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# NUTRITIVE VALUE OF CORN GLUTEN MEAL AND SESAME SEED MEAL IN FEED FOR HYBRID TILAPIA, (*OREOCHROMIS NILOTICUS* X *OREOCHROMIS AUREUS*)

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## SUMMARY

Feeding experiments were conducted with hybrid tilapia in net enclosures to examine the potential use of corn gluten meal and sesame seed meal as a partial replacement of dietary protein. Two dietary protein levels were gradually replaced (40, 60, 80%) by corn gluten meal or sesame seed meal. The experimental diets were fed to groups of hybrid tilapia of 41.5 ± 0.9g initial body weight at a rate 3% of total fish biomass 14 days per 15 days for 150 days. Average water temperature through out the experimental period was 29 $^0$C. Results revealed that, hybrid specific tilapia fed a diet containing 40% corn gluten meal had best percentage weight gain and growth rate compared to control diets. Final body weight was distinctly higher for fish fed corn gluten meal than sesame seed meal. Average amounts of feed consumed as affected by protein level increased with increasing dietary protein level from 25 to 30%. With each decrease in percentage corn gluten meal and with sesame seed meal in the diets, the feed conversion ratio of hybrid tilapia was improved gradually. Increasing percentage of test plant protein sources fed had positive significant ($P<0.05$) effect on hepatosomatic index. The triglyceride contents of the serum decreased significantly ($P<0.05$) as the percentage of corn gluten meal or sesame seed meal increased in the diet. Evidence is presented to show that corn gluten meal promoted reasonable growth to hybrid tilapia when providing 40 and 60% of both dietary protein level (25 and 30%), while sesame seed meal might have been performed more favourably if the diet contributes more than 40% of the total protein when dietary protein level was 25%.

**Keywords:** *Hybrid tilapia, corn gluten meal, sesame seed meal, growth performance, hematological characteristics, total serum protein, triglyceride.*

## INTRODUCTION

Traditionally, fish meal has been utilized as a main component in balanced diets for fish. However, its cost are high and sometimes of poor quality which limits its potential for use in commercial fish diets. This constraint has necessitated research to find alternative protein sources which have a high level of protein, so that, these can partially or wholly replace fish meal in fish diets (El-Sayed, 1999).

Therefore, fish nutritionists have made several attempts to partially or even fully replacement of fish meal by plant protein sources such as soybean, corn gluten meal. Moyano et al (1991) on rainbow trout Hassanen et al., (1992) on sea bream; Shimeno et al., (1993) on yellowtail, proposed that the total replacement of fish meal by corn gluten meal for maximal growth should not exceed 30%. Tibaldi and Lanari (1991) suggested that protein sources such as corn gluten meal can be employed successfully in formulating practical diets for sea bass *(Dicentrarchus labrax)* using small amounts of fish meal and providing adequate supplementation with lysine and other essential amino acids.

In fact, the corn gluten diet showed a better apparent digestibility coefficients of protein and fat and a lower apparent digestibility coefficient of nitrogen-free extract than fish meal (Morales et al., 1994). Wu et al., (1995) showed that the diets containing corn gluten meal yielded higher weight gain, higher protein efficiency ratio and better feed conversion ratio of tilapia (*Oreochromis niloticus*) than a commercial fish feed containing 36 % crude protein with fish meal. Regost et al. (1999) suggested that, protein from corn gluten meal can replace one third of fish meal protein in the diets for turbot (*Psetta maxima*). Though, they found that the incorporation of corn gluten meal in diets significantly affected plasma cholesterol and triglycerides concentrations.

Other oilseed by-products like sesame seed it may have a good potential as protein source for tilapia. Sesame cake in contrast to most other oilseed meals, has a high methionine content. It is also rich in arginine and leucine but it is deficient in lysine. Therefore, it has a great potential if mixed with lysine-rich feedstuffs. While, it has a high content of phytic acid and appears to bind calcium, thus the amount of calcium in sesame meal containing diets requires supplementation (Gohl, 1975).

El-Sayed (1987) evaluated the effects of replacing casein / gelatine protein by sesame seed protein in diets of *Tilapia zillii* fingerlings. He found that fish fed sesame seed diets exhibited poor performance and showed pathological signs, however, its were disappeared when either lysine or zinc was added to the diets.

Zarate and Lovell (1997) used the basal diet contained sesame meal as the primary protein source and supplemented it with free or protein-bound lysine. They reported that sesame assigned the same digestible energy value and amino acid availability coefficient as soybean meal.

The objectives of the present were: to evaluate the effect of gradual incorporation of corn gluten and sesame seed meals on growth performance of hybrid tialpia under two dietary protein levels and to evaluate the effect of corn gluten meal and sesame seed meal on hepatosomatic index, hemtocrite value, haemoglobin value, total serum protein and triglycerides concentrations.

## MATERIALS AND METHODS

### Location and period

This experiment was carried out at the Fish Research Station at El-Kanater El-Khyria, Qulubia, Egypt. Fifteen net enclosures about of total volume 10 $m^2$ (2.5 X 4.0 m) each were constructed in concrete ponds. Enclosures were supplied of fresh water from Nile River.

The experimental period expanded 150 days from 24 May to 20 October, 1998)

### Experimental fish

Hybrid tilapia (*Oreochromis niloticus* X *Oreochromis aureus*) was used as experimental fish. The fish were stocked at a density of 40 per enclosure with an average initial weight of 41.5 ± 0.9 g. Fish were acclimated to the new environment and fed on a commercial pelleted diets for 15 days perior to the experimental start.

### Experimental diets

Fourteen experimental diets were formulated (Table 1) to represent two protein levels (25 and 30%) within each level two protein replaces were tested (corn gluten meal and sesame seed

