

UTILIZATION OF MUNG BEAN (*VIGNA RADIATE*, *LINNAEUS*) AS A PROTEIN SOURCE IN EXPERIMENTAL DIETS FOR FRY NILE TILAPIA (*OREOCHROMIS NILOTICUS*): EFFECTS ON GROWTH PERFORMANCE, FEED UTILIZATION AND APPARENT DIGESTIBILITY CO-EFFICIENCY

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SUMMARY

Seven experimental diets (30% crude protein and 402.48±1.44 kcal/100g GE) were formulated to replace 0.0, 15, 30, 45, 60, 75 and 100% of soybean meal protein (SBM) as plant protein source by mung bean seed (MBS). Nile tilapia fry with an average initial weight (0.5±0.09 g/fish) were stocked at a rate of 15 fry/fiber glass tank (7 experimental diets x 3 replicates (21 fiber glass tanks)) and fed with those diets for 14 weeks to evaluate the growth performance, feed utilization and apparent digestibility co-efficient under the indoor conditions. Results showed significant decrease (P<0.05) in growth performance with increasing level of MBS up to 15%. The highest values of dry matter, protein, fat and energy intakes were recorded by the control and 15% MBS group with significant differences (P<0.05) compared with the other treatments groups. On the other hand, significant differences (P<0.05) among groups for ADC% of CP, EE, NFE, DM and energy were observed with increasing rate of MBS more than 15%. There are significant differences (P<0.05) for FCR, but contrary no significant differences for FER among all the groups. Apparently, there were no effect for all levels of MBS on chemical composition (CP, DM, EE, GE and HSI) and survival rate. Incorporation of raw MBS more than 15% affected adversely on growth performance, feed utilization and ADC%. This may be due to anti-nutritional factors contents of MBS.

Keyword: *Mung bean seed, soybean meal, Nile tilapia, growth performance, apparent digestibility.*

INTRODUCTION

Fish feed represent almost 65 to 70% of the fish culture inputs, many attempts have been done to reduce the feed costs by using cheaper alternative sources of protein and/or energy of that so called non-traditional ingredients or by-products, which may have great values in producing cheap fish diets (Abd El-Hakim *et al.*, 2003). Protein remains the most expensive ingredient in prepared feeds for most cultured organism, yet it is also the most important factor affecting growth performance of fish. Therefore, one of the foreseen constraints to intensification of fish farming is the scarcity of inexpensive, readily available and nutritive sources of protein (James *et al.*, 2015). Soybean meal (SBM) is the most important nutritious of all plant protein sources (Lovell, 1988). Because of its high protein content, high digestibility, relatively well-balanced amino acid profile and steady supply, SBM is widely used as a cost-effective feed ingredient for many aquaculture animals (Storebakken *et al.*, 2000); it is currently the most commonly used plant protein source in fish feeds (El-Sayed, 1999). The use of soybean meal as an alternative protein source became so expensive. So, it becomes a demand to look for another alternative protein source that could be used to partially or totally replace soybean meal without competing with

human demand and locally available protein sources (Mohammed, 2008). The high cost and fluctuating quality of fish meal and soybean meal as well as uncertain availability (Alcerte, 2000), have led to the need to identify alternative protein sources for fish. Considerable emphasis has been focused on the use of conventional plant protein sources, such as mallow (Abd El-Hamid *et al.*, 2004), and water hyacinth (Abd El-Hamid *et al.*, 2006). Leguminous plants such as mung bean, (*Vigna radiate*, Linneaus) (De Silva and Anderson, 1995) and African Yam beans have been identified to be suitable protein sources for fish diets (Olaifia and Bello, 2011). Mung bean is a drought-resistant plant and is cultivated in many tropical countries. It contains high levels of protein and energy and has a good amino acid profile comparable to soybean, kidney pea meal, and to an FAO/WHO reference protein (El-Adawy, 1996). Also, mung beans play an important role in nutrition because they are rich source of nutrients with 23.7% crude protein (CP), crude fat (CF) of 1.9%, certain amount of minerals and vitamins and essential amino acids which are comparable with that of soybean and kidney beans (Deshpande *et al.*, 1982 and Habibullah and Shah, 2007). So, green mung bean was used to replace for fish meal in Asian sea bass (Eusebio and Coloso, 2000) and milkfish diets (Apines-Amar *et al.*, 2015) without deleterious effects on growth of the fish. Mung bean seed (MBS) is an excellent source of high quality protein, cheapest and richest sources of plant protein which is commonly used in many products, ground mung bean may be used as a substitute or in combination with other ingredients in many food products (Kenawi *et al.*, 2009). Also, Kataria *et al.* (1989) reported that some promising strains of amphidiploids (black gram x Mung bean) have been developed by Haryana Agricultural University, Hisar (India). The nutritive value of mixed rations depends on the nutrient composition of the individual feed components and the ability of the animal to digest and absorb the nutrients (Kirchgessner *et al.*, 1986). No many studies so far done to evaluate the efficiency of MBS as feedstuffs. Such information is of paramount importance in the assessment of the economical use of this macro-phyte plant in aquaculture (Rahman-Tibin *et al.*, 2012). Digestibility of feedstuff by the animal depends not only on the animal digestive tract architecture, physiology and environmental conditions, but also on its physical and nutrient characteristics (Lee and Lawrence, 1985; Akiyama *et al.*, 1989).

