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Effect of Feeding Regimen on Growth Performance, Feed Utilization, Body Composition and Economic Efficiency by *Argyrosomus regius* (Asso, 1801)

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ABSTRACT

The present study was conducted in a private fish farm. Fry (1-1.5g initial body weight) were brought from the farm and reared under the normal farm feeding system (natural feed) for 45 days in a rearing cage for adaptation. Thereafter, fish were fed the experimental diets (T_1, T_2 and T_3) once a day, 6 days a week. The trial was continued for 3 months. Two synthetic diets with different crude protein (CP) contents [diet A (T_2) 33.47% and diet B (T_3) 36.81%] were formulated. The diets were pelleted to 2 and 4 mm diameter. Fish rearing water criteria ranged between 23 and 25 **°C** throughout the experimental period, 7.7-8.0 pH, and 14.0-17.5 **‰** salinity. The growth performance of the tested fish cleared that there were no significant ($P \geq 0.05$) differences among dietary treatments for body weights and body lengths. Yet, the final BW after three months of the experimental feeding did not differ between the control and the artificial feed B, but the artificial feed A had lower final BW. Moreover, the final BL did not fifer among the three treatments. The artificial diets, particularly, the artificial diet B (42 % CP) caused more gains in total bodyweights and daily bodyweights of the experimented fish during the whole experimental period. The artificial diets, particularly, the artificial diet B (42 % CP) caused more gains (350-130 %) in total body length and daily body length (355-130 %) of the experimented fish during the whole experimental period. The RGR increased by 238 % and 250 % on the artificial diets A and B, respectively comparing with control (natural feed). Also, the SGR increased by 162 % and 166 % on the artificial diets A and B, respectively comparing with control (natural feed). Again, The BLG increased by 229 % and 240 % on the artificial diets A and B, respectively comparing with control (natural feed). The artificial diets, particularly the diet B was the best, since it was responsible for lower FC by 13.6 %, better FCR by 31.5 %, more FE by 45 %, improved PER, PPV, and ER by 47.8, 12.9, and 31.6 % comparing with the natural feed (control diet). There were no significant ($P \geq 0.05$) differences among treatments for chemical composition of the fish body; yet, the artificial feeds, particularly B diet increased the CP and energy contents but decreased EE and ash contents comparing with the natural feed. The artificial feeds increased the costs of producing one kg of bodyweight gain of the fish by 318 and 320%, respectively comparing with the natural feed. Yet, the same artificial feeds resulted in higher cost of bodyweight gain by 111.8 and 126 %, respectively comparing with the control (natural feed). So, both diets (A and B) were more efficient economically in producing BWG of meager by 357.3 and 403.7 %, respectively with the comparison with the control. Conclusively, meager fish could be fed artificially pelleted diet (37 % crude protein), which enhance growth, feed utilization, body composition, and economics of producing this fish species more than the natural feed.

Keywords: Meagre ulture – Natural feed – Artificial feed – Growth – Nutrients utilization – Fish composition – Economic efficiency.

INTRODUCTION

The history of meagre in aquaculture is quite recent. First trials with wild brood stock were conducted in the south of France, where some of the *Sciaenidae* family was thought to have good aquaculture potential. Starting from 1996, fry production has been very limited, with a single hatchery operating in France. In fact the rearing protocol of this species is still relatively unknown, and has not yet been made public. The first commercial production (in France) was recorded in 1997. Since then production has expanded slowly in nearby regions, especially on the Tyrrhenian side of the Italian coast, and in Corsica. The adult meagre market is now slowly expanding, especially in Italy; this could promote fry production in the future, as well as research on fry and juvenile production. Commercial production in Italy was first reported to FAO only in 2002. Production of farmed meagre is very limited so far and is confined to the Mediterranean Basin (southern France, Corsica and Italy). Reported production in 2002 was 231 tonnes (50 percent from Italian cages; 7 percent from Italian tanks; 40 percent from French cages; 3 percent from French tanks) with a value of USD 1.55 million (FAO, 2006)**.** This study aims to evaluate the growth performance, feed utilization, fish composition, and economic efficiency of meager fish in an erythrean farm and fed different commercial diets with different protein / energy ratio comparing with the common natural feed.

MATERIALS AND METHODS

At the beginning of the fry season (middle of April), about 600 fry (1-1.5g initial body weight) were brought from the farm and reared under the normal farm feeding system (natural feed, minced trash fish, unmarketable tilapia from the fish collection market of Port Said) for 45 days in a rearing cage (3x3x1.5 m) with very small mesh size net. Then fish were transferred to 3 cages (3x3x1.5 m). All cages were placed near aeration machine. Fish were fed the experimental diets (T_1, T_2 and T_3) once a day, 6 days a week. At the start of the experiment, 5 fish were taken and stored frozen for subsequent chemical analysis. At the end of the experiment, 5 fish per cage were sampled and kept frozen in the same way for the chemical analyses. At subsequent monthly intervals and at the end of the experiment, fish were individually weighed and measured. The trial was continued for 3 months.

Two synthetic diets (Table 1) with different crude protein (CP) contents [diet A (T_2) 33.47% and diet B (T_3) 36.81%] were formulated from local ingredients, except fish meal from Morocco. First, dry components were grinded and mixed very well, after that oil was added and mixed very well then each diet was packed separately. The sinking diets A and B were pelleted in El-Max feed unit (Chinese production line "man yong" operating by dry steam, grinding by pulverizer 10 micron, and the pump capacity is 3 ton / h) belonging to the fish experimental research station in Alexandria, National Institute for Oceanography and Fisheries. The diets were pelleted to 2 and 4 mm diameter. The 2 mm one was used at the first 6 weeks and the 4 mm one was used at the second 6 weeks according to Eid (2007).

Table 1: ***Composition of the experimental diets used.***

Ingredients	Diets		
	Control	A (33.47% CP)	B (36.81% CP)
Morocco fish meal (60%)	Minced tilapia fish	25 kg	40 kg
Soybean meal (44%)		20 kg	20 kg
Gluten (60%)		10 kg	1o kg
Yellow corn		35 kg	20 kg
Fish oil		7 kg	7 kg
Dicalcium phosphate		2 kg	2 kg
Premix (Vit. & Min.)*		1 kg	1kg
Total		100	100

Water quality parameters (temperature degrees, pH-values, and salinity) of the earthen pond's water were measured weekly (Abdelhamid, 1994; 1996, 2009a and b). Average body weight and length of fishes were measured biweekly during the experimental period (90 days) for calculating growth performance and nutrients utilization parameters according to Abdelhamid (2009a). At the start and at the end of the experiment, fish samples were collected and kept frozen till the proximate analysis of the whole fish body, besides the experimental rations according to AOAC (1995). Their gross energy contents were calculated according to NRC (1993), being 5.65, 9.45 and 4.22 kcal/g of protein, fat, and charbohydrates, respectively.