**Table 1 . Ingredients and proximate composition of the experimental diets**

| Crude protein level | 25% | | | | | | | 30% | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Test protein source | control | corn gluten meal * | | | sesame seed meal * | | | control | corn gluten meal * | | | sesame seed meal * | | |
| Plant protein as % of total protein | 0 | 40 | 60 | 80 | 40 | 60 | 80 | 0 | 40 | 60 | 80 | 40 | 60 | 80 |
| Ingredients % | | | | | | | | | | | | | | |
| Test protein source | | 24.1 | 36.1 | 48.2 | 22.8 | 34.2 | 45.7 | | 28.9 | 43.4 | 57.8 | 27.4 | 41.1 | 54.8 |
| Fish meal (72%. Cp.) | 25.0 | 13.2 | 7.1 | 1.4 | 13.3 | 7.8 | 2.0 | 33.0 | 18.3 | 11.3 | 4.0 | 18.7 | 11.6 | 4.4 |
| Rice brane | 29.0 | 14.5 | 14.7 | 12.5 | 13.0 | 10.9 | 5.7 | 28.0 | 26.0 | 15.7 | 19.1 | 18.1 | 5.9 | |
| Corn yellow | 40.0 | 43.8 | 37.0 | 32.4 | 43.8 | 38.0 | 36.4 | 32.6 | 19.0 | 23.5 | 10.4 | 26.4 | 32.5 | 30.4 |
| Cotton seed oil | 4.0 | 1.8 | 2.3 | 2.5 | 4.6 | 6.5 | 7.4 | 4.4 | 5.5 | 3.6 | 5.8 | 7.2 | 6.5 | 7.7 |
| Vitamin and mineral premix *** | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Lysine-HCl 98.0 % | | 0.6 | 0.8 | 1.0 | 0.5 | 0.6 | 0.8 | | 0.3 | 0.5 | 0.9 | 0.2 | 0.4 | 0.7 |
| Proximate composition: | | | | | | | | | | | | | | |
| Moisture | 8.80 | 9.20 | 8.60 | 9.10 | 7.80 | 8.10 | 7.90 | 8.40 | 8.30 | 8.70 | 8.30 | 7.80 | 7.80 | 7.50 |
| Crude protein | 25.00 | 25.10 | 25.10 | 25.30 | 25.00 | 25.20 | 25.30 | 30.00 | 30.00 | 30.10 | 30.10 | 30.00 | 29.90 | 29.80 |
| Ether extraxt | 11.80 | 7.30 | 7.30 | 6.70 | 11.30 | 13.10 | 13.70 | 12.60 | 12.20 | 8.70 | 10.50 | 14.80 | 13.20 | 14.00 |
| Crude ash | 3.20 | 2.40 | 2.20 | 1.90 | 3.00 | 3.20 | 3.20 | 3.50 | 3.10 | 2.50 | 2.30 | 3.70 | 3.50 | 3.50 |
| Crude fibre | 4.50 | 4.50 | 5.20 | 5.60 | 4.80 | 5.50 | 5.90 | 4.30 | 5.70 | 5.50 | 6.60 | 5.50 | 5.50 | 6.00 |
| Nitrogen free extract | 46.70 | 51.50 | 51.60 | 51.40 | 48.10 | 44.90 | 44.00 | 41.20 | 40.70 | 44.50 | 42.20 | 38.20 | 40.10 | 39.20 |
| Metabolizable energy (Kcal/Kg) | 2990 | 3017 | 2992 | 2992 | 3009 | 3008 | 3002 | 3014 | 2998 | 3015 | 3014 | 3002 | 3002 | 2996 |
| P/E | 83.60 | 83.20 | 83.90 | 84.60 | 83.10 | 83.80 | 84.30 | 99.50 | 100.1 | 99.80 | 99.80 | 99.90 | 99.60 | 99.60 |
| Carbohydrate / lipid ratio | 3.96 | 7.05 | 7.07 | 7.67 | 4.26 | 3.43 | 3.21 | 3.27 | 3.34 | 5.11 | 4.02 | 2.58 | 3.04 | 2.80 |
| Test plant protein | | 10.00 | 15.00 | 20.00 | 10.00 | 15.00 | 20.00 | | 12.00 | 18.00 | 24.00 | 12.00 | 18.00 | 24.00 |
| Total plant protein | 12.00 | 15.60 | 20.00 | 24.30 | 15.40 | 19.60 | 23.90 | 6.20 | 16.80 | 22.00 | 27.20 | 16.50 | 21.50 | 26.60 |
| Total animal protein | 18.00 | 9.50 | 5.10 | 1.00 | 9.60 | 5.60 | 1.40 | 23.80 | 13.20 | 8.10 | 2.90 | 13.50 | 8.40 | 3.20 |
| Protein energy/total metablizable energy | 41.97 | 41.60 | 41.95 | 42.28 | 41.54 | 41.89 | 42.14 | 49.77 | 50.03 | 49.92 | 49.93 | 49.97 | 49.80 | 49.73 |

* : Corn gluten meal (41.5% crude protein: 2.5% ether extract: 7.0% crude fibre: 1.9%crude ash: 38.1% nitrogen free extract and 2940 Kcal/Kg

**: Sesame seeds meal (43.8% crude protein; 8.6% ether extract; 9.7% crude fibre; 5.5% crude ash; 25.6% nitrogen free extract and 2060 Kcal/Kg

***: Vitamin and mineral premix, each 1 Kg contains: 4.8 m.I.U. vit A; 0.8 m.I.U. vit D3; 4.0 g vit E; 0.8 g vit K; 4.0 g vit B12; 4.0 g vit B2; 0.6 g vit B6; 4.0 g vit pantothenioc acid; 8.0 g vit Nicotinic acid; 400 mg vit Folic acid, 20 mg vit Biotin; 200g Choline chloride; 4.0 g copper; 0.4 g Iodine; 12 g Iron; 22 g Manganese; 22 g Zinc and 0.04 g Selenium

Table 2 . Calculated levels of essential amino acids in the Experimenatal diets (%) and the essential amino acid requirements of tilapia (40% protein diet) are shown for comparison

| Crude protein level / Test protein source / Plant protein as % of total protein | * Amino acid requirement of tilapia | 25% Control | 25% corn gluten meal | | | 25% sesame seed meal | | | 30% Control | 30% corn gluten meal | | | 30% sesame seed meal | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 40 | 60 | 80 | 40 | 60 | 80 | 0 | 40 | 60 | 80 | 40 | 60 | 80 |
| **Items** | | | | | | | | | | | | | | | |
| **Arginine** | ** < 1.59 | 1.68 | **** 1.07 | **** 1.03 | **** 1.00 | 1.85 | 2.21 | 2.56 | 1.65 | **** 1.25 | **** 1.18 | **** 1.14 | 2.18 | 2.58 | 2.99 |
| **Histidine** | 0.43 | 0.60 | 0.60 | 0.60 | 0.60 | 0.61 | 0.62 | 0.62 | 0.72 | 0.72 | 0.71 | 0.72 | 0.73 | 0.73 | 0.73 |
| **Isoleucine** | 0.80 | 1.10 | 1.19 | 1.23 | 1.28 | 1.14 | 1.17 | 1.20 | 1.33 | 1.42 | 1.48 | 1.53 | 1.37 | 1.40 | 1.42 |
| **Leucine** | 1.35 | 2.04 | 3.05 | 3.51 | 4.01 | 2.31 | 2.07 | 2.08 | 2.37 | 3.50 | 4.12 | 4.66 | 2.36 | 2.40 | 2.39 |
| **Lycine** *** | ** 1.62 | 1.69 | 1.62 | 1.62 | 1.62 | 1.62 | 1.62 | 1.62 | 2.12 | 1.62 | 1.62 | 1.62 | 1.62 | 1.62 | 1.62 |
| **Methionine** | ** < 0.53 | 0.66 | 0.64 | 0.82 | 0.62 | 0.67 | 0.67 | 0.67 | 0.81 | 0.77 | 0.76 | 0.74 | 0.81 | 0.81 | 0.81 |
| **Phenylalanine** | 1.00 | 1.05 | 1.30 | 1.42 | 1.55 | 1.16 | 1.22 | 1.27 | 1.24 | 1.52 | 1.68 | 1.81 | 1.36 | 1.42 | 1.48 |
| **Threonine** | 1.17 | 1.25 | **** 0.97 | **** 0.93 | **** 0.90 | **** 1.01 | **** 1.00 | **** 0.98 | 1.25 | **** 1.15 | **** 1.11 | **** 1.06 | **** 1.20 | 1.18 | **** 1.15 |
| **Valine** | 0.88 | 1.52 | 1.45 | 1.42 | 1.40 | 1.46 | 1.45 | 1.42 | 1.82 | 1.74 | 1.70 | 1.66 | 1.74 | 1.71 | 1.76 |
| **Tryptophan** | 0.17 | 0.38 | 0.22 | 0.18 | **** 0.16 | 0.35 | 0.39 | 0.42 | 0.34 | 0.27 | 0.23 | 0.19 | 0.42 | 0.46 | 0.50 |

* Jauncey et al., (1983) ** Jackson and Capper (1982) *** With supplemented lysine **** less than requirement

meals). The protein replaces incorporated to provide 40, 60 and 80% of the diet protein. For each protein level and a control diet was formulated. Also, one experimental enclosure surfed as a treatment without any artificial diets. The experimental diets were formulated to be isocaloric and contained 3000 Kcal/Kg diet metabolizable energy. ME was calculated from gross energy as 70 % as reported by Hepher et al. (1983).

