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2- REARING ADVANCED FRY OF SEA BASS (*Dicentrarchus labrax*) IN TANKS AT DIFFERENT STOCKING DENSITY AND CULTURE METHODS

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ABSTRACT

The effects of stocking density (30 and 40 fry/m^3) and culture methods (mono or polyculture) on growth performance, survival rate and feed utilization parameters of sea bass (*Dicentrarchus labrax*), advanced fry (0.26 g) reared in indoor fiberglass tanks (0.5 m^3 each) were investigated. The fish were fed artificial diet with 48% protein, two times daily to satiation for 105 days. The results revealed that:1- Sea bass advanced fry reared under moderate density (30 fish /m^3) had best growth, survival rates and feed utilization parameters; 2- Condition factor (K) was not only affected by high density; 3- Sea bass advanced fry grow better in monoculture than in polyculutre with sea bream, *Sparus aurata*, Cannibalism was the main cause of death in sea bass and bream polyculture conditions; and 4- Stocking 10 golden grey mullet, *Liza aurata*, per m^3 with 20 sea bass advanced fry did not lower sea bass growth, survival rates and condition factor.

keywords: Sea bass, Stocking density, Growth performance, Production, Culture methods.

INTRODUCTION

Sea bass, *Dicentrarchus labrax*, due to their high economical value and wide distribution in the Mediterranean Sea, Black Sea and along the Eastern Atlantic Coast from great Britain to Sengegal (Moretti *et.al.*,1999) has been studied in the natural habitat and recently in aquaculture in the Mediterranean region (Muir and Basurco, 2000). The production techniques are very diverse, ranging from extensive to highly intensive systems, involving valli systems, earthen ponds, floating cages or raceways and tanks (Essa, 1999). Intensifying the production of marine fish is atrend, which has been developed between 1984 and 1994 (Nehr *et al.*, 1998). The effect of stocking density of formed species are known for many species; salmonids, cyprinids, mullet, tilapias and African or European catfish (Holm *et al.*, 1990; Essa, 1996; Hengswat *et al.*, 1997; Hafez *et al.*, 2000), but for sea bass the knowledge was limited (Paspatis *et al.*, 2000). Therefore, the present work aimed to check of the effect of stocking density may have effects on the growth performace, survival rate and feed utilization parameters of sea bass advanced fry to rear in monoculture or polyculture with golden grey mullet (*Liza aurata*) or gilthead sea bream (*Sparus aurata*) was also assessed during the present study.

MATERIALS AND METHODS

1-Experimental studies and techniques:

Sea bass (*Dicentrarchus Labrax*) advanced fry weighe 0.26 g were obtained from Marine Hatchery of National Institute of Oceanography and Fisheries, Alexandria, in March 21, 2000. While for golden grey mullet (*Liza aurata*) advanced fry of about 3.24 g mean weight and 5.90cm mean total length, as well as sea bream (*Sparus aurata*) fry of about 1.10 g mean weight and 4.30 cm mean length, were naturally collected from El-Mudiah Boughaz, lake Edko Behera Governorate during the end of March, 2000. Eight conical bottomed fiberglass tanks (500 (l) volume each) were used during present experiment . The system was supplied with aerated filtered sea water at a flow rate of 120(l)/h/tank, by using power filter. Each tank was equipped with an airstone and an external standpipe. To evaluate the effect of stocking density, sea bass advanced fry with mean weight of 0.26g and 3.02 cm in total length were stocked in fiberglass tanks at a density of 30 and 40 fry/m^3, two tanks /treatment.

During experimental period, all experimental fish were fed on artificial diet with liver of cartilages (Table1) two times daily (9.00 A.M. and 14:00 P.M.) to satiation, 6 days a week. The mean consumption for each treatment was computed for the experimental period (105 days).

Table (1): Composition and proximate analysis of the artificial diet used in the second experiment, expressed as % of dry weight.

Ingredients	(%)
Fish meal	30
Soybean meal	20
wheat milling by- products	10
Liver of cartilages (trash)	**22**
Starch	10
Cod oil	3
Vitamin premix	2
Mineral premix	3
Proximate analysis	
Dry matter (DM)	72.2
Crude protein(CP)	48.12
Ether extract(EE)	15.11
Crude fiber(CF)	6.30
Ash	11.60
Nitrogen free extract (NFE)	18.87
Calculated gross energy (Kcal GE/100g DM)	493.90
P/E ratio	9.74

2. Water quality Determinations:

Dissolved oxygen was determined using Winkler's technique (Huet, 1972) and pH was measured using a portable pH meter (Drion Research Model 210). Ammonia, was determined according to the methods described by Golterman *et al.*, (1978).

