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Growth performance and feed efficiency of Bayad (*Bagrus bajad*) fed diets containing different fish meal/plant protein ratios with two protein levels

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Abstract

A factorial experiment 2 × 2 was conducted to investigate the effect of protein level (30% and 35%) within each level substitution ratio of fish meal (FM) and plant protein (PP) percentage (50% FM: 50% PP, and 33% FM: 67% PP) on the growth performance, feed utilization, survival rate %, carcass chemical composition and economical evaluation of Bayad (*Bagrus bajad*) fingerlings with average of initial body weight 31.86 ±0.34g. The survival rate was within the range 96.67–100 %. The highest growth parameters and the best feed conversion ratio (FCR) were obtained with the diet contained on (35% CP and 50% FM: 50% PP). The diet contained (30% CP and 33% FM: 67% PP) had the lowest growth and the worst FCR than other treatments. However, differences in growth parameters among diets contained on (30% CP, 50% FM: 50% PP) and (35% CP, 33% FM: 67% PP) were insignificant. Final body weight was progressively decreased with increasing plant protein under both protein levels of diets. The improvement of growth performance and FCR tested in diets containing higher levels of fish meal under both protein levels of diets. The results showed significant difference in obtained of carcass composition however ash had insignificant differences. Regarding to economical evaluation 35% protein level is more economical in Bayad aquaculture. Net returned of Bayad were better for the 35% treatment (50 FM: 50 PP) which was 1.20 but the worst was 30% (33 FM: 67 PP) which was 0.77.

It could be concluded that 35 % and 30% crude protein levels (CP) were the best under composition of the diet (50 FM:

50 PP) in terms of growth performance, feed utilization and economical evaluation under these experimental conditions.

Key words: protein level, protein source, fish meal, plant protein, growth performance, feed conversion ratio, Bayad (*Bagrus bajad*).

INTRODUCTION

The Bayad is found in rivers, lakes and wetlands (**Olaosebikan and Raji, 1998).** It avoids salt water, spends almost all of the dayligt hours in rock crevices and is therefore seldom seen (**Bishai and Khalil, 1997**). Lives on or near the bottom and feeds **(Lewis, 1974).** Adult predators prey on small fish, particularly Alestes spp., or Chrysichthys auratus as in Lake Kainji **(Lewis, 1974)**; also feeds on insects, crustaceans, mollusks, vegetable matter, spawning season extends from April to July **(Bishai and Khalil, 1997),** high commercially importance **(Alhassan and Ansu-Darko, 2011 and El-Drawany and Elnagar, 2015)**. Egypt production of Bayad fish reached 7772 tons. The Nile River represents about 79% and other production from laks (**GAFRD, 2017**).

The dominant ingredient in commercially prepared diets for many fish species is fish meal. FM prices have risen dramatically in the past few years as a result of the rapid growth in fish and shellfish farming and are expected to rise further with continued growth in demand (**Hardy and Tacon, 2002)**. As with general aquaculture feeding, the reduction and potential removal of FM and fish oil is a focus area of major study (**Gatlin and Hardy, 2002**). The uncertain future of the supply of FM and its possible high costs have forced the analysis of alternative sources of protein of good nutritional quality that are ideally accessible and less cost-effective than FM. This would reduce the cost of production and produce a high-quality product suitable for any small or large-scale fish production system (**Goda *et al.*, 2007**).

One of the best ingredients to replace FM is soybean meal (**Lovell, 1988**). Soybean meal (SBM) is inexpensive, readily available, and high in protein content and has the best quality of protein among plant protein feedstuffs used in fish diet as alternative sources of protein to FM (**Lovell, 1988 and Rumsey *et al.*, 1993**). Important differences occur, however in the ability of various fish species to use soybean protein. Less than optimum amino acid (AA) equilibrium in SBM protein and the existence of residual amounts of trypsin inhibitors are theories that describe this loss of performance (**Webster *et al.*, 1992, 1995 and Refstie *et al.*, 1997 and 1998).**

The main component of the fish body is protein, so a proper dietary supply is necessary for optimum growth. In the fish diet, protein is the most costly macronutrient (**Pillay, 1990**). Thus for fish development, the amount of protein in the diet should be just enough where the excess protein in fish diets can be wasteful and cause diets to be excessively costly. Reducing feeding costs may be a key factor in aquaculture's successful growth.