This work aimed to evaluate the replacement of soybean meal protein by raw MBS on growth performance, feed utilization of Nile tilapia fry and apparent digestibility of dry matter, crude protein, ether extract, ash, NFE, energy and crude fibre.

MATERIALS AND METHODS

First study: Feeding trial design

An experimental attempt was carried out for 14 weeks (Dept. of Fish Nutrition, Central Lab. for Aquaculture Research (CLAR), Abbassa, Abou Hammad, Sharkia, Egypt) and aimed to investigate the effects of replacement of soybean meal (SBM) with raw MBS -as a main dietary plant protein source- on growth performance, feed utilization efficiency and digestibility of nutrients for male Nile tilapia (*O. niloticus*) fry. Twenty-one circular fiberglass tanks (50x40x35 cm with 50 liters in volume) were filled with de-chlorinated tap water and supplied with compressed air. Proximate analysis and essential amino acid profile of SBM and MBS used in the experimental are shown in Table (1). Seven experimental diets were formulated as following; the first (control) was formulated to contain soybean meal as the only main dietary plant protein source; the other six experimental diets were formulated to replace the raw MBS as plant protein at rate of 15, 30, 45, 60, 75 and 100% instead of the soybean meal protein (Tables 2 & 3). Male Nile tilapia fry (*O. niloticus*) with an average initial weight (0.5 ± 0.09 g/fish) were obtained from tilapia hatchery of CLAR. The fish were transported and adapted for the wet Lab. conditions. Fish were classed to seven groups (with three replicates per each) and stocked at a rate of 15 fry/fiber glass tank. The diets were applied four times daily except Friday (9:00, 11:00, 13:00, and finally 15:00) to the fish at a rate of 10% of the fish biomass/day for six weeks then reduced to 5% for the rest time. All fish were weighed biweekly and the amount of the offered feed was readjusted accordingly. One third of water volume was changed daily but the whole water volume was totally changed weekly.

The proximate chemical analysis of diets and fish:

At the beginning of the experiment, randomized samples of the tested diets and whole-fish body (5 fish) from each treatment were analysed according to the standard methods of AOAC (1990) for moisture, protein, fat, and ash.

Table (1): Proximate analysis and essential amino acid profile of SBM and MBS used in the experimental diets (%; on DM basis) as cited from El Sherbiny (2008)

Item	Proximate analysis		Item	*EAA	
	SBM	MBS		SBM	MBS
DM	91.50	89.02	Arginine	4.07	1.24
CP	44	25.40	Histidine	1.35	0.77
EE	1.43	0.82	Isoleucine	2.73	1.24
CF	7.50	4.89	Leucine	4.14	2.23
Ash	7.27	3.60	Lysine	3.52	1.99
**NFE	39.80	65.29	Methionine	0.79	0.24
¹ Total P	0.70	0.50	Cystine	0.83	0.10
² AV. P	0.27	0.35	Phenylalanine	2.71	1.44
GE ³ (kcal/kg)	4751	4438	Tyrosine	1.86	0.62
			Threonine	2.15	0.75
			Tryptophan	0.77	1.14
			Valine	2.82	1.36

*EAA= essential amino acids.

**NFE, nitrogen free extract = 100 - (CP% + CF % +EE % + Ash %). ¹Total P, total phosphorus. ²AV. P, Available phosphorus = Total phosphorus % - phytate phosphorus % according to (Wheeler and Ferrel, 1971).

³GE, gross energy content was determined using bomb calorimeter according to (AOAC, 2005).

Table (2): Ingredients portions of the experimental diets in the experiment.

Ingredient	Tested diets (mung bean levels %)						
	Control	15%	30%	45%	60%	75%	100%
Fish meal	16	16	16	16	16	16	16.5
Soybean meal	30	27	23.2	21	18.3	12.8	-----
MBS	----	5	11	16.6	22.6	35.2	62
Yellow corn	20	20	20	20	18	15	3.5
Wheat bran	23	23	23	20	19	16	13
Cellulose	2	2	1.2	1.2	1.2	1.00	1.00
Corn oil	5	3	3	2.6	2.3	1.6	1.6
Vit. ¹ & min. ² Premix	2.00	2.00	1.4	1.4	1.4	1.4	1.4
Starch	2	2	1.2	1.2	1.2	1.00	1.00

¹Vitamin 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; cyanocobalamin, 0.005 g; a-tocopherol acetate, 20.1 g; menadione, 2.0 g; retinol palmitate, 100.000 IU; cholecalciferol, 500.000 IU.

²Minerals 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.

Table (3): Proximate analysis (on dry matter basis %) of the experimental diets.

Item	Tested diets (mung bean levels %)						
	Control	15	30	45	60	75	100
DM	89.97	89.93	90.80	91.03	91.57	91.1	90.77
CP	30.21	30.18	30.01	30.08	30.03	30.06	30.04
EE	7.8	7.09	6.68	5.90	6.59	6.30	6.39
Ash	8.5	7.98	8.07	8.67	7.94	8.06	7.10
CF	6.07	5.97	6.53	6.38	6.48	6.20	6.83
NFE ³	47.42	48.78	48.71	48.97	48.96	49.38	49.64
GE ⁴ (kcal/ 100 g diet)	406.51	397.34	404.49	403.68	405.96	402.09	397.28

³Nitrogen-free Extract (calculated by difference) = 100 - (Protein + lipid + ash + fiber). ⁴Gross energy (GE) was calculated from (NRC, 1993) as 5.65, 9.45, and 4.11 kcal/g factors for protein, lipid, and carbohydrates, respectively.

