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دراسات بيولوجية واقتصادية
على استزراع ثعبان السمك فى تنكات

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دراسات بيولوجية واقتصادية على استزراع ثعبان السمك فى تنكات

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الهدف من هذه الدراسة هو تقييم استزراع ثعبان السمك فى تنكات فيبرجلاس تحت كثافات تخزين مختلفة مع استخدام مستويين من البروتين فى العليقة المغذية فى موسم نمو استمر ١٨٥يوم، حيث تم استخدام اربع معاملات مختلفة عباره عن عدد أثنين عليقة تجارية احتوت الأولى على ٢٥ والثانية على٣٥ % بروتين خام بالإضافة الى مفروم الأسماك بنسبة ١:٢ مع معدل تخزين للأسماك ٥٠ او ٧٥ اصبعية ثعبان سمك للمتر المكعب بمتوسط وزن ٣٥ جرام. تم تكرار كل معاملة مرتين.

أفضل معدل نمو تم الحصول عليه من العليقة ٣٥% بروتين بالإضافة لمفروم الأسماك ومن الناحية الأخرى أدى زيادة كثافة ثعبان السمك فى التنكات من ٥٠-٧٥ اصبعية الى نقص ملحوظ فى اوزان الجسم بغض النظر عن مستوى البروتين فى العليقة.

وكذلك كان لمستويات البروتين تأثير معنوى على النسب المئويه للتركيب الكيماوى للأسماك ، الرطوبة والبروتين والدهون والرماد فى اجسام الأسماك. ونفس النتائج تم الحصول عليها بالنسبة لتأير كثافات التخزين على التركيب الكيماوى.

ومن الناحية الاقتصادية اظهرت النتائج ان مستوى البروتين ٢٥% بالإضافة لمفروم الأسماك اعطى افضل النتائج بالنسبة للعائد الصافى الى التكلفة الكلية بسبب ارتفاع سعر العلائق المغذية لثعبان السمك.

BIOLOGICAL AND ECONOMICAL STUDIES OF EEL (*Anguilla anguilla*) CULTURE IN TANKS

By

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ABSTRACT

The present study was carried out to evaluate eel (*Anguilla anguilla*) culture in fiberglass tanks at different stocking density using two levels of dietary protein throughout 185 days growth period. The four treatments applied included commercial diet containing (25 or 35 crude protein) plus trash fish at a rate of 2 to 1 within each two densities (50 or 75/m³ eel elvers 35 g . average initial weigh) were tested. Each treatment was performed in duplicates.

The best growth rate was obtained with 35% dietary protein; on the other hand, increasing the stocking density form 50 to 75 eel / m³ decreased significantly body weights regardless of protein level fed.

Dietary protein levels had significant effect on the percentages of moisture, protein, fat and ash, and the same results were recorded for the effect of stocking density on the chemical composition of fish flesh. From the economical point of view a diet containing 25 % protein plus trash fish seemed to be the best in terms of ratio of returns to total costs due to the higher costs of eel fish food.

Key words: Eel culture;tank; production possibilities and water quality

INTRODUCTION

Climatic and economical considerations allowed Japanese and North-European farmers to get profit out of European eels (*Anguilla anguilla*) cultivated according to distinct techniques (Gousset,1990). A polyculture of eel (*Anguilla anguilla*), Nile tilapia(*Oreochromis niloticus*) and Grey mullet(*Mugil cephelus*)could be applied in cages using a mixture of commercial diet containing 45% protein with trash fish at a ratio of 2 to 1 for best yield and growth performance. However the highest net returns were obtained with trash fish due to the lower costs of the diet (**Abdel-Hakim,** *et al.* 2001).

Abdel- Hakim, *et al.* (2001a) reported that tilapia, mullet and eel can be cultured together in earthen ponds and growth parameters of the three species improved with each increase in the dietary protein level fed from 20, 32 and 44%, however a diet contained 32 % protein seemed to be the best from the economical point of view.

