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Effect of using taro leaves as a partial substitute of soybean meal in diets on growth performance and feed efficiency of the Nile tilapia *Oreochromis niloticus*.

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ABSTRACT

This experiment was conducted to evaluate the effect of using taro leaves meal (TLM) as a partial substitute of soybean meal (SBM) in fish diets on growth performance and feed utilization of Nile tilapia *Oreochromis niloticus* (6.00g). Five experimental diets were formulated to contain isonitrogenous (29% crude protein) and isocaloric (4.27 kcal/g diet) as follows: control and different levels of taro leaves replaced 10, 15, 20, or 25% soybean meal. Each diet was fed in triplicate groups two times a day for 8 weeks to apparent satiation. Results demonstrated that growth performance parameters (final body weight, weight gain, specific growth rate, and survival rate) were increased significantly with increasing taro leaves meal (TLM) in fish diets. Maximum growth was obtained when fish fed on a diet containing 20% of TLM. No significant differences ($P > 0.05$) were found in the survival rate among treatments. Values of feed efficiency parameters were increased significantly with increasing TLM in fish diets and the highest values were recorded with fish fed on a diet contained 20% of TLM. Results indicated that fish proximate chemical analysis affected significantly by partial replacement of TLM for SBM in fish diet. Moreover, results showed that the incorporation of TLM (10% to25%) in the fish diet reduced the price of one kg diet as compared to the control group. These results suggest that taro leaves meal could substitute up to 20% of soybean meal in the Nile tilapia diet without any adverse effects on growth performance or feed efficiency and with an economic return and reduced the feed cost.

INTRODUCTION

Aquaculture is one of the fastest growing industries in the world. There is a need for enhanced feed efficiency and growth performance of cultured fish species **(El-Tawil, 2015).** A current priority in the aquaculture industry is the need to partially or totally replace fishmeal with less expensive and easily available plant protein sources to reduce dependence on fish meal and soybean meal as the fundamental protein sources for aquatic animal diets without reducing the nutritional quality of feeds **(Toan and Preston, 2010; Castillo and Gatlin, 2015).** Numerous studies have been carried out on the use of different plants as partial or complete replacements for fishmeal or soybean meal in aqua feeds **(Richter *et al.*, 2003; Chhay *et al.*, 2010).**

Taro *Colocasia esculenta* is herbaceous perennial plant belonging to the Araceae family, it is an important staple food crop in many tropical countries where it is cultivated for its edible energy-rich corm, which mainly consists of starch **(Vinning, 2003).** Taro (*Colocasia esculenta*) leaves have been partly used for human food as leafy vegetables in most countries in Asia, Pacific region and parts of Africa **(Onwuoeme, 1999)** after heat treatments, such as boiling, blanching, steaming, stewing, frying, and pressure cooking **(Lewu *et al.*, 2009).** Moreover, taro leaves have been reported to be rich in crude protein and nutrients including, minerals and vitamins such as calcium, phosphorous, iron, vitamin A, C, B1 (thiamine), B2 (riboflavin) and niacin which are important constituents of human and animal diets **(Onwuoeme, 1999; Aregheore and Perera, 2003).** It appears that taro leaves (*Colocasia esculenta*) offers the most potential as a protein supplement to replace fish meal and soybean meal as the digestibility of the protein and its biological value are high **(Chhay *et al*., 2010).**

Addition of exogenous enzymes in fish feeds can improve nutrient utilization, thereby reducing nutrient losses **(El-Tawil, 2016).** Nowadays, exogenous enzymes are extensively used all over the world as additives in fish diets to improve the nutritional value of fish feeds, especially with the raise of using plant proteins in aquafeeds and reduce water pollution **(Goda *et al*., 2012).**

However, there appears to be very little information available on the use of taro leaves as fish feed. Therefore, this study was conducted to evaluate the effect of using taro leaves as a partially substitute of soybean meal in fish diets on growth performance and feed efficiency of Nile tilapia *Oreochromis niloticus*.

MATERIALS AND METHODS

This experiment was carried out at the fish nutrition laboratory, central laboratory for aquaculture research, CLAR, Abbassa, Abo-Hammad, Sharqia, Egypt.

Fish rearing and feeding regime.

