	13.14 ± 0.48a	9.936 ±0.48a	8.917 ± 0.48ab	8.761 ±0.48b
Initial fish length (cm)	5.45 ±0.16 a	5.375 ±0.16 a	5.475 ±0.16 a	5.4 ±0.16 a	5.25 ±0.16 a	5.525 ±0.16 a	5.45 ±0.16 a
Final fish length (cm)	8.219 ±0.16 a	8.6 ±0.16 c	8.9 ±0.16 b	9.2 ±0.16 a	8.3 ±0.16 a	8.144 ±0.16 a	8.083 ±0.16 a
Average daily gain (%)	0.181 ± 0.02d	0.69 ± 0.02c	0.826 ± 0.02b	0.96 ± 0.02a	0.308 ±0.02c	0.424 ±0.02b	0.548 ±0.02a
Total weight gain (g)	6.743 ± 0.75a	7.855 ± 0.75c	9.098 ± 0.75b	10.181 ± 0.75a	6.946 ±0.75a	5.929 ±0.75b	5.766 ±0.75b
Relative growth rate (%)	130.492 ± 3.9b	142.32 ± 3.9c	156.373 ± 3.9b	167.812 ± 3.9a	131.767 ±3.9a	119.257 ± 3.9c	116.669 ± 3.9d
Specific growth rate (%)	1.106 ± 0.21a	1.698 ± 0.21a	1.913 ± 0.21a	2.115 ± 0.21a	1.247 ±0.21a	1.286 ±0.21a	1.393 ±0.21a
Condition factor	1.759 ± 0.09b	2.314 ± 0.09ab	2.43 ± 0.09a	2.572 ± 0.09a	1.99 ±0.09a	2.036 ±0.09a	2.139 ±0.09a
No.of fish at Start.	20	20	20	20	20	20	20
No.of fish at End.	19	20	18	17	18	20	18
Survival ratio (%)	95	100	90	85	90	100	90

a, b , c… : Meaning the same row with different superscripts are significantly different (P< 0.05)

D1= Control DIET (100% fish meal protein).
D2= diet contained peas waste to replace 25% fish meal protein.
D3= diet contained peas waste to replace 50% fish meal protein.
D4= diet contained peas waste to replace 75% fish meal protein.
D5= diet contained tomato pomace to replace 25% fish meal protein.
D6= diet contained tomato pomace to replace 50% fish meal protein.
D7= diet contained tomato pomace to replace 75% fish meal protein.

Results were presented in table (4) showed that at the end of the experimental period (14 weeks), maximum final weight were achieved in the experimental fish fed diet (D4) which containing 75% PW and diet (D5) containing 25% TP with an averages of 13.14 and 9.936 (g), respectively .However, the lower final weight were noted in experimental fish fed diet (D7) 75% TP with an average of 8.761 (g) and diet (D2, 25% PW) with an average of 10.85 (g). substantial weight was also noted in experimental fish fed diet

(D1, control, D3(50% P w), and D6 (50% TP) with the average of 9.74, 12.08 and 8.917 (g), respectively. These results of averages of final fish weights indicated that replacing 75% of PW or 25% of TP showed positive effects on growth performances of male Nile tilapia juveniles (O.niloticus) and improvement in body weight was more pronounced in the fish fed the experimental diet (D4) containing PW to replace 75% of fish meal protein.

