

**Impact of replacement of soybean meal with guar korma meal on growth performance and some physiological parameters of the Nile Tilapia (*Oreochromis niloticus*) fingerlings.**

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**ABSTRACT**

This study aimed to evaluate the partial and complete substitution of soybean meal as crude protein by various levels (0%, 25%, 50%, 75% and 100%) of guar korma meal (GKM) (*Cyamopsis tetragonolobus*) in the Tilapia diet on growth performance, feed utilization, carcass composition and physiological parameters (ALT, AST and glucose level). Water quality parameters were checked and evaluated on a daily basis and the other factors were analyzed fortnightly of the Nile Tilapia (*Oreochromis niloticus*) fingerlings. Five isonitrogenous (30% crude protein) and isocaloric (4300 kcal/kg gross energy) diets were formulated to contain guar korma meal at 0, 9.5, 18.5, 27.75 and 37 % crude protein levels by replacing soybean meal at 0, 25, 50, 75 and 100% crude protein, respectively. An experimental diet containing 37 % soybean meal and 0% guar meal protein was used as a control diet. All fish were fed at 5 % body weight / day in three replicates. Results of the present study concluded that guar korma meal is a promising ingredient source of protein in aqua feeds and can be included up to 18.5 % crude protein by replacing 50% of soybean meal crude protein during feed formulation for the Nile Tilapia (*O. niloticus*) diets system without affecting the growth performance and feed utilization.

**Keywords:** *Oreochromis niloticus*; soybean, meal replacement, guar korma, growth performance, feed utilization; water quality, physiological parameters.

**INTRODUCTION**

Tilapias are known to be an important component of subsistence fisheries for thousands of years and are being described as the second most important farmed fish globally next to carps and also as the most important aquaculture species of the twenty-first century. The Nile tilapia (*Oreochromis niloticus*) is one of the fastest growing, most valuable and economical freshwater fish and is the main cultured species in many parts of the world, it is responsible for the significant increase in global tilapia aquaculture production due to its suitability for farming in a wide array of culture systems, in ponds and cages, ranging from extensive, low-input culture to intensive systems. It is accounted for about 83% of total tilapias produced worldwide. It is native to Egypt and distributed to all parts of the world for its excellent biological characteristics (Singh and Lakra, 2012).

Feed is an important critical input which alone contributes more than 60% of operating cost of aquaculture system. Thus, the increase in aquaculture production must be supported by a corresponding increase in the production of formulated feeds for corresponding increase (FAO, 2012).

Cost effective feed stuffs that are compatible with fish species, easily digested and readily available are the demand of the industry and can play pivotal role in the advancement of fish industry (Iqbal *et al.*, 2015). Guar plant (*Cyamopsis*

*tetragonoloba*) is a drought-tolerant legume that can be grown in unsuitable conditions. The minimum crude protein percentage of guar meal is rated at 50% compared to 48% of soy bean meal (Mathur and Mathur, 1989 and Conner, 2002).

In fish, as in mammals, guar gum tends to increase digesta viscosity and decrease gastric emptying time, leading to a delay of nutrient absorption (Storebakken 1985; Amirkolaie *et al.*, 2005 and Leenhouders *et al.*, 2006). The increase in digesta viscosity may also be responsible for impairment of macronutrient digestibility, thus leading to growth and feed efficiency depression. Inclusion of small amounts of guar gum (0.3 %) in rainbow trout *Oncorhynchus mykiss* diets enhanced feces stability in water, indicating that soluble NSPs may improve processing of fecal wastes in this species (Brinker *et al.*, 2005 and Brinker 2007, 2009). On the contrary, in the Nile tilapia *Oreochromis niloticus*, guar gum reduced feces stability due to its high water-binding capacity, thus not acting as appropriate feces binder in this species (Amirkolaie *et al.*, 2005). Most available literature on soluble NSPs in fish focuses on growth, digestibility and feces characteristics, and there is little information available on its effect on glucose and lipid metabolism. Thus, while some studies reported that dietary supplementation with soluble NSP decrease blood glucose due to slower intestinal absorption of carbohydrates (Furuichi *et al.* 1983; Shiau *et al.* 1989), other studies were unable to show such effect (Kraugerud *et al.*, 2007 and Leenhouders *et al.*, 2007). A reduction in both muscle and plasma cholesterol levels was reported in several fish species fed on soluble NSPs (Kraugerud *et al.*, 2007 and Kumar *et al.*, 2011).

Guar korma meal contains 13-18% residual galactomannan gum (Anderson and Warnick, 1964 and Nagpal *et al.*, 1971). The negative effects of adding guar korma meal on body weight and feed conversion ratio might be attributed to that guar korma meal contains 5-13% of dry matter triterpenoid guar saponin (Hassan *et al.*, 2007). Guar meal contains other types of antinutritional factors: trypsin inhibitors, saponin, haemagglutinins, hydrocyanic acid and polyphenols have been identified (Gutierrez *et al.*, 2007). The large saponin content of guar seed (up to 13% DM) could have both antinutritional effect and a positive antimicrobial activity (Hassan *et al.*, 2010, Hussain *et al.*, 2012 and Gupta *et al.* 2012).

The objective of the present study was to evaluate the potential of partial substitution (0%, 25%, 50%, 75% and 100%) of guar korma meal (GKM) (*Cyamopsis tetragonolobus*) by for the expensive, soybean meal (SBM) in the fish diet on the growth performance, feed utilization, body composition, physiological parameters (ALT, AST and glucose level) of the Nile Tilapia (*Oreochromis niloticus*) fingerlings reared in cages in earthen ponds. Water quality will also be evaluated.

## MATERIALS AND METHODS

### Study Area

During the production season (2014), this work was carried out at a private fish farm in Kafr El-Sheikh Governorate, Egypt. The experimental fish, sex reversed mono sex Nile tilapia fingerlings (*Oreochromis niloticus*), were obtained from a commercial tilapia fish farm in Kafr El-Sheikh Governorate, Egypt, and were acclimated in 4-m<sup>3</sup> net cages before starting the feeding trial.