One hundred and fifty healthy *Oreachromis niloticus*, 6.00±0.2g mean body weight were obtained from fish hatchery at the central laboratory for aquaculture research, CLAR, Abbassa, Abo-Hammad, Sharkia. Fish were transported to a laboratory then the health status of the experimental fish was inspected and tank water was disinfected. Before the feeding trial, fish were acclimatized to laboratory conditions for 2 weeks and fed a commercial diet containing 29% crude protein. Fish were randomly distributed to 5 groups in three replicates of 10 fish per aquarium. Glass aquaria filled with 120 L of water with continuous aeration. Settled fish wastes with one half of aquaria water were siphoned daily and water volume was replaced by aerated tap water from a storage tank. Fish were fed on the treated diets up to apparent satiation twice a day for 8 weeks. Fish feeding was offered 6 days/week. Fish were weighed at the beginning of the experiment and then biweekly for 8 weeks experimental period.

Taro leaves preparation.

Fresh Taro leaves (*Colocasia esculenta*) were collected from the local market in Kaluobiya governement. Leaves washed well with fresh tap water then distributed on plastic sheets and left in sun to dry, then put in drying oven at (60-70^{O}C) to complete dryness, then crushed and grinded through a food mixer then cooked by using an autoclave with a maximum pressure of 1.2 kg /cm², for 15 minutes according to **El-Dahhar and El-Shazly (1993)** and kept dry until used in diets formula.

Diets formulation and preparation.

Five isonitrogenous and isocaloric experimental diets were used in this study containing both animal and plant proteins sources to provide 29% protein and 4.27 kcal/ g diet. The composition and chemical analysis of the experimental diets represented in Table1. Diets were formulated from commercial ingredients. Five different levels of taro leaves replacing of soybean meal were used in this study, the control diet was prepared with 0% taro leaves. The remaining four diets were prepared at graded levels of taro leaves with 10, 15, 20 or 25% respectively, of soybean meal substituted. Dietary ingredients were homogeneously ground to thoroughly mixed. The ingredients of each diet were separately blended with additional 100 mL of warm water to make a paste of each diet. The pastes were separately passed through a grinder, and pelleted in a modified paste extruder to form the tested diets. The diets were dried in a drying oven model (Fisher oven 13–261–28A) for 24 hours on 65°C and stored in plastic bags which were kept dry until they were used.

Chemical analysis of diets and fish.

Samples of the experimental diets and whole-fish body from each treatment at the beginning and at the end of the experiment were analyzed according to the methods of **AOAC (1990)** for moisture, crude protein, total lipids, ash and fiber. Moisture content was estimated by drying the samples to constant weight at 85°C in a drying oven (GCA, model 18EM, Precision Scientific group, Chicago, Illinois, USA). Nitrogen content was determined using a micro kjeldahl apparatus (Labconco Corporation, Kansas, Missouri, USA). Lipid content was determined by ether extraction in a multi-unit extraction Soxhlet apparatus (Lab-Line Instruments, Inc., Melrose Park, Illinois,USA) for 16 h. and ash was determined by combusting dry samples in a muffle furnace (Thermolyne Corporation, Dubuque, Iowa, USA) at 550 °C for 6 h. Crude fiber was estimated according to **Goering and Van Soest, (1970).** Gross energy was calculated according to **NRC (1993)** as 5.65, 9.45, and 4.11 kcal/g for protein, lipid, and carbohydrates, respectively.

Parameters of growth performance and feed utilization.

Growth performance and feed efficiency parameter were calculated as the following equation:

Weight gain (WG) = W1-W0.

Specific growth rate (SGR%/day) = [(Ln W1− Ln W0)/T] × 100.

Where, Ln = natural log, W0 = Initial body weight (g), W1= Final body weight (g) and T= Time (day).

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

Protein efficiency ratio (PER) = total weight gain (g)/protein intake (g).

Protein productive value (PPV %) = 100 (protein gain/protein intake).

Energy retention (ER %) = 100 (gross energy gain/gross energy intake).

Table 1. Formulation of feed ingredients and proximate chemical composition (% on dry matter basis) for the experimental diets.