The objective of the present study was to evaluate the effects of feeding Bayad (*Bagrus bajad*) with diets containing different levels of crude protein (30% and 35%) and partial substitute fish meal with plant protein on the growth performance, survival rate, feed utilization and economic evaluation of Bayad fingerlings.

MATERIAL AND METHODS

This study was conducted in 2019 from September 21to November 30 (70 days) at Fish Farm, Faculty of Agriculture, Fayoum University, Egypt to investigate the effect of protein level and percent of substituation (FM by PP) on the growth performance, feed utilization and survival rate % of Bayad (*Bagrus bajad*) fingerlings.

Fish- rearing conditions.

Bayad (*Bagrus bajad*) fingerlings were obtained from a private farm in Kafr El-Sheikh Governorate, Egypt.

The experimental Bayad wer transported in a car intended for transporting fish fingerlings with plastic tanks filled with water and oxygen to the farm. Bayad (31.86±0.34g/fingerling) were adapted randomly into twelve hapas. Each hapa has an area of 4×7m with a water depth of 1 m. Three hapas per treatment. Hapas were placed in an earthern pond (0.75 Feddan area×1.5 m depth) with water depth level 1.3m. About 30% of water was changed with new fresh water every 3 days, the distance between each treatment was 5 m. Fish were held under natural photoperiod condition during the experimental period. The average water quality criteria in the trial are presented in Table (2).

Experimental design.

The experimental of Bayed fish were distributed to 4 treatments in 12 hapas ($4×7×1m^3$) placed in earthern pond according to adding of protein level and replacement percentage in the diets as found in Table 1 during the experimental periods (10 weeks), the first factor was protein level (30% and 35%) with two protein source (50% FM: 50% PP and 33% FM: 67% PP). Bayad fish with average weight 31.86±0.34g as an initial body weight were randomly distributed and stocked at 15 fish / hapa in 12hapas.

Diets were hand made, the ingredients were mixed well with water, then pelleted diet was produced through a meat mincer with a 1.5 mm diameter then dried by air and stored at the room temperature until use. Feed was offered at a daily rate of 3% of total biomass for 6 days / week twice daily at 9.00 and 14.00 h (Table 1). Every 14 days, Bayad groups were randomly obtained from each hapa, then weighted and the amount of feed was adjusted according to the changes in body weight throughout the experimental period. The diets formulated, supplemented protein level and replacement percentages as follow: T_1: protein level 30% and 50% FM: 50% PP. T_2: protein level 30% and 33% FM: 67% PP. T_3: protein level 35% and 50% FM: 50% PP. T_4: protein level 35% and 33% FM: 67% PP. Feed consumption was recorded daily. Initial and final data for growth performance were obtained by sampling all the experimental fish.

Parameters measurements

At the end of the experiment, growth performance, survival rate and feed utilization were calculated as follows:

Weight gain (g) = final weight (g) - initial weight (g).

Average daily gain (g) = average weight gain (g)/experimental period (day).

Specific growth rate (SGR, %) = [(ln final weight -ln initial weight)/ period in days] × 100, where ln is the natural log.

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

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

Energy efficiency ratio (EER) = weight gain (g)/energy intake (Kcal).

Survival rate % = (number of fish at the end/ number of fish at the start) × 100.

Water quality samples

Water temperature, dissolved oxygen, pH and ammonia were measured every day during the experimental period using centigrade thermometer, Orion digital pH meter Model 201, oxygen meter, Cole parmer Model 5946 and Honna instruments ammonia test kit (HI 8429).

Water quality parameters was shown in Table (2). The Bayad are one of warm water fish so all tested water quality criteria (temperature, pH, salinity, value DO and ammounia) were suitable and within the acceptable limits for rearing Bayad as reported by to **Auta. (1993) and Adakole. (2000).**

Table (1): Composition of groups diet used during the experimental period.

Protein level	30 %		35 %	
Protein sources (FM: PP)	**50:50**	**33:67**	**50:50**	**33:67**
Ingredients, %				
Fish meal	21.2	14.2	24.5	16.5
Soybean meal	23	35	32	46
Yelow corn	48.3	43.3	36	30
Molasses	2	2	2	2
Fish oil	5	5	5	5
Vit & Min[1]	0.5	0.5	0.5	0.5
Total	100	100	100	100
Chemical composition	**(as fed, %)**			
Dry matter	89.44	89.76	90.10	90.43
Crude protein	29.85	30.32	34.28	34.89
Ether extract	7.91	7.45	8.09	7.55
Crude fiber	3.01	3.69	3.43	4.23
Ash	6.60	5.99	7.61	6.93
Nitrogen free extract (NFE)[2]	42.07	42.31	36.69	36.83
GE, kcal/g[3]	4.283	4.304	4.346	4.368
Prices of Kg, L.E	8.87	7.73	12.53	10.70