Economic efficiency was calculated to appoint the most profitable treatment during the rearing period. So, the local prices during 2012 of feed consumed to produce one kilogram fish body gain were calculated to calculate the economic efficiency. The obtained numerical data collected were statistically analyzed for one-way analysis of variance using SAS (2001). When F-test was positive, least significant differences were calculated (Duncan, 1955) to differentiate the significance among means.

RESULTS AND DISCUSSION

1- The experimental diets

Three experimental diets were tested in this study, mainly a natural diet (trash tilapia fish) and two artificial (external feeds) diets (Table 2). The natural one consisted of minced tilapia fish. The other ones consisted of Morocco fish meal (60%), soybean meal (44%), gluten (60%), yellow corn, fish oil, dicalcium phosphate, and premix (vit. & min. mixture) to formulate 33.47 (A) and 36.81 (B) % crude protein (CP) diets. Proximate chemical analysis of the tested diets is presented in Table 2, which shows that the actual CP contents of the artificial diets on dry matter (DM) basis were lower (being 33.4 and 36.8 %, respectively) than in the natural feed (being 37.1 %). Also, the ether extract and ash percentages were lower, but the carbohydrates were higher than in the natural feed.

The digestible energy (DE) content based on 5, 9, 2 kcal / g of protein, lipid, and carbohydrates, respectively (Wee and Shu, 1989) was calculated for the three diets (natural feed, artificial feed A, and artificial feed B) as 430.1, 366.8, and 399.9 kcal / 100 g, respectively. Their protein / energy (P/E) ratio was calculated as 74.0, 69.1, and 73.1 mg CP / kcal GE, respectively. Abdel-Hakim *et al*. (2004) in this connection mentioned that the proportion of DE of the fish meal is more than that of the plant sources of proteins. However, Chatzifotis *et al*. (2010) fed meager the diet

Table 2: ***Data* (means ± standard errors) of chemical composition (dry matter basis) of the tested diets fed to meager (Argyrosomus regius) fish during the experiment.***

Treatments	Crude protein (%)	Ether extract (%)	Carbohydrate (%)	Ash (%)	Energy** content (kcal/100g)
Natural feed	37.18 ± 1.02	23.38 ± 0.46	16.90	22.54 ± 0.95	502.3
Artificial feed A	33.47 ± 3.91	13.18 ± 0.54	40.41h	12.94 ± 0.28	484.2
Artificial feed B	36.81 ± 6.57	16.72 ± 1.88	32.67	13.80 ± 0.79	503.8

****: Each figure is the mean of 9 determinations or calculations.***
*****: Gross energy (GE) was calculated according to NRC, 1993; where one gram of crude protein, lipid, and carbohydrates contains 5.65, 9.45, 4.22 kcal, respectively.***

contained (DM basis) 12.9-21.1 % lipids, 43.1-43.4 % CP, 17.1-26.9 % carbohydrates, and 19.9-22.3 kJ/g diet.

2- Rearing water's criteria

Fish rearing water criteria ranged between 23 and 25 **°C** throughout the experimental period (90 days), 7.7-8.0 pH, and 14.0-17.5 **‰** salinity (Table 3), since the rearing water of Lake Manzalah is a brackish water coming from fresh water (inland drainage water) and Mediterranean Sea (marine water). These water conditions are the same like the local water used for culture of meager fish in Damietta governorate where the aquaculture of this fish species is widespread.

3- Fish performance

The following Tables illustrate the growth performance of the tested fish. It is clear that there were no significant ($P \geq 0.05$) differences among dietary treatments for body weights and body lengths (Table 4) throughout the three experimental intervals (months). Yet, there were significant ($P \leq 0.05$) differences among intervals within each of the natural feed as well as the artificial feed B, with the best final BW and BL (after three months of the feeding period). Although the initial BW in the control (natural feed) was more than double that in the other two treatments and the initial BL in the control was longer than that for the other treatments; yet, the final BW after three months of the experimental feeding did not differ between the control and the artificial feed B, but the artificial feed A had lower final BW.

Table 3: ***Averages of some water quality criteria measured in the rearing water of the experimental fish during the whole experimental period (90 days).***

Criteria	Sampling times			
	1st July 2012	**1st Aug. 2012**	**1st Sept. 2012**	**1st Octo. 2012**
Temperature, °C	**23.0**	**25.0**	**24.0**	**24.0**
The pH value	**7.90**	**8.00**	**7.70**	**7.70**
Salinity, ‰	**14.0**	**16.0**	**17.0**	**17.5**

Table 4: ***Means* ± standard errors of the body weights (BW) and lengths (BL) of the tested meager (Argyrosomus regius) fish during the experimental period (90 days).***

Criteria	Natural feed	Artificial feed A	Artificial feed B
Initial BW (after 45 days adaptation period)	**92.0^{ab} ± 26.0**	**43.4^{b} ± 7.84**	**46.3^{ab} ± 11.0**
BW after 1 month	110.0^{b} ± 7.64	102.0 ± 6.43	105.0^{b} ± 5.77
BW after 2 months	155.0^{ab} ± 48.0	153.3^{b} ± 43.7	181.7^{ab} ± 31.1
BW after 3 months	256.0^{a} ± 80.2	227.3^{b} ± 18.8	252.7^{a} ± 86.7
Initial BL	19.0 ± 2.00	15.7 ± 0.88	15.8 ± 0.73
BL after 1 month	20.0 ± 0.58	19.3 ± 0.33	19.3 ± 0.33
BL after 2 months	22.3 ± 12.0	21.7 ± 1.20	22.3 ± 0.67
BL after 3 months	23.0 ± 1.73	23.3 ± 0.67	23.8 ± 1.36

****: Means superscripted with different letters in the same column differ significantly (P≤0.05).***

Moreover, the final BL did not differ among the three treatments. Hassanen and El-Gamal (1994) reported that the increase of dietary protein level (42 %) improved final body weight of penaeid shrimp, *Penaeus japonicus*. El- Dahhar *et al.* (2000) revealed that increasing dietary crude protein increased final body weight of juvenile Nile tilapia significantly (P≤0.05). Also, Abdel-Hakim *et al*. (2001) registered significant (P≤0.05) increases in final body weight of Nile tilapia and eel with increasing the dietary protein levels up to 44 %. Moreover, Ayyat *et al*. (2002) found that live body weight of common carp increased significantly (P≤0.01) with increasing dietary protein level.

Sweilum *et al*. (2005) reported that small fish require a high-protein and low-energy diet, whereas large fish require a low-protein and high-energy diet to achieve highest production. Higher body weight and length was obtained with the diet high in protein high in energy (Soltan *et al.*, 2006).