### Study period

The study was carried out for a period of 112 days from 1<sup>st</sup> July 2014 to 20<sup>nd</sup> October 2014 in cages placed into earthen pond system.

### **Experimental design**

The feeding trial was conducted in five groups of healthy mono sex fingerlings Nile Tilapia (*Oreochromis niloticus*) fish in fifteen groups with 6m<sup>3</sup> (2 x 3 x 1 m ) net cages (in triplicate ); were placed in a 4200 m<sup>2</sup> (one feddan ) earthen pond system, with a depth of 1.5 m, with water flow. Net cages were set on wooden stales and attached to wooden structures .The pond was rectangular in shape, well exposed to sunlight, independent completely free from aquatic vegetation, basin conformation and bottom soil type were also similar. The pond has inlet and outlet facilities. The main source of water was drainage water. The embankment was well protected.

### **Pond preparation**

Prior to the experiment, pond was de-watered and aquatic vegetations were cleaned. The dikes of pond were repaired. Pond was filled (on day-2) with water. Quicklime (on day-3) was applied to the pond by spreading methods at the rate of 100 kg / feddan. After one week of lime application the pond was fertilized with both of urea and TSP 5 kg/ pond. TSP and urea were mixed together and dissolved in plastic bucket for 10-12 hours then applied to the pond. After 5 days of fertilizer application fingerlings of (all-male) Nile Tilapia (*Oreochromis niloticus*) were stocked in cages. The cages were suspended on the pond surface waters by direct attachment to wooden piers.

### **Cages management**

The nets were cleaned regularly during feeding time. The dead fish were removed if observed any to keep the environment clean for fish. The cages were lifted from water every 3 days to check the net whether had any damage.

### **Stocking of fingerlings**

The fish were kept for acclimatization at the experimental conditions for seven days before the trial began. After the groups were allocated and fish acclimatized, samples of fish were weighed using a digital scale and measured using a measuring board to obtain the initial samples of the groups. From this study, a total of 2250 fish (25 fish/ m<sup>3</sup> x 6 m<sup>3</sup> /cage x triplicate group x 5 alternative dietary source for tilapia) with a 10.0 ±0.01- 10.04±0.03 g mean initial body weight were randomly stocked into fifteen 6m<sup>3</sup> net cages with 3 replicates per treatment. A completely randomized design was adopted, where five diets were fed to triplicate groups.

### **Sampling of fish and Feeding**

Fish were sampled weekly (between 07:00 and 10:00 hours) during when the weights (Ohaus portable digital scale (model DIGI DS 671); ± 0.1 g), standard and total length (measuring board; ± 1.0 mm) and the number of fish were assessed for each treatment. At least fifty live fish in each cage -in-pond were randomly scooped out of each cage unit for their measurements and immediately returned to their respective cages. The cage nets were inspected and cleaned during each sampling.

Caged Nile Tilapia finger lings were fed twice a day at 10 AM and 3 PM with experimental pellet feed at the rate of 5 % body weight. Feeding rate was adjusted weekly. Daily feed consumption (feed given to fish) and mortalities were recorded. Dead fish were replaced immediately with similar size specimens within the first ten days of culture. The amounts of feed in respective fish type were determined through the sampling that was carried out weekly throughout the culture period to monitor growth performance.

### **Harvesting of fish**

At the end of the experiment, water was pumped out of pond and all fish from each experimental cages were harvested, recovered, weighed in kilograms and

counted. The individual body weight and total fish weight were taken. The total length of fish was measured as well (Precision = 1 mm).

### Analytical methods

Samples of fish and nutritional composition were collected from several sacks and send for proximate analysis at the Central Laboratory for Aquaculture Research at Kafr El-Sheikh Governorate, Egypt. The proximate composition (moisture, crude protein, crude lipid and ash) of fish body composition have been carried out before and after the experiment according to the methods of AOAC (2005). The nutritional composition of the feed ingredients and composition of experimental diets ratio of test feeds were analyzed prior to diet formulation. (Tables 1&2).

Table 1: Proximate composition of the feed stuffs samples used in diet formulation (% on dry matter basis) (Mean  $\pm$  SD) (n = 3)

Proximate composition (%)	Guar meal	Soybean meal	Fish meal	Corn meal	Wheat bran
Dry matter (DM)	92.47 $\pm$ 0.21	90.81 $\pm$ 0.43	91.33 $\pm$ 0.08	88 $\pm$ 0.62	89 $\pm$ 0.35
Crude protein (CP)	51.85 $\pm$ 0.43	47.12 $\pm$ 0.53	72.31 $\pm$ 0.07	8.5 $\pm$ 0.48	16.4 $\pm$ 0.52
Ether extract (EE)	4.93 $\pm$ 0.38	3.14 $\pm$ 0.11	8.07 $\pm$ 0.03	3.6 $\pm$ 0.27	4 $\pm$ 0.46
Crude fiber (CF)	8.32 $\pm$ 0.09	7.22 $\pm$ 0.17	0.6 $\pm$ 0.01	2.3 $\pm$ 0.15	9.9 $\pm$ 0.18
Total ash	4.79 $\pm$ 0.34	7.11 $\pm$ 0.22	16.62 $\pm$ 0.06	1.3 $\pm$ 0.33	5.3 $\pm$ 0.42
<sup>1</sup> Nitrogen free extract (NFE)	30.11 $\pm$ 0.20	35.41 $\pm$ 0.23	2.4 $\pm$ 0.21	84.3 $\pm$ 0.11	64.4 $\pm$ 0.34
<sup>2</sup> Gross energy(GE) Kcal/Kg	4050	4462	4844	4284	4276
<sup>3</sup> Digestible energy ( DE)	3653	3506	3871	3213	3207

<sup>1</sup> NFE, nitrogen free extract Calculated by differences = 100-(CP+ CF+ EE+ Ash %).

<sup>2</sup> GE, gross energy value was estimated according to Jobling, (1983) ,using the 5.65, 9.45, and 4 for CP, EE and NFE, respectively.

<sup>3</sup>DE Digestible energy was estimated according to Jobling, (1983), using digestible energy = gross energy X 0.75.