1: Vitamins and minerals mixture each 3 kg of mixture contains: 12000 000 IU Vit. A, 2000 000 IU Vit. D_3, 10000 mg Vit. E, 2000 mg Vit. K_3, 1000 mg Vit. B_1, 5000 mg Vit. B_2, 1500 mg Vit. B_6, 10 mg Vit. B_{12}, 50 mg Biotin, 10000 mg Pantothenic acid, 30000 mg Nicotinic acid, 1000 mg Folic acid, 60000 mg Manganese, 50000 mg Zinc, 30000 mg Iron, 10000 mg Copper, 1000 mg Iodine,100 mg Selenium, 100 mg Cobalt, add to 3 kg carrier ($CaCo_3$).

2: Nitrogen free extract (NFE %) = 100 – Crude protein – Crude lipid – Crude fiber – Crude ash.

3: Gross energy was calculated according to **NRC (1993)** as 5.65, 9.45, and 4.11 kcal/g for crude protein, crude fat, and carbohydrates, respectively.

Table (2): Averages of water quality parameters during the experimental period.

Items	Measurement
Water temperature (ºC)	24.5-26
Water salinity (ppt)	0.1-0.3
pH	6.9-7.3
Dissolved oxygen (mg/l)	6.2-7.4
Ammonia (mg/l)	0.03

Chemical analysis

Diets used were analyzed for their proximate composition in triplicates following the methods described by **AOAC (2012)**. Gross energy was calculated according to **NRC. (1993)** for formulated diets the factors 5.64, 9.44 and 4.11 Kcal/g for protein, fat and carbohydrates, respectively, for fish 5.5 and 9.5 Kcal/g for protein and fat, respectively.

Statistical analysis.

The data were analyzed by general linear model and significant differences were determined by Duncan waller Multiple Range Test at 5% level using SPSS Statistical Package Program **(SPSS, 2008)** release 17statistical software.

RESULTS AND DISCUSSION

Effect of protein levels, replacement of fish meal by plant protein on growth performance and survival rate

Protein levels:

Results of growth performance parameters and survival rate% of fish fed on the different protein levels are shown in Table (3). There was no significant difference in the initial average body weight of the fish among treatments indicating that the experimental groups at the start of the experiment were randomly distributed. The survival rate was 98.33%, with insignificant differences were observed regardless replacement of fish meal by plant protein treatments applied. The results showed that significant differences ($P \leq 0.05$) were obtained in final weight, total gain, daily weight and specific growth rate (SGR). Results of growth performance parameters were highest with fish fed on 35% CP diet compared with 30% CP diet. These results indicated that the best growth rate was with fish fed on 35% CP diet under experimental conditions.

With increasing the protein intake, the growth parameters values have been improved, this correlates with the findings of other research in different species. **Ng *et al.* (2001)** reported that bagrid catfish (*Mystus nemurus*) percentage weight gain increased almost linearly with increased dietary protein content up to about 410 g/kg diet, reached a plateau, and then decreased at protein levels above 471 g/kg diet. A corresponding increase in *Mystus* weight gain, with an increase in protein levels (270-420 g/kg diet) and growth depression when the protein levels further increased to 470 g/kg diet and beyond were also observed by **Khan *et al.* (1993)**. **Giri *et al.* (2011)** investigated the impact of different dietary protein levels (25, 30, 35, 40 and 45%) of *Horabagrus brachysoma* bagrid catfish in accordance with the current research. In fish fed 35% of the protein diet, the highest body weight gain and unique growth rate were observed. **Keremah and Beregha (2014)** also reported that the growth indices (weight gain, percent weight gain and SGR) increased from 25 percent to 35 percent with a rise in the source of FM dietary protein and then decreased to 40 percent CP. This study suggested that a 35% high-quality protein ration with FM would likely provide African catfish (*Clarias gariepinus*) fingerlings with the necessary protein for good growth results **(Keremah and Beregha, 2014).**

Feed accounts for 60-70 percent of overall aquaculture investment. Any reduction in the amount of dietary protein without impacting the growth of fish will dramatically reduce the cost of fish feed (**Jamabo and Alfred-Ockiya, 2008**). The fish use dietary protein for growth, energy and body maintenance (**Kausshik and Medale, 1994)**. The requirement of protein for the maximum growth of any fish species is a step forward in the production of cost-effective feed for fish farming, and this has to do with determining the optimum quantity required for the maximum growth rate to be achieved (**Sang-Min and Tae-Jun 2005**).