3. Biochemical analysis:

At the end of each experiment, diets and fish samples were frozen kept for chemical analysis. The frozen samples were dried at 70°C and passed through a meat mincer into one composite homogenate per group. Contents of homogenized samples were analyzed for protein (Kjeldhal method), fat (ether extract method, Soxhelt), moisture (oven drying) and ash (burn oven) using procedures of Association of Official Analytical Chemists (AOAC, 1995). Energy content (100 g) was estimated by the following equation:

Energy content = (Protein content x 5.64)+(lipid content x 9.44) + (carbohydrates content x 4.11).

4. Growth performance:

At the end of each experiment, several measurements namely growth and feed utilization parameters were calculated as mentioned in Ballestrazzi *et al.*, (1994) as follows:

4.1. Daily weight gain = Final body weight (g)- Initial body weight (g)/ Days

4.2. Condition factor (K) = Weight (g)/ (Total length cm)^3 x100

4.3. Specific growth rate (SGR) % = (Ln W_2 - Ln W_1) x 100/ T

Where: W_2 = Weight at the end of the experiment.
W_1 = Weight at the beginning of the experiment.
T = Time (days).

4.4. Survival rate = No. fish harvested / No. of fish stocked x 100

4.5. Feed conversion ratio (FCR) = Feed intake (g)/ Weight gain (g)

4.6. Protein efficiency ratio (PER) = Weight gain (g)/ Protein intake (g)

4.7. Protein productive value (PPV) = Protein increment (g) / Protein intake (g) x100

Protein increment is the protein content in fish carcass at the end – at the start of the experiment.

5. Statistical Analysis:

Statistical Analysis were performed by using a computer software program Graph PAD instate (Version 2.01) copyright © 1990-1993 Steve Whetzel, Park- Davis 930762 A. Graph PAD software.

RESULTS AND DISCUSSION

(1) Water quality criteria:

For basic understanding of water quality in the studied tanks, water temperature, dissolved oxygen, pH, salinity and ammonia concentration were determined and are summarized in Table (2).

Table (2): Water quality criteria in indoor fiberglass tanks, during the second experiment. (April 5 to July 20, 2000)

Items	Minimum	Maximum	X' ± SE
Temperature (C°)	22	26	24 ±2.01
Dissolved oxygen(mg/l)	6.1	7.9	7.1± 0.79
PH	7.7	8.3	8.1 ±0.13
Salinity (ppt)	31.1	33.54	32.75 ± 0.49
Ammonia NH_3 (mg/l)	0.061	0.081	0.07 ±0.012

During the present study the results showed that, water temperature varied between 22-26 °C. This range was suitable to sea bass juveniles growth and feed efficiency (Peres and Oliva-Teles, 2001). They reported, the apparent digestibility coefficient of dry matter and protein for sea bass juveniles, significantly improve with the increase of water temperature from 18 °C to 25 °C. The average dissolved oxygen levels in water tanks ranged between 6.1 7.9 mg/l. These values are desirable to fish survive and growth (Erez *et al.,* 1990). pH values in the experimental water tanks were on the alkaline side,7.7- 8.3 . this range is most suitable for sea bass growth (Sayer *et al.,*1993).

The results in Table (2) revealed also that, the differences between tanks for ammonia concentrations were slightly varied between 0.061 and 0.081 mg/l. and almost laid on desirable range for marin fish rearing (Tudor *et al.,*1994).

2. Effect of stocking density:

After 105 days of sea bass advanced fry rearing at moderate (30 fish/m^3) and high (40 fish/m^3) density, the results in Table (3) revealed that sea bass advanced fry reared under low density (30 fish/m^3 or L30) had the heaviest body weight and longest body length comparing with those reared in high density (40 fish/m^3 or H 40).

Table (3): Average initial and final individual body length weight and condition factor (k) of sea bass, *Dicentrarchus labrax*, advanced fry.*

Items	30 fry / m^3 (x' ±SE)	40 fry / m^3 (x' ±SE)
1- Stocking data		
Av. initial length (cm)	3.08 ± 0.05	3.12 ± 0.04
Av. initial weight (g)	0.26 ± 0.01	0.25 ± 0.09
Av. initial condition factor (k)	0.89 ± 0.01	0.83 ± 0.02
2- Harvesting data *		
Av. Final length (cm)	8.81 ± 0.23^a	7.64 ± 0.24^b
Av. Final weight (g)	6.21 ± 0.29^a	4.54 ± 0.28^b
Av. Final condition factor (k)	0.90 ± 0.08^a	1.01 ± 0.10^a

*** Different superscript in the same row, indicates significant differences ($P < 0.05$)**

Condition factor (K) was only not affected by high stocking density, whereas high density group was higher values than low density group (0.90 vs 1.01). But the differences due to densities between body weight and body length were insignificant ($P < 0.05$) (Table 3).