Recent efforts to incorporate plant ingredients into tilapia diets have concentrated on replacing fish meal with single or complex ingredients. The general trend of these experimental has shown replacement of fish meal with a single plant source (peas waste or tomato pomace) higher than 25-75% of diet dry matter in poor growth which was mainly attributed to antinutritional factors (Soltan, 2002, Massoud, 1992, Olvera – Novoa, *et al*., 1988, 1990. Daily Weight Gain(DWG),Specific Growth Rate(SGR) and Condition Factor As described in table (4),results showed that the experimental fish fed on D4(75%PW) and D5 (25%TP) had a significantly ($P<0.05$) higher total weight gain compared to the control diet than the rest of the experimental diets . Whereas the lowest total weight gain (5.766) was achieved by experimental fish fed on diet containing 75% TP. The worst growth performance obtained for experimental fish fed the experimental diet D4 (75%PW). On the other hand, the experimental fish fed on D4(75%PW) or D5(25%TP) had a significantly ($P<0.05$) higher specific growth rate (SGR%) than the rest of experimental diets. However at the end of the experimental, the lowest value of SGR was found to be 0.893 %/d in the experimental fish fed on diet containing 75% TP . It is interesting to note that, highest value of SGR was observed for the diet 75% peas waste. The statistical evaluation of date revealed that experimental fish fed on D7(75% TP) showed significantly ($P<0.05$) lower K values compared to the other experimental diets, and among them differences in K values were insignificant (table 4).Statistical analysis for (RGR%) indicated that the worst (SGR%) was observed by experimental fish fed diet D4 (75% PW) or diet D5(25%TP), and insignificantly ($P<0.05$) differences compared With control diet (D1).

Feed utilization:

Averages of feed utilization in terms of feed intake (FI), feed conversion ratio (FCR), feed efficiency (FE), protein efficiency ratio (PER), productive protein value (PPV) ,energy retention (ER) and energy utilization (EU) are presented in table (5). These results indicated that differences in D1(control) among the experimental diets were insignificant.($P<0.05$). On the other hand, the experimental fish fed on D4 (75%PW)orD5(25%TP) had a significantly ($P<0.05$) higher feed in take (27.387 and 21.789/fish) than the rest of experimental diets . Whereas the lowest feed intake (20.314 g/fish) was achieved by experimental fish fed on diet containing 75% tomato pomace (fish meal was 75% replaced by plant protein sources. Results of feed utilization in terms of feed conversion ratio (FCR) are presented in table (5). Replacement percentage of 75% peas waste and 25% tomato pomace (diets 4 and5, respectively) demonstrated the best significantly ($P<0.05$) feed conversion ratio (FCR) (2.842 and 3.173 g DM feed per g fish gain),

respectively. The worst FCR was observed by diet D7(75%TP). Average of FCR during the period had a significant differences (P<0.05) among the experimental diets (table 5) . All experimental diets contained treated peas waste and tomato pomace improved the average fish weight gain. Diets 4 (75% peas waste) and D5(25% tomato pomace) increased the total weight gain significantly from 6.743 g with control diet D1 to 7.855 and 6.946, respectively, FCR improved significantly (P<0.05) using the diets contained treated peas waste and tomato pomace.Also, the results of feed efficiency (FE) followed the same trend as (FCR)(table 5). Results also revealed that, the plant protein sources (peas waste protein or tomato pomace protein) could replace up to 50% fishmeal protein in growing Nile tilapia juvenile diets without any adverse effects on growth performance and feed utilization parameters .

Table (5) : Effect of the dietary treatments on nutrient utilization of Nile tilapia.

Treatments	D1	D2	D3	D4	D5	D6	D7
Total weight gain (g)	6.743 ± 0.75a	7.855 ± 0.75c	9.098 ± 0.75b	10.181 ±0.75a	6.946 ±0.75a	5.929 ±0.75b	5.766 ±0.75[b]
Feed intake (g/fish)	21.496 ±0.205c	23.44 ±0.205b	24.2 ±0.205b	27.587 ±0.205a	21.78 ±0.205a	20.443 ±0.21a	20.314 ±0.205a
feed conversion ratio	3.706 ±1.24a	2.842 ±1.24a	2.66 ±1.24a	2.503 ±1.24a	3.173 ±1.24a	3.706 ±1.24a	3.729 ±1.24a
Feed efficiency	0.272 ±0.066a	0.296 ±0.066a	0.326 ±0.066a	0.35 ±0.066a	0.275 ±0.066a	0.248 ±0.066a	0.243 ±0.066a
Protein efficiency ratio	1.036 ±2.62b	1.13 ±2.62b	1.24 ±2.62a	1.33 ±2.62a	1.046 ±2.62a	0.946 ±2.62a	.926 ±2.62a
Productive protein value	14.199 ±0.57ab	12.92 ±0.57b	14.39 ±0.57a	13.456 ±0.57a	12.66 ±0.57bc	10.83 ±0.57c	10.862 ±0.57c
Energy retention	275.73	220.33	256.63	217.96	196.92	187.31	281.55
Energy utilization	30.73	24.84	31.57	27.48	20.23	18.64	24.61

a, b, c… : Meaning the same row with different superscripts are significantly different (P< 0.05)