Supplementary or complete artificial feeds are more effective way of increasing the available foods for fish compared to fertilization and consequently fish production per unit area. Development of artificial feeds became important for intensive fish culture in Egypt (Hamza, 1996); however, supplementation of complete formulated ratios is a principle factor in aquaculture to increase growth and production of reared fish. Meanwhile, realization of the optimum protein level for cultured fish would help in reducing the costs and maximizing the feed conversion efficiency (Charles *et al.*, 1984; Sampath, 1984 and Chiu *et al* 1987).

The aim of the present study was to investigate the effect of dietary protein levels on growth performance; water quality; productivity and economical efficiency of eel (*Anguilla anguilla*) cultured in tanks at different stocking density.

MATERIALS AND METHODS

The present study was carried out in a private farm at El- Mahmoudiya -Behira Governorate, Egypt. The experiment was conducted during one growing season for 185 days. Eight circular tanks each of one m^3 volume were used. The four tanks represent two stocking densities (50 or 75fish / m^3) and within each density two protein levels (25 or 35%) were tested. The experimental fish were obtained from Idko Lake, Behira Governorate. Fish were transported in a tank and after arrival to the farm they were adapted to the new conditions for 7 days, and then distributed randomly into eight fiberglass tanks to represent the four treatments each in duplicate. The initial weight of the eel at the start of the experiment was 35.08 ± 0.2 g/fish. Fish were fed on the experimental diets two times daily (10 a.m. and 2 p.m) five days a week at a rate of 3% of their biomass. Feed amounts were monthly adjusted on basis of the new fish weight. Feed was offered 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.

Water temperature, dissolved oxygen and pH were measured daily at 6^{00}a.m. and 12^{00} p.m. using temperature and dissolved oxygen meter

(YSI model 57) and pH meter (model Corning 345). Determinations of water quality parameters (alkalinity, phosphorus and ammonia were carried out every two weeks according to the methods of Boyd (1979).

Two experimental diets were formulated to contain 25 and 35% crude protein. Compositions of the two experimental diets are illustrated in table (1). The two tested diets were analyzed for dry matter, crude protein, ether extract (EE) and ash contents according to A.O.A.C. (1990) Gross energy (GE) contents of the experimental diets was calculated according to Omar (1984).

Live body weight and length of individual fish at start and monthly were recorded till the termination of the experiment. specific growth rate (SGR) was calculated using the following equation:-

$$SGR\% = 100\ (Ln\ W_2 - LnW_1)\ /\ T2-T1$$

Where W_2 is the weight at final time and W_1 is the weight at first time and Ln is the natural log. (Bagenal and Tesch, 1978)

At the experimental end 6 fish were taken randomly from each treatment. Six fish were exposed to chemically analyze for the whole fish according to the methods of A.O.A.C. (1990).

Statistical analysis:

The statistical analysis of data was carried out by applying the computer program Harvey, (1990) by adopting the following fixed model.

$$\mathbf{Y_{ijk} = \mu + P_i + S_j + (PS)_{ij} + e_{ijk}}$$

Where:

Y_{ijk} = observation of the ijk- th fish

μ = overall mean

P_i = fixed effect of the i-th protein level

S_j = fixed effect of the j-th stocking density.

$(PS)_{ij}$ =interaction between the effect of i-th protein level and j-th stocking density

e_{ijk} = random error assumed to be independently randomly distributed (0, δ^2e).

Differences between means were tested for significance according to Duncan's multiple range tests (1955).

RESULTS AND DISCUSSION

The water quality parameters

Physical characteristics:

Averages water quality parameters as affected by treatments are presented in table (2). Results revealed that water temperature is one of the physical properties that are greatly affected by treatments. It has ranged between 26 and 27.5 °C (table 2). The higher difference values of water temperature in tanks received feeds (35%CP) in all period may be attribute to the increase in organic matter contents of these tanks that may lead to temperature increases. These results are in agreement with those of Boyd, (1983); Jobling, (1983), **Abdel- Hakim,** *et al.*, (2000) and Abdel-Rahman, (2003), who found a slight increase in water temperature with increasing manure levels and the optimal temperature for Nile tilapia (*Oreochromis niloticus*) ranged between 15 and 30°C.