Ingredient%	Taro leaves levels%				
	Control	10%	15%	20%	25%
Fish meal (HFM)	12.5	12.5	12.5	12.5	12.5
Soybean meal (SBM)	40	36	34	32	30
Corn meal	24	25	24	24	22
Wheat bran (WB)	14	13	13	13	13
Taro leaves	0	7	10.5	14	17.5
Oil	2.5	2.5	2.5	2.4	2.9
Vitamins premix	1	1	1	1	1
Minerals Premix	1	1	1	1	1
Starch	5.0	1.9	1.4	0	0
Enzyme	0.0	0.1	0.1	0.1	0.1
Total	100	100	100	100	100
Dry matter	92.24	92.31	92.66	92.43	92.76
Crude protein	29.18	28.36	28.79	29.42	28.83
Crude fat	7.19	7.26	7.15	7.21	7.16
Ash	8.63	8.86	8.91	9.27	9.52
Fiber	6.38	6.63	7.85	7.42	8.91
NFE	48.62	48.89	47.3	46.68	45.58
GE(Kcal/100g)	432.15	429.29	424.16	425.74	417.41

1- Vitamins premix (per kg of premix): thiamine, 2.5 g; riboflavin, 2.5 g; pyridoxine, 2.0 g; inositol, 100.0 g; biotin, 0.3 g; pantothenic acid, 100.0 g; folic acid, 0.75 g; para-aminobenzoic acid, 2.5 g; choline, 200.0 g; nicotinic acid, 10.0 g; cyanocobalamine, 0.005 g; α-tocopherol acetate, 20.1 g; menadione, 2.0 g; retinol palmitate, 100,000 IU; cholecalciferol, 500,000 IU.

2- Minerals premix (g/kg of premix): CaHPO4.2H2O, 727.2; MgCO4.7H2O, 127.5; KCl 50.0; NaCl, 60.0; FeC6H5O7.3H2O, 25.0; ZnCO3, 5.5; MnCl2.4H2O, 2.5; Cu(OAc)2.H2O, 0.785; CoCl3..6H2O,0.477; CaIO3.6H2O, 0.295; CrCl3.6H2O, 0.128; AlCl3. 6H2O, 0.54; Na2SeO3, 0.03.

3- Enzyme activity(unit/g) at 30°C, pH 7.2: Cellulase 5000 unit/g, Xylanase 10000 unit/g, ß-glucanase1000 unit/g, Protease 6000 unit/g, α- amylase 1800 unit/g, Phytase500 unit/g, Pectinase 140 unit/g.

Parameters of growth performance and feed utilization.

Growth performance and feed efficiency parameter were calculated as the following equation:

Weight gain (WG) = W1-W0.

Specific growth rate (SGR%/day) = [(Ln W1− Ln W0)/T] × 100.

Where, Ln = natural log, W0 = Initial body weight (g), W1= Final body weight (g) and T= Time (day).

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

Protein efficiency ratio (PER) = total weight gain (g)/protein intake (g).

Protein productive value (PPV %) = 100 (protein gain/protein intake).

Energy retention (ER %) = 100 (gross energy gain/gross energy intake).

Survival rate (SR %) = 100 x (fish No. at the end/ fish No. stocked at the beginning)

Water quality measurements.

Water temperature and dissolved oxygen were measured weakly early in the morning at a depth of 20 cm using a YSI Model 58 oxygen meter (Yellow Springs Instrument, Yellow Spring, OH, USA). Total ammonia, nitrite and nitrate were measured peridically using a DREL 2000 spectrophotometer by the method of **Golterman *et al*. (1978).** pH was monitored using an electronic pH meter (pH pen; Fisher Scientific, Cincinnati, OH, USA). Unionized ammonia was measured using DREL/2 HACH kits (HACH Co., Loveland, Colorado, USA).

Blood sampling.

At the end of experiment, blood samples were drawn from the caudal blood vessels from five fish per aquarium **(Lied *et al.*, 1975)** into clean dry Eppendorf, centrifuged at 3000 rpm for 15 minutes for serum separation and stored at -20^{o}c.

Serum protein profile.

Total protein (g/dL) **(Lowry *et al.*, 1951)** and albumin (g/dL) **(Doumas *et al.*, 1971)** were assayed as well as, globulin (g/dL) was calculated by subtraction of albumin from total protein.

Statistical analysis.

Data were analyzed (means ± SD) using a one-way analysis of variance (ANOVA). Differences between means were tested at the 5% probability level using Duncan Multiple Range test. All the statistical analyses were done using SPSS program version 18 (SPSS, Richmond, VA, USA) as described by **Dytham (1999).**

Economical evaluation.

A simple economic analysis was conducted for different experimental treatments to estimate the cost of feed required to produce a unit of fish biomass. The estimation was based on local retail sale market price of all the dietary ingredients at the time of the study. These prices (in LE/kg) were as follows: herring fish meal, 17.00; soybean meal, 4.00; yellow corn meal, 2.50; wheat bran, 2.25; corn oil, 10.00; starch, 6.00; vitamins mixture, 10; minerals mixture, 6.00; Enzyme mixture, 120 and taro leaves 0.5 LE/kg.