Replacement of fish meal by plant protein:

With regard to the effect of replacement of fish meal by plant protein on growth performance parameters and survival rate of fish fed on the different protein source of diet are shown in Table (3). There was no significant difference in the initial average body weight of the fish among treatments. Survival rate was within the range 96.67 – 100 %, with insignificant differences were observed. The results showed that significant differences (P≤0.05) were obtained in final weight, total gain, daily gain and SGR. Results were good, highest with fish fed on diet containing (50% FM: 50% PP) compared with the diet containing (33% FM: 67% PP). These results indicated that the best growth rate for fish was obtained with diets containing (50% FM: 50% PP) under experimental conditions.

These results led to believe that fish meal presented in the diet resulted in improving growth rate as it has better essential amino acid profile and a good source of minerals and vitamins.

Similar observations are related to those of **Kokou *et al.* (2012)**, which examined the effects of partial FM substitution in juvenile Gilthead Sea bream with a bioprocessed soy product (BS). The final fish weight did not vary greatly between the FM and the BS 20 classes, but steadily decreased with higher BS inclusion. However, between the FM, BS 20 and BS 40 diets, weight gain and SGR did not vary substantially, but decreased significantly at the 60 percent BS inclusion stage (P<0.001).

These findings conflict with the results of **Goda *et al.* (2007)** who researched the impact of totally or partially replacing fish meal by alternate protein sources on the growth of African catfish (*Clarias gariepinus*). The final body weight and specific growth rate of the SBM-containing fish feeding diets (75% and 100%) were higher but not substantially different from those of the control diet fed fish (100 FM). The effects of the addition of soybean meal on the performance of goldenhead sea bream were also studied by **Venou *et al.* (2006)**. Raising the SBM amount has no major influence on SGR.

Iteraction between protein level and replacement of fish meal by plant protein:

Results presented in Table (3) show that variations were significant (P>0.05) due to the interaction between protein level and replacement of fish meal by plant protein which indicated that these two factors act dependently on each other and also each of them had its own significant effect. The averages of initial weights of Bayad were 32.02, 31.77, 31.80 and 31.85g; while at the end of the experiment, were 61.77, 49.77, 69.96 and 61.29g, respectively for the treatments (30*50FM: 50PP, 30*33FM:

67PP, 35*50FM:50PP and 35*33FM: 67PP). The survival rate was within the range 96.67 – 100 %, with insignificant differences were observed. The results showed that significant differences (P≤0.05) were obtained in final weight, total gain, daily gain and SGR. The highest values obtained with the diet contained on (35% CP and 50% FM: 50% PP). The diet contained on (30% CP and 33% FM: 67% PP) had the lowest value than other treatments. However, differences in growth parameters among diets contained on (30% CP, 50% FM: 50% PP) and (35% CP, 33% FM: 67% PP) were insignificant (P≥0.05). Final body weight was progressively decreased with increasing PP under both protein level of diets. The improvement of all growth performance parameters tested in diets containing higher levels of fish meal under both protein level of diets.

These results led to believe that the fish meal presented in the diet contain a good smell which attract the fish to consume the diet and resulted in improving growth rate as it has better essential amino acid profile and a good source of essential minerals and vitamins.

These observations are similar to those of **Agbo *et al.* (2014)**, who examined the effects of dietary protein levels (32.1%, 34.6 %, 42.8 %, and 47.1 %) on the growth rate of fingerlings of clarteid catfish (*Chrysichthys nigrodigitatus*) using fish meal/soybean meal as protein sources. The findings revealed an improvement in body weight gain and SGR after 10 weeks of feeding, with an increase in dietary protein levels of up to 42.8 % (P<0.05). **Diyaware *et al.* (2009)** clarified the rise in growth rate and nutrient consumption for hybrid catfish with an increase in dietary protein levels. Also, similar to the observations of **Jamabo and Alfred-Ockiya (2008)** on *Heterobranchus* fingerlings, **Fagbenro *et al.* (1992)** for *H. bidorsalis* fingerlings and **Obasa and Faturoti (2000)** for *Cryptocoryne walker*.

Effect of protein levels, replacement of fish meal by plant protein on feed utilization of Bayad (*Bagrus bajad*).