**Analytical methods**

Analysis of samples (diets and fish bodies) was carried out according to A.O.A.C. (1990). Muscle gross energy by NRC (1983).

Blood samples were collected from the caudal artery by cutting the caudal fine. Hematocrit value (%) was determined using microhematocrit heparinized capillary tubes by centrifugation at 3000 r.p.m. for 20 minutes (Zanug and Carrillo, 1985). Haemoglobin concentration (g/100ml) was determined as described by Larson and Snieszlco (1961). Total serum protein was determined spectrophotometrically using Diamono Diagnosteves Kits, according to Henery (1964) and Drevon and Schmit (1964). Triglyceride (mg/100ml) was determined using Diamono Diagnosteves Kits according to Trinder, (1969). The physico-chemical characteristics of the water were determined according to the methods described by, The American Public Health Association (A.P.H.A., 1989) (Table 3).

**Experimental procedure:**

At the experimental start, 12 fish were sampled randomly for analysis of whole body composition. The experimental diets were offered to the corresponding fish groups 14 days each 15 days at a rate of 3% of total fish mass.

During the growth study, fishes of each treatment were weight in fifteenth day with the feeding allowance adjusted accordingly at fifteen days intervals. The study was conducted for 150 days. At the end of growth, individual weight of fish were recorded to the nearest 0.1 g. six fish per treatment were used to take blood samples. Six fish were dissected and liver were weight. A sample of dorsal muscle was withdrawn for analysis.

**Records maintained:**

**Specific growth rate =**

$$\frac{\text{Ln final body weight} - \text{Ln initial body weight}}{\text{Time(day)}} \times 100$$

**Feed conversion ratio =**

$$\frac{\text{Feed supplied (g) on dry}}{\text{Body weight gain (g)}}$$

**Feed conversion efficiency =**

$$\frac{\text{Body weight gain (g)} \times 100}{\text{Feed supplied (g)}}$$

**Protein efficiency ratio =**

$$\frac{\text{Body weight gain (g)}}{\text{Protein fed (g)}}$$

**Specific growth rate in body protein =**

$$\frac{\text{Ln final body protein} - \text{Ln initial body protein}}{\text{Time (day)}} \times 100$$

According to Xie *et al.*, (1997)

**Protein retained ratio =**

$$\frac{\text{Protein gained (g)}}{\text{Protein intake (g)}}$$

**Hepatosomatic index =**

$$\frac{\text{Liver weight (g)}}{\text{Body live weight (g)}} \times 100$$

Table 3. Monthly changes in physico-chemical characteristics of water during the experimental period in the present study (mean ± sd)

| Month | Water temperature (0C) | pH | Dissolved Oxygen (mg/l) | Alkalinity (ppm) | NH4+ (ppm) |
|---|---|---|---|---|---|
| June | 30.2 ± 1.8 | 7.6 ± 0.2 | 5.7 ± 0.2 | 331 ± 12.0 | 0.42 ± 0.2 |
| July | 29.5 ± 2.4 | 7.5 ± 0.3 | 5.4 ± 0.3 | 357 ± 10.0 | 0.37 ± 0.2 |
| August | 31.3 ± 2.2 | 8.0 ± 0.1 | 5.8 ± 0.5 | 276 ± 17.0 | 0.52 ± 0.2 |
| September | 28.7 ± 2.1 | 7.7 ± 0.2 | 6.1 ± 0.2 | 239 ± 11.0 | 0.43 ± 0.1 |
| October | 25.4 ± 1.9 | 7.8 ± 0.3 | 6.3 ± 0.4 | 341 ± 8.0 | 0.33 ± 0.3 |

**Mean corpuscular haemoglobin concentration** =

$$\frac{\text{Haemoglobin concentration (g / 100 ml)}}{\text{Hematocrit value (\%)}} \times 100$$

**Statistical analysis:**

Statistical analysis was done according to the procedure reported by Steel and Torrie (1980), Duncan's test was applied in each experiment whenever possible to test mean differences (Duncan, 1955). The data were analyzed using Model

$X_{ijkl} = \mu + \alpha_i + \beta_j + \lambda_k + (\alpha\beta)_{ij} + (\alpha\lambda)_{ik} + (\beta\lambda)_{jk} + (\alpha\beta\lambda)_{ijk} + \varepsilon_{ijkl}$

Where:

$X_{ijkl}$ = is the observation on $i^{th}$ protein level in the $j^{th}$ test protein source under the $k^{th}$ plant protein as % of total protein

$\mu$ = is the over all mean.

$\alpha_i$ = is the effect of the $i^{th}$ protein level

$\beta_j$ = is the effect of the $j^{th}$ test protein source

$\lambda_k$ = is the effect of the $k^{th}$ plant protein as % of total protein

$(\alpha\beta)_{ij}$, $(\alpha\lambda)_{ik}$, $(\beta\lambda)_{jk}$ = is the effect of two factor interaction

$(\alpha\beta\lambda)_{ijk}$ = is the effect of three factor interaction

$\varepsilon_{ijkl}$ = is the fixed residual associated with the $ijkl^{th}$ record

## RESULTS AND DISCUSSION

Results presented in table (4) revealed that differences in initial body weight among the treatment groups were insignificant indicating the complete randomization of sampling at the start of the experiment.

For two protein levels, gain in weight, specific growth rate and percentage weight gain were distinctly higher for fish fed corn gluten meal than that fed on sesame seed meal diets (Table 4 and fig. 1b), these may be due to sources of dietary protein which aren't identical in their nutritional and biological values. Anderson et al., (1992) found that the average true amino acid availability from corn gluten meal was 91.9% while that flamedired erring meal was 90.7%. Though, Scott et al., (1982) showed that the increase in the availability of the amino acids by the wet miliing process, and the removal of large percentage of starch and increase in digestibility of the remaining starch due to heating of the meal, may explain the high availiabilities of the amino acids of the corn gluten meal. This may be also explained in other animals by the production of amino acids through microbial action in the gut (Trust et al., 1979). However, Masumoto et al., (1996) found low apparent digestibility coefficients in yellowtail (*Seriola quinqueradiata*) fed a diet containing corn gluten meal. They attributed to that the relatively higher acidity in the corn gluten meal.

Results of table 4 and fig. (1c) showed also that increasing the sesame seed meal in diet to replace 80% of the protein resulted insignificant decrease ($P < 0.05$) in weight gain and specific growth rate. These results are in agreement with the findings of El-Sayed (1987) who evaluated the effects of replacing casein / gelatin protein by sesame seed protein in *Tilapia zillii* fingerlings. He reported that fish fed sesame seed diet exhibited poor growth performance and showed hemorrahage and red spots in the mouth and at the base of the fins even at the lowest sesame seed level (25 %), but, when either lysine or zinc was added to the diets, the pathological signs were disappeared and growth rate increased.

The results presented in table (4) show that the daily weight gain as a percentage of that recorded by the group without feeds increased significantly ($P < 0.05$) with each decrease corn gluten meal and sesame seed meal level feed.