RESULTS

In the present study, values of water quality parameters showed that temperature ranged from 28 to 29 °C, dissolved oxygen ranged from 5.3 to 6.3 mg/L, pH range was 7.8–8.1 and total ammonia ranged from 0.6 to 0.9 mg/L.

Results of growth performance parameters are shown in Table (2). Data showed that final body weight (FBW), weight gain (WG) and specific growth rate (SGR %) of Nile tilapia *Oreochromis niloticus* were improved significantly ($P < 0.05$) with supplemented treatments in fish diet. The growth performance parameters were increased gradually as the level of replacement of soybean meal (SBM) by taro leaves meal (TLM) increased up to 20% then increasing the level of TLM in the diets from 20 to 25% did not exert any additional advantage to growth of fish. The highest values of FBW (20.85g), WG (14.84g) and SGR % (2.07%) were recorded in fish fed diet containing 20% TLM. Survival rate at the end of the experiment showed that there were insignificant differences (P > 0.05) among treatments.

Table 2. Growth performance values (means ± SE) of Nile tilapia fed diets containing different levels of taro leaves meal.

Items	Control	Taro leaves levels (%)			
		10%	15%	20%	25%
Initial fish weight	6.01±0.01	6.06±0.07	6.00±0.06	6.01±0.12	6.00±0.12
Final fish weight	17.87±0.23c	18.26±0.20c	19.87±0.20b	20.85±0.11a	18.3±0.26c
Weight gain (g)	11.85±0.22c	12.20±0.21c	13.87±0.19b	14.84±0.11a	12.3±0.27c
Specific growth rate	1.81±0.02c	1.83±0.02c	1.99±0.02b	2.07±0.01a	1.86±0.03c
Fish survival (%)	100±0.0	100±0.0	100±0.0	100±0.0	100±0.0

Means with different superscripts in the same row are significantly different (P<0.05). N= 3

Values of feed conversion ratio FCR, protein efficiency ratio PER, protein productive value PPV% and energy retention ER % of Nile tilapia (*Oreochromis niloticus*) are shown in Table (3). Data indicated that FCR values were improved significantly (P < 0.05) with increasing the inclusion rate of TLM in diet and ranged from 1.63 to 1.76.

With respect to PER values, results indicate that highest significant (P<0.05) value of PER was found in fish maintained on 20% TLM (2.09) while the lowest significantly PER value (1.95) was found in fish maintained on control diet. Results of PPV indicate that highest significant (P<0.05) values was found in fish maintained at 15 TLM, with a value of 36.22. Results of energy retention (ER %) as shown in Table 3, indicated that fish maintained at 15 and 20 % TLM were significantly (P < 0.05) higher than other treatments, they were 23.6 and 22.6 % respectively, without any significant difference between them.

With respect to body composition of Nile tilapia (*Oreochromis niloticus*), results in Table (4) observed a significant differences (P < 0.05) between treatments in moisture percentage of fish body contents, the highest values were found in fish maintained on control treatments 74.86%, while the lowest value were found in fish maintained on 15% TLM 71.36%. Results of body protein content showed significant differences (P<0.05) between treatments where the highest values of body protein content (P<0.05) were found in fish maintained on 15 and 20% TLM with the values 15.96 and 15.55 respectively, without significant difference between last two treatments. Results of fish body lipid contents showed that there were significant differences (P<0.05) among treatments. Fish maintained on 15% TLM diet were significantly (P<0.05) the highest fish body lipid content than other treatments, while the lowest (P<0.05) values were found with fish maintained on 25% TLM diet.

Table 3. Feed utilization values (means ± SE) of Nile tilapia fed diets containing different levels of taro leaves meal.

Items	Control	Taro leaves levels (%)			
		10%	15%	20%	25%
Feed intake(g)	20.83±0.3b	20.94±0.19b	23.34±0.73a	24.18±0.29a	20.86±0.45b
FCR	1.76±0.02a	1.71±0.02ab	1.68±0.02ab	1.63±0.03b	1.69±0.035ab
PER	1.95±0.03b	2.06±0.02ab	2.06±0.03ab	2.09±0.04a	2.045±0.04ab
PPV	29.36±0.49c	32.6±0.56b	36.22±0.49a	35.2±0.34a	32.63±0.64b
ER%	19.25±0.23c	21.49±0.43b	23.65±0.24a	22.66±0.22a	20.59±0.32b

Means with different superscripts in the same row are significantly different (P<0.05).