Results of protein efficiency ratio (PER) productive protein value (PPV), energy retention (ER) and energy utilization (EU) of Nile tilapia juvenile fed experimental diets containing treated peas waste and tomato pomace are presented in table (5).As shown in table (5), results revealed that experimental fish diets increased PER, and PPV values significantly (P<0.05).Concerning protein efficiency ratio (PER) values, it differences in this trial among the experimental fish fed the experimental diets were significant (P<0.05). The lower PER percentages obtained for the higher replacing levels (50 to 75% of FM by TP) indicating progressive reduction in nutritional value compared to the lower inclusion levels (25%) . This effect may be due to the reduced efficiency in protein utilization leading to a depression in feed intake (Dabrowski , 1986 and Hilton, 1983). Furthermore , protein efficiency ratio (PER) and utilization were improved with increasing levels of pea seed meal in extruded diets , when FCR and SGR values did not differ significantly (Gouveia and Davies,2000).

Results of energy retention (ER) and energy utilization (EU) indicated that experimental fish fed on experimental diets decreasing of PW and TP significantly (P<0.05) increased energy utilization (ER and EU).

Considerable interest in pea protein sources results from its more balanced amino acid pattern with only methionine being the first limiting amino acid. The use of pea protein flour with a crude protein of over 80% is a distinct improvement and allows higher substitution of fish meal proteins in diets in nutrient dense diets for fish (Davies and serwate ,2005).

The opportunities and constraints of utilizing feed peas in aquaculture diets were reviewed by (Mecallum, 1997). Indeed the promising role of pea meal by-products in diets for marine fish was presented by the work of Gouveia and Davies (1998-2000).in experimental trials with sea bass. There has been limited work undertaken with salmonid species, and for juvenile rainbow trout, Thiessen *et al.* (2003) found excellent digestibility for pea seed meal protein for row / whole peas, row / de-hulled peas, extruded /de-hulled peas and autoclaved air-classified pea protein in experimental practical type diets –Digestibility of the protein component was uniformly high for all pea ingredients (90.9-94.6%), regardless of the processing method employed and supports strongly the results described in Davies and serwata (2005) study . The same author was recorded excellent protein and essential amino acid digestibility coefficients for the pea protein flow including methionine despite the slightly lower contribution in the complete diet.

According to the experimental results Nile tilapia growth was not negatively affected by the high inclusion level of peas waste and by 25% tomato pomace substitution .The results of the current trial revealed the possibility of replacing 25% of the high cost fish meal by the low cost tomato pomace meal (TPM) in Nile tilapia diets , but increasing the level of (TPM) in the experimental diets above this level (25%) significantly (P<0.05) decreased body weight, growth performance and feed utilization of Nile tilapia juvenile, O.niloticus compared with control diet. Soltan(2002) found that the higher BW (30.70g) was recorded for the group fed TBM 10 diet (replacing level of 10%).The same author mention specifically that insignificant differences in body weight and growth performance for fish fed the experimental diets contained 0,10,20,30,40 and 50% of TBM .Saad(1998) recorded that replacement of SBM by TBM up to 88.9 % increased the final BW of Nile tilapia juvenile, while the complete replacement decreased the final body weight and growth performance .

Massoud, *et al.* (1992) reported the inclusion of 10% of tomato wastes in the diet improved the growth performance of Nile tilapia, and feed and nutrient utilization were decreased with increasing the levels of T.W more thane 10% of diets instead of fish meal .

Soltan (2002) found that, The 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 replete replacement decreased the final body weight.

Results from Soltan (2002) 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 compete 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).

Soltan (2002) 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 , and methionine and lysine are limiting essential amino acid 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 Soltan (2002).