Protein levels:

As shown in Table (4). The results showed that insignificant differences (P≥0.05) were obtained in FCR, PER and EER between treatments except the feed intake. Feed intake values were highest with diet containing (35% CP). Also, the best FCR was recorded with diet containing (35% CP). The same trend was observed with PER and EER, but FCR, PER and EER values obtained insignificant differences (P≥0.05).

Table (3): Effect of protein level, replacement of fish meal by plant protein and interaction on growth performance and survival rate of Bayad (*Bagrus bajad*).

Variable	Initial weight (g)	Final weight, g/fish	Total gain (g)	Daily gain, (g/day)	SGR (%/ day)	Survival, %
Protein level, %						
30%	31.89	55.77[b]	23.88[b]	0.341[b]	0.789[b]	98.33
35%	31.83	65.62[a]	33.79[a]	0.483[a]	1.030[a]	98.33
SED*	0.7368	4.7261	4.4446	0.6324	0.1048	2.358
Replacement %						
50FM: 50 PP	31.91	65.87[a]	33.96[a]	0.485[a]	1.032[a]	100
33FM: 67PP	31.81	55.53[b]	23.72[b]	0.339[b]	0.787[b]	96.67
SED*	0.7362	4.5502	4.3220	0.0632	0.1024	1.9254
Interaction between Y*T						
30*50FM: 50 PP	32.02	61.77[b]	29.76[b]	0.425[b]	0.938	100
30*33FM: 67PP	31.77	49.77[c]	18.01[c]	0.257[c]	0.641c	96.67
35*50FM: 50 PP	31.80	69.96[a]	38.16[a]	0.546[a]	1.126[a]	100
35*33FM: 67PP	31.85	61.29[b]	29.44[b]	0.421[b]	0.934	96.67
SED*	1.269	3.492	2.391	0.034	0.037	3.335

(a, b, c) Average in the same row having different superscripts are differ significantly (P≤0.05).

* SED is the standard error of difference.

These findings are identical to those of **Ng *et al.* (2001)** who reported that the efficiency of the use of protein as according to PER generally did not vary significantly between 202-410 g/kg dietary protein levels of bagrid catfish fish (*Mystus nemurus*). In *Menidia ester*, **Martinez-Palacios *et al.* (2007)** also reported a decrease in daily feed intake in response to a dietary protein level below 300 g/kg. In accordance with **Agbo *et al.* (2014)** who explained the impact of dietary protein levels (32.1%, 34.6%, 42.8%, and 47.1%) using fish meal/soybean meal as protein sources on growth measurements of claroteid catfish (*Chrysichthys nigrodigitatus)* fingerlings. The findings revealed an improvement in the protein efficiency ratio after 10 weeks of feeding, with an increase in dietary protein levels of up to 42.8 %, but there were no substantial variations between the treatments. The feed conversion ratio declined as the amount of dietary protein rose, with the 42.8 percent protein diet providing the lowest FCR.

Replacement of fish meal by plant protein:

As shown in Table (4). The results showed that significant differences (P≤0.05) were obtained in all feed utilization parameters among treatments, except the feed intake. The highest feed intake was observed with fish fed on diet containing (50% FM: 50% PP), with insignificant differences among treatments. The best FCR (lowest) was recorded with fish fed on diet containing (50% FM: 50% PP). The same trend was observed with PER and EER.

These observations are comparable to those of **Venou *et al.* (2006)**, who examined the impact of the addition of soybean meal on the efficiency of the Gilthead Sea bream. The soybean meal inclusion level dramatically improved FCR. The inclusion of soybean meals substantially decreased PER.

Such findings conflict with the results of the study by **Kokou *et al.* (2012)** of the impact of partial substitution of fish meal by bioprocessed BS in juvenile Sea bream gilthead. Feed intake, especially at the higher levels of inclusion, was positively affected by the level of BS. PER, suggested that any distinction between groups began at the stage of inclusion of 40 percent BS.