Table 4. Body composition (Means ± SE) % on dry weight basis of Nile tilapia fed diets containing different levels of taro leaves meal.

Treatments	Moisture%	Lipid%	Protein%
Control	74.86±0.136a	5.79±0.68cd	14.08±0.105c
10% (TLM)	73.46±0.256bc	6.29±0.086ab	14.67±0.112b
15%(TLM)	71.36±0.121d	6.54±0.051a	15.96±0.135a
20%(TLM)	72.84±0.266c	5.95±0.052bc	15.55±0.185a
25%(TLM)	74.17±0.174ab	5.51±0.096d	14.75±0.087b

Means with different superscripts in the same column are significantly different (P<0.05).

With respect to serum protein (Table 5) (total protein, albumin and globulin), values in all treated groups were significantly (P<0.05) elevated than control treatment and their ranges were 2.51 to 2.96, 0.88 to 1.02 and 1.63 to 1, 94 respectively.

Table 5. Serum protein profile groups for Nile tilapia fed diets containing different levels of taro leaves

Items	Control	Taro leaves levels%			
		10%	15%	20%	25%
Total protein(g/dl)	2.51±0.03c	2.64±0.04bc	2.68±0.02b	2.96±0.049a	2.65±0.07bc
Albumin (g/dl)	0.88±0.017b	0.926±0.027ab	0.94±0.017ab	1.02±0.04a	0.92±0.346b
Globulin (g/ dl)	1.63±0.017c	1.72±0.026b	1.74±0.005b	1.94±0.026a	1.73±0.036b

Means with different superscripts in the same row are significantly different (P<0.05). N= 3

Results showed that the incorporation of TLM in diet was more economic and reduced the feed cost compared to the control treatment. However, the reduction in feed cost to produce one kg fish gain ranged between 7.73 to 16.61 % in the fish fed on TLM inclusion compared to fish fed on control diet.

Table 6. Economic efficiency for production of one kg gain of Nile tilapia fed diets containing different levels of taro leaves.

Items	Control	Taro leaves levels%			
		10%	**15%**	**20%**	**25%**
Price (L.E)	5.95	5.65	5.53	5.35	5.39
FCR	1.76	1.71	1.68	1.63	1.69
Feed cost (L.E)	10.47	9.66	9.29	8.73	9.15
Reduction cost %	100	7.73	11.27	16.61	12.6

DISCUSSION

All water quality parameters in the present study were within the acceptable ranges for normal growth of Nile tilapia during the course of the experiment **(Boyd, 1984).**

As the aquaculture is in continuous development, expanding and intensifying **(Bostock *et al.*, 2009)**, it is essential to involve different components in fish feed **(Tacon, 2005)** and provide their maximal utilization. Soybean meal is currently the most commonly used plant protein source in fish feeds and amounts to 50% of the diet of freshwater omnivorous fish species **(Yue and Zhou, 2019).** Results of the present work indicate that growth performance of the Nile tilapia were affected significantly ($P < 0.05$) by different levels of taro leaves meal in fish diet. Final body weight, weight gain and Specific growth rate of Nile tilapia improved significantly ($p<0.05$) with increasing taro leaves in the diet up to 20%. Increasing taro leaves level beyond 20% had no significant effect on growth. These results are agree with that found by **Mathia and Fotedar (2012)** where boiled taro leaves can be used as a complete replacement of shrimp meal protein in Nile tilapia diets without any significant differences ($P > 0.05$) were observed in specific growth rate, survival rate or apparent food conversion ratio. **Wee and Wang, (1987); Richter *et al.*, (2003); El-Saidy and Saad, (2008)** suggest that a complete replacement of plant protein may have some diverse effects on the growth performance. So, replacement taro leaves meal in the present study more than 20% may be had an adverse effect on growth performance. Moreover, **Azaza *et al.* (2009)** showed that feba bean meal could be incorporated up to 24% in diets of juvenile Nile tilapia which corresponds to a reduction of 20% soybean meal in the control diet without compromising growth or feed conversion ratio.