Chemical characteristics

Average of pH values for treatments T_1Sr_1; T_1Sr_2; T_2Sr_1 and T_2Sr_2 were 8.7; 8.7; 8.5 and 8.4 respectively. The lower values of pH in tanks received high levels of protein and high stocking rate may be attributing to the increase in organic matter contents of these tanks, which may lead to pH decreases. Averages of dissolved oxygen (DO) have ranged between 7.2 to 7.7 mg/L. These values are beneficial to fish cultivation and indicate that water dissolved oxygen slightly decreased in tanks received feeds 35% CP compared to the other tanks.

Averages of phosphorus had ranged between 0.27 and 0.37 mg/L, which represent the normal range of phosphorus in fish tanks. In this connection Fortes *et al* (1986) showed that the available phosphorus was significantly ($P \leq 0.01$) highest in the chicken manure and feed combination.

Averages of ammonia concentration (NH_3), as affected with treatments in experimental tanks had ranged between 0.14 to 0.18 mg/L and lay in the normal range. These values are beneficial to fish cultivation and agreed with the findings of Robinette (1976) who concluded that the toxic levels for unionized ammonia for short time exposure usually lie between 0.6 to 2.0 mg/L for pond fish. Also Degani, *et al.*, (1985),Abdel -HaKim *et al.*, (2000) and Abdel- Rahman, (2003), reported that ammonia production was lower in the group fed on pellets containing 25% protein and higher in the groups receiving higher protein diets and the average concentration of unionized ammonia (NH_3) had ranged between 0.53 and 0.68 ppm.

Averages of Total alkalinity have ranged between 241 to 256 mg/L. The slight differences in values of total alkalinity in tanks received feeds may be attributed to the increase in organic matter contents of these tanks.

Growth Performance:

As described in Table (3), the average body weight of fish increased from 35 to 328.1; 330.70; 391.71 and 378.13 g. for T_1; T_2 T_3 and T_4, respectively. Daily gain (g) was between 1.58 and 1.92g day. Table (3) also shows that the body length of Eel increased from 16 cm. to 33.70; 30.95; 36.97 and 35.45 cm. for T_1, T_2, T_3 and T_4, respectively. After 185 days of culture in tanks, the values of fish condition factor had recorded 0.86; 1.12; 0.77 and 0.85 for T_1, T2, T3 and T_4 respectively.

Results of SGR as affected by protein levels (25 and 35%) and stocking density (50 and 75 fish /m^3) were 1.21 for the low protein and 1.28- 1.3 for the high protein level respectively, indicating that fish fed the diet high protein level showed the high SGR records compared with those fed diet the low protein level.

As shown in table (3) increasing the stocking density from 50 to 75 fish /m^3 decreased SGR at all studied periods and this trend was observed during the whole experiment (0-185 day). These results indicated that Eel fish at lower stocking density grow better than those stocked at higher density. These results are in agreement with the findings of **Degani,** *et al.*, (1985) who reported that average weight increase of eels that were fed on a diet of pellets containing 35%, 45% or 55% protein was significantly higher than the mean weight increase of eels fed on pellets containing 25% protein. And also **Abdel- Hakim,** *et al.*, (2001) who reported that growth parameters of the three species (Tilapia, Mullet and Eel) cultured together in earthen ponds improved with each increase in the protein level fed from 20 , 32 and 44%.

With regard to the interaction between protein level and stocking density it noticed that the best SGR value was recorded by fish fed the high protein level diet (35%) and reared with the low stocking density (table 3).