Studies on rainbow trout (Hilton and Atkenson, 1982) and Nile tilapia (Anderson.*et al*.,1984) have demonstrated that increasing fiber level in the diets has resulted in a significant reduction in feed digestibility and assimilation . the results of Omar *et al*. (1992) clearly showed the role of NaOH treatment in improving the quality of fish feeds and the growth performance of tilapia and carp to decrease the dietary fiber content and increase the solubility of unsoluble carbohydrates and energy content.

Chemical composition of whole body:

Averages of chemical composition of whole fish body of the beginning and the end of the experiment including dry matter (DM) , crude protein (CP), ether extract (EE) , ash, and gross energy (GE kcal/kg) are shown in table (6).Averages DM contents of Nile tilapia juvenile whole bodies at the experimental diets start was 22.9±1.09 and increased significantly ($P<0.05$) in all experimental diets groups at the end of the experiment. Results of the same table revealed that crude protein (CP) in whole fish body at the experimental start was significantly ($P<0.05$) higher in the experimental diet (D1=control) than that of all experimental diets at the end indicating a decrease in CP parallel are increase in whole fish body ether extract (EE).

Increasing levels of fish meal replacement in experimental diets by peas waste decreased significantly ($P<0.05$) dry matter and crude protein of whole fish bodies from 24.059 and 56.4 with the control diet (D1) to 23.62,

52.25, 44.345, 51.21 and 22.766, 51.58% with experimental diets D2, D3, and D4, respectively after 14 weeks . But inclusion of 25%, 50% and 75% tomato pomace in the experimental diets increased DM and CP contents significantly (P<0.05) in whole fish bodies at the end of the experimental period (24.31, 55.2, 24.61, 53.8, 24.311 and 45.6 for diets D5, D6, and D7, respectively) compared with its initial values (22.9 and 54.65 for DM and CP, respectively). The reverse trend was observed with fish body EE where it was significantly (P<0.05) low at the experimental start (20.59%) and increased significantly (P<0.05) by the increasing levels of fish meal replacement by peas waste and tomato pomace in experimental diets at the end of the experiment (22.32, 23.99, 24.3, 25.03, 21.21, 23.61, and 22.84% for D1, D2, D3, D4, D5, D6, and D7, respectively compared with its initial values (20.59%). On the other hand , its increased significantly (P<0.05) to 25.03 and 21.205 in whole fish bodies with diets D4 (75% PW) and D5 (25% TP) , respectively , at the end of the experimental period .

These results indicated in general that CP% content in whole fish bodies is related to EE contents where the increase in one is decrease on the costs of the other.

Table (6): Whole body composition (DM bases)of Nile tilapia (O. niloticus) juvenile feed the experimental diets (Mean ±SE)after 14 weeks.

Chemical analysis	Initial	D1	D2	D3	D4	D5	D6	D7
Dry matter(DM)	22.9 ± 1.09a	24.059 ± 1.09a	23.62 ± 1.09a	24.345 ± 1.09a	22.766 ± 1.09a	24.31 ± 1.09a	24.606 ± 1.09a	24.311 ± 1.09a
Crude protein (CP)	54.65 ± 1.03a	56.4 ± 1.03a	52.25 ± 1.03b	51.21 ± 1.03b	51.58 ± 1.03b	55.2 ± 1.03a	53.85 ± 1.03b	54.6 ± 1.03a
Ether extract (EE)	20.59 ± 1.4b	22.315 ± 1.4a	23.99 ± 1.4a	24.305 ± 1.4a	25.03 ± 1.4a	21.205 ± 1.4a	23.61 ± 1.4a	22.835 ± 1.4a
Ash	23.5 ± 1.18a	19.605 ±1.18c	22.15 ± 1.18b	22.405 ±1.18b	21.19 ±1.18b	21.500 ± 1.18a	20.8 ± 1.18b	21.015 ±1.18b
Growth energy (GE)Kcal GE/Kg	5080.81 ± 40.13c	5356.54 ±40.13a	5277.73 ± 40.1bc	5268.12 ± 40.13b	5362.36 ± 40.13a	5201.14 ± 40.1bc	5337.44 ± 40.13a	5298.77 ± 40.13a

a, b, c… : Meaning the same row with different superscripts are significantly different (P< 0.05)