Table 5 shows that the artificial diets, particularly, the artificial diet B (36.81 % CP) caused more gains in total bodyweights and daily bodyweights of the experimented fish during the whole experimental period. Generally, the absolute bodyweight gains, whether total or daily, increased by time duration. Hassanen and El-Gamal (1994) reported that the increase of dietary protein level (42 %) improved total body weight gain of penaeid shrimp, *Penaeus japonicus*. El-Dahhar *et al*. (1999) observed linear increase in body

Table 5: ***Averages of the total body weight gains (TBWG, g/fish) and daily body weight gains (DBWG, g/fish) of the tested meager (Argyrosomus regius) fish during the experimental period (90 days).***

Criteria	Natural feed	Artificial feed A	Artificial feed B
TBWG during the 1st month	**18.0**	**58.7**	**58.7**
TBWG during the 2nd month	**45.0**	**51.3**	**76.7**
TBWG during the 3rd month	**101.0**	**74.0**	**71.0**
TBWG during the 3 months	**164.0**	**184.0**	**206.4**
DBWG during the 1st month	**0.60**	**1.96**	**1.96**
DBWG during the 2nd month	**1.50**	**1.71**	**2.56**
DBWG during the 3rd month	**3.37**	**2.47**	**2.37**
DBWG during the 3 months	**1.82**	**2.04**	**2.29**

weight gain with increasing the dietary crude protein intake of fry Nile tilapia. Moreover, Ayyat *et al*. (2002) found that daily live body weight gain of common carp increased significantly (P≤0.01) with increasing dietary protein level. Magouz (2002) also showed that fish fed the highest dietary protein level (40 %) produced significantly best average daily weight gain, and total weight gain. The highest weight gain in small fish was obtained on high dietary protein level but the heaver fish required less dietary protein (Sweilum *et al*., 2005). Higher body weight gain was obtained with the diet high in protein high in energy (Soltan *et al*., 2006).

Table 6 shows that the artificial diets, particularly, the artificial diet B (42 % CP) caused more gains (350-130 %) in total body length and daily body length (355-130 %) of the experimented fish during the whole experimental period. However, the absolute gains in fish length decreased by age ongoing in contrary to the body weight gains affecting the condition factor as will be illustrated thereafter. Averages of the condition factor (K), relative growth rate (RGR, %), specific growth rate (SGR, %/d), and body length gain (BLG, %) during the experimental period (90 days) are given in Table 7. The K-factor increased with age advance for the increase in weight than in length as mentioned before. The RGR decreased with age ongoing (in contrary to the absolute weight which increases by age) at the artificial diets, but increased by 238 % and 250 % on the artificial diets A and B, respectively comparing with control (natural feed). Also, the SGR decreased with age ongoing (in contrary to the absolute weight which increases by age) at the artificial diets, but increased by 162 % and 166 % on the artificial diets A and B, respectively comparing with control (natural feed). Again, The BLG decreased with age ongoing, but increased by 229 % and 240 % on the artificial diets A and B, respectively comparing with control (natural feed).

Nour *et al*. (1993) found that growth performance of grey mullet (*Mugil cephalus*) increases with increasing the protein level in the diet from 25 to 40 %. Also, Hassanen and El-Gamal (1994) reported that the increase of dietary protein level (42 %) improved specific growth rate of penaeid shrimp, *Penaeus japonicus*. Moreover, Kheir and Sweilum (1997) reported that high dietary crude protein (30 %) gave the best growth and survival by Nile tilapia fry. Also, Abdel-Hakim *et al*. (2001) reported significant (P≤0.05) increases in specific growth rate of Nile tilapia, eel and mullet with increasing the dietary protein levels up to 44 %.

Abdelhamid *et al*. (2001) fed gilthead seabream (*Sparus aurata*) pelleted diet, trash fish, and small shrimp. They reported superior

Table 6: ***Averages of the total body length gains (TBLG, cm/fish) and daily body length gains (DBLG, mm/fish) of the tested meager (Argyrosomus regius) fish during the experimental period (90 days).***

Criteria	Natural feed	Artificial feed A	Artificial feed B
TBLG during the 1st month	**1.00**	**3.60**	**3.50**
TBLG during the 2nd month	**2.30**	**2.40**	**3.00**
TBLG during the 3rd month	**0.70**	**1.60**	**1.50**
TBLG during the 3 months	**4.00**	**7.60**	**8.00**
DBLG during the 1st month	**0.33**	**1.20**	**1.17**
DBLG during the 2nd month	**0.77**	**0.80**	**1.00**
DBLG during the 3rd month	**0.23**	**0.53**	**0.50**
DBLG during the 3 months	**0.44**	**0.84**	**0.89**

Table 7: Averages of the condition factor* (K), relative growth rate (RGR, %), specific growth rate*** (SGR, %/d), and body length gain**** (BLG, %) of the tested meager (*Argyrosomus regius*) fish during the experimental period (90 days).**

Criteria	Natural feed	Artificial feed A	Artificial feed B
K during the 1st month	1.34	1.41	1.17
K during the 2nd month	1.38	1.42	1.46
K during the 3rd month	1.40	1.50	1.64
K during the 3 months	2.10	1.80	1.87
RGR during the 1st month	19.6	135.6	126.8
RGR during the 2nd month	40.9	50.3	136.9
RGR during the 3rd month	65.2	48.3	39.1
RGR during the 3 months	178.3	424.9	445.8
SGR during the 1st month	0.596	2.856	2.729
SGR during the 2nd month	1.143	1.358	1.828
SGR during the 3rd month	1.673	1.313	1.099
SGR during the 3 months	1.137	1.842	1.886
BLG during the 1st month	5.26	22.9	22.2
BLG during the 2nd month	11.5	12.4	15.5
BLG during the 3rd month	3.14	7.37	6.73
BLG during the 3 months	21.1	48.4	50.6

: K= 100W/L^3, where W= body weight (g) and L= body length (cm).

****: RGR, %= 100 X body weight gain (g)/initial body weight (g).***

(P≤0.05) final body weight, condition factor, daily weight gain, specific growth rate, feed consumption and feed conversion efficiency with the pelleted diet than with the other two wet diets for the betterness of essential amino acids index in the first diet than the wet diets. However, Gaber (2002) observed significant differences in the growth of Nile tilapia fed diets with carbohydrate – to lipid ratios ranging from 4.8 to 1.22. Low fat diets led to lower performance. Hemre *et al.* (2002) cited that dietary carbohydrates (inclusion levels and balance between macro-nutrients) affect growth through influence glucose metabolism in fish to a high degree. Magouz (2002) showed that fish fed variable dietary protein levels had no clear trend for survival rate, but there was a positive relationship between dietary protein level and specific growth rate. Mohammed and Hanafy (2002) indicated that growth of *O. niloticus* increased with increasing dietary protein (30 %), while growth of *Cyprinus carpio* fed a diet contained 25 % protein was higher than those fed 30 % protein. They found also that weight gain percentage decreased with the increase in body weight but increased as protein level increased. They added that specific growth rate of *O. niloticus* fry was higher than those of fingerlings. Attalla *et al*. (2005) reported the best growth for Nile tilapia on the high dietary crude protein (30 %) level. Higher SGR was obtained with the diet high in protein high in energy (Soltan *et al.,* 2006).