**Table 4. Growth performance of hybrid tialpia (*Oreochromis niloticus* X *O. aureus*) fed experimental diets for 150 days (mean ± sd)**

| Crude protein level | 25% | | | | | | | 30% | | | | | | | non |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Test protein source | control | corn gluten meal * | | | sesame seed meal * | | | control | corn gluten meal * | | | sesame seed meal * | | | fed |
| plant protein as % of total | 0 | 40 | 60 | 80 | 40 | 60 | 80 | 0 | 40 | 60 | 80 | 40 | 60 | 80 | |
| Items | | | | | | | | | | | | | | | |
| Initial body weight (g) | a | a | a | a | A | a | a | a | a | a | a | a | a | a | a |
| | 40.78 ± | 40.65 ± | 42.1 ± | 42.03 ± | 40.70 ± | 40.23 ± | 42.06 ± | 41.65 ± | 42.85 ± | 41.30 ± | 41.32 ± | 42.37 ± | 40.45 ± | 41.24 ± | 41.35 ± |
| Final body weight (g) | b | a | ab | d | b | bc | c | a | a | a | c | bc | c | d | e |
| | 187.85 | 206.05 | 193.7 ± | 130.82 | 184.7 ± | 177.33 | 156.23 | 201.45 | 202.85 | 198.07 | 155.81 | 190.24 | 171.98 | 136.54 | 74.05 ± |
| Weight gain (g) | b | a | ab | d | B | bc | cd | a | a | a | c | bc | c | d | e |
| | 147.07 | 165.4 ± | 151.60 | 88.79 ± | 144.0 ± | 137.1 ± | 114.17 | 159.8 ± | 160.0 ± | 156.8 ± | 114.5 ± | 147.87 | 131.53 | 95.30 ± | 32.7 ± |
| Specific growth rate (%/day) | a | a | a | c | bc | bc | c | a | a | a | c | bc | bc | c | d |
| | 1.018 ± | 1.082 | 1.018 | 0.76 ± | 1.008 | 0.99 | 0.88 | 1.051 | 1.036 | 1.045 | 0.89 | 1.001 | 0.97 | 0.80 | 0.38 |
| Percentage weight gain (g) | a | a | ab | d | b | bc | c | a | a | a | c | bc | c | d | e |
| | 357.32 | 405.9 ± | 360.0 ± | 211.1 ± | 353.5 ± | 340.3 ± | 211.4 ± | 383.76 | 373.2 ± | 377.8 ± | 377.0 ± | 346.5 ± | 324.8 ± | 230.1 ± | 79.0 ± |
| Daily weight gain as a percentage | b | a | ab | d | b | bc | cd | a | a | a | c | bc | c | d | |
| | 431.8 ± | 495.5 ± | 459.1 ± | 263.6 ± | 436.64 | 413.64 | 336.36 | 481.8 | 488.81 | 472.7 ± | 345.5 ± | 422.7 ± | 390.9 ± | 281.8 ± | |
| Survival rate (%) | 93.30 | 90.00 | 93.30 | 83.30 | 93.30 | 96.70 | 86.70 | 93.30 | 86.70 | 90.00 | 80.00 | 96.70 | 93.30 | 83.30 | 66.7 |

a, b, c, d and e means in the same row with different superscript are significantly different ($P < 0.05$)

Results presented in (table 4) showed that the lower survival rate recorded by the group without feeds may attribute to the insufficiency of the natural feeds in the treatment without any artificial foods to meet the nutritional requirements of fish under enclosure conditions, while in growth fed diets replaced with 80% of its protein with corn gluten meal, the higher acidity may be the cause of its lower survival rate (Masumoto et al., 1996). On the other hand, the lower survival rates obtained by sesame seed meal could be a direct results of its high contents of phytic acid (Gohl, 1975).

Results of feed intake (Table 5 and fig. 2c) revealed that feed intake within each protein level fed decreased with each increase in the level of both protein sources tested. These results may attribute to the imbalance in arginine and threonine amino acids in the tested diets compared to their controls (Table 2) (D'Mello, (1993) and Regost et al., (1999)). Increase in feed intake of control diet (Table 5) may be due to increase in fish meal which is attractive to the fish (Chou, 1983).

Results illustrated in table (5) and fig. 2(a,b,c) show that the best significant ($P < 0.05$) feed conversion ratio within the 25% protein level were obtained with diets containing corn gluten meal in replacement with the control diet protein at levels of 40 and 60% compared with other treatment groups. On the other hand, within the 30% protein level replacing the dietary protein with 40% or 60% with corn gluten meal improved significantly ($P < 0.05$) the feed conversion ratio, while sesame seed meal showed the reverse effect at all replacement levels tested.

In this connection Regost et al., (1999) who found that turbot (*Psetta maxima*) fed diet with 20% corn gluten meal had a feed efficiency not significant different from those fed fish meal based diet.

The results present in table (5) and fig 4(a,b,c) show that incresing protein level from 25 to 30% in fish fed 80% corn gluten meal increased significanlty ($P < 0.05$) feed conversion efficiency from 28.49 to 36.28% respectively. These results are in agreement with the findings of Akiyama et al., (1981) and Ince et al., (1987) who reported that feed conversion efficiency increased as the dietary protein level increase in rations of chum salmon and rainbow trout.

Analysis of variance of results (Table 5 and fig. 5(a,b,c)) indicate that differences in protein efficiency ratio among the nutritional groups were significantly ($P <0.05$) for the favour of the groups fed lower percentage of corn gluten meal and sesame seed meal. These results are close to those suggested by Pongmoneerat et al., (1993), who found that protein efficiency ratio fell with incorporation of corn gluten meal much as in common carp. Gomes et al., (1995) and Regost et al., (1999) reported that protein efficiency ratio was related to protein apparent digestibility coefficients. They found that digestible protein decreased with increasing corn gluten meal levels.

Also results presented in table (5) and fig. (5a) indicate that increasing the protein level from 25 to 30% may improve growth rate but it decreased the protein efficiency ratio due to fact that excess protein in hybrid tilapia diets may be used as a source of energy so that more protein in diet could required for one unit of gain Jauncey (1982). Also, its may be attributed to increasing nitrogrn free extract in experimental diets (Table 1) (Spyridakis et al., 1986 and Tibaldi et al., 1991).

Decreasing protein retention with increasing protein level in diet (Table 5 and fig. 6a) are in agreement with the findings of Spyridakis et al., (1986) in *Dicentrarchus labrax* and Berger and Halver (1987) in *Morone saxatilis*. Who stated that protein retention is inversely related to protein level in the diet.