There results also revealed that PW released more potential in fat than TP when incorporated in growing Nile tilapia juvenile diets. Whole tilapia body fat as significantly (P<0.05) higher for diets PW compared to control and TP , respectively that is increasing whole body EE with elevating levels of carbohydrates (Wang *et al*, 2005).Averages of whole fish bodies ash % results revealed that ash% in whole tilapia bodies was significantly (P<0.05) highest at the initial of the experiment (25.5%) compared to those of all experimental diets at the end of the experiment. At the end of the experiment, the control diets (D1) showed the lowest (P<0.05) ash % (19.61)) followed by diets contained TP and diets included of PW, respectively. The

higher ash % in the diets contained TP due to higher ash percentages in TP used in the current study.

As presented in the same table, energy contents as GE kcal/kg dry matter at the initial of the experiment was found to be 5083.81 kcal/kg dry matter and it was increased significantly ($P<0.05$) to 5356.54, 5277.73, 5268.12, 5362.36, 5201.14, 5337.44, and 5298.77 kcal/kg dry matter in the experimental diets D1,D2,D3, D4, D5, D6, and D7 ,respectively , at end of the experimental period.

In the current study Nile tilapia juvenile showed no negative effects on whole fish bodies proximate composition of either incorporation of PW or TP in Nile tilapia diets when compared to the control. Pea waste meal was successfully including in diets of juveniles the same species with equivalent results (Wang *et al*., 2005). Soltan (2002) and Hassanen *et al*.(1995) showed that as the inclusion level of TBM in the experimental diets increased , protein and fat content of whole fish significantly ($P<0.05$) decreased and ash increased ($P<0.05$) but moisture content was significantly changed . Jauncey (1982) reported that the carcass moisture and protein contents were lower, and lipid and energy higher in O.niloticus maintained on low protein diets. Desilva and Gunasekera (1989) concluded that the carcass .%moisture, %protein and %ash decreased with decreasing dietary protein level, whereas the% lipid and energy (Kcal/kg) decreased with increasing dietary protein level. Soltan *et al*,(2008) showed that DM and CP of whole body increased with increasing level of plant protein meal (PPM) in diets and whole body content of EE and Ash significantly ($P<0.05$) increased with increasing PPM content of tilapia diets Barros *et al*. (2000) reported that body fat content is closely related to weight gain and inversely related to body moisture content. In this respect, Massoud (1992) found that increased partial replacement percentage of fish meal by pea waste or tomato pomace as a plant protein sources was increased DM, CP and EE content, also showed that, ash content was decreased significantly with each increase of PW and TP in the experimental diets.

Economical evaluation :

The economic evaluation showed that the incorporation of PW or TP in Nile tilapia juvenile diets seamed to be economic and sharply reduced the feed cost of Nile tilapia juvenile diets as reported in table (7).These results indicate that incorporation of pea waste (PW) or tomato pomace (TP) in Nile tilapia (O. niloticus) juvenile diets reduced the total feed costs. From the economic standpoint, replacement of fish meal (FM) with cheaper pea waste (PW) or tomato pomace (TP) in a practical diets for Nile tilapia (O. niloticus) can alleviate the problem of low FM availability and high cost. However , the incorporation of PW or TP in Nile tilapia diets seemed to be economic as incorporation of PW or TP in the diets sharply feed costs by 00.00, 30.80, 43.08, 49.77, 24.55, 24.57, and 31.90For experimental diets D1, D2, D3, D4, D5, D6 and D7,respectively.Calculation of the economical efficiency of the tasted diets was based an the costs of feed because the other costs were equal for all studied treatments . As described in table (7) feed costs (LE) were the highest for the control (D1) diet and gradually decreased with increasing the replacing levels of plant protein sources. The reduction of feed

costs was easily observed for the feed costs pea Kg weight gain which decreased with increasing incorporation levels of PW or TP in agreement with Soltan (2005), Soltan *et al*, (2008) for Nile tilapia , Eid and Mohamed (2007) and Eid *et al.*, (2009). Collins *et al.*, (1979) found that feeding costs in fish production is about 50% of total production costs.All other costs of in the present experiment are constant, there fore, the feeding costs required to produce one Kg in weight gain can be used to compare the different experimental diets. EL-said and Gaber(2003) reported that, partial as complete replacement of FM by a mixture of plant protein sources significantly reduced incidence costs and improved profit indices compared to the basal diets.