Whole body composition of eel:

As illustrated in table (4), when protein level increased from 25 to 35%, the percentages of moisture, protein and ash were decreased from 43.13 to 36.4%; 44.43 to 43.72 % and 5.72 to 3.13 %, respectively and the percentage of fat increased from 49.85 to 60.52% with insignificant effect of protein level on the above reported components. These results may indicate that fat contents in eel 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 energy source which resulted in deposition of more fat rather than body muscles. The same trend was observed at treatment of 75 fish/m^3. These results are in agreement with **Abdel- Hakim,** *et al.*, (2001)who reported that eels fed on 32 or 42% protein diets had higher moisture percentages in the whole bodies compared to those fed that 20% protein diet and protein contents decreased significantly ($p<0.05$) with each increase in the protein level fed and fat percentages showed the reverse trend

Survival rate: -

The survival rates for entire period for different groups are presented in (Table 5). From Table (5) it can be seen that fish in tanks (T3) which received 35%CP at 50 fish / m^3 exhibited higher survival rate (93%) than T1and T2 treatments which resulted in 90% and 92% respectively.

Mortalities were within the acceptable range of eel culture and all mortalities recorded were due to accidental factors rather than treatments.

The most mortality figures occurred during the biweekly sampling, particularly the first month after stocking. The high initial moralities were probably due to the small size of the fish at stocking. Hepher and Pruginine, (1981) reported that mortalities are often correlated to the size of fish, since smaller fish are more susceptible to disease and handling than larger one.

Total Production and Economical Evaluation:

Table (5) indicates the changes in the total costs LE. and total yield (Kg/m^3) of eel reared in tanks under different treatments for 185days. Averages of total production costs including fingerlings price; diets and labor were found to be 190.3; 229.94; 245.55 and 298.92 LE. for the experimental groups T1; T2; T3 and T4, respectively. The higher inputs costs of groups T2 and T4 had due to the higher inputs in fingerlings (75 fish) and consequently the price of diet consumed. The maximum net production rate was obtained from the (T_4) treatment, being 26.09 Kg/M^3 But the lowest net production rate was found at the (T_1) treatment, being 14.76 Kg/m^3.

From the data in table (5) it can be seen that the gross income (from the sale of fish) varied among all treatments. Since, the (T_4) treatment had the highest income, while the (T_1) treatment had lowest income. On the other hand net returns (total returns over total costs) were the highest for treatments T2 followed by T4; T3 and T1, respectively. This may lead us to recommend a stocking density of eels at a rate of 75 fish/m^3 of tank water and feeding it on a diet with 25% crude protein, thus this group achieved the highest net income (79.39%) to the total costs These results are in agreement with **Degani,** *et al.*, (1985) who reported that production per m^3 was higher in the groups fed on 45% or 55% protein than in the groups on 25% or 35% protein. And production was higher in the groups stocked at high density and lower in those stocked at low densities. The production of slowly growing eels was lower than that of moderately growing eels. Also Gousset,(1990) found that climatic and economical considerations allowed Japanese and North- European farmers to get profit out of European eels (*Anguilla anguilla*) cultivated according to distinct techniques. Therefore results of economical evaluation suggest that applying this scheme (T_2 treatment) is viable and it is more important for expansion of eel culture in Egypt.

CONCLUSION

Based on obtained results in this study it could be recommended that a feeding system for Eel culture tanks which includes performing 25% CP. plus trash fish at a rate of 2 to 1 for five days a week at a rate of 3% of their biomass weight per tank, when the tanks are stocked with 75 eel (35 g. average weigh) /m^3.

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(Table 1): The composition of the experimental diets.