### Fish grouping:

The diets were substituted by guar korma meal (GKM) protein, and protein in soybean was replaced and diets were formulated to contain guar korma meal as follows:

1. Control diet (D<sub>1</sub>); without guar korma meal (0 % GKM) with 100 % soybean meal protein,
2. Diet (D<sub>2</sub>); substituted by (9.5 % GKM protein) with 25% replacement of soybean protein,
3. Diet (D<sub>3</sub>); substituted by (18.5% GKM protein) with 50% replacement of soybean protein,
4. Diet (D<sub>4</sub>); substituted by (27.75 %GKM protein) with 75% replacement of soybean protein,
5. Diet (D<sub>5</sub>); substituted by (37% GKM protein) with 100% replacement of soybean protein.

Table 2: Percent ingredient composition of guar meal based diets and Proximate chemical analysis of the experimental diet (% on dry matter basis).

Ingredient	Experimental diets (Inclusion level %)				
	D1 (Control)KM 0%	D2 GKM 9.5 %	D3 GKM 18.5%	D4 GKM 27.75 %	D5 GKM 37%
Fish meal (FM)	10	10	10	10	10
Guar korma meal (GKM)	0	9.5	18.5	27.75	37
Soybean meal (SBM)	37	27.5	18.5	9.25	0
Corn meal	25	26	29	31	33
Wheat bran	18	17	14	12	10
Lin Oil	4	4	4	4	4
Vit. Mix <sup>1</sup>	2	2	2	2	2
Min Mix <sup>1</sup>	1	1	1	1	1
CMC <sup>2</sup>	3	3	3	3	3
Total	100	100	100	100	100
Chemical analysis of the experimental diets (% on DM basis)					
Crude protein (CP)%	29.85	30.04	30.06	30.16	30.26
<sup>3</sup> GE	4282	4323	4387	4342	4360
<sup>4</sup> DE	3211	3242	3290	3257	3270
<sup>5</sup> Protein/energy ratio(P/E) (mg CP/kcal GE)	69.71	69.49	68.52	69.46	69.40

<sup>1</sup> Vitamins & minerals mixture/kg premix: Vitamin D, 0.8 million IU; A, 1.33g; D3, 1.68g; E, 6.66g; C, 16.8g; k, 0.8g; B1, 0.4g; Riboflavin 3.75g; B6 2.45g; B12, .33mg; NI, 9.42g; Pantothenic acid, 12.42g; Folic acid, 0.68g; Biotin, 16.6mg; BHT, 0.5g; Mn, 14.7g; Zn, 31.6g; Fe, 18.3g; I, 0.62g; Selenium, 0.22g and Co, 6.8mg.

<sup>2</sup>Carboxy methyl cellulose.

<sup>3</sup>GE (Gross energy) (kcal / 100 g DM) = CP × 5.65 + EE × 9.45 + NFE × 4 calculated according to **Jobling, (1983)**

<sup>4</sup>DE Digestible energy, estimated according to **Jobling, (1983)**, using digestible energy = gross energy X 0.75.

<sup>5</sup>Protein/energy (P/E) ratio (mg CP/kcal GE) = crude protein × 10000 / Gross energy.

### Essential amino acids composition of soybean meal and Guar Korma meal feed ingredients

Amino acid was analyzed using HPLC after a 20 hour hydrolysis process with 6 molar HCl and a previous stabilisation with Ba (OH) 2 of tryptophan. Separation of amino acids was done using a eineryperphil ODS 250 x 4 mm-column after pre-column derivatisation with OPA (orthophthalaldehyde) (ALVA, 1983 and Altmann, 1992). Amino acid compositions for the soybean meal and Guar Korma meal feed ingredients are shown in Table 3.

Table 3: Amino acids composition of soybean meal and Guar Korma meal feed ingredients and amino acids requirements for *O. niloticus*(% of dry matter). (Data for EAAs requirement of Nile tilapia from Santiago & Lovell 1988).

Amino acid (%)	Soybean meal	Guar korma meal	EAAs requirement for <i>O. niloticus</i> (g/kg DM)
Arginine	3.4	0.65	1.2
Histidine	1.1	3.09	1
Isoleucine	2.5	4.33	1
Leucine	3.4	7.67	1.9
Lysine	2.9	1.04	1.6
Methionine	0.65	1.37	0.7
Cysetine	0.76	0.47	0.3
Phenyl alanine	2.2	4.09	1.1
Therionine	1.7	3.03	0.5
Triptovan	0.6	3.55	1.1
Valine	2.4	5.48	0.3

**Biological evaluation:**

Fish from each cage were measured individually for weight and length every 7 days and at the end of the 112 days trial. Besides, growth parameters were measured according to NRC (2010) at the end of the culture period. Final harvesting was made through draining of water by water pump.

**Growth performance** for each treatment group was determined and feed utilization as follows:

**Mean weight gain** = [final mean weight (g) – initial mean weight (g)]

Where:  $W_1$  and  $W_2$  are the initial mean and final mean fish weight, respectively.

**Mean daily weight gain**

This was calculated as  $(W_f - W_i) / t - 1$  where  $W_f$  is the final mean weight at harvest (g),  $W_i$  is the initial mean weight at stocking and  $t$  is the time in days.

**Specific growth rate (SGR)**

The specific growth rate for each treatment group was calculated using the formula:

$SGR = 100 \times [(\log_e W_f - \log_e W_i) / t - 1]$

Where,  $\log_e$  is natural log,  $W_f$  is the final mean wet weight (g),  $W_i$  is the initial mean wet weight and  $t$  is the time in days (Ricker, 1975).

**Food conversion ratio (FCR) :**

$FCR = \text{dry weight of feed consumed (Feed intake) (g) / wet weight gain (g)}$ .

**Condition Factor (K)** was calculated according to Tesch, (1971) as :

$K = 100 (Wt/L^3)$ , where  $K$  = condition factor,  $Wt$  is fish body weight (g),  $L$  is total length (cm).

**Protein efficiency ratio (PER)** = Wet body weight gain (g)/ Crude protein fed (intake)

Where, Protein intake = (% protein in feed x total diet consumed) /100.