Brown meagre *Sciaena umbra* Linnaeus 1758 is a demersal species living at depths of 0–200 m with a wide distribution in the Mediterranean Sea, Black Sea and eastern Atlantic Ocean. It exhibits nocturnal behavior and occupies bottom caves and seabeds covered with vegetation. This study presents the first data on brown meagre growth under culture conditions and contributes some basic information on its dietary protein requirement by feeding isoenergetic diets with different protein–lipid ratios by means of self-feeders. Fish with 78.8 ± 15.8 g body weight were divided into four groups and subjected to four different feeding regimes for 77 days. In the first group, fish were supplied with a high protein and low fat diet (HPLF, 52 : 8 w/w fat–protein ratio), the second one a medium protein and medium fat diet (MPMF, 42 : 14), the third with a low protein and high fat diet (LPHF, 31 : 23). In the fourth group, fish had access to both HPLF and LPHF diets. Fish fed on HPLF and MPMF diets showed significantly better growth and feed conversion ratios than fish fed on the LPHF diet. Fish with access to HPLF and LPHF diets exhibited comparable growth to the HPLF group but their feed conversion ratio was significantly higher. The condition factor and hepatosomatic index revealed no significant differences between dietary regimes (Chatzifotis *et al*., 2006).

Two comparative studies on the effect of initial larval density and feeding sequence on meagre (*Argyrosomus regius*) rearing trials were conducted. A positive interaction was found between rearing density and feeding sequence. Final survival was also affected by initial larval density and feeding sequence. The best final survival (53.4±12.03%) was obtained in high larval density treatment, while early Artemia introduction reduced final survival (36.75± 3.62%). Furthermore, no significant interaction was found among density and feeding sequences on biochemical composition, and no significant differences were detected on total fatty acid composition (Roo *et al*., 2010).

On the other side, Omar *et al*. (1997) and El- Dahhar *et al*. (1999) mentioned that growth performance of Nile tilapia fingerlings and fry, respectively was significantly ($P \leq 0.05$) reduced at the higher dietary protein levels tested. Also, Shalaby *et al*. (2001) revealed that no significant differences ($P \geq 0.05$) were observed in growth of rabbitfish fed varying carbohydrate / protein ratios. Also, El-Saidy and Gaber (2005) revealed that there was no significant increase in condition factor, survival rate, growth rate or in specific growth rate with increasing dietary protein level (from 20 to 30 %).

4- Feed utilization

Data of the feed and nutrients utilization by the experimented meager (*Argyrosomus regius*) fish are presented in Table 8. The artificial diets, particularly the diet B was the best, since it was responsible for lower FC by 13.6 %, better FCR by 31.5 %, more FE by 45 %, improved PER, PPV, and ER by 47.8, 12.9, and 31.6 % comparing with the natural feed (control diet), respectively.

Nour *et al*. (1993) found that feed conversion ratio, protein efficiency ratio, and protein productive value of grey mullet (*Mugil cephalus*) significantly ($P \leq 0.05$) decreased with

Table 8: Averages of the feed consumption (FC), feed conversion ratio (FCR), feed efficiency (FE), protein efficiency ratio (PER), protein productive value (PPV), and energy retention (ER) by the tested meager (*Argyrosomus regius*) fish during the experimental period (90 days).

Criteria	Natural feed	Artificial feed A	Artificial feed B
FC, g/fish/3 months	323.4	288.6	279.5
FCR	1.97	1.57	1.35
FE	0.51	0.64	0.74
PER	1.36	1.90	2.01
PPV, %	122.8	123.4	138.7
ER, %	74.7	89.8	98.3

increasing the protein level in the diet to 40 %. However, energy utilization was significantly ($P \leq 0.05$) improved with increasing the protein level in the diet. Also, Hassanen and El-Gamal (1994) reported that the increase of dietary protein level (42 %) supported better protein efficiency ratio and protein productive value of penaeid shrimp, *Penaeus japonicus*. Moreover, Kheir and Sweilum (1997) reported that high dietary crude protein (30 %) gave the best feed conversion by Nile tilapia fry. On the other side, Omar *et al*. (1997) mentioned that feed and nutrient efficiency was significantly ($P \leq 0.05$) reduced at the higher dietary protein tested by Nile tilapia. El-Dahhar *et al*. (1999) observed an increase in feed efficiency with increasing the dietary crude protein up to 28 %, but they found that protein efficiency ratio and protein productive value were reduced significantly as dietary protein level increased from less than 20 % to 24 % and more by fry Nile tilapia fry. Moreover, El- Dahhar *et al.* (2000) revealed that increasing dietary crude protein up to 20 % increased feed intake and improved feed conversion by juvenile Nile tilapia. Yet, protein efficiency ratio and protein productive value were decreased as dietary protein increased, while energy retention increased. Also, Ayyat *et al*. (2002) found that feed conversion by common carp increased with increasing dietary protein level. However, Gaber (2002) observed significant differences in the feed conversion by Nile tilapia fed diets with carbohydrate – to lipid ratios ranging from 4.8 to 1.22. Low fat diets led to lower performance. Attalla *et al*. (2005) reported the best feed conversion and protein efficiency for Nile tilapia on the high dietary crude protein (30 %) level. Soltan *et al*. (2006) found the best FCR and PER with the diet high in protein high in energy.

However, Shalaby *et al*. (2001) revealed that no significant differences ($P \geq 0.05$) were observed in feed conversion by rabbitfish fed varying carbohydrate / protein ratios. Although protein sparing effect occurred at two sub-optimum (35 and 25 % crude protein) levels, the maximum sparing of protein was found when fish were fed 1.9 carbohydrate / protein ratio in diet containing lower protein (26 %) and higher carbohydrate (50.13 %) levels based on feed conversion and protein efficiency ratio. Protein efficiency ratio and protein productive value improved as carbohydrate / protein ratio increased. Higher protein efficiency ratio values were obtained with diet of 1.9 carbohydrate / protein ratio. Moreover, Magouz (2002) showed that increasing dietary protein level negatively affected protein efficiency ratio and protein productive value. Also, Mohammed and Hanafy (2002) indicated that feed conversion and protein efficiency ratio were decreased by increasing dietary protein level, whereas protein productive value was increased with increasing the dietary protein level. Also, Sweilum *et al*. (2005) found that feed conversion ratio and protein efficiency ratio varied with different dietary protein-energy ratio and body size. The FCR increased with increasing protein in the diet, and values in small fish were higher than values in large fish. The PER decreased with increasing dietary protein level. Chatzifotis *et al*. (2010) studied the effect of dietary lipids on growth of meager (*Argyrosomus regius*) juveniles. Triplicate groups of fish (average weight±SD, 229.7±1.4 g) were fed for 110 days three isonitrogenous experimental diets (43% crude protein, dry matter) containing 13, 17, or 21% crude lipids. Body weight, total length and specific growth rate of fish fed the 17% lipid diet were significantly higher than that of fish fed the 13 and 21% lipid diets. Daily feed intake was not affected by the dietary lipid level, but there were significant differences in feed conversion ratio and protein efficiency ratio. There was no significant difference in condition factor, hepatosomatic or viscerosomatic indexes.