**Table 5. Feed efficiency and protein efficiency ratio for hybrid tilapia as affected by experimental diets**

| Crude protein level | 25% | | | | | | | 30% | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Test protein source | control | corn gluten meal | | | sesame seed meal | | | control | corn gluten meal | | | sesame seed meal | | |
| plant protein as % of total protein | 0 | 40 | 60 | 80 | 40 | 60 | 80 | 0 | 40 | 60 | 80 | 40 | 60 | 80 |
| **Item:** | | | | | | | | | | | | | | |
| **Average feed intake (g)** | 358.9 | 365.5 | 351.6 | 311.7 | 355.8 | 339.8 | 327.5 | 381.1 | 370.0 | 358.9 | 315.6 | 361.4 | 337.4 | 330.8 |
| **Feed Conversion ratio** | $2.44^{cd}$ | $2.21^{d}$ | $2.32^{d}$ | $3.51^{a}$ | $2.47^{c}$ | $2.48^{c}$ | $2.87^{b}$ | $2.38^{d}$ | $2.31^{d}$ | $2.29^{d}$ | $2.76^{b}$ | $2.44^{cd}$ | $2.56^{bc}$ | $3.47^{a}$ |
| **Feed conversion efficiency %** | $40.97^{b}$ | $45.25^{a}$ | $43.12^{ab}$ | $28.49^{d}$ | $40.47^{b}$ | $40.34^{b}$ | $34.86^{c}$ | $41.93^{ab}$ | $43.24^{ab}$ | $43.68^{ab}$ | $36.28^{c}$ | $40.92^{b}$ | $38.99^{c}$ | $28.81^{d}$ |
| **Protein efficiency ratio** | $1.64^{a}$ | $1.80^{a}$ | $1.72^{a}$ | $1.13^{d}$ | $1.62^{ab}$ | $1.60^{b}$ | $1.38^{cd}$ | $1.40^{c}$ | $1.44^{bc}$ | $1.45^{bc}$ | $1.21^{d}$ | $1.36^{cd}$ | $1.30^{cd}$ | $0.97^{d}$ |
| **Energy conversion efficiency** | $13.71^{b}$ | $15.0^{a}$ | $14.4^{ab}$ | $9.52^{d}$ | $13.45^{b}$ | $13.41^{bc}$ | $11.6^{c}$ | $13.18^{bc}$ | $14.43^{a}$ | $14.49^{a}$ | $12.04^{c}$ | $13.63^{b}$ | $12.98^{c}$ | $9.62^{d}$ |
| **Protein retained %** | $24.1^{b}$ | $28.2^{a}$ | $27.0^{a}$ | $18.7^{d}$ | $24.4^{b}$ | $25.5^{b}$ | $21.7^{c}$ | $18.0^{d}$ | $23.7^{bc}$ | $21.8^{c}$ | $18.5^{d}$ | $20.9^{c}$ | $20.3^{cd}$ | $15.3^{e}$ |
| **Energy retained %** | $21.20^{b}$ | $23.1^{a}$ | $22.1^{a}$ | $15.8^{e}$ | $20.3^{bc}$ | $19.9^{c}$ | $17.8^{d}$ | $20.5^{bc}$ | $22.9^{a}$ | $22.0^{ab}$ | $18.9^{cd}$ | $20.6^{bc}$ | $19.6^{cd}$ | $14.6^{e}$ |
| **Specific growth rate in protein (%/day)** | $1.11^{a}$ | $1.19^{a}$ | $1.12^{a}$ | $0.88^{c}$ | $1.09^{ab}$ | $1.10^{ab}$ | $0.98^{bc}$ | $1.05^{b}$ | $1.17^{a}$ | $1.13^{a}$ | $0.97^{bc}$ | $1.09^{ab}$ | $1.06^{b}$ | $0.90^{c}$ |
| **Specific growth rate in energy (%/day)** | $1.11^{a}$ | $1.18^{a}$ | $1.11^{a}$ | $0.88^{c}$ | $1.09^{ab}$ | $1.06^{ab}$ | $0.96^{bc}$ | $1.12^{b}$ | $1.15^{a}$ | $1.13^{a}$ | $0.98^{bc}$ | $1.08^{ab}$ | $1.05^{b}$ | $0.88^{c}$ |

a, b, c, d and e means in the same row with different superscript are significantly different ($P < 0.05$)

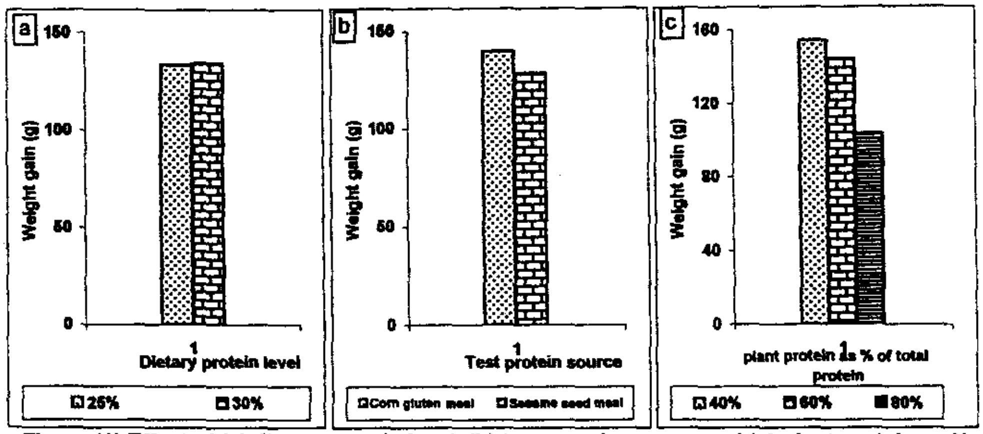


Figure (1) Effect of (a) dietary protein level, (b) test protein source and (c) plant protein as % of total protein on weight gain

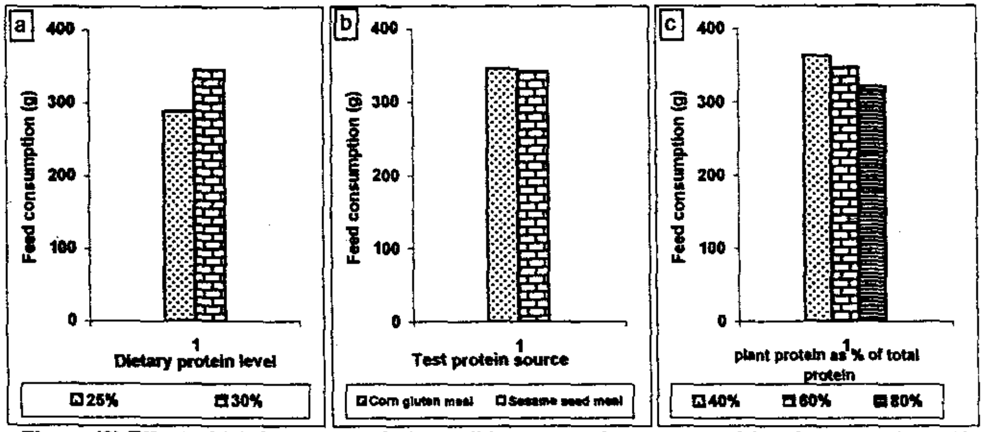


Figure (2) Effect of (a) dietary protein level, (b) test protein source and (c) plant protein as % of total protein on feed consumption

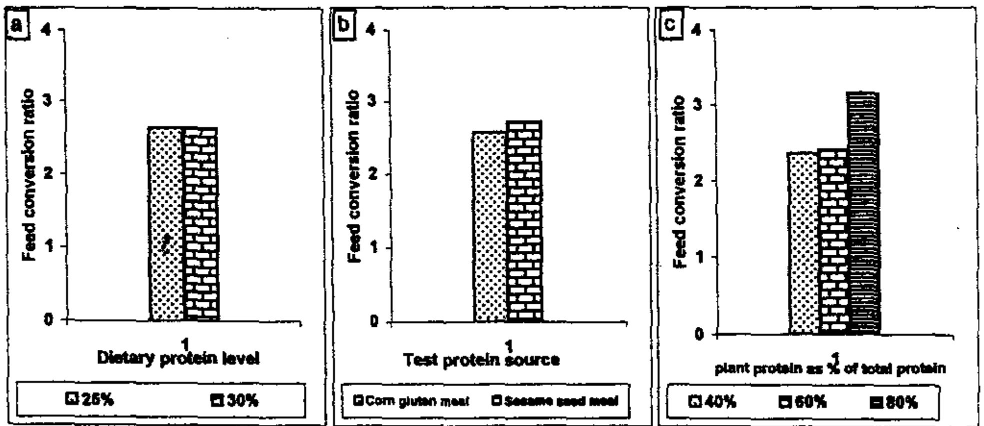


Figure (3) Effect of (a) dietary protein level, (b) test protein source and (c) plant protein as % of total protein on feed conversion ratio

In general, the highest protein retention values were obtained by groups fed the control (25%) and the diets containing 40 and 60% corn gluten meal as well as diets containing 40 or 60% sesame seed meal (fig. 6b,c). Viola et al., (1981) who reported that both energy and protein retention are improved if fat is added at the same level of protein which is used in preference to build body fat, thereby fat spares the protein. This, well known effect has an energyetic aspect; the transformation of protein into fat (in the absence of dietary fat source) carbohydrates or proteins are transformed into body fat which explains the low retention rate at higher level of protein. In this case is protein wasteful in terms of energy because, carbon residues of amino acids have to be degraded and fatty acids synthesized from acetyl-Co A. also part of the nitrogen is excreted which represents further loss of energy. However fat is assimilated into body fat with little degradation and with a minimal loss of energy.