Table (7): Feed cost (L.E) for producing one kg weight gain by Nile tilapia (O.niloticus) juvenile feed on the experimental diets.

Exp. diets	Costs (L.E)kg	Relative to control(%)	Decrease in Feed costs* (L.E)/kg Weight gain	FCR	FEED COST *(L.E)/kg Weight gain	Relative to control	Decrease in Feed costs* (L.E)/kg Weight gain
D1	2.84	100.00	0.00	3.71	10.51	100.00	0.00
D2	2.56	90.24	9.76	2.84	7.28	69.20	30.80
D3	2.25	79.31	20.69	2.66	5.99	56.92	43.08
D4	2.11	74.37	25.63	2.50	5.28	50.23	**49.77**
D5	2.50	88.12	11.88	3.17	7.93	75.45	24.55
D6	2.14	75.43	24.57	3.71	7.93	75.43	24.57
D7	1.92	67.68	32.32	3.73	7.16	68.10	31.90

***Feed costs/kg weight gain = FCR × costs of kg feed, Local market price (L.E./ton) for feed ingredients used for formulating the experimental diets when the experiment was started; soybean meal, 3000 L,E,; fish meal, 7500 L.E.; yellow corn, 1500 L.E; tomato Pomace)DRY), 500 L.E.; pea waste (DRY)1000L.E.;Wheat bran,1150 L.E premix (vit & min.), 3000 L.E.**

From the all aforementioned results , it could be detected that PW or TP could be utilized by Nile tilapia safely and efficiently as alternative protein instead of 50% of FM without adverse effects on the growth performance of Nile tilapia. In addition, these plant protein sources are locally available at much lower prices than imported fish meal. Further researches are required to determine the feasibility of improving the nutritional values and using of the PW and TP as plant protein sources composed of different combinations of ingredients and to examine the effects of PW and TP use in diets on large sizes of fish under the fish field conditions.

REFERENCES

A O A C (1995) . Association of Official Analytical Chemists. Official Methods of Analysis . 16th edition. AOAC, Arlington VA.1832 pp

Anderson, J., Jackson, A.J., Matty, A.J. and Capper, B.S. (1984) Effects of dietary carbohydrate and fibre on the tilapia Oreochromis niloticus (Linn.). Aquaculture, 37: 303–314.

Burel, C., Boujard, T., Tulli, F., Kaushik, S.J., 2000. Digestibility of extruded peas, extruded lupin, and rapeseed meal in rainbow trout (Oncorhynchus mykiss) and turbot (Psetta maxima). Aquaculture 188, 285-298.

Carter, C.G., Hauler, R.C., 2000. Fish meal replacement by plant meals in extruded feeds for Atlantic salmon, Salmo salar L. Aquaculture, 185: 299-311.

Cruz-Suarez, L.E., Ricque-Marie, D., Tapia-Salazar, M., McCallum, I.M., Hickling, D., 2001. Assessment of differently processed feed pea (Pisum sativum) meals and canola meal (Brassica sp.) in diets for blue shrimp (Litopenaeus stylirostris). Aquaculture, 196: 87-104.

Dabrowski, K., Guderley, H., 2002. Intermediary metabolism. In: Halver, J.E. and Hardy, R.W. 3rd ed. Fish Nutrition. Elsevier Science, Academic Press, pp. 309-365.

Davies, S.J., Morris, P.C., Baker, R.T.M., 1997. Partial substitution of fish meal and full-fat soya bean meal with wheat gluten and influence of lysine supplementation in diets for rainbow trout, Oncorhynchus mykiss (Walbaum). Aquac. Res., 28: 317-328.