Growth and feed utilization parameters:

Body weight gain (BWG); average daily gain (ADG); specific growth rate (SGR); feed conversion ratio (FCR); feed efficiency ratio (FER); protein, fat, and energy retention in fish body and finally survival rate (SR) were calculated according to the following equation:

1- Body weight gain (BWG; g/fish) = W2 – W1.

2- Average daily weight gain (ADWG; g/fish/day) = (W2 – W1)/T.

3- Specific growth rate (SGR; %/day) = [100 x (LnW2 – LnW1)]/T.

Where: W1 = the initial weight (g), W2 = the final weight (g), T = the feeding period (days) and Ln= Natural log.

4- Feed intake (FI; g /fish) = amount of feed intake (g/fish)/period.

5- Feed Conversion Ratio (FCR) = feed intake (on DM basis)/body weight gain.

6- Feed Efficiency Ratio (FER) = [body weight gain (g)/(DM) feed intake (g)] x 100.

7- Hepatosomatic Indix (HIS; %) = liver weight (g)/body weight (g) ×100.

8- Protein retention (PR; g/fish) = body protein at the end- body protein at the start.

9- Fat retention (FR; g/fish) = body fat at the end – body fat at the start.

10- Energy retention (ER; Kcal GE/fish) = body energy at the end – body energy at the start.

11-Survival rate (%) = [No. of fish at the end of the study/ No. of fish at the start of the study] x100.

12- Dry matte intake (DM I; g/fish) = amount of consumed DM in feed (g/fish)/period.

13- Protein intake (PI; g/fish) = amount of consumed protein in feed (g/fish)/period.

14- Fat intake (FI; g/fish) = amount of consumed fat in feed (g/fish)/period.

15- Energy intake (EI; Kcal/fish) = amount of consumed energy in feed (Kcal/fish)/period.

The second study: Digestibility trial

At the end of experimental period, a digestibility trial was carried out and the apparent digestibility coefficients of nutrients (ADC) were determined using ash or fibers as an internal marker according to Jones & De Silva (1998) and Sales & Janssens (2006). ADC % of nutrients was calculated according to the following equation:

$$\text{ADC (\%)} = 100 - \left[\frac{100 \times \% \text{marker in feed}}{\% \text{marker in feces}} \times \% \text{nutrient in feces} / \% \text{nutrient in feed} \right]$$

Twenty-four fish from each treatment were allotted third aquaria (8 each represent replicated) to carry out the digestibility trial. The fish were fed the experimental diets at a daily rate of 1% of aquarium

fish biomass. The experimental diets were offered once daily at 11:00 am, after feces collection. Feces were collected by siphoning one time daily before feeding. Feces were kept in a deep freezer at 4°C after collection to avoid the fermentation according to the method of AOAC (1990). The digestion trial lasted 21 days.

Statistical analysis:

The data were statistically analyzed by analysis of variance using SPSS, 2001 (version 11.0) statistical software package (SPSS Inc., Prentice, Hall, USA). Analysis of variance (ANOVA) according to the following model: $Y_{ij} = \mu + A_i + e_{ij}$ Where: Y_{ij} = The observation, μ = Overall mean, A_i = Effect of rations and e_{ij} = Experimental error. The Duncan's Post Hoc Multiply Comparisons test was performed to evaluate the difference among treatments means (Duncan, 1955).

RESULTS AND DISCUSSION

From the tables (1, 2 & 3) it can be concluded that amino acids profile in the SBM was higher than that of MBS except the tryptophan acid (0.77) where it was higher in MBS (1.14). Also, SBM contained higher crude protein, ether extract, total phosphorus, crude fiber and gross energy as compared to those of MBS except available phosphorus where higher for MBS (0.35%) than SBM (0.27%) was observed. In general, both calculated and determined chemical composition of the experimental diets showed limited variations in nutrients contents among the different experimental diets.

Growth performance:

