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# Studies on Fish Production : Growth and Survival of Eel (*Anguilla anguilla*) Fingerlings fed at Different Intake Levels

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## ABSTRACT

A fish production trial was carried out to study the effect of different feeding levels on growth, survival, feed conversion ratio (FCR), total production, body composition and cost benefit of eel (*Anguilla anguilla*) fingerlings. Eight fiberglass tanks , each one hold about 0.2$m^3$, were used to stock 10 fingerlings / tank (50 fish/$m^3$) with an average of 35.30 g/fish initial size. Four different feeding levels (2, 4, 6 and 8 % of biomass weight of fish) were tested in the experiment. Fish were fed on the experimental diet which contains 27% crude protein plus trash fish at a rate of 2 to 1 .The daily feed was divided into two equal parts for 210 days feeding period. The obtained results indicated that growth performance of eel (*Anguilla anguilla* ) was related directly to feeding levels. It was increased as feeding level increases. The specific growth rate (SGR) values were 0.88, 0.94, 1.00, and1.08%/day for fish received 2, 4, 6 and 8% feeding levels, respectively. However, feed conversion ratio (FCR) improved by decreasing the feeding levels. The best FCR value was obtained at low feeding level (2% biomass weight). On the other hand, fish production improved with the increase of feeding levels. From economic view, low feeding level (2%) had lower feed cost and higher profit index than all other tested feeding levels .This indicated that this level was economically recommended to be used in eel (*Anguilla anguilla*) feeding, under similar conditions to those of the present study.

**Key word :** Eel (*Anguilla anguilla* ), Tank culture , Feeding levels , Growth, Survival , Fish production , Cost benefit.

## INTRODUCTION

The European eel , *Anguilla anguilla*, is one of the most important warm water fish species cultured in southern Europe and the Mediterranean as well as in northern countries including Germany , the Netherlands and Denmark (Nielsen and Esteve- Gassevt, 2006). *Anguilla anguilla* is distributing along the Nile River specially the north Delta region near

Brollos, Mnzalah ,Idko, Maryout lakes and costal Lagoons. Eel farms will be successful in Egypt because of the Egyptian climate is very suitable for eel farming and production costs in Egypt is lower than Japan and Taiwan (Hamza, 1996 and GAFRD, 2005).

Family Anguillidae had variable feeding levels according to water temperature , size and food type. Kafuku and Ikenoue (1983) showed that the ideal feeding level of young eels is 2-6% of the total biomass and 1-3% for the adult daily .Increasing the stocking density from 50 to 75 eel/$m^3$ in fiberglass tanks decreased significantly body weights regardless of protein level fed (25-35% ). A diet containing 25% protein plus trash fish at a rate of 2 to 1 seemed to be the best in terms of ratio of return to total costs due to the higher costs of eel fish food (Bakeer *et al.*, 2003)

The present study is an attempt to study the effect of different feeding rates on growth performance, feed conversion ratio, survival rates, total fish production and economical efficiency of eel (*Anguilla anguilla*) cultured in tanks .

## MATERIALS AND METHODS

The experiment was conducted during one growing season for 210 days at tanks were located in private fish farm at Idko Lake, Behira, Governorate. Eight circular fiberglass tanks each of 0.2$m^3$ volume were used each tank was covered with nylon net (1 mm mesh) .The experimental fish were obtained from Idko Lake. The fish caught were transported in small bucket [30L-capacity] immediately to a circular fiberglass tanks filled with freshwater. Freshwater was added gradually to the bucket containing the caught fish, in order to acclimate it to rearing water temperature .Fish spent one week in the rearing tank .During this period, healthy fish of similar weight replaced the dead one and then ten fingerlings of fish having similar weight 35.15–35.45g/fish were selected and distributed randomly into eight fiberglass tanks to represent the four treatments (2,4,6 and 8% of biomass weight of fish), each in duplicate.