Iteraction between protein level and replacement of fish meal by plant protein:

Results of feed utilization of fish fed on the different protein level and source of diets are shown in Table (4). Feed intake had significantly different between treatments (P≤0.05) and the value was highest with diet contained on (35% CP and 50% FM: 50% PP). Feed intake values were lowest with diet contained on (30% CP and 33% FM: 67% PP). FCR values were significantly different between treatments (P≤0.05), the best FCR (lowest) was recorded with diet contained on (35% CP and 50% FM: 50% PP). The worst FCR was recorded with diet containing on (30% CP and 33% FM: 67% PP). The improvements in FCR for groups fed higher levels of fish meal under both protein level of diets. The diets contained on (30 and 35% CP with 50% FM: 50% PP) had the highest PER value. However differences in PER among diets contained on (30 and 35% CP with 50% FM: 50% PP) and among (30 and 35% CP with 33% FM: 67% PP) were insignificant. The highest EER value was recorded with diet containing on (35% CP and 50% FM: 50% PP). The quantity and quality of feed requirements for routine maintenance and operation will largely determine the impact of food consumed on the growth **(Warren and Davis, 1967)**. Feed utilization expressed as FCR is known to be affected by body weight

(Pandian, 1967), ration, size **(Condrey, 1982)** and temperature **(Smith, 1989)**.

These findings are comparable to those of **Keremah and Beregha (2014)** for African catfish (*Clarias gariepinus*), who clarified that the higher FCR for 25 and 30 percent CP diets suggested that the use of feed became less effective and that fish obviously did not consume the amount of protein needed for optimum growth (**Anguas-Vélez *et al.*, 2000)**. At higher levels of dietary protein (35-45 percent CP), however, FCR was lower, reflecting similarities (3.89-4.14) but better feed efficiency. With an increase in the amount of protein within the range of 25-40% CP, the FCR values obtained tended to decrease.

Table (4): Effect of protein level, replacement of fish meal by plant protein and interaction on feed utilization of Bayad (*Bagrus bajad*).

Variable	Feed intake (g/fish)	FCR	PER	EER
Protein level, %				
30%	107.72^{b}	3.37	0.74	0.22
35%	126.73^{a}	3.98	0.76	0.51
SED*	7.5562	0.4722	0.0836	0.00057
Replacement %				
50FM: 50 PP	124.80	3.72^{b}	0.844^{a}	0.063^{a}
33FM: 67PP	109.64	4.78^{a}	0.651^{b}	0.049^{b}
SED*	8.8896	0.40804	0.0287	0.000452
Interaction between Y*T				
30*50FM: 50 PP	119.35^{a}	4.02b^{c}	0.835^{a}	0.058^{b}
30*33FM: 67PP	96.08^{b}	5.63^{a}	0.618^{b}	0.044^{c}
35*50FM: 50 PP	130.26^{a}	3.42^{c}	0.854^{a}	0.068^{a}
35*33FM: 67PP	123.20^{a}	4.19^{b}	0.684^{b}	0.055^{b}
SED*	4.845	0.261	0.036	0.002

(a, b, c) Average in the same row having different superscripts are differ significantly (P≤0.05).

* SED is the standard error of difference.

These results were also endorsed by the **Mohanty and Samantaray (1996)** findings for snakehead *Channa striata* fry and **Lochmann and Phillips (1994)** for gold fish *Carassius auratus* juveniles using casein or other protein sources. It appeared that protein, regardless of the dietary protein level, was used with very low performance **(Anguas-Vélez *et al.*, 2000)**. The effect of different dietary protein levels, 25, 30, 35, 40 and 45% of bagrid catfish, *Horabagrus brachysoma* was studied by **Giri *et al.* (2011)**. In fish fed with a 35% protein diet, the highest PER and lowest FCR were observed. The nutritional value of a protein source is a function of its digestibility and amino acids make up to influence feed utilization and growth **(Otisi and Ufodike, 1986)**. Fish meal satisfies this requirement and is also a rich source of energy and minerals. **Giri *et al.* (2011)** explained that daily dry matter intake by 30–45% CP fed fishes did not vary significantly (P≥0.05). Therefore, another reason for inferior growth performance of fish fed on the 25 and 30% CP diets could be because of higher levels of carbohydrates in their diets, which supports to the observations of **Jantrarotai *et al.* (1994)** in hybrid catfish, **Giri *et al.* (2000)** in *Clarias batrachus*, **Giri *et al.* (2003)** in hybrid catfish and **Martinez-Palacios *et al.* (2007)** in *Mexican silverside*, *Menidia estor*. The high-carbohydrate diet decreases enzyme activities and digestibility of carbohydrate and protein, which culminated in retarded growth in fish **(Ufodike and Matty, 1983)**.