Results of the effect of replacing SBM by MBS on final body weight (FBW), average body weight gain (ABWG), specific growth rate (SGR) and survival rate (SR) of Nile tilapia fry are presented in Table (4). The initial fish weight ranged between 0.56 to 0.58 g with insignificant differences among the dietary treatments. No significant difference ($P > 0.05$) was observed for FBW of fish that fed control and 15% MBS, but the FBW decreased significantly ($P < 0.05$) with increase of MBS level. So, it can be concluded that the replacement of 30, 45, 60, 75 and 100% MBS depressed the FBW of Nile tilapia. Also, a same trend was observed for both relative BWG (g/fish) and ABWG (g/fish/day). While, the lowest daily weight gain (g/fish/day) was obtained from both 75 and 100% groups. Contrary, the values of SGR were affected significantly ($P < 0.05$) at all treatments. The best SGR values were observed at both 15% MBS (3.142) and control diet (3.140). The increase of replacement % of MBS, the decrease of survival rate% (where the control, 15, 30, 45, 60, 75, and 100% MBS were 70.5, 68.9, 67.3, 66.7, 64.9, 62.1 and 60.5%, respectively) with no significant differences ($P > 0.05$) among treatments. To a great extent, a similar results were obtained by El Sherbiny (2008), where he found that the replacement of raw MBS at 25% of SBM protein had highly significant reduction ($P < 0.001$) in FBW, BWG and SGR compared the control group, while, the lowest FBW was exhibited by the group fed 50% raw MBS). In another study, Ahmed *et al.* (2009) reported that the FBW, BWG and SGR were decreased with the increase of black seed meal (*Nigella sativa*) (BSM) level in the tested diets. They attributed the reduction in FBW to the presence of various anti-nutrients. Adebayo *et al.* (2004) reported that the fish fed on 670 kg *Cassia fistula* seed meal (CFM) dietary inclusion had the lowest percentage survival rate, and may due mainly to the effect of fish handling. In the current study, the decreased values of growth parameters may be attributed to phytic acid, saponin and polyphenol contents in grains of various varieties of black gram (*Vigna mungo*) Mung bean (*Vigna radiata* L.) amphidiploids which ranged from 697 to 750, 2746 to 2972 and 702 to 783 mg /100g, respectively (Kataria *et al.*, 1989). They, also, mentioned that domestic processing and cooking methods including soaking, ordinary and pressure-cooking of soaked and unsoaked seeds, and sprouting significantly lowered phytic acid, saponin and polyphenol contents of the amphidiploid seeds. They, also, indicated that anti-nutrient concentrations declined following sprouting; the longer the period of germination the greater was the reduction.

Table (4): Effects of experimental diets (different levels of MBS) on the growth performance parameters of fry Nile tilapia (*O. niloticus*) reared under indoor conditions for 14 weeks study period.

Item	Initial weight (g/fish)	FBW (g/fish)	BWG (g/fish)	ADW G (g/fish/day)	SGR (%/day)	SR (%)
Control	0.57 ±0.009	15.40 ^a ±1.47	14.83 ^a ±1.48	0.141 ^a ±0.015	3.140 ^{ab} ±0.11	70.5 ^a ±2.23
15%	0.58 ±0.003	15.98 ^a ±0.68	15.39 ^a ±0.68	0.147 ^a ±0.006	3.142 ^a ±0.05	68.9 ^{ab} ±2.20
30%	0.57 ±0.015	11.93 ^b ±0.80	11.36 ^b ±0.79	0.108 ^b ±0.008	2.896 ^{bc} ±0.05	68.3 ^{ab} ±3.83
45%	0.58 ±0.007	11.93 ^b ±0.99	11.35 ^b ±0.99	0.108 ^b ±0.011	2.880 ^{bc} ±0.08	66.7 ^b ±3.84
60%	0.56 ±0.006	11.76 ^b ±0.52	11.21 ^b ±0.86	0.107 ^b ±0.009	2.917 ^{abc} ±0.07	64.9 ^{bc} ±4.43
75%	0.57 ±0.009	11.71 ^b ±0.88	11.14 ^b ±1.05	0.106 ^b ±0.009	2.879 ^c ±0.09	62.1 ^{bc} ±4.44
100%	0.56 ±0.009	11.74 ^b ±0.45	11.18 ^b ±0.44	0.106 ^b ±0.004	2.898 ^{bc} ±0.023	60.5 ^c ±0.00

Means having the same letter in the same column are not significantly differed at ($P < 0.05$).

As shown in Table (5), results of feed intake (FI) indicated that control and 15% MBS diets had a significant difference ($P < 0.05$) with highest values (37 and 36.28, respectively) than that of the rest treatments (the other levels of MBS), where they did not affected significantly ($P > 0.05$). FCR values were affected negatively and significant differences ($P < 0.05$) for both 15% and 100% MBS when compared with the other groups. The FER ranged from 39.83 (the lowest value for 75% MBS) to 45.12 (the highest value for 60% MBS) with no significant different among treatments. El Sherbiny (2008) replaced soybean meal protein by 25% and 50% raw MBS and found that a highly values in FCR compared with the control diet. Ahmed, *et al.* (2009) who reported that the FI was significantly decreased with increasing of BSM level ($P < 0.05$) excepted diets containing up 20% black seed meal. Abd El-Hakim *et al.* (2008) reported that replacing 30% of soybean meal protein by rumen content or sunflower meal or sesame seed cake had no adverse effect on feed efficiency ratio (FER) of growing Nile tilapia. It can be summarized that there was a significant correlation between the fish weight gain and feed intake (FI; the ability of feed consumption) of the fish where they had, to a great extent, a similar trend.

Table (5): Effects of experimental diets (with different levels of MBS) on feed utilization of fry Nile tilapia (*O. niloticus*) reared under indoor conditions for 14 weeks study period.