The constraints in using many plant leaves like taro leaves in fish diet are the anti-nutritional factors, such as the concentrations of calcium oxalate, which appears to be a limiting factor in consumption of the fresh leaves **(Buntha *et al.*, 2008)**, linkages between the protein and fiber can result in decreased digestibility **(Ogle, 2006).** From studies on the nutritive value of tropical leaves, **Leterme *et al.* (2005)** concluded that tropical tree leaves offer a variable amount of proteins that are well balanced in essential amino acids but not well digested by animals. So, it is needed to improve processing methods and to develop new products that will be suitable for fish consumption and utilization. In the present study, cooking taro leaves reduced calcium oxalate concentration. These results agree with those found by several authors who reported that most of the oxalates are usually lost by leaching during boiling, soaking, fermentation, ensiling, and at some extent, sun drying **(Aregheore and Perera, 2003; Savage and Dubois, 2006; Oscarson and Savage, 2007; Martensson and Savage, 2008; Hang and Preston, 2010).**

El-Dahhar (2006) stated that treating the diet by heat and pressure concentrate on expecting to improve product quality and make the best nutritional use of the raw materials. It can also sterilize the product and give the flexibility to utilize a wider range of raw materials while maximizing their nutritional quality. **Drew *et al.* (2007)** reported that studies on the nutritional value of processed plant proteins in various fish species have consistently shown improved digestibility and growth compared to feeding unprocessed ingredients.

In the present study, values of feed conversion ratio, protein efficiency ratio, protein productive value and energy retention of fish affected significantly ($P < 0.05$) by different levels of taro leaves in fish diet, it increased significantly with increasing taro leaves in the diet. **Jiang (1999)** reported that protein content of taro leaves is approximately 23% and they are rich in essential amino acid but is rather low in histidine, methionine and lysine. Moreover, Adding 0.1% of exogenous digestive enzymes to fish diets in the present study may be enhanced fish performance and improve the nutrient utilization. These results in agreement with those found by **El-Tawil (2015)** who stated that addition of exogenous enzymes in fish feeds can improve nutrient utilization, thereby reducing nutrient losses. Exogenous enzymes have been proven to improve nutritional value of feed and decrease environmental pollution. Also, certain enzymes provide an additional powerful tool that can inactivate anti-nutritional factors and enhance the nutritive value of plant protein in feeds. **Saenphoom *et al.* (2011)** showed that the enzyme is effective in breaking down fiber in taro leaves. **Castillo and Gatlin (2015)** stated that exogenous enzymes supplementation improve nutrient digestibility and reduce nutrient excretion of plant-based fish diets. **Dalsgaard *et al.* (2014)** indicate that plant-based feed ingredients typically contain remnants of dietary fibers that have various anti-nutritive effects in fish. Exogenous enzymes have been shown to improve the apparent digestibility coefficients of plant-based diets presumably by assisting in the breakdown of non-starch polysaccharides and alleviating some of the anti-nutritive effects.

With respect to body composition of Nile tilapia in the present study (Table 4), results showed that values of body protein contents increased up to 20% TLM, while lipid contents increased significantly ($P<0.05$) at fish maintained on 15% TLM. These results in agreement with those found by **Yue and Zhou (2008)** where crude protein contents of Nile tilapia increased significantly with increasing the level of replacement of soybean meal by cotton seed meal levels in fish diets.

In the present study the results of serum total protein (Table 5) stated that values in all treated groups were significantly ($P<0.05$) elevated than control treatment. Total serum protein concentration is important to evaluate the nutritional state of the fish health condition **(Pratriche *et al.*, 2011).** These results in agreement with those found by **Olaniyi (2010).** Excessively serum total protein and albumin have been reported to be directly responsive to protein intake and quality **(Onifade and Abu, 1998).**

In the present work, economic evaluation of the experimental diets is shown in Table (6). Results showed that incorporation of TLM in fish diet was more economic and reduced the feed cost compared to the control treatment. However, the reduction in feed cost to produce one kg fish gain ranged between 7.73 to 16.61 % in the fish fed on TLM inclusion compared to fish fed on control diet. One of the aims of present study was to evaluate the effect of TLM on cost analysis of production. Similar results were observed by **Buntha *et al.* (2008)**; they indicated that feed costs were lowest for the fish meal and taro leaf silage diet than other treatments, indicating that a mixture of fish meal and taro leaf silage can be the most economic feed.

CONCLUSION

As a conclusion of this study, it is suggested that taro leaves could safely replace soybean meal up to 20% in practical diets for Nile tilapia. Moreover, it is improve fish growth performance and the feed efficiency. Also, it is more economic and sharply reduced the fish feed cost.

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