Body composition:

Fish body chemical composition and energy content of Bayad (*Bagrus bajad*) at the end of the experiment were shown in Table (5) The results showed significant difference in obtained of moisture, CP, ether extract (EE) and gross energy (GE) of body composition at (P≤0.05) however ash had insignificant differences. The highest moisture content was recorded with fish fed the diet contained (35% CP and 50% FM: 50% PP). The highest body content of protein recorded with the diet contained 30% CP and 33% FM: 67% PP followed by the diets 35% CP 33% FM: 67% PP and 50% FM: 50% PP while the diet 30% CP and 50% FM: 50% PP had the lowest protein content and was the highest EE content than other treatments. Through these results it can be affirmed that the different of dietary protein level and the replacement levels of FM by SBM affected on fish body chemical composition.

Obviously, fish fed diet containing 30% CP and FM replacing at level 67% by SBM was the highest in CP content and the lowest in EE content. This finding was agreed with **Goda *et al.* (2007),** who discovered that African catfish fed a diet containing SBM protein at 100% or 75% of its protein level had the highest CP content in the body. Also **Abou-Zied *et al*. (2013)** found that the content of CP in the sea bream body increased with increased inclusion of plant protein in their diets. **Ng *et al.* (2001)** stated that the different levels of dietary protein significantly influenced the final lipid composition of the entire body of bagrid catfish (*Mystus* *nemurus*). In addition, **Khan *et al.* (1993)** stated that the whole body protein of *M. nemurus* affected significantly with increasing dietary protein levels up to 420 g/kg.

Table (5): Effect of protein level, replacement of fish meal by plant protein on fish body chemical composition and energy content of Bayad (*Bagrus bajad*).

Variable	FM/PP	Moisture, %	CP, %	EE, %	Ash, %	GE, kcal/g
30%CP	50: 50	77.78[b]	69.22[b]	11.71[a]	18.08	4.919[a]
	33: 67	79.39[a]	73.69[a]	5.91[c]	18.41	4.614[b]
35%CP	50: 50	80.14[a]	71.14[ab]	7.84[b]	19.53	4.657[b]
	33: 67	78.18[b]	72.06[ab]	8.59[b]	17.86	4.779[ab]
SED*		0.300	1.041	0.589	1.130	0.071

(a, b, c) Average in the same row having different superscripts are differ significantly ($P \leq 0.05$).

* SED is the standard error of difference.

Several studies have shown that catfish body fat increases as dietary protein concentration decreases as the ratio of protein/energy decreases **(Reis *et al.* 1989; Li and Lovell, 1992).** On the other hand. **Khan *et al.* (1993)** observed higher levels of lipids in body fish fed with 470 and 500 g/kg protein diets that removed the risk of delaminating and retaining the excess dietary protein as body fat. Studies with other fish species have shown that the lipid content of the fish carcass has decreased with increasing dietary protein. **(Jauncey, 1982 and Martinez-Palacios *et al.* 1996)**, this is consistent with the results of the present study.

Economic Evaluation of protein level and replacement of fish meal by plant protein:

Table (6) presents the economical evaluation of protein ratio (30% and 35% crude protein) with two partial replacement (50% FM: 50% PP and 33% FM: 67% PP) throughout the experimental period (70 days) on Bayad feeding. It is well known that feeding cost in fish production is about 50% and more of the total production costs as declared. Under the present experimental condition, all other costs are constant; therefore, the feeding cost to produce one Kilogram of fresh body weight could be used as a measure to compare between the tested diets. It is expected that, future of aquaculture developments will be in the form of semi-intensive or intensive culture systems which and these require appreciable inputs of fertilizers and/ or artificial feeds.

The results of the current study demonstrated that the 35% protein level is more economical in Bayad aquaculture, Net returned of Bayad were better for the 35% treatment (50 FM: 50 PP) which was 1.20) but the worst was 30% ((33 FM: 67 PP) which was 0.77.

Table (6): Economical evaluation of protein level and replacement of fish meal by plant protein of Bayad fingerlings throughout the experimental period (70 days).

Protein level	30 %		35%	
Treatments	**50: 50 FM: PP**	**33: 67 FM: PP**	**50: 50 FM: PP**	**33: 67 FM: PP**
Feed intake	119.35	96.08	130.26	123.2
Feed cost /kg L.E	8.87	7.73	12.53	10.70
Relative to feed cost L.E/ fish [1]	70.79	61.69	100	85.39
Final weight	61.77	49.77	69.96	61.29
Price of fish sold[2]	2.16	1.74	2.45	2.15
Net returne [3]	1.10	0.97	1.20	1.07

1. Feed cost × Feed intake 2. Feed intake × price of Kg (35 L.E)
3. Price of fish sold - Feed cost L.E

CONCLUSION

Bayad is an important food fish due to its good eating flesh, in Egypt Bayad meat was highly acceptable to consumers, However, nutritional information on this fish is still limited, This study tried to make suitable diets for this fish. For this study, It could be concluded that 35 % and 30% crude protein level was the best under composition of diet (50 FM: 50 PP) in terms of growth performance, feed utilization and economical evaluation under these experimental conditions.