Experimental fish were reared in fresh water at temperature, pH, dissolved oxygen and photoperiod values being 27±0.3$^oC$, 8.5±0.2, 6 ppm and 12 hour, respectively .Water was changed one time daily at rate of 25% of the total volume. Fish were fed the experimental diet containing 27% crude protein plus trash fish at a rate of 2 to 1 at two times daily (10.00a.m. and 15.00 p.m.) five days a week .Fish were weighted at two weeks intervals and feed amounts were adjusted on the basis of the new fish weight .Feed was offered as paste in floating fodder made of P.V.C pipes as a frame with a net inside the frame to keep the feeds available for the fish.

The experimental diet was prepared by mixing dry ingredients with water through meat mincer .The diet stored at -20$^{o}$C until used.

Fish samples were taken at the beginning and at the end of the experiment to determine body composition .Chemical analysis of feed and fish were done according to the methods described by A.O.A.C. (1990) for crude protein, crude fat, crude fiber, ash and dry matter. Composition of the experimental diet is illustrated in Table (1).

Table (1): *Ingredients and chemical composition of the experimental diet* .

| **Ingredients** | **%** | **Chemical composition** | **%** |
|---|---|---|---|
| Fish meal | 25 | Dry mater % | 89.65 |
| Soybean meal | 20 | % on the DM bais | |
| Yellow corn | 10 | Crude protein | 27.38 |
| Wheat milling by-product | 10 | Ether extract | 9.80 |
| Starch | 24 | Crude fiber | 2.00 |
| Sunflower oil | 2.5 | Nitrogen free extract | 52.22 |
| Fish oil | 2.5 | Ash | 8.6 |
| Lysine | 0.25 | Gross energy kj.g$^{-1}$ | 19.31 |
| Methionine | 0.25 | | |
| Cholesterol | 0.5 | | |
| Vitamin C | 0.5 | | |
| Vitamins premix [1] | 2.0 | | |
| Minerals premix [2] | 2.0 | | |
| Sodium chloride | 0.5 | | |

*1-Vitamins premix contained 12,000 000IU, 2.000 000IU, 10g,2g,1g,4g,1.5g,10g, 20g, 10g, 1g, 50 mg and 500mg of vitamin A, $D_3$,E, K,$B_1$,$B_2$,$B_6$,$B_{12}$, nicotinic acid , pantothnic acid, folic acid , biotin and cholin , respectively.*

*2- Minerals premix contained 13.4 , 33.4, 3.2 , 13.4 , 23.2 , 8.4, 4.2, 0.6, 0.6, 0.6 and 897.4g of calcium di-hydrogen phosphate , calcium lactate , ferric citrate , magnesium sulfate , di-potsium phosphate, sodium hydrogen phosphate, sodium di- hydrogen phosphate , aluminum chloride , zinc sulfate , cupped sulfate and manganese sulfate , respectively.*

*3- The gross energy was calculated by using factors of 23.6, 39.4 and 17.2 k joule g$^{-1}$ of protein , lipid and carbohydrate , respectively ( NRC, 1993)*

The Economical efficiency for fish production was calculated based on the profit index, cost of feed intake and the price of the fish production according to the market price at the time of harvesting.

Live body weight (g) of individual fish was measured at the start and the end of the experimental period for each tank .Growth performance and feed conversion ratio were calculated .

The statistical analysis of data was carried out by applying the computer program (Harvey, 1990). Differences among means were tested for significance according to Duncan's multiple range test (1955) .

## RESULTS AND DISCUSSION

Results in Table (2) show the effect of different feeding levels on growth, feed intake, feed conversion ratio (FCR) and survival. Results indicated that eel (*Anguilla anguilla*) weighed 35.30 g/fish reached to 225, 258, 290 and 345 g/fish in 210 days when fed daily at 2, 4, 6 and 8% of their live body weight, respectively, and gained 0.90, 1.06, 1.21 and 1.47 g/day, respectively. The specific growth rate (SGR) values were increased from 0.88 at low level (2%) to 1.08%/day at the highest level (8%). SGR values were 0.88, 0.94, 1.00 and 1.08 %/day for fish that received 2,4,6 and 8% of BW feeding levels, respectively (Table 2). Results showed that increasing of feed amount for fish resulted in an increase of feed conversion ratio. Values of FCR were 1.60,2.30,2.80 and 3.50 for fish fed daily on 2,4,6 and 8% of their live weight, respectively. However, growth was increased by feeding levels increases, the optimum level under the present conditions of this study was 2% of body weight, which achieved low FCR (Table 2).