Davis, D.A., Arnold, C.R., McCallum, I., 2002. Nutritional value of feed peas (Pisum sativum) in practical diet formulations for Litopenaeus vannamei. Aquac. Nutr. 8, 87-94.

Duncan, D.B. (1955): Multiple range and multiple Ftest. Biometrics, 11: 142.

Edwards, P.W.; Eskew, P.K.; Honers, Jr.N.C. Aceto and Redfield, CS. (1952): Recovery of tomato processing wastes. Food Technol., 6: 303306.

Eid, and Mohamed ,K,(2007). Effect of fishmeal substitution by plant protein sources on growth performance of seabass fingerlings (D. labrax). Agr. Res. J. Suez Canal Univ. , 7(3): 35-39

Eid, Elfattah B.,Mohamed K.,(2009) Effect of fishmeal substitution by plant protein sources on growth performance and body composition of gilthead sea bream (Sparus aurata) fingerlings Agric. Res. J. Suez Canal Univ. 16/11.

ElHassan, M.A.E.C. (1999): Effect of some agricultural industrial byproducts on the performance of broiler chicks. Ph.D. Thesis, Fac. Agric., Zagazig Univ., Egypt.

Gouveia, A., Davies, S.J. 1998. Preliminary nutritional evaluation of pea seed meal (Pisum sativum) for juvenile European seabass (Dicentrarchus labrax). Aquaculture, 166: 311-320.

Gouveia, A., Davies, S.J., 2000. Inclusion of an extruded dehulled pea seed meal in diets for juvenile European seabass (Dicentrarchus labrax). Aquaculture, 182: 183-193.

Hassan, M.Sh.M. (2004): Nutritional studies on carp fish M.Sc. Thesis, Fac. of Agric., Moshtohor, Zagazig Univ., Banha Branch.

Hassanen *et al*, (1995). Effect of different dietary lipids on growth performance and feed expenses of juvenile catfish, Clarias lazera , C&V., J. Egypt.Ger.Soc.Zool.,16(A) : 177-1

Hilton, J.W., Slinger, S.J., 1983. Effect of wheat bran replacement of wheat middlings in extrusion processed (floating) diets on the growth of juvenile rainbow trout (Salmo gairdneri). Aquaculture, 35: 201-210.

Jauncey, K., 1998. Tilapia, Feed and feeding by Kim Jauncey. Pisces Press Ltd: Stirling, Scotland, pp. 27-33.

Jobling , M 1983. Ashort Review and critique of Methodology used in fish growth and nutrition studies . J. fish Biol., 23: 685

Khadzhinikolova, L. and Tomasyan, K.H. (1984): Tomato waste for feeding carp up to one year. Ribnostopanstvo, 30(7):2021. (B9) Inst.

Sladkovodno ribov'dstvo, Plovdiv, Blugaria (1985). (c.f. Nut. Abst. and Rev., 55: 417

Massoud M.H.H.,1992 . Effect of replacing of animal protein by plant protein in fish diets .Msc Thesis .Fac. Agric. Alex. Univ.109pp.

McCallum,I.1997 . Opportunities and constraints for feed peas and chickpeas in aquaculture feeds. Notes for the presentation to Saskatchewan Pules Growers Association (SPGA) October ,25, 1997,24pp.

Olvera-Novoa, M.A., Campos G.S., Sabido G.M., Palacios, C.A.M. 1990. The use of alfalfa leaf protein concentrates as a protein source in diets for tilapia (Oreochromis niloticus). Aquaculture, 90: 291-302.

Saad, F.A. (1998): Some studies on fish nutrition. M.Sc. Thesis, Fac. Veterinary Medicine, Moshtohor, Zagazig Univ., BanhaBranch.

Sauvant, D., Perez, J.-M., Tran, G., 2004. Tables of composition and nutritional value of feed materials. Pigs, poultry, cattle, sheep, goats, rabbits, horses and fish. Wageningen Academic Publishers, The Netherlands and INRA, Paris, France, pp. 144-158.