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تأثير نسبة بروتين الغذاء مع الإستبدال الجزئي لمسحوق السمك بالبروتين النباتي على أداء إصبعيات أسماك البياض

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أجريت تجربة عاملية 2×2 لدراسة تأثير كل من نسبة البروتين الخام (30٪ و35٪) ومصدر البروتين (50٪ مسحوق سمك : 50٪ بروتين نباتي و33٪ مسحوق سمك : 67٪ بروتين نباتي) في أربع معاملات علي كل من مظاهر النمو, معدل البقاء وكفاءة الإستفادة من الغذاء والتحليل الكيماوي للجسم لأصبعيات أسماك البياض بمتوسط وزن31.86 ± 0.34. تراوح معدل البقاء بين 96,67٪ -100٪ مع عدم وجود إختلافات معنوية بين الأربع معاملات. أظهر التحليل الإحصائي وجود إختلافات معنوية عند الحصول على مقاييس النمو متمثلة في الوزن النهائي والزيادة الكلية ومعدل النمو النوعي وكان أعلي قيم تم الحصول عليها مع المعاملة الثالثة التي تغذت فيها الأسماك على عليقة تحتوي على 35٪ بروتين خام مع مصدر البروتين (50٪ مسحوق سمك: 50٪ بروتين نباتي). وكانت أقل قيم تم الحصول عليها مع المعاملة الثانية التي تغذت فيها الأسماك على عليقة تحتوي على 30٪ بروتين خام مع مصدر البروتين (33٪ مسحوق سمك : 67٪ بروتين نباتي). لا يوجد فروق معنوية في مقاييس النمو بين المعاملة الأولى التي تغذت فيها الأسماك على عليقة تحتوي على 30٪ بروتين خام مع مصدر البروتين (50٪ مسحوق سمك: 50٪ بروتين نباتي) والمعاملة الرابعة التي تغذت فيها الأسماك على عليقة تحتوي على 35٪ بروتين خام مع مصدر البروتين (33٪ مسحوق سمك: 67٪ بروتين نباتي). تأثر معدل التحويل الغذائي معنويا وكان أفضل معدل مع العليقة التي أحتوت علي35٪ بروتين خام مع مصدر البروتين (50٪ مسحوق سمك: 50٪ بروتين نباتي). وكان أسوأ معدل مع العليقة التي أحتوت على 30٪ بروتين خام مع مصدر البروتين (33٪ مسحوق سمك: 67٪ بروتين نباتي). أظهرت نتائج التحليل الكيماوي للجسم وجود فروق معنوية بين المعاملات فيما عدا نسبة الرماد حيث سجلت أعلي قيم للرطوبة بالمعاملة 35% بروتين (50٪ مسحوق سمك: 50٪ بروتين نباتي) بينما كانت أعلي قيمة لبروتين الجسم مع المعامله 30% بروتين (33٪ مسحوق سمك: 67٪ بروتين نباتي) بينما سجلت المعامله 30% بروتين (50٪ مسحوق سمك: 50٪ بروتين نباتي) أقل محتوي بروتين وأعلي محتوي من دهون الجسم ، فيما يتعلق بالتقييم الإقتصادي يعتبر مستوى البروتين 35٪ أكثر اقتصاداً فى إستزراع البياض. صافي العائد كان أفضل لنسبة البروتين 35٪ (50٪ مسحوق سمك : 50٪ بروتين نباتي) والذي كان 1.20 والأسوأ إقتصاديا كان مع 30٪ (33٪ مسحوق سمك : 67٪ بروتين نباتي) والذي كان 0.77.

يمكن الإستنتاج أن مستوى البروتين الخام 35٪ و 30٪ كان الأفضل مع نسبة (50٪ مسحوق سمك : 50٪ بروتين نباتي) من حيث أداء النمو والإستفادة من الغذاء والتقييم الاقتصادي في ظل ظروف التجربة.

الكلمات الداله: مستوي البروتين – مصدر البروتين – مسحوق السمك – بروتين نباتي – اداء النمو – الإستفادة من الغذاء – اسماك البياض.