Item	BWG (g/fish)	FI (g/fish)	FCR	FER
Control	14.83 ^a ±1.48	37.00 ^a ±2.84	2.49 ^a ±0.19	40.00 ^a ±2.20
15%	15.39 ^a ±0.68	36.28 ^a ±1.57	2.36 ^c ±0.07	41.63 ^a ±1.52
30%	11.36 ^b ±0.79	27.66 ^b ±2.53	2.43 ^b ±0.13	42.10 ^a ±2.17
45%	11.35 ^b ±0.99	26.67 ^b ±1.37	2.36 ^c ±0.12	41.65 ^a ±2.25
60%	11.21 ^b ±0.86	25.54 ^b ±0.91	2.43 ^b ±0.10	45.12 ^a ±4.25
75%	11.14 ^b ±1.05	27.05 ^b ±0.89	2.45 ^{ab} ±0.16	39.83 ^a ±1.87
100%	11.18 ^b ±0.44	26.28 ^b ±1.86	2.35 ^b ±0.07	43.27 ^a ±1.77

Means having the same letter in the same column are not significantly differed at $P > 0.05$.

As presented in Table (6), all the values of the dry matter (DM) intake, protein intake (g/fish), fat intake (g/fish) the energy intake (EI) (kcal/fish), not only, had a similar trend, but also, were affected significantly ($P < 0.05$) where the control and 15% MBS had the high significant ($P < 0.05$) one than that the other treatments. So, the increase of MBS levels the decrease the previous mentioned items. These results are agreement with the finding of Azaza *et al.* (2009) where are found that when the diets containing faba bean meal (FBM) content exceeded 24%, the amount of dry matter, protein, fat and energy intake were decreased, Also, Sidduraju and Becker (2001) reported that the diets containing higher than 13% mucuna meal produced increased in amount of dry matter, protein, fat and energy intake. In general, all feed utilization parameters were decreased significantly by replacing the SBM by the MBS.

Table (6): Effects of experimental diets (with different levels of MBS) on the dry matter, protein, fat, and energy intake for fry Nile tilapia (*O. niloticus*) reared under indoor conditions for 14 weeks study period.

Item	DM intake (g/fish)	Protein intake (g/fish)	Fat intake (g/fish)	Energy intake (kcal/fish)
Control	26.21 ^a ±2.01	10.21 ^a ±0.89	1.41 ^a ±0.11	129.33 ^a ±10.15
15%	25.33 ^a ±1.08	9.90 ^a ±0.62	1.36 ^a ±0.05	125.39 ^a ±6.08
30%	20.04 ^b ±1.88	7.96 ^b ±0.99	1.06 ^b ±0.11	98.60 ^b ±9.21
45%	19.17 ^b ±0.91	7.42 ^b ±0.38	1.01 ^b ±0.05	94.08 ^b ±4.65
60%	18.48 ^b ±0.63	7.15 ^b ±0.32	0.98 ^b ±0.04	90.39 ^b ±3.29
75%	19.45 ^b ±0.55	7.48 ^b ±0.32	1.09 ^b ±0.01	95.69 ^b ±3.046
100%	18.81 ^b ±1.29	7.26 ^b ±0.41	0.99 ^b ±0.06	92.44 ^b ±6.21

Means having the same letter in the same column are not significantly differed at $P > 0.05$.

Averages of protein, fat and energy content of whole-fish bodies at the start of the study were not significantly differences ($P > 0.05$) among the treatments, but they differed significantly ($P < 0.05$) at the end of the study except for protein content. The protein retention value did not affected significantly ($P > 0.05$) with replacing of MBS, contrary, the protein retention % of was affected significantly ($P < 0.05$). On the other hand, all retention values and their percentages for the rest parameters (fat and energy) were affected significantly ($P < 0.05$) (Table 7). The 100% MBS group had the highest significant percent of protein retention% (160.85%), whereas the 30% MBS group had the highest significant percent of fat retention% (101.59), and finally, the 15% MBS group had the highest significant percent of energy retention% (105.80) when compared with the control. This result agree with findings of El-Sherbiny (2008) who found that was a significant reduction in the protein, fat and energy retention in whole-fish bodies when fed the diets containing 25% and 50% raw MBS compared to the control diet. Also, Sidduraju and Becker (2001) recorded significant ($P < 0.05$) reduction in total dietary protein and decreasing apparent net protein utilization and energy retention when common carp was fed more than 13% raw mucuna seed. The authors are attributed this depression in protein, fat and energy retention in the fish fed raw legume seeds to both limitations and change in the ratio between essential fatty acids. Limitation of essential fatty acids might have resulted from the presence of antinutritional factors. In this connection, Norton, (1991) explained the action of trypsin inhibitors on protein utilization, based on the hypothesis that, trypsin inhibitors block the receptors of the protuletic enzymes, where one molecule from trypsin inhibitors could block one or two molecules of chymotrypsin and one or two molecules of trypsin thus causing a break in the metabolic cycle of protein. This was reflected on the retained amount of protein in Nile tilapia body.

Table (7): The retention of protein, fat and energy by fry Nile tilapia (*O. niloticus*) fed experimental diets (with different levels of MBS) for 14 weeks under indoor conditions.