Resulted presented in table (5) show that specific growth rate in protein and energy of group fed 80% of both corn gluten meal and sesame seed meal was significantly ($P < 0.05$) lower that those recorded with percentage 40 and 60% corn gluten meal and sesame seed meal at both protein levels tested. In this connection **Xie et al., (1997)** examined the specific growth rate of protein and energy in Nile tilapia (*Oreochromis niloticus*). They found that both items were increased when the feeding rate increased from 0.5 to 4% of body weight per day and also satiation.

Analysis of variance (Table 6) indicate that neither percentage of plant protein source nor protein level fed had a significant effect on the moisture, crude protein, ether extract, ash and gross energy content of dorsal muscle of hybrid tilapia. Similar finding was reported by Moyano et al., (1992) in rainbow trout, Pongmoneerat et al., (1993) in crap Shimeno et al., (1993) in yellowtail and Regost et al., (1999) in turbot ( *Psetta maxima)* didn't find any effect of dietary corn gluten meal on whole body protein contents.

The statistical evaluation for hepatosomatic index (Table 7) indicated that increasing percentage of test plant protein sources fed had positive significant ($P < 0.05$) effected on this trait. These results are in agreement with the findings of Alexis et al., (1986) in rainbow trout (*Salmo gairdneri*). They show that the correlation observed might result either from glycogen accumulation created by a high digestibility of carob seed germ meal carbohydrates. Regost et al., (1999) found that no difference between hepatosomatic index of fish fed a diet containing fish meal or corn gluten meal.

As given in table (7) analysis of variance for hematocrit value indicates that there are significant differences among the experimental groups. However haemoglobin concentration decreased insignificantly ($P > 0.05$) with increasing percentage of incorporation test plant protein sources. Alexis et al., (1986) found negative correlation between carob seed germ meal level in the diet and hematocrit value and haemoglobin concentration in rainbow trout. The mean corpuscular haemoglobin concentration have particular importance in most animals in describing anemia and can be used in diagnosis and therapy (Coles, 1986). As presented in table (7) there were no significant effects of increasing levels of both corn gluten meal and sesame seed meal in diets on the mean corpuscular haemoglobin concentration. In this connection Weber and Wells (1989) mentioned that mean corpuscular haemoglobin concentration could be used as an indicator of blood

**Table 6. Chemical composition and energy content of muscle hybrid tilapia as affected by different treatments**

| Crude protein level | Initial | 25% | | | | | | | 30% | | | | | | | non fed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Test protein source | Initial | Control | corn gluten meal * | | | sesame seed meal * | | | Control | corn gluten meal * | | | sesame seed meal * | | | non fed |
| Plant protein as % of total protein | | 0 | 40 | 60 | 80 | 40 | 60 | 80 | 0 | 40 | 60 | 80 | 40 | 60 | 80 | |
| **Items %** | | | | | | | | | | | | | | | | |
| **Moisture** | 76.23 ±1.03 | 74.33 ± 1.63 | 73.4 ± 2.5 | 73.8 ± 1.3 | 72.7 ± 1.5 | 74.73 ± 1.47 | 74.3 ± 0.82 | 73.5 ± 1.73 | 74.28 ±2.71 | 72.8 ± 1.4 | 73.4 ± 1.3 | 73.1 ± 1.5 | 74.14 ± 2.16 | 74.12 ± 2.29 | 73.43 ±2.07 | 79.35 ±2.14 |
| **Crude protein** | 12.9 ± 0.53 b | 14.70 ± 0.38 a | 15.1 ± 0.62 a | 15.1 ± 0.4 a | 15.4 ± 0.51 a | 14.6 ± 0.36 a | 15.24 ± 0.48 a | 15.0 ± 0.43 a | 12.88 ± 0.2 b | 15.7 ± 0.43 a | 14.6 ± 0.63 a | 14.7 ± 0.52 a | 14.77 ± 0.17 a | 14.93 ±0.26 a | 14.97 ±0.31 a | 10.04 ±0.53 c |
| **Ether extract** | 5.83 ± 0.40 a | 6.32 ± 0.34 a | 6.60 ± 0.40 a | 6.50 ± 0.40 a | 7.00 ± 0.53 a | 6.34 ± 0.22 a | 6.20 ± 0.29 a | 6.40 ± 0.34 a | 6.43 ± 0.15 a | 6.60 ± 0.41 a | 6.70 ± 0.40 a | 6.90 ± 0.82 a | 6.90 ± 0.25 a | 6.27 ± 0.25 a | 6.17 ± 0.32 a | 3.27 ± 0.04 b |
| **Ash** | 4.80 ± 0.36 b | 4.83 ± 0.22 b | 5.20 ± 0.5 b | 4.80 ± 0.30 b | 4.60 ± 0.42 b | 4.48 ± 0.27 b | 4.57 ± 0.17 b | 4.77 ± 0.27 b | 5.54 ± 0.24 b | 4.30 ± 0.35 b | 5.00 ± 0.50 b | 5.60 ± 0.70 b | 4.06 ± 0.27 b | 4.57 ± 0.31 b | 4.93 ± 0.30 b | 7.31 ± 0.60 a |
| **Gross energy (Kcal/100g)** | 128.9 ±5.36 b | 148.8 ± 4.91 a | 148.9 ± 6.15 a | 147.8 ± 5.08 a | 154.3 ±4.88 a | 146.4 ± 6.67 a | 144.1 ± 4.49 a | 146.8 ± 4.49 a | 143.1 ± 4.97 a | 152.2 ± 5.49 a | 146.7 ± 6.36 a | 149.3 ± 7.65 a | 145.9 ± 5.18 a | 145.5 ± 5.30 a | 145.1 ± 6.30 a | 88.27 ± 5.90 c |

a, b and c means in the same row with different superscript are significantly different ($P < 0.05$)