Growth performance was found to be directly related to feeding levels. Results indicated that eel *Anguilla anguilla* has a good appetite for the experimental diet, which mixed daily with minced boiled trash fish at a ratio of 2:l during the experimental period. Final body weight, daily gain, and SGR of eel increased with increasing quantities of feed daily. On the other hand, FCR values declined as feeding level increases. Pervious studies on other fish species were confirmed with these results, Omer (1984) with *Cyprians carpio*, Omer (1986) with *Tilapia zilli*, Meyer-Bugelorff *et al*. (1989) and Sayed and Abou-Seif (2006) with *O.niloticus*. They reported that SGR increased with each increase in feeding levels that ranged from 2 up to10%. Abdel-Hakim *et al*. (2000 and 2001) found that SGR improved significantly in tilapia and Eel as the level of protein increased from 20 to 32 or 44%. In addition SGR was 1.2 and 1.3 %/day for eel (*Anguilla anguilla*) weighing 35.0 g. and fed on commercial diets containing 25 to 35% crude protein (Bakeer *et al.*, 2003)

Table (2): *Least square means and standard errors for the effect of feeding levels on growth, feed intake , feed conversion ratio and survival of eel(Anguilla anguilla).*

| Feeding levels | Initial weight ( g/fish) | Final weight ( g/fish) | Daily gain (g) | SGR* (%/day) | Feed intake (g/fish) | FCR** | Survival*** |
|---|---|---|---|---|---|---|---|
| 2% | 35.30 | 225 d | 0.90 d | 0.88 c | 303.52 d | 1.60 d | 100 a |
| | ±a 0.42 | ±5.31 | ±0.06 | ± 0.02 | ±0.250 | ±0.020 | ±1.43 |
| 4% | 35.12 | 258 c | 1.06 c | 0.94 b | 512.62 c | 2.30 c | 100 a |
| | ±a 0.42 | ±5.31 | ±0.06 | ±0.02 | ±0.250 | ±0.020 | ±1.43 |
| 6% | 35.45 | 290 b | 1.21 b | 1.00 a | 712.74 b | 2.80 b | 90 b |
| | ±a 0.42 | ±5.31 | ±0.06 | ±0.02 | ±0.250 | ±0.020 | ±1.43 |
| 8% | 35.60 | 345 a | 1.47 a | 1.08 a | 1082.90 a | 3.50 a | 90 b |
| | ±a 0.42 | ±5.31 | ±0.06 | ±0.02 | ±0.250 | ±0.020 | ±1.43 |

*Values are means ± SE of two replications.*

*Means in the same column having the same superscript are not significant by differed at 0.05 level.*

**Specific growth rate (SGR) = (Ln final wt-Ln initial wt)× 100 /days*

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

**** Survival rate % = (Final No of fish / Initial No of fish) × 100*

In the present study, daily gain ranged from 0.90 to 1.47 g/day for fish fed at 2-8 % feeding levels, respectively. This gain is higher than that found for eel reared in earthen ponds in polyculture system with tilapia and mullet by Gousset (1990)

and Abdel -Hakim *et al.* (2001). The differences between the two studies may be due to condition and culture methods. Also, Bakeer *et al.* (2003) reported that daily gain of eel *Anguilla anguilla* reared in tanks reached to 293.02 g in 185 days with an average gain of 1.58 g/day. Relationship between feeding rate, growth and FCR was described by De-Silva and Anderson (1995). They reported that, there is a rapid increase in growth rate when the feeding rate is over maintenance requirement since the energy consumed equals the energy required by fish to maintain itself without mobilizing endogenous energy reserves. Then, growth increases at a decreasing rate to a point that is the maximum of feeding rate. Moreover, FCR decreases as the feeding rate increases towards to the maximum rate. However, this level varies according to the fish species, water temperature and fish size. In the present study, FCR was improved by decreasing the feeding levels. These results are completely in agreement with those obtained by Omer (1986); El-Sayed *et al*., (1993), El-Ebiary (1994); Abdel-Hakim *et al*. (2000 and 2001) and Bakeer *et al.* (2003). They found that increasing feeding level and improved growth, but increased FCR.