Four commercial diets containing different levels of crude protein and crude lipid (44/25, 43/21, 46/20 and 47/20%) were assayed in duplicated groups in juvenile meagre (*Argyrosomus regius)* (initial individual weights were 94 g) in an experiment lasting 173 days.

The essential amino acid contents (expressed in g/kg of diet basis) in diets 46/20 and 47/20 were higher than in diets 44/25 and 43/21. The HUFAs represented 184 and 207 g/kg in diets 46/20 and 47/20, respectively and 98 and 116 g/kg in diets 44/25 and 43/21, respectively. The fish fed diet 47/20 obtained the best growth and efficiency results, reaching a final individual weight of 393 g, followed by the meagre fed with diet 46/20. Meagre from the 47/20 group retained more of the ingested protein and energy than those fed diets 46/20. Fish fed 44/25 and 43/21 obtained the significantly lowest protein and energy efficiency. The results of the current experiment show that the fish fed commercial diet 47/20 obtained the best results in meagre growth, followed by fish fed diet 46/20. Diets 43/21 and 44/25 presented the worst growth and feed efficiency results (**Martínez-Llorens *et al.*, 2008**).

5- Chemical composition

Table 9 shows the data as means ± standard errors of the proximate chemical analysis of the whole fish body. Crude protein, ether extract and energy contents increased at the end but ash content decreased generally. There were no significant (P≥0.05) differences among treatments for each criterion; yet, the artificial feeds, particularly B diet increased the CP and energy contents but decreased EE and ash contents comparing with the natural feed.

Nour *et al*. (1993) found that carcass crude protein, ether extract, and dry matter contents of grey mullet (*Mugil cephalus*) were positively correlated with increasing the protein level in the diet, while ash content was negatively correlated. Yet, Hassanen and El-Gamal (1994) reported that carcass protein was independent of dietary protein level, wilst the carcass fat increased in penaeid shrimp, *Penaeus japonicus* fed diets with low protein / energy ratio. Moreover, Kheir and Sweilum (1997) reported that high dietary crude protein (30 %) gave the highest values of crude protein content and the lowest values of ash content by Nile tilapia fry. The fat content increased with increasing the protein level in the artificial diets. El-Dahhar *et al*. (1999) observed linear increase in carcass protein and energy with increasing the dietary crude protein and energy intake of fry Nile tilapia. Moreover, El- Dahhar *et al.* (2000) revealed that increasing dietary crude protein level increased body protein by juvenile Nile tilapia, while body lipid and moisture were not affected. Also, Abdel-Hakim *et al*. (2001) registered that dietary crude protein levels fed had significant effects on the proximate analysis of whole bodies of Nile tilapia, eel and mullet.

Table 9: ***Data* (means ± standard errors) of effects of the dietary treatments** on chemical composition (dry matter basis) of the tested meager (Argyrosomus regius) fish.***

Treatments	Crude protein (%)	Ether extract (%)	Ash (%)	Energy content (kcal/100g)
At the beginning	**37.49 ± 1.87**	**21.15 ± 1.23**	**13.60 ± 1.01**	**411.7**
		At the end of the experiment		
Natural feed	**51.23 ± 6.41**	**35.21 ± 1.02**	**13.56 ± 0.73**	**622.2**
Artificial feed I	**53.69 ± 5.02**	**34.63 ± 2.03**	**11.68 ± 1.16**	**630.6**
Artificial feed II	**58.25 ± 4.81**	**31.09 ± 3.22**	**10.66 ± 0.49**	**622.9**

****: Each figure is the mean of 9 determinations or calculations.***
*****: There are no significant (P ≥ 0.05) differences among treatments for each criterion.***

Abdelhamid *et al.* (2001) fed gilthead seabream (*Sparus aurata*) pelleted diet, trash fish, and small shrimp. They reported significantly higher fat and lower crude protein percentages in the final body composition at the end of the experimental period (twelve weeks) for the fish group fed the pelleted diet than the other two wet diets (trash fish and small shrimp).

Magouz (2002) also showed that fish fed the highest dietary protein level (40 %) produced significantly highest crude protein and ash contents and decreased ether extract in fish body. Yet, Mohammed and Hanafy (2002) indicated that fish body composition was slightly affected by the dietary protein level. Anyhow, Sweilum *et al*. (2005) found that proximate composition of the soft tissue (wet weight basis) in small fish was significantly influenced by dietary protein-energy levels, but larger fish contained highest protein when fed lower protein level. Chatzifotis *et al*. (2006) gave the chemical analysis (%) of the meager as moisture 74.10-75.42, protein 21.09-20.89, lipid 3.60-2.41, and ash 1.24-1.31. Moreover, lower protein and higher fat contents were obtained with the diet high in protein high in energy (Soltan *et al.*, 2006).

Chemical-nutritional composition of cultured meagre (*Argyrosomus regius*) of different size collected from Italian farms (Orban *et al*., 2008) weighed (kg) 0.65-4.83, length (cm) 43-84 was moisture (%) 72.69-76.1, protein (%) 19.14-21.71, total lipid (%) 1.68-4.18, ash (%) 1.12-0.35, non-protein nitrogen (%) 0.31-1.36, and energy value (kcal) 97-124.

Piccolo *et al.* (2008) evaluated the effect of two diets with different protein/fat ratios (P/F) (diet A: P/F 2.26; diet B: P/F 3.36) on the chemical composition, fatty acid profile and some somatic indexes of meager (*Argyrosomus regius*). The trial was carried out on two groups of meager raised in two different sea cages during 15 months. At the end of the production cycle biometric measures as well as chemical-nutritional analysis of the fillets were conducted on 25 fishes per group. Diet A, with a lower P/F, furnished animals with higher percentages of mesenteric fat (0.48 *vs* 0.41%; $P<0.01$) and of fillet yield (51.21 *vs* 48.12; $P<0.01$). Moreover, the fillets obtained with the diet A showed higher percentage of fat (3.60 *vs* 2.41%; $P< 0.01$), lower moisture (74.10 *vs* 75.42%; $P<0.01$), lower losses of water under pressure (16.73 *vs* 20.20%; $P<0.01$) and after 48 h of refrigeration (3.08 *vs* 4.23%; $P<0.01$). The fatty acids profile of fillets was affected by the diet. Diet A resulted in a higher level of saturated fatty acids (26.44 *vs* 23.17% of total lipid; $P<0.01$) and a lower percentage of polyunsaturated fatty acids (31.56 *vs* 36.08%; $P<0.01$) in the fillet, mainly due to the lower content of linoleic acid (13.63 *vs* 19.77%; $P<0.01$). The atherogenic (AI) and thrombogenic (TI) indexes, which resulted very low in the fish of Group B (AI=0.48 *vs* 0.60, $P<0.01$; TI=0.33 vs 0.37, $P<0.01$), together with the low lipid content of meat in both groups, confirmed the very high nutritional quality of meager fillets.