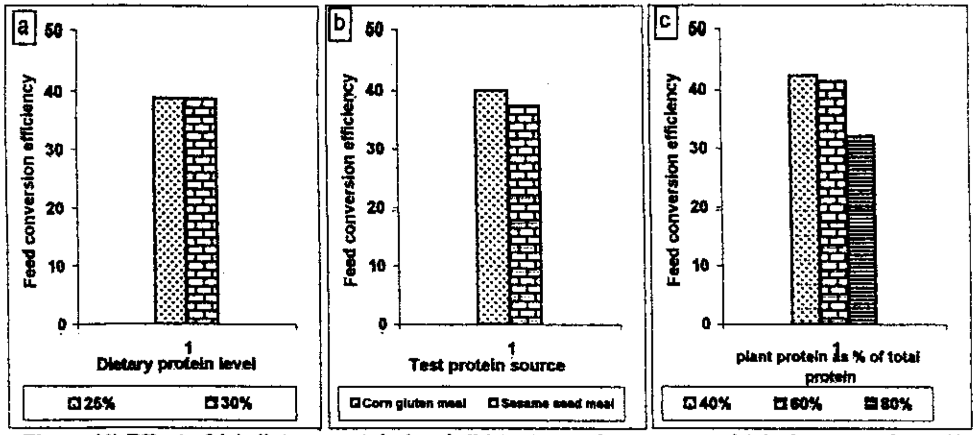


Figure (4) Effect of (a) dietary protein level, (b) test protein source and (c) plant protein as % of total protein on feed conversion efficiency

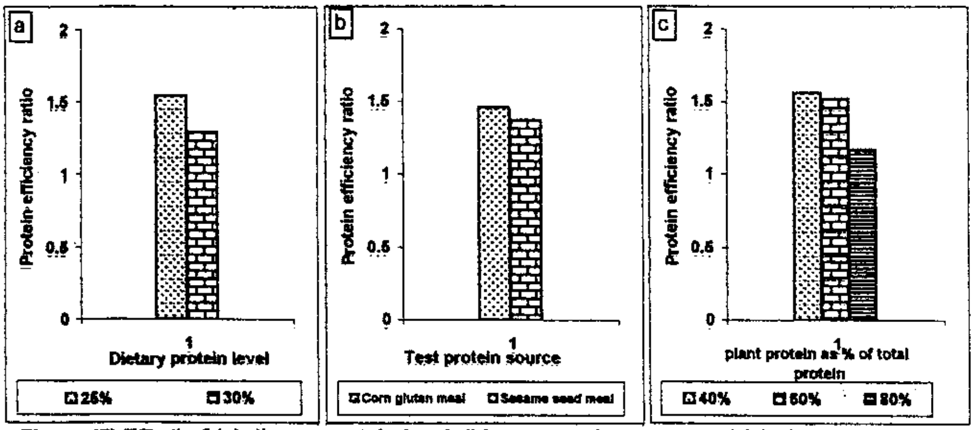


Figure (5) Effect of (a) dietary protein level, (b) test protein source and (c) plant protein as % of total protein on protein efficiency ratio

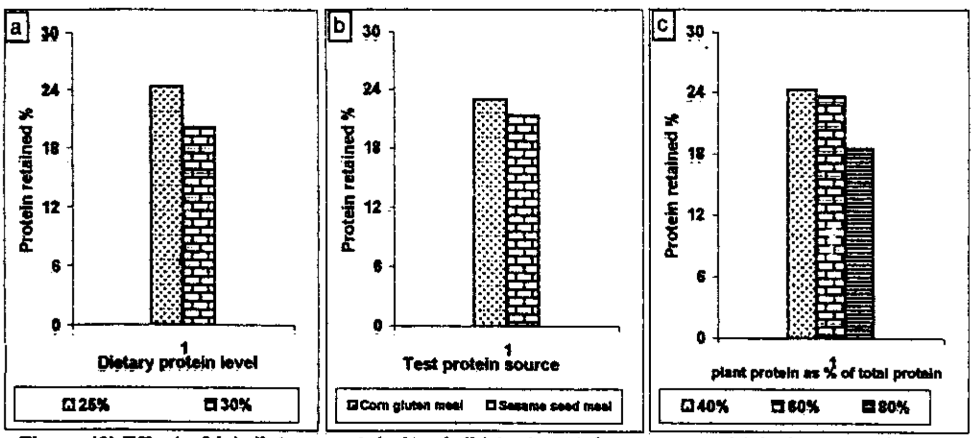


Figure (6) Effect of (a) dietary protein level, (b) test protein source and (c) plant protein as % of total protein on protein retained %

**Table (7) Hepatosomatic index, hematological characteristics and content of some serum constituents of hybrid tilapia**

| Crude protein level | 25% | | | | | | | 30% | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Test protein source | control | corn gluten meal | | | sesame seed meal | | | control | corn gluten meal | | | sesame seed meal | | |
| plant protein as % of total protein | 0 | 40 | 60 | 80 | 40 | 60 | 80 | 0 | 40 | 60 | 80 | 40 | 60 | 80 |
| **Hepatosomatic index %** | 2.20 ± 0.38$^{b}$ | 2.13 ± 0.35$^{b}$ | 2.60 ± 0.28$^{a}$ | 2.51 ± 0.22$^{a}$ | 2.02 ± 0.45$^{c}$ | 2.38 ± 0.31$^{ab}$ | 2.45 ± 0.50$^{ab}$ | 2.05 ± 0.24$^{c}$ | 2.01 ± 0.31$^{c}$ | 2.30 ± 0.40$^{ab}$ | 2.42 ± 0.29$^{a}$ | 2.05 ± 0.21$^{c}$ | 1.98 ± 0.27$^{c}$ | 2.09 ± 0.18$^{bc}$ |
| **Hematology** | | | | | | | | | | | | | | |
| **Hematocrit value %** | 31.82 ± 2.63 | 31.80 ± 1.97 | 31.2 ± 2.09 | 31.3 ± 1.97 | 33.07 ± 2.35 | 32.8 ± 2.37 | 32.07 ±2.18 | 31.33 ± 2.09 | 31.2 ± 1.7 | 31.0 ± 2.63 | 31.3 ± 2.51 | 32.71 ±1.59 | 30.63 ±2.15 | 31.46 ±2.63 |
| **Haemoglobin value, g/100ml** | 8.30 ± 1.97 | 8.21 ± 0.87 | 7.90 ± 0.43 | 7.52 ± 0.52 | 8.17 ± 1.51 | 7.87 ± 1.84 | 7.43 ± 1.12 | 8.35 ± 1.55 | 8.21 ± 0.90 | 8.13 ± 0.69 | 7.72 ± 0.34 | 7.98 ± 1.64 | 7.76 ± 0.89 | 7.51 ± 0.47 |
| **Mean corpuscular haemoglobin concentration, g/100ml** | 26.14 ± 2.13 | 25.9 ± 2.51 | 25.0 ± 2.37 | 23.6 ± 1.37 | 24.78 ±2.03 | 24.04 ±1.87 | 23.28 ±2.76 | 26.71 ±1.98 | 26.71 ±1.85 | 26.0 ± 1.52 | 24.7 ± 2.55 | 24.45 ±1.74 | 25.36 ± 2.3 | 23.76 ±2.46 |
| **Serum analysis** | | | | | | | | | | | | | | |
| **Total serum protein, g/100ml** | 5.51 ± 1.08$^{a}$ | 5.72 ± 0.73$^{a}$ | 4.84 ± 0.51$^{ab}$ | 4.21 ± 0.80$^{b}$ | 5.08 ± 0.85$^{ab}$ | 5.16 ± 0.69$^{a}$ | 4.02 ± 0.39$^{b}$ | 5.49 ± 1.03$^{a}$ | 5.91 ± 0.61$^{a}$ | 5.22 ± 0.51$^{a}$ | 4.08 ± 0.73$^{b}$ | 4.86 ± 0.43$^{ab}$ | 5.58 ± 0.60$^{a}$ | 4.22 ± 0.81$^{b}$ |
| **Triglycerides mg/100ml** | 244.8 ± 9.59$^{ab}$ | 239.0 ±10.04$^{ab}$ | 226.0 ± 11.8$^{bc}$ | 222.0 ± 9.8$^{cd}$ | 241.7 ± 9.82$^{ab}$ | 222.0 ± 8.04$^{c}$ | 219.3 ± 6.85$^{cd}$ | 253.7 ±10.34$^{a}$ | 247.0 ±11.03$^{ab}$ | 238.2 ±10.92$^{bc}$ | 205.8 ± 12.5$^{d}$ | 260.7 ±10.52$^{a}$ | 235.4 ± 8.58$^{bc}$ | 214.2 ± 8.59$^{d}$ |

a, b, c and d means in the same row with different superscript are significantly different ($P < 0.05$)