Survival rate decreased to 90% for fish fed at 6 and 8% feeding levels However no mortality was observed for fish fed at 2 and 4% feeding levels (Table 2). These results are in agreement with those of Abdel - Hakim *et al*. (2001) and Bakeer *et al.* (2003).

### *Chemicals composition of the whole fish body*

Results of Table (3) revealed that increasing feeding level from 2 to 8 of BW increased significantly ($P<0.05$) the percentages of dry matter and crude fat contents in eel (*Anguilla anguilla*) whole body. On the other hand, crude protein and ash decreased significantly ($P<0.05$). These results may indicate that fat contents in eel (*Anguilla anguilla*) whole bodies increased on the costs of the protein contents. This is true, thus eels fed on higher protein diets grow faster and utilized the dietary protein as an energy source which resulted in deposition of more fat rather than body muscles.

These results are in partial agreement with the findings of Abdel-Hakim *et al*. (2000 and 2001) and Bakeer *et al*. (2003). They reported that increasing the protein level in the diet of eel reared in ponds and tanks decreased protein contents and increased fat in the whole fish body. Also, El-Dakar (1999) reported that there is a positive correlation between dry matter and fat contents of rabbit fish. Initial fish had

Table (3): *Least square means and standard errors for the effect of different feeding levels on body composition of eel (Anguilla anguilla).*

| Feeding levels | Dry matter% | % on DM basis | | |
|---|---|---|---|---|
| | | Crude protein | Crude fat | Ash |
| Initial fish | 26.90 | 63.80 | 17.07 | 19.12 |
| 2% | 28.82 b ± 0.53 | 63.02 a ± 0.94 | 19.05 c± 0.64 | 17.92 a ± 0.28 |
| 4% | 28.97 b ± 0.53 | 62.83 a ± 0.94 | 23.05 c± 0.64 | 14.11 b ± 0.28 |
| 6% | 29.31ab ± 0.53 | 61.66 b ± 0.94 | 25.31 b± 0.64 | 13.02 c ± 0.28 |
| 8% | 30.90 a ± 0.53 | 58.70 c ± 0.94 | 28.29 a± 0.64 | 13.00 c ± 0.28 |

*Values are means ± SE of two replications.*
*Means in the same column having the same superscript are not significant differed at 0.05 level.*

higher contents of protein and ash than fish at the end of the experiment. However, fat and dry matter contents of fish have an increasing trend with increasing feeding levels from 2 to 8 % of their live weight.

***Total fish production (kg /$m^3$)***

Total fish yields (kg /$m^3$) as affected by feeding levels are presented in Table (4). Results revealed that total fish yields at harvesting for 2,4,6 and 8 % daily feeding levels of biomass weight of fish were found to be 11.25,12.90, 13.05 and 15.52 kg /$m^3$ , respectively. These results indicate that increasing feeding levels from 2 to 4% resulted in an increase in fish total yield by 14.6% and a further increase in the feeding level to 6% resulted in an increase in the total yield by 16.00% and a further increase in the feeding level to 8% resulted in an increase in the total yield by 38.0% compared to the lowest feeding level (2%).

These results indicated that the maximum net production rate was obtained from the feeding level (8%), being 15.52 kg/$m^3$ but the lowest net production rate was found at the (2%) being 11.25 kg/$m^3$. These results indicated that feeding levels of 8% or above 8% are required for better yields of eel culture in tanks.

These results are in partial agreement with the finding of Gousset(1990), Abdel-Hakim *et al.* (2000 and 2001) and Bakeer *et al.* (2003) who reported that increasing the protein level in diets of eel in tanks from 25 to 35 plus trash fish increased the total yield kg/$m^3$.

***Cost benefit***

The feed cost and profit index of the tested feeding levels resulted in an increase of feed cost (Table 5). On the other hand, profit index was improved by decreasing the feeding levels. The best feeding level achieved low feed cost and high profit index was 2%. Therefore, from the view point of economic production, using this level in eel *Anguilla anguilla* feeding in fish production is recommended. These results are in completely agreement with kafuku and Ikenoue (1983) and partial agreement with of El-Daker (1999), working with rabbit fish reared in tanks.