Proximate analysis indicated that the lipid content of whole body and muscle was affected by the diets, whereas the other chemical components of whole body, muscle and liver were unaffected by the increase in dietary lipid content. Whole body and muscle of fish fed the 21% lipid diet showed significantly higher values of total lipids (whole body: 7.41±0.45% and muscle: 0.64±0.13%) than fish fed 17 and 13% lipid (whole body: 5.92±0.12%, muscle: 0.37±0.08% and whole body: 5.76±0.23%, muscle: 0.31±0.02%, respectively). In conclusion, meager juveniles appear to have similar lipid requirements with other Mediterranean species and excess dietary lipid level should be avoided, since the increase from17% to 21% resulted in higher fat accretion and impaired growth performance (Chatzifotis *et al*., 2010).

However, for interpretation of the obtained results, a negative relationship was noticed between CP and EE contents of fish body but a position relationship between CP and ash contents was recorded too (Abdelhamid *et al*., 2002 & 2007; El-Saidy and Gaber, 2002 and El-Ebiary and Zaki, 2003). Yet, El-Saidy and Gaber (1998) and El-Saidy *et al*. (1999) found a positive correlation between crude protein and fat contents of the fish.

6- Economic efficiency

Table 10 presents that the artificial feeds increased the costs of producing one kg of bodyweight gain of the fish by 318 and 320%, respectively comparing with the natural feed. Yet, the same artificial feeds resulted in higher cost of bodyweight gain by 111.8 and 126 %, respectively comparing with the control (natural feed). So, both diets (A and B) were more efficient economically in producing BWG of meager by 357.3 and 403.7 %, respectively with the comparison with the control.

Abdelhamid *et al.* (2001) fed gilthead seabream (*Sparus aurata*) pelleted diet, trash fish, and small shrimp. They found that diet one was more expensive than the live diets, thus the cost of one kg fresh weight gain produced from feeding the first diet was more than five times comparing with the live diets for the betterness of essential amino acids index in the first diet than the wet diets. The aquaculture activities and the market situation and prospect of the meagre (*Argyrosomus regius*) in the Mediterranean countries are documented. Meagre culture started in France and in Italy in the late '90s and is developing in the Mediterranean Region, jumping from a few tonnes in 2 000 to over 10 000 tonnes expected in 2010, highlighting the appearance of a new aquaculture species on the market. Meagre is currently sold by a limited number of players on niche segments (small volumes at relatively high prices to selected market segments). From a market viewpoint, meagre is endowed with intrinsic values such as attractive fish shape, good processing yield, good nutritional values, low fat content, excellent taste, firm texture suitable for a large variety of recipes. Yet it is very little known to end consumers. Meagre production is expected to grow fast in the medium term and ex-farm prices will probably drop under the pressure of increasing supply. This is what will most likely happen if the coming increased production converges towards favorable markets like Spain, Italy and Portugal. The picture of the existing market of meager describes the possible routes for development. Indeed, based on its aquaculture characteristics, meagre has the potential to become a mass market species, moving from the present position of a niche species with a limited production directed to selected market segments. Some actions have to be undertaken to consolidate good conditions for future growth and to reduce commercial risks. Most of the information used originates from national data and from the author's personal estimates (Monfort, 2010).

Table 10: ***Data of effects of the dietary treatments on the economic efficiency (EE %, dry matter basis) by the tested meager (Argyrosomus regius) fish.***

Criteria	Natural feed	Artificial feed A	Artificial feed B
Cost of feed*/kg bodyweight gain, LE	**2.96**	**9.42**	**9.48**
Cost of bodyweight gain, LE**	**2.46**	**2.75**	**3.10**
Economic efficiency*, %**	**3.23**	**11.54**	**13.04**

****: One kg of the natural feed, artificial feed A, and artificial feed B costs 1.5, 6.0, and 7.0 LE, respectively.***
*****: One kg of this fish species lower than 0.5 kg/fish is 15 LE.***
******: EE = 100 [Cost of 1 kg feed (LE) X consumed feed (kg)] / Cost of 1 kg fish (Abdel- Hakim et al., 2004)***

REFERENCES

Abdel-Hakim, N. F., Baker, M. N. and Soltan, M. A. (2001). Effect of dietary protein levels on growth performance and pond productivity of Nile tilapia (*Oreochromis niloticus*), eel (*Anguilla anguilla*) and grey mullet (*Mugil cephalus*) reared in polyculture system. Egypt. J. Aquat. Biol. & Fish., 5 (4): 61-85.

Abdel-Hakim, N. F.; Younes, T. M. Abd El-Wareth, A. A. and Soltan, M. A. (2004). Scientific Bases for Fish Feeding and Their Diets Formulation. Deposit No. 7707/2004, ISBN: 977-17-1395-7.

Abdelhamid, A.M. (1994). Scientific Fundamentals for Fish Production and Management. An Arabic Textbook, Dar Al-Nashr for Egyptian Universities – Alwafaa Bookshop, Cairo, I.S.B.N. 977–5526–04–1, 658p.

Abdelhamid, A.M. (1996). Field and Laboratorial Analysis in Animal Production. Dar Annashr for Universities, Cairo, I.S.B.N. 977–5526–47–7, 680 p.

Abdelhamid, A.M. (2009-a). Fundamentals of Fish Production and Culture. New Universal Office, Alexandria, I.S.B.N. 977–438–052–5, 393 p.

Abdelhamid, A.M. (2009-b). Modern Approach in Aquaculture. New Universal Office, Alexandria, I.S.B.N. 977–438–053–3, 393 p.

Abdelhamid, A.M., El-Fadaly, H.A. and Ibrahim, S.M. (2007). Studies on integrated fish/duck production system: 1- On water quality and fish production. J. Agric. Sci. Mansoura Univ., 32: 5225 – 5244.

Abdelhamid, A.M., Khalil, F.F., Zaki, V.H., El-Shaieb, A.F. and El-Mezaien, A.M.M. (2001). Effect of feeding systems on performance of caged gilthead seabream (*Spaus aurata*) under Egyptian conditions. Egypt. J. Nutr. and Feeds, 4: 139 – 152.

Abdelhamid, A.M., Magouz, F.I., Salem, M.F.E., Mohamed, A.A. and Mohsen, M.K. (2002). Effect of dietary graded levels of aflatoxin B1 on growth performance and biochemical, chromosomal and histological behaviour of Nile tilapia, *Oreochromis niloticus*. Proc. 1st Ann. Sc. Conf. Anim. & Fish Prod. Mansoura, 24 & 25 Sep., pp: 231 – 250.