**Protein productive value (PPV)** = (Final fish body protein - initial body protein)/ Crude protein intake × 100

**i. Gross Yield** = No. of fish caught x Average final weight

**ii. Net Yield** = No. of fish caught x Average weight gained

**Serum collecting and Haematological analysis**

At the end of the growth trial, after final weighing, blood samples were taken from ten fish samples from each treatment and control cages were randomly collected using hand net. The captured fish were degutted and cleaned with tap water and were anesthetized and blood was placed in non-heparinized tubes (the blood was collected in vials having EDTA as an anticoagulant and left to clot at 4°C for 15 min. The sera were separated into aliquots for analysis of blood chemistry. Serum was analyzed for Glucose (mg%), alanine aminotransferase (ALT) (U/ml) and aspartate aminotransferase (AST) (U/ml) activity.

**Pond and water quality parameters management**

Physico-chemical parameters of water in the vicinity of the cages including water temperature, conductivity dissolved oxygen, and pH were analyzed and recorded on the dike of the pond. For each parameter three samples were tested. Water temperature was measured and monitored daily around 09:00 hours and 13:00 hours GMT using a glass Celsius thermometer. DO was measured using model 57 oxygen meter (YSI industries, Yellow Springs, Ohio, 4387, USA), while a glass electrode pH meter, Hi-9024 microcomputer (Hanna Instruments Ltd., Chicago, IL., USA), was used to measure pH values, while electrical conductivity and salinity were determined through conductivity meter (Condi 330i WTW 82362 Weilheim Germany).

### Economic analysis

Economic analysis was conducted to determine economic returns. The analysis was based on market prices in Egypt for harvested fishes and all other items, which were expressed in Egypt .The following simple equation was used according to Asaduzzaman *et al.*, (2006).

$$R=I-(FC+VC+Ii)$$

Where,  $R$ =net return,  $I$ =income from mono sex tilapia sale,  $FC$ =fixed/common costs,  $VC$ =variable costs and  $Ii$ =interest on inputs

The Benefit-cost ratio, BCR was calculated as:

$$BCR = \text{net benefit (Total net return)} / \text{total expenditure (Total input cost)}$$

$$(\text{Value of fish/kg}) / (\text{Total cost of production}).$$

$$\text{Profit index, PI : PI} = \frac{\text{Production (Kg/m}^2\text{)}}{\text{Production (Kg/m}^2\text{)}}$$

$$\text{Production (Kg/m}^2\text{)} = (\text{Total weight of fish harvest (Kg)}) / (\text{volume of cage}).$$

### Statistical analysis

All the data collected during experiment were recorded and preserved in computer spread sheet. One way analysis of variance (ANOVA) was applied for comparison of the mean values using SPSS (Statistical Package for Social Sciences 2006 version 15.0); and level of significance was based on  $p < 0.05$  was established .Duncan's Multiple Range Test (DMRT) (**Duncan, 1955**) was applied to compare means for detection of the level of variation among treatments.

## RESULTS AND DISCUSSION

### Water quality parameters

Water quality parameters of pond and cages were examined to observe any appreciable changes that might have occurred between pond and cages. The overall mean values of each water quality parameter as recorded from different sampling are presented in Table 4. One way analysis of variance (ANOVA) was performed on the data to observe whether any difference exists in different sampling or not. Water quality did not vary significantly ( $P > 0.05$ ) among treatments, both in cages and in pond over the culture periods.

Table 4: Mean value with standard Error ( $\pm$ SE) of water quality parameters as recorded from inside of cages and outside of cages (pond) during the experimental period.

Water quality parameters	Cages	Pond
Temperature ( $^{\circ}$ C)	29.50 $\pm$ 0.10 a	27.10 $\pm$ 0.3 a
Dissolved Oxygen (mg/l)	7.11 $\pm$ 0.14 a	7.70 $\pm$ 0.0 a
pH (pH unit)	7.8 $\pm$ 0.54 a	7.4 $\pm$ 0.0 a
Ammonia (NH <sub>4</sub> -N) (mg/l)	0.173 $\pm$ 0.005a	0.141 $\pm$ 0.03a
Nitrite (NO <sub>2</sub> -N) (mg/l)	0.09 $\pm$ 0.0002a	0.07 $\pm$ 0.03a
Nitrate (NO <sub>3</sub> -N) (mg/l)	0.36 $\pm$ 0.006b	0.21 $\pm$ 0.01b

a = no significant level, b = significant level

The physico-chemical parameters for different samples did not vary, indicating that the water quality parameters had equally affected inside and out side the cages. Water quality in broader sense includes all physical, chemical and biological characteristics of the water. The existence, growth, production and wellbeing of aquatic life are mediated through a chain of interacting physical and

chemical parameters of water. Moreover, water quality is directly related to the productivity of water body, the growth, production and survival of fish and other aquatic animals. In the present study all values obtained were within the optimal ranges conducive for aquaculture growth and negatively affect the culture of fish. Moreover, the water quality parameters in different cages were same as in the pond water, suggesting that cage culture does not alter the pond environment. Akter (2007) and BFRI (1994) found more or less similar ranges of water quality parameters in their studies indicating that cage culture does not affect the pond productivity.

Influence of partial and complete replacement of soybean meal protein by guar korma (GKM) protein on growth performance of Nile Tilapia fingerlings

The present study used mono sex Nile tilapia (*O. niloticus*) fingerlings population to reduce variability. Male tilapia grow faster than females (Beardmore *et al.*, 2001) but a study conducted by (Fauconneau *et al.*, 1997) showed that mixed sexes group (males and females) of Nile tilapia had a higher feed intake and lower growth compared to an all male or all female population. However, the all male population had a higher protein efficiency ratio and lower feed conversion ratio compared with the all female population ratio (Fauconneau *et al.*, 1997). Even though most small scale production systems do not sort their fish, it was beneficial to this experiment in order to reduce variability (Beardmore *et al.*, 2001).

The results revealed that averages of initial weights and lengths of the Nile tilapia at the start of the experiment had ranged between  $10.0 \pm 0.00$  and  $10.04 \pm 0.03$  for weight and  $8.5 \pm 0.03$  and  $8.6 \pm 0.03$  for length, with insignificant differences among them indicating complete randomization of individual fish among the experimental trials.