Ingredient	Diet No	
	Diet (1) (25% C.P)	**Diet (2) (35% C.P)**
Yellow corn	40.4	-
Fish meal (73.3% C.P.)	25.0	60.4
Rice	25.6	-
starch	-	26.6
Fat	4.0	-
Fish oil	-	2
Vitamin premix*	1	3
Mineral mixture**	1	2
Cellulose	2	5
Carboxymethyl cellulose	1	1
Total	100	100
Calculated diet compositions fed		
Protein%	25	35
Gross energy K cal/100g***	299.0	398.44
Analyzed % on dry matter basis		
Crude protein (C.P)	24.6	34.3
Ether extract (E.E)	11.80	10.00
Crude fibers%	4.50	5.9
Nitrogen free extract(NFE)	55.5	34.5
Ash%	3.20	14.6

*Each gram of vitamin premix contains 20.00 iu vit. A 200Iu vit. D3, 400 vit E, 20 mg Niacin 4.5 mg riboflavin, 3mg pyridoxine, 0.013 mg vit. B12, 100 mg chorine chloride and 2 mg vit.K.

**Each gram contains 0.83 Ca. 0.63P. 078 Na. 0.018 Mn. 0.011 Zn. And 0001 Cu. The Mixture was prepared by mixing 35 parts of dicalcium phosphate, 3 parts of mineral premix and 2 part of common salt.

*** According to Omar (1984).

Table (2): Averages of water quality parameters of tanks during different months of the experiment (185 days).

Treatment	Months	pH		D.O mg/L		Alkalinity mg/l ca co3		P_2O_5 mg/l	NH_3 mg/l	Temperature °C	
		6^{00}	12^{00}	6^{00}	12^{00}	6^{00}	12^{00}			6^{00}	12^{00}
Tr_1	Julie.	8.4	8.9	7.2	8.5	255	295	0.39	0.13	25	28
	Aug.	8.8	8.8	7.3	8.5	245	285	0.25	0.31	25	30
	Sep.	8.9	9.0	7.4	8.7	235	245	0.32	0.20	24	30
	Oct.	8.8	8.8	7.1	8.0	205	265	0.22	0.11	24	29
	Nov.	8.9	9.2	7.2	7.8	205	235	0.12	0.10	23	28
	Dec.	8.9	9.2	6.6	8.0	207	237	0.34	0.10	24	27
Average		8.7		7.7		241		0.27	0.15	26	
Tr_2	Julie.	8.9	8.8	7.0	8.5	211	241	0.23	0.34	25	29
	Aug.	8.9	8.9	7.1	7.8	249	289	0.26	0.16	26	30
	Sep.	8.4	9.2	7.2	8.3	239	249	0.35	0.23	24	31
	Oct.	8.8	8.8	6.4	7.8	209	269	0.40	0.14	25	29
	Nov.	8.9	9.2	7.0	7.6	209	239	0.13	0.13	23	29
	Dec.	8.8	9.0	6.9	8.3	259	299	0.33	0.13	25	27
Average		8.7		7.5		245		0.28	0.18	26.5	
Tr_3	Julie.	8.2	8.7	6.9	8.2	265	247	0.32	0.12	25	30
	Aug.	8.6	8.6	7.0	8.2	217	295	0.34	0.30	26	28
	Sep.	8.7	8.8	7.1	8.4	245	255	0.39	0.19	25	31
	Oct.	8.6	8.6	6.8	7.7	215	275	0.22	0.10	26	29
	Nov.	8.7	9.0	6.9	7.5	215	245	0.12	0.9	24	29
	Dec.	8.7	9.0	6.3	7.7	255	305	0.25	0.9	25	31
Average		8.5		7.4		251		0.27	0.14	27	
Tr_4	Julie.	8.1	8.5	6.7	8.0	270	252	0.44	0.11	26	32
	Aug.	8.5	8.6	6.8	8.0	260	300	0.32	0.10	27	30
	Sep.	8.6	8.7	6.9	8.2	240	260	0.42	0.20	25	31
	Oct.	8.5	8.9	6.6	7.5	220	280	0.35	0.13	26	30
	Nov.	8.6	8.9	6.7	7.3	220	250	0.22	0.10	24	30
	Dec.	8.6	8.5	6.1	7.5	222	315	0.49	0.31	26	28
Average		8.4		7.2		256		0.37	0.15	27.5	

Tr_1 (25% CP, 50 fish/m^3); Tr2 (25% CP, 75 fish/m^3); **Tr_3** (35% CP, 50 fish/m^3); **Tr_4** (35% CP, 75 fish/m^3)

Table (3): Least Square means and standard error for the effect of stocking density and experimental diets on growth performance of Eel (*Anguilla anguilla*).