AOAC (1995). Association of Official Analytical Chemists, Official Methods of Analysis, 16th Ed., Arlington, VA. 1832.

Attalla, R. F.; Ibrahim, S. A., Saad, A. S. and El-Kasheif, M. A. (2005). Effect of different dietary protein and energy levels in the diet of *Oreochromis niloticus* L. on growth performance and feed utilization. Egypt. J. Aquat. Biol. & Fish., 9 (4): 293-307.

Ayyat, M. S.; Abbas, F. S., Sharaf, M. M. and Sharaf, S. M. (2002). Effect of dietary protein levels and copper supplementation in growth performance of common carp fish *C. carpio* L. Egyptian J. Nutrition and Feed, 5 (2): 207-223.

Chatzifotis, S.; A. V. Martin-Prat, N. Limberis, N. Papandroulakis and P. Divanach (2006). First data on growth of cultured brown meagre *Sciaena umbra* using diets with different protein and fat contents. Fisheries Science, 72: 83–88.

Chatzifotis, S.; M. Panagiotidou, N. Papaioannou, M. Pavlidis, I. Nengas and C. C. Mylonas (2010). Effect of dietary lipid levels on growth, feed utilization, body composition and serum metabolites of meager (*Argyrosomus regius*) juveniles. Aquaculture, 307: 65–70.

Duncan, D. (1955). Multiple range and multiple F-test. Biometrics, 11:1.

Eid, A. (2007). Nutritional requirements for fish. Academy of Scientific Research and Technology, Cairo, 36 p.

El-Dahhar, A. A.; Zeweil, H. S. and El-Tawil, N. E. (1999). Protein and energy requrements of fry Nile tilapia, (*Oreochromis niloticus*) for maintenance and maximum growth. Egyptian J. Nutrition and Feeds, 2 (Special Issue): 807-821.

El-Dahhar, A. A.; Zeweil, H. S. and El-Tawil, N. E. (2000). Effect of protein and energy levels in commercial diets on growth performance of juvenile Nile tilapia, (*Oreochromis niloticus*). Egypt. J. Aquat. Biol. & Fish., 4 (2): 267-285.

El-Ebiary, E.H. and Zaki, M.A. (2003). Effect of supplementing active yeast to the diets on growth performance, nutrient utilization, whole body composition and blood constituents of monosex tilapia (*Oreochromis niloticus*). Egypt. J. Aquat. Biol. & Fish., 7(1): 127–139.

El-Saidy, D.M.S.D. and Gaber, M.M.A. (1998). Effects of using ascorbate polyphosphate in practical diets on Nile tilapia (*Oreochromis niloticus*) fry performances. Menofiya J. Agric. Res., 23(2): 363 – 378.

El-Saidy, D.M.S.D. and Gaber, M.M.A. (2002). Optimal dietary lipid levels for growth of Nile tilapia (*Oreochromis niloticus* L.) fry. Annals of Agric. Sci., Moshtohor, 40(3): 1461 – 1473.

El-Saidy, D.M.S.D., Gaber, M.M.A. and Magouz, F.I. (1999). Effect of dietary energy level on growth, feed conversion, body composition, digestibility coefficients and energy budget of Nile tilapia (*Oreochromis niloticus*). Egypt. J. Aquat. Biol. & Fish., 3(3): 159–178.

FAO (2006) Cultured Aquatic Species Information Programme. http://wrec.igfa.org/WRecordsList.aspx?lc=AllTackle&cn=Meagr

Gaber, M. M. (2002). Effects of dietary carbohydrate – to lipid ratios on growth performance and body composition of Nile tilapia, *Oreochromis niloticus* (L.), fingerlings. Egypt. Aquat. Biol. & Fish., 6 (2): 25-40.

Hassanen, G. D. I. and El-Gamal, A. A. (1994). Effect of dietary protein level on growth, feed conversion, protein utilization, and body composition of the penaeid shrimp, *Penaeus japonicus.* 5th Conf. Agric. Dev. Res., Fac. Agric., Ain Shams Univ., Cairo, Egypt, 1: 75-88.

Hemre, G. I.; Mommsen, T. P. and Krogdahl, Å. (2002). Carbohydrates in fish nutrition: effects on growth, glucose metabolism and hepatic enzymes. Aquaculture Nutrition, 8: 175-194.

Kheir, M. T. and Sweilum, M. A. (1997). Effects of different dietary protein levels on the growth, survival rate and body composition of fry *Oreochromis niloticus.* Bull. Fac. Sci., Zagazig Univ., 19 (1): 274-286.

Magouz, F. I. (2002). Effect of different zinc and protein levels on growth performance and feed efficiency of Nile tilapia. Proc. 2nd Conf. Foodborne Contamination and Egyptians' Health, 23-24 April, El-Mansoura, Egypt, pp: 313-328.

Martínez-Llorens, S.; Espert, J., Moya, J., Cerdá, M. J. and Tomás-Vidal, A. (2008). Growth and nutrient efficiency of meagre (*Argyrosomus regius*, Asso. 1801) fed extruded diets with different protein and lipid levels. International Journal of Fisheries and Aquaculture, 3 (10): 195-203.

Mohammed, R. A. and Hanafy, M. A. (2002). Effect of dietary protein and energy levels on growth and body composition of *Oreochromis niloticus* (L.) and *Cyprinus carpio* (L.). Proc. 1st Sc. Conf. Aqua., El-Arish, 13-15 Dec., pp: 217-233.

Monfort, M. C. (2010). General fisheries commission for the Mediterranean. Present market situation and prospects of meager (*Argyrosomus regius*), as an emerging species in Mediterranean aquaculture. Studies and reviews No. 89, ISSN 1020-9549, Food and Agriculture Organization of the United Nations, Rome,

Nour, A.; Mabrouk, H., Omar, E., Abou Akkada, A. and Abo El Wafa, M. (1993). Effect of dietary protein levels on growth performance and feed utilization of grey mullet (Mugil cephalus). Proc. Aqucul. Symp. "Technology and Investment Opportunities", 11-14 April, Riyadh, Saudi Arabia,pp: 560-569.

NRC (National Research Council) (1993). Nutrient requirements of fish. Committee on Animal Nutrition Board on Agriculture. National Academy Press, Washington D. C, USA. 114p.

Omar, E. Al-Sagheer, F. M. Nour, A. M. And Abou Akkada, A. R. (1997). Effect of protein level and stocking sensity on growth performance, feed utilization and resistance of Nile tilapia (*Oreochromis niloticus*) to infection against aeromonas septicemia (*Aeromonas hydrophila*). Proc. Workshop CIHEAM on TECAM, jointly organized by CIHEAM, FAO & IEO Mazarròn (Spain), 24-26 June 1996, Sci. Ed. A. Tacon & B. Basurco, 1997, pp: 67-77.