Results present in Table (5) show that at the end of the experimental period (16 weeks), maximum final weight were achieved in the experimental fish fed on diet (D2) which contain 9.5% GKM and diet (D3) contain 18.5 % GKM with averages of 165.66 and 151.72 g/ fish , respectively. However, the lower final weight were noted in experimental fish fed diet (D5) 100% of GKM with an average of 117.84 g/ fish and diet D4 (27.75% GKM) with an average of 127.55 g/fish.

Table 5: Effect of partial and complete replacement of soybean meal by guar korma meal (GKM) on growth performance of mono sex Nile Tilapia (*O. niloticus*) fingerlings reared in cages in earthen pond system(112 days, three replicates, mean  $\pm$  SE)

Items	Experimental diets (Inclusion level %)				
	D1(Control) GKM 0%	D2 GKM 9.5 %	D3 GKM 18.5%	D4 GKM 27.75 %	D5 GKM 37%
Initial weight (g/fish)	10.03 $\pm$ 0.03	10.04 $\pm$ 0.03	10 $\pm$ 0.00	10 $\pm$ 0.00	10.01 $\pm$ 0.00
Final weight (g/fish)	138.65 $\pm$ 0.3c	165.66 $\pm$ 0.9a	151.72 $\pm$ 1b	127.55 $\pm$ 1d	117.84 $\pm$ 0.5e
Initial length (cm/fish)	8.63 $\pm$ 0.03	8.6 $\pm$ 0.03	8.6 $\pm$ 0.06	8.56 $\pm$ 0.03	8.5 $\pm$ 0.06
Final length (cm/fish)	18.2 $\pm$ 0.06a	18.33 $\pm$ 0.07a	18.26 $\pm$ 0.09a	17.63 $\pm$ 0.12b	17.36 $\pm$ 0.09b
Weight gain (g/ fish)	128.61 $\pm$ 0.3c	155.62 $\pm$ 0.8a	141.72 $\pm$ 1b	117.56 $\pm$ 1d	107.83 $\pm$ 0.5e
Daily Weight gain (g/fish/day)	1.14 $\pm$ 0.00c	1.39 $\pm$ 0.00a	1.26 $\pm$ 0.00b	1.04 $\pm$ 0.00d	0.96 $\pm$ 0.00e
Specific growth rate (%/day)	1.05 $\pm$ 0.03a	1.09 $\pm$ 0.00a	1.08 $\pm$ 0.02a	0.98 $\pm$ 0.00b	0.95 $\pm$ 0.00b
Condition factor (K)	2.3 $\pm$ 0.02c	2.69 $\pm$ 0.02a	2.49 $\pm$ 0.04b	2.32 $\pm$ 0.02c	2.25 $\pm$ 0.03c

Mean in a row with different superscripts are significantly different ( $p < 0.05$ ).

These results of averages of final fish weights indicated that replacing up to 18.5% of GKM showed positive effects on growth performances of male Nile tilapia



fingerlings (*O. niloticus*) and improvement in body weight was more pronounced in the fish fed on the experimental diet containing up to 18.5% of GKM to replace 50 % of soybean meal protein. As described in Table (5), results showed that the experimental fish fed on D2 (9.5 % GKM) and D3 (18.5% GKM) had a significantly ( $P<0.05$ ) higher total weight gain compared to the control diet (0 % GKM) than the rest of the experimental diets, whereas the lowest total weight gain (107.83 g) was achieved by experimental fish fed on diet containing 37 % GKM protein .

The worst growth performance was obtained for experimental fish fed on the experimental diet D5 (37 % GKM protein). On the other hand, the experimental fish fed on diets up to 18.5% GKM protein had a significantly ( $P<0.05$ ) higher specific growth rate (SGR%) than the rest of experimental diets. However, at the end of the experiment, the lowest value of SGR was found to be 0.95 % / d in the experimental fish fed on diet containing 37 % GKM protein. It is interesting to note that, highest value of SGR was observed for the diet 9.5 % GKM protein. The statistical evaluation of data revealed that fish fed on D5 (37% GKM protein) showed significantly ( $P<0.05$ ) lower K values compared to the other experimental diets, and among them differences in K values were insignificant (Table 5). Statistical analysis for (SGR%) indicated that the worst was observed by in fish fed on diet D5 (37% GKM protein), and insignificantly ( $P<0.05$ ) differences compared with control diet (D1).

Significant ( $p < 0.05$ ) increase in average weight gain (155.62 and 141.72 g/ fish), daily weight gain (1.39 and 1.26 g/fish/day), specific growth rate (1.09 and 1.08 %/day) and Condition factor (K) (2.69 and 2.49) were observed in fingerlings that fed on diet with 9.5% and 18.5% guar meal compared to that of D1 (control diet, 0% guar meal). However, there was a significant ( $p > 0.05$ ) difference in all the growth indices at 9.5 and 18.5% guar meal diets compared to control one. When the inclusion of guar meal was increased by more than 18.5%, the fingerlings in all the experimental groups showed significant ( $p < 0.05$ ) decrease in all the growth indices (Table 5).

The negative effect of high levels of guar meal inclusion in experimental diets on growth performance is documented by several researchers and they attributed this effect to guar gum residues in guar meal. These results are in agreement with those of Thakur and Pradhan (1975a), who recorded that the birds consuming lower level of guar korma meal gained more weight than those consumed higher levels of guar meal. Also, Patel and Mc Ginnis (1985) reported that increasing guar meal level in diet decreased BWG.