Table (4): *Effect of different feeding levels on total fish production eel (Anguilla anguilla) kg/$m^3$.*

| **Feeding levels** | **Total production kg/tank (200 L)** | **Total production kg/$m^3$** | **% of the smallest value** |
|---|---|---|---|
| 2% | 2.25 | 11.25 | 100% |
| 4% | 2.58 | 12.90 | 114.6% |
| 6% | 2.61 | 13.05 | 116.0% |
| 8% | 3.10 | 15.52 | 138.0% |

Table (5) *Costs of feed and profit index per one kg fish( in LE )at different feeding levels.*

| Items | Feeding level (% of biomass) | | | |
|---|---|---|---|---|
| | **2%** | **4%** | **6%** | **8%** |
| Feed intake per one kg gain(kg) | 1.60 | 2.30 | 2.80 | 3.50 |
| Cost of feed intake[1](LE)[2] | 3.20 | 4.60 | 5.60 | 7.00 |
| % of the smallest value | 100% | 143.75 | 175.00 | 218.75 |
| Profit index[3] | 7.81 | 5.43 | 4.46 | 3.57 |
| % of the smallest value | 218.76 | 152.10% | 125.00% | 100% |

*1- Price of one ton of feed equal 2100 L.E*

*2- LE means Egyptian pound 0.16 US$*

*3- Profit index = income of kg gain of fish /feed intake cost ( price of fish was calculated as 25.00 LE per 1kg fish ).*

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**دراسات على إنتاج الأسماك : النمو والإعاشة لاصبعيات ثعبان السمك تحت مستويات تغذية مختلفة**

محمد نجيب بكير

قسم بحوث الاستزراع السمكى- المعمل المركزى لبحوث الثروة السمكية بالعباسة- شرقية.

أجريت هذه الدراسة بغرض التعرف على تأثير اختلاف مستويات التغذية على النمو والإعاشة ومعدل التحويل الغذائى و الإنتاج الكلى والتقييم الاقتصادى لأسماك ثعبان السمك، تم تسكين عشرة اصبعيات ( ٥٠ سمكة/ متر مكعب ) بمتوسط وزن ابتدائى ٣٥.٣٠ جم/ سمكة فى أحواض فيبرجلاس سعة ٠.٢م$^{٣}$ . استخدمت أربعة مستويات من التغذية يومياً هى ٢ ، ٤ ،٦ ، ٨% من الوزن الحى للأسماك . وقد غذيت الأسماك مرتين يوميا لمدة ٢١٠ يوما وقد تم تغذية الأسماك على عليقة تجارية احتوت على ٢٧%بروتين خام بالإضافة إلى مفروم الأسماك بنسبة ٢ : ١. وقد أوضحت النتائج المتحصل عليها أنه بزيادة مستويات التغذية يزداد النمو لأسماك الثعبان وكانت قيم معدل النمو النوعى ( SGR) للأسماك التى تغذيت على ٢، ٤، ٦ ، ٨ % من الوزن الحى هى ٠.٨٨ ، ٠.٩٤ ،١.٠٠ ،١.٠٨% لكل يوم على التوالى . وقد تحسنت قيم معدل التحويل الغذائى (FCR) بنقص معدلات التغذية فقد أعطى المستوى المنخفض من الغذاء (٢%) أفضل معدل تحويل . ومن ناحية أخرى فقد تحسنت قيم الإنتاج الكلى لثعبان السمك بزيادة معدلات التغذية ومن الناحية الاقتصادية زادت كميات الأعلاف المستهلكة وتكلفة الغذاء لكل كيلو جرام من الأسماك المنتجة مع انخفاض ملحوظ فى صافى الأرباح و أعطى المستوى ٢% من الوزن الحى اقل تكلفة غذاء لكل كجم سمك و أعلى دليل ربحية عن كل المستويات الأخرى المختبرة ولذا فتوصى الدراسة باستخدام هذه المستوى فى تغذية اصبعيات ثعبان السمك تحت الظروف المماثلة لظروف التجربة.