Orban, E.; Nevigato, T., Di Lena, G., Masci, M., Casini, I., and Caproni, M. (2008). Ricerche di supporto alla innovazione di prodotto e processo della acquacoltura Toscana: opportunità competitive della ombrina (*Argyrosomus regius*) e Solea solea in mercati di nicchia. Project funded by ARSIA Toscana 2007–2009. Research Project Report.

Piccolo, G.; F. Bovera, N. De Riu, S. Marono, F. Salati, R. Cappuccinelli and G. Moniello (2008). Effect of two different protein/fat ratios of the diet on meager (*Argyrosomus regius*) traits. Ital. J. Anim. Sci., 7: 363-371.

Roo, J.; Hernández-Cruz, C. M., Borrero, C., Schuchardt, D., and Fernández-Palacios, H. (2010). Effect of larval density and feeding sequence on meager (*Argyrosomus regius*; Asso, 1801) larval rearing. Aquaculture, 302: 82–88.

SAS (2001). SAS statistical guide for personal computer, SAS Institute Inc. Cary, NC.

Shalaby, S. M.; El-Dakar, A. Y. And Ghoneim, S. (2001). Protein – sparing effect by carbohydrate in diets of rabbitfish, *Siganus rivulatus.* Egypt. J. Aquat. Biol. & Fish., 5 (4): 87-98.

Soltan, M. A.; Mohamed, K. A. and Eid, A. H. (2006). Effect of protein to energy ratio on growth performance and body composition of red tilapia reared in freshwater. J. of the Egypt. Aquac.. Soc., 1: 57-69.

Sweilum, M. A.; Abdella, M. M., and El-Din, S. A. S. (2005). Effect of dietary protein-energy levels and fish initial sizes on growth rate, development and production of Nile tilapia, *Oreochromis niloticus* L. Aquaculture Research, 36: 1414-1421.

Wee, K. L. and Shu, S. W. (1989). The nutritive value of boiled feed -fat Soy bean in pelted feed for Nile tilapia. Aquaculture, 81: 303-314.

تأثير نُظم التغذية على أداء النمو والاستفادة الغذائية وتركيب الجسم والكفاءة الاقتصادية فى أسماك اللوت

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فى دراسة حقلية فى أقفاص شبكية لمدة أثنى عشر أسبوعا فى ماء شروب تم تغذية صغار (وزن أولى 1-1.5 جم) أسماك اللوت (بعد فترة تمهيدية 45 يوما، بتخزين عدد 100سمكة / قفص / معاملة غذائية) على ثلاث علائق تجريبية محببة غاطسة، هى عليقة طبيعية تتكون من السمك البلطى المفروم، عليقة صناعية (أ) المفترض بها 32 % بروتين خام، عليقة صناعية (ب) المفترض بها 42 % بروتين خام. قُدم العلف لمدة 6 أيام / أسبوع، ولقد أظهر التحليل الكيماوى للعلائق على أساس المادة الجافة أن البروتين الخام فى العليقتين الصناعيتين منخفض (33.47 % و 36.81 %) عما فى العليقة الطبيعية (37.18 %)، كما انخفضت نسب كل من المستخلص الإيثيرى والرماد وارتفعت الكربوهيدرات عما فى العليقة الطبيعية. وتراوحت قيم درجات حرارة الماء ما بين 23 و 25 °م، والأس السالب لتركيز أيون الهيدروجين 7.7-8.0، والملوحة 14.0-17.5 ‰. لم يختلف وزن وطول السمك معنويا بين المعاملات، ورغم ذلك كان هناك اختلاف معنوى بين الفترات فى كل من العليقة الطبيعية والعليقة الصناعية (ب)، ورغم عدم اختلاف الطول للسمك بين المعاملات، إلا أن العليقة (أ) أدت لأقل وزن نهائى، لكن لم تختلف الأوزان النهائية بين العليقتين الطبيعية و (ب) رغم تفوق الوزن الأولى للعليقة الطبيعية عن العليقة (ب). حققت العلائق الصناعية (خاصة العليقة ب)أفضل عائد فى وزن الجسم كلى ويومى خلال فترة التجربة الكلية، ولقد زاد العائد فى وزن الجسم المطلق بزيادة العمر. حققت العلائق الصناعية (خاصة العليقة ب)أفضل عائد فى طول الجسم كلى (130-350 %) ويومى (130-355 %) خلال فترة التجربة الكلية، ولقد انخفض العائد فى طول الجسم المطلق (عكس العائد فى وزن الجسم المطلق) بزيادة العمر، مما ينعكس على قيم معامل الحالة. زاد معامل الحالة بالعمر، وذلك لزيادة الوزن عن الطول، لكن انخفض على العلائق الصناعية. وانخفض كل من معدل النمو النسبى ومعدل النمو النوعى والزيادة فى طول السمك بالعمر (على العكس من الوزن المطلق الذى كان يزيد) على العلائق الصناعية، لكن زاد كل من معدل النمو النسبى بمعدل 238 و 250 % ومعدل النمو النوعى بمعدل 162 و 166 % والزيادة فى طول الجسم بمعدل 229 و 240 % على العليقتين (أ) و (ب) مقارنة بالعليقة المقارنة (الطبيعية). أظهرت العلائق الصناعية (خاصة العليقة ب) أفضل استهلاك غذائى (بـ 13.6 %)، وأفضل تحويل غذائى (بـ 31.5 %)، وأفضل كفاءة غذائية (بـ 45 %)، كما حسنت كل من معدل كفاءة البروتين والقيمة الإنتاجية للبروتين و والطاقة المحتجزة بمعلات 47.8، 12.9، و 31.6 % عن العليقة المقارنة الطبيعية. زاد فى جسم الأسماك محتواه من كل من البروتين الخام، والمستخلص الإيثيرى والطاقة بتقدم العمر، ولم تختلف معنويا أى من نسب مكونات التحليل الكيماوى لجسم السمك فيما بين المعاملات الغ1ائية، رغم أن العلائق الصناعية (خاصة العليقة ب) قد أدت لزيادة المحتوى البروتينى والطاقة فى جسم الأسماك مع انخفاض المحتوى الدهنى والرماد عن العليقة المقارنة. أدت العلائق الصناعية الى زيادة تكاليف إنتاج كيلو جرام زيادة فى وزن جسم الأسماك بمعدل 318 و 320 % عن العليقة الطبيعية، إلا أن العلائق الصناعية قد زادت من سعر العائد من الزيادة فى وزن جسم الأسماك بمعدل 111.8 و 126 % عن العليقة الطبيعية، فزادت بالتالى اقتصاديات إنتاج أسماك اللوت على العلائق الصناعية بمعدل 357.3 و 403.7 % مقارنة بالعليقة المقارنة على الترتيب. وعلى ذلك يمكن التوصية بإنتاج أسماك اللوت بتغذيتها صناعيا على عليقة مُحببة (37 % بروتين خام) والتى تؤدى الى تحسن فى النمو والاستفادة الغذائية وتركيب الجسم واقتصاديات الإنتاج عن الغذاء الطبيعى.