Item	Protein (g/fish)				Fat (g/fish)				Energy (Kcal GE/fish)			
	Start	Final	Ret.	%	Start	Final	Ret.	%	Start	Final	Ret.	%
Control	56.40 ^a	52.83 ^a	3.57 ^a	100.00 ^{bc}	14.83 ^a	28.23 ^a ±	13.40 ^a	100.00 ^a	1.96 ^a	66.64 ^{ab}	64.68 ^{ab}	100.00 ^a
	± 1.15	± 1.17	± 0.82	±0.00	± 0.19	0.45	±0.50	±0.00	±0.001	±7.44	±7.44	±0.00
15%	56.40 ^a	53.43 ^a	2.97 ^a	82.36 ^c	14.83 ^a	25.07 ^c	10.23 ^c	76.32 ^c	2.01 ^a	68.99 ^a	66.99 ^a ±3.06	105.8 ^a
	± 1.15	± 0.84	± 0.86	± 12.33	± 0.19	± 0.49	±0.49	±1.24	±0.001	±3.05		± 11.06
30%	56.40 ^a	52.20 ^a	4.20 ^a	131.17 ^b	14.83 ^a	28.43 ^a	13.60 ^a	101.59 ^a	1.96 ^a	53.75 ^{abc}	51.79 ^{abc}	83.63 ^{bc}
	±1.15	±0.51	± 0.92	±46.03	± 0.19	±0.24	±0.38	±1.99	±0.008	±4.21	±4.16	± 17.30
45%	56.40 ^a	53.10 ^a	3.77 ^a	110.61 ^{bc}	14.83 ^a	19.33 ^e	4.50 ^e	33.52 ^f	1.96 ^a	49.48 ^c	47.52 ^c ±5.55	77.89 ^c
	±1.15	±0.85	±1.53	±53.25	± 0.19	±0.20	±0.36	±1.96	±0.001	±5.55		± 19.49
60%	56.40 ^a	51.33 ^a	5.07 ^a	165.3 ^a	14.83 ^a	23.07 ^d	8.23 ^d	61.65 ^d	1.91 ^a	50.94 ^{bc}	49.03 ^{bc}	79.43 ^{bc}
	±1.15	±1.13	±1.22	±64.06	± 0.19	±0.23	±0.34	±3.74	±0.047	±3.21	±3.26	± 15.89
75%	56.40 ^a	51.57 ^a	4.83 ^a	154.49 ^{ab}	14.83 ^a	22.03 ^d	7.20 ^d	53.76 ^e	1.96 ^a	44.37 ^c	42.26 ^c ±6.44	66.07 ^c
	±1.15	±0.80	±1.30	±63.34	± 0.19	±0.53	± 0.40	±2.71	±0.001	±6.36		± 8.48
100%	56.40 ^a	51.47 ^a	5.60 ^a	160.85 ^a	14.83 ^a	26.33 ^b	11.50 ^b	86.10 ^b	1.91 ^a	58.28 ^{abc}	56.37 ^{abc}	89.76 ^{ab}
	±1.15	±1.84	±2.31	±73.32	± 0.19	±0.39	±0.21	±3.98	±0.047	±2.38	±2.37	± 11.77

Means having the same letter in the same column are not significantly differed at $P > 0.05$.

The effect of dietary treatment on the chemical composition and energy content of Nile tilapia:

Averages dry matter content of final whole-fish body (DM %) had no significant difference ($P>0.05$) for all treatments (where the% ranged from 23.36 to 24.43%), but they were significantly higher ($P<0.05$) than initial one (21.23%) (Table 8). Regarding to crude protein (CP %), there were slightly significant ($P<0.05$) differences among different treatments due to the inclusion of mung bean in fish diet. The Ether extract (EE %) had the same trend of the DM %. The ash contents % at the study start recorded the highest significant ($P<0.05$) values (28.26%) when compared with all treatments at the end of the study, which had a slightly changes with/without significant (they ranged from 22.56 to 26.47%). It is clear that the hepato-somatic index (HSI %) was not significant differences ($P>0.05$) among the groups. As presented in table (8), the gross energy contents (GE) in whole fish body (on DM basis) of the 15% MBS group showed a highest significant ($P<0.05$) GE contents (19.76) in their bodies when compared with the other groups. This result aggress with that of Azaza *et al.* (2009) who found that the carcass composition was not affected by diets composition, there was no differences in carcass protein, EE, ash content and HSI among the treatments. Also, Siddhuraju and Becker (2001) found that there was no significant difference in body protein, body lipid and ash content for fish fed the control diet and these fed raw mucuna bean seeds up to 13% (10% Of total dietary protein) inclusion. Increasing the inclusion percentage of mucuna seed had significantly reduced body protein content and gross energy. Ahmed *et al.* (2009) reported that no significant differences in chemical composition of whole-fish bodies under the all treatment diets. In the same trend. El Sherbiny (2008) reported that the chemical composition of Nile tilapia body affected with increasing level of raw MBS in fish diet from 25% to 50% MBS compared to the control diet (SBM as protein source). According to (Liener, 1989; cited by Francis *et al.* 2001), that the antinutritional effect of tannins results from the interference with the digestive processes either by binding the enzymes or by binding to feed components like proteins or lipids. Mung bean content from non-starch polysaccharides was very low (0.41-2.5%) as reported by Mubarak (2005) and Ramakrishna *et al.* (2006) compared to soybean grains (5-6%).

Table (8): The chemical composition (%; on DM basis) and energy contents of fry Nile tilapia (*O. niloticus*) carcass fed experimental diets (with different levels of MBS) for 14 weeks under indoor conditions.