On the other hand, for Table (4) it is noticed that, sea bass advanced fry stocked at 30 fish/m^3 attained highest means of average total and daily length gain (5.73 cm and 0.55mm/day, respectively), average total and daily weight gain (5.95g and 56.67 mg/day, respectively), specific growth rate (3.16 vs 2.87%/day) as well as total weight gain (148.76 vs 107.09 g/m^3) as compared with those stocked at 40 fish/m^3.

Table (4): The effects of different stocking densities on growth performance of sea bass, *Dicentrarchus labrax* advanced fry .

Items	Stocking densities	
	30 fry / m^3	40 fry / m^3
Individual total length gain (cm)	5.73	4.52
Individual daily length gain (mm/day)	0.55	0.43
Total weight gain (g) fish	5.95	4.28
Daily weight gain (mg/day)	56.67	40.80
Specific growth rate (SGR%)	3.16	2.87
Total fish weight gain (g/m^3)	148.76	107.09

Survival rate was also significantly ($P<0.05$) affected by high stocking density (Table 25). L30 presented the highest survival rate (83.3%), while H40 the lowest (62.50%).

Table (5) : Effect of different stocking densities on the fish survival rates of sea bass , *Dicentrarchus labrax* advanced fry reared in indoor basins (0.5 m^3 each) for 105 days.*

Stocking densities	No. of fish harvested fish/m^3	Survival rate (%)
30 fry /m^3	25.00	83.33 ± 5.6^a
40 fry /m^3	25.00	62.50 ± 7.13^b

*** Different superscript indicates significant differences ($P < 0.05$).**

The results of the present experiment demonstrated that, the growth performance and survival rate decreased significantly with higher density at identical feeding regimes. This is in agreement with Holm *et al.*, (1990), Seafdec (1990), Via *et al.*, (1998), Paspatis *et al.*, (2000) and Hatziathanasiou *et al.*, (2002). They found that a decreased growth rate with increasing density can be explained by reduced feed consumption, protein and energy utilization, or /and increased energy-demanding activity levels connected with social interactions. Metcalfe (1986) reported a positive correlation between metabolic expenditure and feed intake influenced by social behavior in rainbow trout, and this may explain the differences found in growth between different densities. The results of feed utilization parameters during the present experiment supported these findings. Table (6) showed that feed efficiency correlated negatively with fish density. L30 sea bass advanced fry utilized artificial diet better than H 40 group by 51.7%, 53.0%, 51.7% and 19.6% for feed conversion ratio, Protein productive value, protein efficiency ratio and energy utilization, respectively.

According to Essa *et al.*, (1989) and Holm *et al.*, (1990) for mullet, carp and rainbow trout, feed availability has an increasing importance for a high growth rate when densities increase. Therefore, density effects on growth extremely sea bass advanced fry can partly be compensated for by feeding regimes (continuously or hourly feeding).

Table (6): The effects of different stocking densities on feed utilization parameters [feed conversion ratio (FCR),protein efficiency ratio (PER),protein productive value (PPV),energy utilization(EU)] of sea bass, *Dicentrarchus labrax* advanced fry.*

stocking densities	Total weight gain (g/m^3)	Total feed consumed (g/m^3)	(FCR)	PROTEIN UTILIZATION		EU (%)
				PPV (%)	(PER)	
30 fry/m^3	148.76 ± 4.63^a	311.68 ± 5.61^a	2.09 ± 0.19^a	2.54 ± 0.03^a	0.99 ± 0.09^a	10.86 ± 1.35^a
40 fry/m^3	111.39 ± 3.62^b	352.61 ± 7.61^b	3.17 ± 0.35^b	1.66 ± 0.01^b	0.656 ± 0.01^b	9.08 ± 2.51^a

*** Different superscript in the same column, indicates significant differences ($P < 0.05$)**

3 Comparison between mullet, *L. aurata*, and sea bream, *S. aurata*, as additional fish in sea bass advanced fry (*D. labrax*) cultures:

Polyculture (rearing of several species together) is a way to increase fish production through better utilization of natural and supplementary feeds existing in aquatic environment (FAO, 1983). However, few results are available for rearing golden grey mullet or sea bream with sea bass under controlled conditions in 0.5 m^3 cylindroconical fiberglass tanks. Thus, on the basis of previous presented results; the experimental design was conducted in order to evaluate the performance of sea bass fry under the ployculture conditions and at 30 fish densities, which showed better results than 40 fish densities.