Treatment No	Diet (1) 25%CP		Diet (2) 35%CP	
	1	2	3	4
Items	(50 f/m^3)	(75 f/m^3)	(50 f/m^3)	(75 f/m^3)
Avg. Initial Body Weight (g)	35.08^{a} ± 0.2	35.12^{a} ± 0.22	35.18^{a} ± 0.2	35.12^{a} ± 0.2
Avg. Final Body weight (g)	328.10^{c} ±1.34	330.70^{d} ±1.35	391.71^{a} ±1.33	378.13^{b}±1.35
Weight gain (g)	293.02	295.58	356.53	343.01
Daily gain (g)	1.58	1.6	1.93	1.85
Specific Growth Rate (%1 day)	1.20^{b} + 0.2	1.21^{b} ± 0.2	1.3^{a} ± 0.2	1.28^{a} ± 0.2
Initial Body length (cm)	16.34^{a}±0.45	16.21^{a}±0.45	16.24^{a}±0.43	16.35^{a}±0.45
Final Body length (cm)	33.70^{b} ±0.06	30.95^{c}±0.06	36.97^{a} ±0.06	35.45^{a} ±0.06
Condition factor (K)	0.86^{a} ±0.05	1.12^{b} ±0.05	0.77^{c} ±0.05	0.85^{a} ±0.05

Figures in the same row having the same superscript letters are insignificantly different (P≤0.05).

Table (4): Whole body composition of Eel (*Anguilla anguilla*) fed experimental diets.

Items	Diet (1) 25%CP		Diet (2) 35%CP	
	1 (50 f/m^3)	2 (75 f/m^3)	3 (50 f/m^3)	4 (75 f/m^3)
Dry matter %	43.13^{a} ± 0.63	36.13^{b} ± 0.43	36.4^{b} ± 0.45	37.74^{b} ± 1.06
Protein %	44.43^{a} ± 0.67	34.90^{b} ± 023	43.72^{a} ± 0.45	32.26^{b} ± 1.09
Fat %	49.85^{c}± 0.40	60.52^{b} ±0.39	53.15^{b} + 0.43	64.47^{a} ±0.45
Ash %	5.72^{a} ± 0.66	4.58^{a} ± 0.06	3.13^{b} ± 0.68	3.27^{b} ±0.74

Figures in the same row having the same superscript letters are insignificantly different (P≤0.05)

Table (5): Economical Efficiency of Eel (*Anguilla anguilla*) fed experimental diets in L.E./M^3

Item	Diet (1) 25%CP		Diet (2) 35%CP	
	1 (50 f/m^3)	2 (75 f/m^3)	3 (50 f/m^3)	4 (75 f/m^3)
Average size at stoking (g)	35	35	35	35
Average size at harvesting	328.10	330.70	391.71	378.13
Survival rate %	90.0	92.0	93.0	92.0
Production Kg / M^3	14.76	22.81	18.21	26.09
A- Operating costs				
Fish fingerlings	50	75	50	75
Food	40.03	54.94	95.55	123.92
Labor	100	100	100	100
Total Operating costs	190.03	229.94	245.55	298.92
B-Fixed cost				
Taxes (tank)	12.5	12.5	12.5	12.5
Depreciation(tank)	50	50	50	50
Total Fixed cost	62.5	62.5	62.5	62.5
C-Total costs/ M^3	252.53	292.44	308.05	361.42
D- Returns				
Fish sales/ M^3				
Total Returns / M^3	339.48	524.63	418.83	600.07
Net returns/ M^3	86.95	232.19	110.78	239.46
E-% Net returns to total costs	34.43%	79.39%	35.96%	66.25%

The economical evaluation of results was carried out according to market prices in 2001 in L.E