Treatments	Initial	Final						
		Control	15%	30%	45%	60%	75%	100%
DM %	21.23 ^b ±0.62	23.74 ^a ±0.38	23.36 ^a ±0.17	24.26 ^a ±0.32	24.35 ^a ±0.74	24.07 ^a ±0.41	23.76 ^a ±0.43	24.43 ^a ±0.51
CP %	55.69 ^a ±0.38	52.88 ^{ab} ±1.19	53.46 ^{ab} ±0.83	52.23 ^{ab} ±0.50	52.14 ^{ab} ±0.86	51.31 ^b ±1.15	51.61 ^b ±0.80	51.21 ^b ±1.59
EE %	14.29 ^d ±0.50	22.26 ^{abc} ±0.70	23.98 ^a ±0.40	23.65 ^{ab} ±1.28	20.39 ^c ±0.31	23.09 ^{ab} ±0.25	22.07 ^{bc} ±0.54	23.26 ^{ab} ±0.22
Ash %	28.26 ^a ±0.69	24.85 ^{ab} ±1.80	22.56 ^b ±1.02	24.12 ^b ±0.81	26.47 ^{ab} ±0.98	25.60 ^{ab} ±1.14	26.31 ^{ab} ±1.12	25.48 ^b ±1.69
HSI%	-	2.64 ^a ±0.44	2.89 ^a ±0.43	2.34 ^a ±0.51	2.16 ^a ±0.15	2.79 ^a ±0.46	2.44 ^a ±0.53	2.68 ^a ±0.37
Energy (Kcal GE/fish)	0.52 ^d ±0.017	18.69 ^{ab} ±2.42	19.76 ^a ±0.91	15.07 ^{bc} ±1.41	14.36 ^{bc} ±1.82	14.72 ^{bc} ±1.18	13.97 ^c ±1.04	14.95 ^{bc} ±0.82

Means having the same letter in the same row are not significantly differed at $P> 0.05$.

Second study: Digestibility trial:

Averages of nutrient digestibility using crude fiber as indicator for dry matter (DM), crude protein (CP), ether extract (EE), Ash, nitrogen free extract (NFE) and energy, are presented in Table (9). Firstly, DM digestibility (%) results revealed that the highest DM digestibility coefficient ($P<0.05$) was recorded by the control diet (91.94) and the lowest value was recorded by 100% MBS (86.06) with significant differences ($P<0.05$) among treatments. Secondly, CP digestibility coefficient group fed on the diet containing 15% MBS had the highest value (73.37) and the lowest value ($P<0.05$) was recorded by the

diet containing 100% MBS (57.72) with significant differences ($P < 0.05$) among treatments. Thirdly, results cleared that the control and 15% MBS groups had the highest significant ($P < 0.05$) of EE digestibility coefficient (84.88 and 83.73% respectively) followed by significant decreasing order for the other groups. Fourthly, digestibility coefficient of ash for 45, 60, 75 and 100% MBS, were significantly ($P < 0.05$) higher than that of the control, 15 and 30% MBS groups. Fifthly, the NFE digestibility recorded the highest value recorded to 15% MBS (90.22) but the 75% MBS, recorded the lowest one (85.15) without any significant difference ($P > 0.05$). Finally, the highest value of energy digestibility coefficients was recorded by the 15% MBS (85.18; $P < 0.05$), but the lowest value recorded by 100% MBS (77.19). These results may indicate that incorporation 15% MBS into diets of Nile tilapia resulted in pronounced improvement in digestibility of CP, EE, NFE and energy. These results according with finding of Hossain and Jauncy (1989) revealed that incorporation of sesame seed meal at 25, 50 and 75% of the dietary protein in common carp diets decreased the apparent digestibility of dry matter, crude protein, lipids and energy compared to the control diet containing 52.50% fish meal. In general, Mung bean contains anti-nutritional substances such as antitrypsin (Desphande *et al.*, 1982) that hinder the digestibility of certain nutrients. The trypsin inhibitor in mung beans is similar to one of the two trypsin inhibitors found in black-eyed peas but different from that of soybeans (Chrispeels and Baumgartner, 1978). Saleh (2001) showed that DM digestibility coefficient of Nile tilapia ranged between 80.04 to 95.09% using fibers as internal marker. Also, CP digestibility coefficient of 60.30 to 85.53% (crude fiber method), and digestibility coefficient of EE and NFE obtained in the present study are almost matching with those reported by the same author and differences may due to the differences in the ingredients tested.

Table (9): Apparent nutrient digestibility coefficient (ADC %) of the experimental diets by using crude fiber as internal digestive indicator for fry Nile tilapia (*O. niloticus*).