Influence of partial and complete replacement of soybean meal protein by guar korma (GKM) protein on feed utilization efficiencies:

Averages values of feed utilization in terms of feed intake (FI), feed conversion ratio (FCR), feed efficiency (FE), protein efficiency ratio (PER), productive protein value (PPV) and energy retention (ER) are presented in Table (6). These results indicated that differences in D1 (control) among the experimental diets were insignificant ( $P<0.05$ ). On the other hand, the fish fed on D2 (9.5% GKM) or D3(18.5% GKM) had a significantly ( $P<0.05$ ) higher feed intake (317.4 and 309.8 g/fish) than the rest of experimental diets. Whereas the lowest feed intake (263.5 g/fish) was achieved by fish fed on diet containing 37% GKM (soybean meal protein was 100 % replaced by GKM sources). Results of feed utilization in terms of feed conversion ratio (FCR) are presented in table (6). FCR improved significantly ( $P<0.05$ ) using the diets contained treated GKM up to 18.5% .Also, the results of feed efficiency (FE) followed the same trend as (FCR) (Table 6).

Table 6: Effect of partial and complete replacement of soybean meal (SBM) by guar korma (GKM) on feed utilization efficiencies of mono sex Nile Tilapia (*O. niloticus*) fingerlings (112 days, mean  $\pm$  SE).

Items	Experimental diets (Inclusion level %)				
	D1(Control) GKM 0%	D2 GKM 9.5 %	D3 GKM 18.5%	D4 GKM 27.75 %	D5 GKM 37%
Feed intake(FI) (g/fish)	291.8 $\pm$ 0.9b	317.4 $\pm$ 0.8a	309.8 $\pm$ 0.9a	274.27 $\pm$ 1.1c	262.5 $\pm$ 1.8d
Feed conversion ratio(FCR)	2.26 $\pm$ 0.00b	2.04 $\pm$ 0.01a	2.18 $\pm$ 0.01a	2.33 $\pm$ 0.01c	2.43 $\pm$ 0.00d
Feed efficiency(FE)	0.44 $\pm$ 0.00b	0.49 $\pm$ 0.00a	0.45 $\pm$ 0.00a	0.42 $\pm$ 0.00c	0.41 $\pm$ 0.00c
Protein intake (g/fish) (PI)	87.55 $\pm$ 0.26b	95.22 $\pm$ 0.24a	92.93 $\pm$ 0.27a	82.28 $\pm$ 0.34c	78.75 $\pm$ 0.54d
Protein efficiency Ratio (PER)	1.46 $\pm$ 0.00b	1.63 $\pm$ 0.01a	1.52 $\pm$ 0.01a	1.42 $\pm$ 0.01c	1.36 $\pm$ 0.00d
Protein productive value (PPV%)	24.88 $\pm$ 0.2b	28.23 $\pm$ 0.2a	25.52 $\pm$ 0.3b	23.41 $\pm$ 0.6c	21.86 $\pm$ 0.11d
Protein retention (PR)	21.78 $\pm$ 0.18b	26.88 $\pm$ 0.17a	23.72 $\pm$ 0.22a	19.26 $\pm$ 0.45c	17.22 $\pm$ 0.03d
energy retention (ER)	4.77 $\pm$ 0.6c	5.78 $\pm$ 0.5a	5.09 $\pm$ 0.52b	4.01 $\pm$ 0.15d	3.53 $\pm$ 0.03e

Mean in a row with different superscripts are significantly different ( $p < 0.05$ ).

Results also revealed that, the GKM protein sources could replace up to 50% soybean meal protein in growing Nile tilapia fingerlings without any adverse effects on growth performance and feed utilization parameters. Results of protein efficiency ratio (PER), productive protein value (PPV), energy retention (ER) and energy utilization (EU) of Nile tilapia juvenile fed on experimental diets containing treated peas waste and tomato pomace are presented in table (6). Results revealed that fish diets increased PER, and PPV values significantly ( $P < 0.05$ ). Concerning protein efficiency ratio (PER) values, it differences in this trial among the fish fed on the experimental diets were significant ( $P < 0.05$ ). The lower PER percentages obtained for the higher replacing levels (75 to 100 % of SBM by GKM) indicating progressive reduction in nutritional value compared to the lower inclusion levels (25 to 50 % of SBM by GKM). The PER observed in GKM 9.5 dietary group (1.63) were significantly higher ( $p < 0.05$ ) than other dietary groups (Table 6). No significant difference ( $p > 0.05$ ) were observed between GKM 0% , GKM 9.5% and GKM 18.5 % dietary groups for PER.

Results of energy retention (ER) indicated that experimental fish fed on experimental diets with low GKM significantly ( $P < 0.05$ ) increased energy utilization (ER and EU). Feed intake (FI) was significantly decreased with increasing GKM. This result disagree with Thakur and Pradhan (1975a); Mishra *et al.* (2013) and Mohamed (2014), while, agree with Verma and McNab (1982) and Kamran *et al.* (2002). The decrease in feed intake may be due to that GKM depressed the digestibility of starch and deprive the fish the available energy. The results (Table 6) indicate that the higher level of GKM (more than 18.5 %), depress feed conversion (FC). These results is in agreement with Thakur and Pradhan (1975a); Kamran *et al.* (2002). Mishra *et al.* (2013) found that GKM had a negative effect on FC. The improvement in FC with enzyme supplementation may be due to that GKM decrease glucose metabolism and retarded insulin secretion rates in swine. (Lee *et al.*, 2005). This relatively high substitution level( up to 18.5% GKM) has to be related to the specific culture conditions. The caged experiment was conducted in a fertilized earthen pond. Therefore it is possible that the fish in the cage experiment got some extra nutrients from the natural pond food, a specific potential strong point of *O. niloticus* (Rakocy&Mcginty, 1989). This source of nutrients may have

supplemented the deficit of essential dietary amino acids. Furthermore, Bowen (1981) reported that tilapias can thrive well on naturally occurring dissolved amino acids.

However, in the current study the good growth recorded in the cages may be due to amino acid utilization from the natural environment, because tilapias feed continuously in a semi-intensive environment. We therefore postulate that the interaction between the natural pond food and GKM may have resulted in an improved dietary amino acid profiles, thus leading to better utilization and growth performance of fish in the cages. This may be due to the extra source of nutrients from the natural pond food, as the pond was fertilized weekly (Lee *et al.*, 2005).