Soltan M.,A., 2005. Partial and total replacement of soybean meal by raw and heat treated linseed meal in tilapia diets .Egypt. J. Nutr. &Feeds (Special Issue) ,8(1):1091-1109

Soltan M.A ,Hanafy M.A.,and Wafa M.,I., 2008. Effect of Replacing fish meal by a mixture of different plant protein sources in Nile tilapia (O. niloticus) diets . Global Veterinaria, 2(4):157-164.

Soltan, M.A. (2002): Using of tomato and potato byproducts as nonconventional ingredients in Nile tilapia, Oreochromis niloticus diets.

Annals of Agric. Sci., Moshtohor, 40(4): 20812096.

Thiessen, D.L., Campbell, G.L. Adelzini, P.D. 2003. Digestibility and growth performance of juvenile rainbow trout (Oncorhynchus mykiss) fed with pea and canola products. Aqua. Nutr., 9: 67-75.

Wang, J.-Q., Li, D., Dong, S., Wang, K. and Tian, X. (1998) Experimental studies on polyculture in closed shrimp ponds. 1. Intensive polyculture of Chinese shrimp (Penaeus chinensis) with tilapia hybrids. Aquaculture, 163: 11–27

تاثيرات الإحلال الجزئى لمسحوق السمك بمخلفات البسلة والطماطم كمواد علفية غير تقليدية فى العلائق المغذاه لأسماك البلطي النيلى .

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لا شك أن الأزمة الاقتصادية العالمية الحالية أدت الى اضطرابات في انتاج الغذاء والأسعار عموماً ، كما أن الطلب المتزايد في الاسواق العالمية على مسحوق السمك وفول الصويا وزيت السمك والذرة الصفراء أدى الى ارتفاع أسعارها ، ومن ثم فقد دعت الحاجة الى البحث عن بدائل لتقليل الاعتماد على تلك المواد في صناعة الأعلاف السمكية وذلك بزيادة الخيارات بين مدى أوسع من المواد الغذائية الأولية منخفضة الأسعار ، ولذا هدفت هذه الدراسة الى تقييم أثر الاستبدال الجزئي لثلاث مستويات مختلفة (25% ، 50% ، 75%) من البروتين الخام لمسحوق السمك في عليقة الكنترول وذلك ببروتين مخلفات البسلة أوتفل الطماطم كمصادر بروتين نباتية ، وتقييم أثر ذلك على أداء النمو والاستفادة الغذائية وتركيب الجسم وكذا الكفائة الإقتصادية لأسماك البلطي النيلي وحيد الجنس ، وقد استمرت التجربة مدة 14 اسبوع وقسمت المعاملات الى 7 مجموعات بوزن ابتدائي للسمك (2.9±0.48 كجم) وغذيت على عليقة (30% بروتين) و(4200 ك كالوري طاقة كلية/جم مادة جافة) وصممت التجربة لتشمل مكررتين (20سمكة/حوض).

أظهرت النتائج أن الاستبدال الجزئي لمسحوق السمك بمخلفات البسلة أوتفل الطماطم لم يؤثر بشكل ملحوظ على أداء النمو(BW, BL, ADG, SR , SGR, K)والاستفادة الغذائية (ER, FI , FCR ,FE , PER PPV) بين الكنترول والعلائق الست الأخرى.

كما لوحظ أن التكلفة الاقتصادية للعليقة انخفضت مقارنة بالزيادة الكلية للوزن(كجم) وذلك تبعاً لزيادة الاستبدال بمخلفات البسلة أوتفل الطماطم.

ويمكن الاستنتاج في نهاية هذه الدراسة الى أن الاستبدال الجزئي لبروتين مسحوق السمك ببروتين مخلفات البسلة أوتفل الطماطم في علائق البلطي النيلي أدت الى نمو واستفادة غذائية عالية.

ومن النتائج نستنتج أن مخلفات البسلة أوتفل الطماطم يمكن ان يستخدمان في علائق البلطي النيلي بأمان وكفائة كبروتين بديل لمسحوق السمك بنسبة ستبدال 50% بدون أي تأثيرات عكسية على أداء النمولأسماك البلطي النيلي ، بالاضافة الى توفر تلك المواد محلياً وبأسعار أقل بكثير من مسحوق السمك المستورد .

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