Treatments	(ADC %)					
	DM	CP	EE	Ash	NFE	Energy
Control	91.94 ^a ±2.05	70.69 ^a ±2.18	83.73 ^a ±6.97	42.79 ^{ab} ±1.90	90.21 ^a ±2.16	84.66 ^{ab} ±1.37
15%	90.67 ^{ab} ±0.74	73.37 ^a ±2.99	84.88 ^a ±2.70	32.79 ^b ±9.81	90.22 ^a ±1.06	85.18 ^a ±1.13
30%	89.03 ^{abc} ±0.29	73.31 ^a ±0.99	80.16 ^{ab} ±4.05	43.33 ^{ab} ±9.57	89.93 ^a ±0.43	84.13 ^{ab} ±0.62
45%	87.41 ^{bc} ±1.80	67.83 ^{ab} ±5.38	61.15 ^b ±6.88	59.41 ^a ±2.37	88.66 ^a ±1.63	80.62 ^{abc} ±2.96
60%	86.93 ^{bc} ±0.59	59.46 ^b ±1.87	61.97 ^b ±7.90	57.67 ^a ±2.16	85.46 ^a ±1.48	80.14 ^{bc} ±1.43
75%	86.93 ^{bc} ±0.53	57.78 ^b ±4.75	61.50 ^b ±10.00	59.20 ^a ±2.59	85.15 ^a ±1.67	79.94 ^{bc} ±0.96
100%	86.06 ^c ±1.62	57.72 ^b ±3.30	61.52 ^b ±4.22	59.13 ^a ±6.19	85.30 ^a ±1.42	77.19 ^c ±0.57

Means having the same letter in the same row are not significantly differed at $P > 0.05$.

CONCLUSION:

To put it in a nut shell, with any adverse effect on Nile tilapia growth performance, feed utilization and apparent nutrient digestibility coefficient (ADC %), the MBS –as a source of protein- can be replaced (with a rate of $\geq 15\%$) with the soybean meal diets. But conversely, increasing the replacement % the anti-nutritional factors (phytic acid, saponin and polyphenol contents) will affect negatively on the performance. These results are similar with that obtained by Ganzon-Naret (2013) who reported, conversely, that 18-20% replacement of fish meal by mung bean protein negatively affected the growth, FCR, and PER, of sea bass So, the raw leguminous plant protein source must be treated (processing and cooking methods including soaking, ordinary and pressure cooking of soaked and unsoaked seeds, and sprouting, where, they significantly decreased phytic acid, saponin, polyphenol enzyme inhibitors, and lectins contents of the amphidiploid seeds (Kataria *et al.*, 1989). In another study Apines-Amar *et al.* (2015) reported that overall, mung bean is a promising protein source for milkfish and can be included

up to 20% of the diet contributing as much as 17% of the total dietary protein without detrimental effects on growth, feed performance, PER, protein retention, HSI, and liver and intestinal histology. However, the economic evaluation of MBS as replacement for soybean meal in feed for the different aquaculture species needs further studies. Lastly, the sensory qualities of the aquaculture products derived from fish fed diets with MBS should also be tested to ensure quality food fish that are acceptable to consumers.

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تأثير إحلال بذور فول المانج الخام (بقلة الماش - اللوبيا الشعاعية) محل فول الصويا فى علائق زريعة البلطي النيلي على أداء النمو والاستفادة من الغذاء ومعامل الهضم الظاهري

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تم تكوين سبعة علائق تجريبية (30% بروتين خام و 3.62 ± 402.09 كيلوكالورى طاقة كلية/100كجم عليقة) حيث إحتوت على نسب مختلفة من بروتين بذور فول المانج الخام (صفر ، 15 ، 30 ، 45 ، 60 ، 75 و 100% كبديل لبروتين فول الصويا. تم تحميل 21 تانك فيبر (حجم 50 لتر ماء/ تانك، موزعة على 7 معاملات بواقع 3 مكررات / معاملة) بزريعة البلطي النيلي بمتوسط وزن (0.09 ± 0.5 جم/سمكة) وإستمرت التجربة لمدة 14 أسبوع، تم تقييم أداء النمو، والاستفادة من الغذاء، وقياس معامل الهضم الظاهري للأسماك. وأظهرت النتائج أن هناك إنخفاض معنوي فى أداء نمو الأسماك بزيادة مستوى بذور فول المانج الخام عن 15%. سجل مستوى إحلال 15% بذور فول المانج الخام أعلى مستوى فى الماكول من المادة الجافة والبروتين والدهون صاحبته إختلافات معنوية فى مستويات الإحلال الأخرى ما عدا الطاقة. لم يلاحظ وجود فروق معنوية فى معامل تحويل الغذاء وكذلك فى معدل الاستفادة من الغذاء. لم تظهر النتائج أى تأثير معنوي للمستويات المختلفة من بذور فول المانج الخام على التركيب الكيماوى للجسم الاسماك (بروتين خام، المادة الجافة، الدهون، الطاقة الكلية و HSI) فى نهاية التجربة. لوحظ أيضا تأثير معامل الهضم الظاهري لكلا من البروتين، الدهون، NFE، المادة الجافة و الطاقة بزيادة مستوى إحلال بذور فول المانج الخام عن 15% بديلا عن فول الصويا، مع وجود فروق معنوية ($P < 0.05$) بين المعاملات المختلفة. وبالتالي فإن إضافة بذور فول المانج الخام بمستوى أعلى من 15% فى العلائق يؤثر سلبيا على أداء نمو والاستفادة من الغذاء ومعامل الهضم الظاهري للأسماك وذلك ربما يعود إلى تأثير العوامل المضادة للتغذية.

الكلمات الدالة: فول المانج، فول الصويا، البلطي النيلي، أداء النمو، معامل الهضم الظاهري.