Dietary inclusion of higher level of plant protein affects the palatability of diets in fish species (Boonyaratpalin *et al.*, 1998). In dairy cows, palatability problems have been reported when more than 5% guar meal was included in the diet (Rahman and Leighton, 1968). It is pertinent to note that even though there was significant reduction in growth indices at higher inclusion of guar meal containing diets, the fingerlings also showed low FCR and high PER. This reflects that increased inclusion of guar meal in the diets showed marked decrease in feed intake and that reflected in FCR and PER. Presence of high level of soluble non starch polysaccharide fraction in the crude fiber content of guar meal is a major limiting factor which affected the nutrient digestibility, growth performance and survival rate of tiger shrimp (*Penaeus monodon*) fed diets containing higher inclusion level of guar meal by more than 5%. (Moriarty, 1997). where the natural food may have provided an important nutrient supplement, Enes *et.al.*, 2013).

#### Chemical composition of the whole body:

Chemical composition of the whole fish body at the beginning and 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 (7).

**Table (7): Effect of partial and complete replacement of soybean meal (SBM) by guar korma meal (GKM) on the whole body chemical composition % of Nile tilapia fingerlings (112 days, mean  $\pm$  SE).**

Proximate composition (%)	At start	At the end				
		D1(Control) GKM 0%	D2 GKM 9.5 %	D3 GKM 18.5%	D4 GKM 27.75 %	D5 GKM 37%
Dry matter (DM)	19.26 $\pm$ 01	23.83 $\pm$ 0.1a	23.13 $\pm$ 0.2ab	23.7 $\pm$ 0.1a	23.33 $\pm$ 0.5ab	22.67 $\pm$ 0.03b
Crude protein (CP)	75.06 $\pm$ 0.11	70.03 $\pm$ 0.17b	71.93 $\pm$ 0.18a	71.43 $\pm$ 0.2a	69.27 $\pm$ 0.17c	69.53 $\pm$ 0.13bc
Total ash	12.66 $\pm$ 0.02	15.36 $\pm$ 0.14b	15.42 $\pm$ 0.06c	15.5 $\pm$ 0.17d	14.5 $\pm$ 0.15a	14.36 $\pm$ 0.08a
Ether extract (EE)	12.26 $\pm$ 0.021	14.6 $\pm$ 0.05a	13.2 $\pm$ 0.2a	12.57 $\pm$ 0.03a	16.23 $\pm$ 0.03b	16.1 $\pm$ 0.05b
Gross energy (GE) Kcal/Kg	5391 $\pm$ 0.2	5400 $\pm$ 0.5c	5479 $\pm$ 16b	5520 $\pm$ 0.5a	5275 $\pm$ 5d	5277 $\pm$ 2d
Digestible energy(DE)	4043 $\pm$ 0.11	4050 $\pm$ 0.4c	4109 $\pm$ 12b	4140 $\pm$ 0.4a	3956 $\pm$ 4d	3958 $\pm$ 2d

Mean in a row with different superscripts are significantly different ( $p < 0.05$ ).

#### The carcass quality was noted as followed

The highest carcass protein and lipid as well as lowest carcass moisture and ash contents have been detected in the fishes fed on GKM up to 18.5 % . No significant ( $P > 0.05$ ) changes in carcass composition has been observed when fish were fed on different test diets, at each inclusion levels. The carcass dry matter and ash levels

have increased with all the diet groups comparing to the values at the start of experiment. The values of carcass protein and lipid with diet D2 and D3 were found to be quite similar to that of GKM; and these values were comparatively higher among experimental diet groups.

Averages of DM contents of Nile tilapia fingerlings whole bodies at the experimental diets start was  $19.26 \pm 0.1$  and increased significantly ( $P < 0.05$ ) in all experimental diets groups at the end of the experiment. Results also revealed that crude protein (CP) in whole fish body at the start experimental was significantly ( $P < 0.05$ ) higher ( $75.06 \pm 0.11$ ) than that of all experimental diets at the end indicating a decrease in CP parallel with increase in the whole fish body ether extract (EE).

In general these results indicated that CP% content in the whole fish bodies is related to EE contents where the increase in one decreases the values of the other. These results also revealed that guar korma meal (GKM) released more potential in fat than soybean meal (SBM) when incorporated in growing Nile tilapia fingerlings. As for fat in tilapia body, it is significantly ( $P < 0.05$ ) higher for diets (D4 and D5) by the increasing levels of soybean meal (SBM) replacement by guar korma meal (GKM) in experimental diets compared to control (100% soybean meal (SBM)). This in agreement with Wang *et al.*, (2005) who reported increasing whole body fat with elevating levels of carbohydrates. Averages of whole fish bodies ash % results revealed that ash% in whole tilapia bodies was significantly ( $P < 0.05$ ) lowest at the initial of the experiment (12.66%) compared to those of all experimental diets at the end of the experiment. At the end of the experiment, the control diets (D1) showed higher ( $P < 0.05$ ) ash % (15.36%) followed by diets contained guar korma meal (GKM). The lowest ash % was found in the diet D5 contained guar korma meal (GKM) due to higher ash percentages in soybean meal (SBM) used in the current study.

In the current study Nile tilapia fingerlings showed no negative effects on whole fish bodies proximate composition of incorporation of guar korma meal (GKM) in Nile tilapia diets when compared to the control. Guar korma meal was successfully including in diets of fingerlings with equivalent results (Wang *et al.*, 2005). It appears from the present study that the presence of natural food improved the protein digestibility in guar gum meal based diets in the cage experiment. The mechanism for the improvement may be linked to the presence of algal based diets. Algae or algal based diets are reported to stimulate secretion of copious amount of gastric acid in *O. niloticus* and *O. mossambicus* (Bowen 1981).

### Fish health

According to results presented in Table (8), all fish were in very good overall condition regardless of treatment. No visible lesions or other macroscopic pathologies were reported, and histological assessments were also favorable, with a few exceptions.

Table 8: Effect of partial and complete replacement of soybean meal as a source of protein by guar korma (GK) on physiological parameters of Nile tilapia fingerlings.