Table 8. Predict equation of linear regression between % test plant protein source in the diet and each of various experimental parameters

| Test protein source | Corn gluten meal | | | Sesame seed meal | | |
|---|---|---|---|---|---|---|
| parameters | a | b | r | a | b | r |
| Weight gain | 242.55 | -0.015 | -0.73 | 208.66 | -0.013 | -0.94** |
| Specific growth rate | 1.3 | -0.008 | - 0.70 | 1.23 | -0.007 | -0.92** |
| percentage weight gain | 459.66 | -0.009 | -0.38 | 507.82 | -0.010 | -0.93** |
| feed conversion ratio | 1.74 | 0.009 | 0.66 | 1.83 | 0.01 | 0.89** |
| feed conversion efficiency | 57.32 | -0.009 | -0.66 | 54.59 | -0.010 | -0.89** |
| protein efficiency ratio | 2.3 | -0.01 | -0.80* | 2.18 | -0.013 | -0.81* |
| Energy conversion efficiency | 19.09 | -0.009 | -0.67 | 18.1 | -0.010 | - 0.89** |
| Specific growth rate in body protein | 1.45 | -0.008 | -0.80* | 1.3 | - 0.006 | -0.89** |
| protein retained | 37.55 | -0.013 | -0.89* | 32.48 | -0.011 | -0.76* |
| Energy retained | 29.01 | -0.008 | -0.72 | 26.96 | -0.010 | -0.89** |
| Chemical body protein | 15.77 | -0.001 | -0.50 | 14.56 | 0.0006 | 0.52 |
| Chemical body gross energy | 149.2 | 0.0001 | -0.07 | 146.11 | -0.00008 | -0.16 |
| Hepatosomatic index | 1.83 | 0.006 | 0.71 | 2.29 | -0.002 | -0.24 |
| Hematocrit value | 31.68 | -0.0003 | -0.44 | 34.27 | -0.003 | -0.70 |
| Haemoglobin value | 8.61 | -0.002 | -0.70 | 8.67 | -0.001 | -0.94** |
| Mean corpuscular hemo. Conc. | 27.21 | -0.002 | -0.52 | 25.46 | -0.006 | -0.49 |
| Total serum protein | 7.66 | -0.011 | -0.90** | 6.03 | -0.004 | -0.58 |
| Triglycerides | 260.57 | -0.003 | -0.52 | 277.95 | -0.006 | -0.78* |

* Significant level ($P < 0.05$)
** Significant level ($P < 0.01$)
A: Intercept b: Slope r: Correlation coefficient

oxygen transport capacity, however, it should be used with caution so that it is more restricted to the intracellular micro environmental adjustments of oxygen transport.

These results of table (7) show that total serum protein values were negatively related to the level of dietary plant protein. In contrast, Alexis et al., (1986), revealed that no correlation between the level of the carob seed germ meal and blood components (protein, lipid and glucose) could be established.

Triglycerides content of serum decreased significantly ($P < 0.05$) as the percentage of corn gluten meal or sesame seed meal increased in the diet (Table 7). It has been observed in yellowtail by Shimeno et al., (1993) and Regost et al., (1999) in turbot (*Psetta maxima*) who found decline in plasma triglycerides concentration with increasing dietary corn gluten meal levels.

Correlation between percentage corn gluten meal and sesame seed meal in the diet and various experimental parameters presented in Table (8). The predicted equation of some parameters suggested that a positive correlation was found between percentage corn gluten meal in the diet and feed conversion ratio, also with hepatosomatic index. However, protein efficiency ratio, protein retained, specific growth rate of protein and total serum protein were negatively ($P < 0.05$) correlated with the percentage of corn gluten meal in the diet.

On the other hand, percentage sesame seed meal had significant ($P < 0.05$) positive correlation with feed conversion ratio and body protein, however, significant ($P < 0.05$) negative correlation was found with weight gain, specific growth rate, percentage weight gain, feed conversion efficiency, protein efficiency ratio, energy conversion efficiency, specific growth rate in body protein, protein retained, energy retained, haemoglobin concentration and triglycerides in serum. In this connection, **Lee and Putnam (1973)** whose found a positive correlation between hepato-somatic index and the protein contents of the diet. Also Alexis et al., (1986) found that the positive correlation observed between the carob seed germ meal level in the diet and hepatosomatic index, however the growth of *Salmo gairdneri* was negatively correlated with carob seed germ meal content of the diet.

Based on the results obtained in this study it could be recommended that corn gluten meal can be incorporated in hybrid tilapia diets to replace 40 to 60% of the dietary protein when diets contain 25 and 30% crude protein. On the other hand, sesame seed meal could replace 40% of the dietary protein in hybrid tilapia diets containing 25% crude protein.

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# القيمة الغذائية لجلوتين الذرة وكسب السمسم في علائق البلطي المهجن

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في تحويطات شبكية أجريت التجربة الغذائية باستخدام بلطي مهجن وذلك لفحص إمكانية الإحلال الجزني لبروتين العليقة ببروتين جلوتين الذرة وكسب السمسم بنسب ٤٠، ٦٠، ٨٠ % داخل كل مستوى من بروتين العليقة.

ولقد استخدمت أصبعيات أسماك بلطي مهجن ذات وزن أولي ٤١,٥ جم مع تغذية الأسماك بمعدل ٣ % من وزن الجسم لمدة أربعة عشرة يوما من كل ١٥ يوم وتم وزن الأسماك في اليوم الخامس عشر مع تعديل كمية الغذاء المأكول وذلك خلال فترة التجربة الكلية وهي مائة وخمسون يوما التي ترلوحت فيها درجة حرارة الماء ٢٩ درجة منوية تقريبا.

لوضحت النتائج أن أسماك البلطي المهجن التي تغذت على معدل إحلال ٤٠% جلوتين ذرة أعطت أعلى نسبة زيادة وزنية مكتسبة وأيضا أعلى معدل نمو بينما الوزن النهائي لجسم الأسماك لظهر زيادة واضحة للأسماك التي تغذت على جلوتين الذرة عن كسب السمسم.

كما أظهرت النتائج زيادة مستوى بروتين العليقة من ٢٥% إلى ٣٠% له أثر إيجابيا على كمية المأكول بينما

ووجد أن وزن الكبد إلى وزن الجسم يزيد معنويا مع زيادة معدل الإحلال بينما ينخفض معنويا تركيز الترای جلسريد في سيرم الدم.

لوضحت نتائج هذه الدراسة أن استخدام جلوتين الذرة بمعدل ٤٠% ، ٦٠% من بروتين العليقة (٢٥% ، ٣٠%) أدى إلى الوصول بأسماك البلطي المهجن إلى معدلات نمو مقبولة. بينما استخدام كسب السمسم أعطى معدل أداء مناسب وذلك إذا لم يزيد معدل إحلاله عن ٤٠% من بروتين العليقة ٢٥% فقط.