Items	Experimental diets (Inclusion level %)				
	D1(Control) GKM 0%	D2 GKM 9.5 %	D3 GKM 18.5%	D4 GKM 27.75 %	D5 GKM 37%
ALT (U/ml)	86±4.b	57±10c	85.5±3b	99±9b	145±0.5a
AST (U/ml)	78.5±3.7ab	54.5±3b	92.5±1ab	102.5±4ab	141±9a
Glucose (mg%)	103.5±1.4d	113±1.7c	109.5±0.8cd	122±4b	134 ±2.8a

Means in the row with different superscripts are significantly different ( $p < 0.05$ ).

All fish grew normally, and no specific signs of disease were observed. No mortality was detected throughout the experiment.

Enes *et al.*, (2013) concluded that, dietary inclusion of guar gum up to 12 % did not impair white sea bream growth performance and feed utilization efficiency. Guar gum did not promote a decrease in plasma glucose and cholesterol levels but seems to decrease gluconeogenesis.

### Economical evaluation

Described in Table (9) 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 per Kg weight gain which decreased with increasing incorporation levels of PW or TP. This is in agreement with Eid and Mohamed (2007), who found that feeding costs in fish production is about 50% of total production costs. This study reports that replacing guar korma with soybean meal decrease feed cost.

### Economical Study

Results of inputs and outputs of the experimental treatments are presented in Table (9). Prices of experimental diets based on feed ingredients in the local market during the experiment were 2.02, 1.71, 1.84 and 1.97 LE for the control, RC, SFM and SSC diets, respectively, which indicated that incorporation of RC, SFM or SSC in tilapia diets to replace 30% of soybean protein reduced the feed price. Total feed costs during the whole experimental period were 13.47, 11.68, 12.53 and 12.78 L.E. for the same experimental groups cited above, respectively.

Table 9: Effect of substitution of soybean meal with guar korma on economic efficiency of Nile tilapia production.

Items	D1 GKM (0%)	D2 GKM (25%)	D3 GKM 0 (50%)	D4 GKM (75%)	D5 GKM (100% )
Guar korma /Kg/100 Kg	0	9.5	18.5	27.75	37
Cost of guar korma/100 Kg	0	36.10	70.30	105.45	140.60
Soybean meal/Kg/100 Kg	37	27.5	18.5	9.25	0
Cost of soybean/100 LE	188.70	140.25	94.35	47.17	0
Change of feed cost due to addition of guar korma/100 Kg	188.70	104.15	24.05	58.28	140.60
		Decreasi ng cost	Decreasi ng Cost	Decreasin g cost	
Cost saving due to completely replacement of soy bean with guar korma/LE/100Kg	48.10 LE Decreasing cost				
Weight of fish/kg/100 fish	16.56	15.17	13.86	12.75	11.78
Return /100 fish/LE	165.60	151.70	138.60	127.50	117.80
Return/fish/LE	1.65	1.01	1.38	1.275	1.17
Feed intake (g/fish)	317.4	309.8	291.8	274.27	262.5
Difference of return from the 1 <sup>st</sup> group/LE	-	14	27	37	48
Difference of return /LE/fish Due to partial removal of soya bean and substitution with guar korma	-	0.14	0.27	0.37	0.48

Calculated on basis of Price of guar korma = 3800 LE. Calculated on the basis of price of soybean = 5100 LE.

**Calculated according to the price of Kg / fish = 10 LE.**

Economic efficiency (calculated as percentage of revenue to total costs) for C, RC, SFM and SSC treatments were 132.51, 145.70, 145.44 and 149.15 percent respectively. These results indicated that the highest economical efficiency was reported by the SSC group followed in a decreasing order by RC, SFM and control group, respectively. These results indicated that, dried rumen contents or sunflower meal or sesame seed cake can be incorporated in tilapia diets to replace 30% of soybean meal for better economical efficiency results as well as better growth performance and nutrient utilization. In this connection, Saleh (2001), reported that incorporation of hatchery by product meal or Brewers's dried grain as alternative protein sources in tilapia diets reduced costs of one ton feed mixture. He reported also that similar trend was obtained when yellow corn was replaced by either date stone meal or potato by-products meal. In conclusion this study indicated that guar meal can be used as a promising ingredient in the diet of Nile Tilapia *O. niloticus* fingerlings up to 18.5% by replacing 50% of soybean meal protein and become an alternative plant protein source in fish diet to lower the production cost of fish and add value to the plant origin.

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## ARABIC SUMMARY

### تأثير احلال مسحوق الجوار كورما محل مسحوق فول الصويا علي اداء النمو وبعض المقاييس الفسيولوجية لأسماك البلطي النيلي

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أجريت هذه الدراسة لتقييم إحلال مستويات مختلفة من كسب الجوار كورما بمستويات مختلفة عند (٠، ٢٥، ٥٠، ٧٥، ١٠٠%) محل كسب فول الصويا في علائق أصابعيات أسماك البلطي النيلي، ومدى تأثير معدلات الإحلال على التركيب الكيميائي لجسم الأسماك ومعدلات النمو المختلفة والخصائص الفسيولوجية لإنزيمات وجلوكوز الدم بالإضافة إلى تأثيره على جودة المياه المرابه فيها تلك الأسماك. قسمت الأسماك إلى خمس مجموعات على حسب محتوى العليقة التي تتغذى عليها اصباغيات الأسماك إلى ٠، ٩.٥، ١٨.٥، ٢٧.٧٥ و ٣٧% جوار كورما ومعدلات استبدال ٠، ٢٥، ٥٠، ٧٥، ١٠٠% بروتين خام. وأستخدمت مجموعة ضابطة تحتوي على ٠% جوار كورما و ٣٧% فول صويا. وتم تغذية الأسماك على العليقة بمعدل ٥% من وزن الأسماك. أوضحت نتائج تلك الدراسة أن أفضل معدل لإضافة الجوار كورما في عليقة أسماك البلطي هو ١٨.٥% محل فول الصويا حيث تتحسن معدلات نمو الاسماك وكذلك مستويات إنزيمات الدم كما أنه تتحسن من جودة وطبيعة المياه التي تربي فيها أسماك البلطي. وخلصت هذه الدراسة ان الجوار كورما يمكن أن تستعمل كبديل لفول الصويا المرتفع الثمن وبالتالي تحسن من الكفاءة الاقتصادية لمزارع الاسماك.