The average initial and final mean body length, weight and condition factor of sea bass, *D. labrax* , golden grey mullet *L. aurata,* and sea bream, *S. aurata*, advanced fry which were used in the present experiment are shown in Table (7) . Sea bass advanced fry had shortest and smallest body length and weight than those of golden grey mullet and sea bream. Sea bream advanced fry had higher of initial condition factor (k). However, the analysis of variance of the initial overall body means for sea bass monoculture, sea bass polyculture with golden grey mullet or sea bream showed that there were no significant differences (Table 7).

Generally, sea bass advanced fry grow better in monoculture than in polyculture with sea bream. Also, a stocking rate of 10 golden grey mullet (*L. aurata)* advanced fry/ m^3 did not lower sea bass body size and condition factor (Table7).

Table (7): Average initial and final individual body length weight and condition factor (k) of advanced fry sea bass , *Dicentrarchus labrax* reared in monoculture and polyculture with mullet *Liza aurata* , or sea bream *Sparus aurata* .*

Items	Monoculture	Polyculture types					
		1			2		
	Sea bass (x' ±SE)	Sea bass (x' ±SE)	Mullet (x' ±SE)	Overall mean (x' ±SE)	Sea bass (x' ±SE)	Sea bream (x' ±SE)	Overall mean (x' ±SE)
1- Stocking data							
Av. initial length (cm)	3.08 ± 0.05	3.02 ± 0.05	5.90 ± 0.20	3.90 ± 0.29	2.88 ± 0.06	4.3 ± 0.18	3.32 ± 0.15
Av. initial weight (g)	0.26 ± 0.01	0.25 ± 0.01	3.24 ± 0.30	1.16 ± 0.30	0.26 ± 0.01	1.1 ± 0.11	0.50 ± 0.08
Av. initial condition factor (k)	0.89 ± 0.01	0.94 ± 0.04	1.57 ± 0.04	1.12 ± 0.06	1.12 ± 0.04	1.31 ± 0.05	1.17 ± 0.03
2- Harvesting data *							
Av. Final length (cm)	8.81 ± 0.23 [a]	8.16 ± 0.29	8.60 ± 0.32	8.29 ± 0.02 [a]	7.31 ± 0.24	8.23 ± 0.20	7.51 ± 0.19 [a]
Av. Final weight (g)	6.21 ± 0.29 [a]	5.77 ± 0.35	8.60 ± 0.36	6.60 ± 0.37 [a]	4.60 ± 0.27	5.43 ± 0.48	4.85 ± 0.21 [b]
Av. Final condition factor (k)	0.90 ± 0.08 [a]	1.11 ± 0.08	1.32 ± 0.10	1.19 ± 0.07 [b]	1.24 ± 0.10	0.99 ± 0.12	1.17 ± 0.08 [b]

* Different superscript in the same row indicates significant differences ($P < 0.05$)

In other words, mean individual total and daily gains in body length or weight, specific growth rate (SGR) and total fish weight gain (g/ m^3) of sea bass advanced fry in monoculture and polyculture with golden grey mullet or sea bream at 105 days of experimentation are shown in Table (8). In regard to culture methods, gilthead sea bream caused a considerable decline in sea bass advanced fry individual daily length and weight gain (34.15 % and 36.88 %, respectively), specific growth rate (39.82%) and total weight gain per cubic meter (48.76%). While golden grey mullet advanced fry did not lower significantly sea bass advanced fry growth and production performance (Table 8)

Table (8):Growth performance of sea bass, *Dicentrarchus labrax* advanced fry reared in monoculture and polyculture with mullet *Liza aurata*, or sea bream *Sparus aurata*, at stocking density (L30).

Items	Monoculture	Polyculture types					
		1			2		
	Sea bass	Sea bass	Mullet	Overall mean	Sea bass	Sea bream	Overall mean
Total length gain (cm)	5.73	5.14	2.76	4.40	4.44	3.43	4.27
Daily length gain (mm/day)	0.55	0.49	0.26	0.42	0.42	0.33	0.41
Total weight gain (g)	5.95	5.51	5.36	5.43	4.33	4.33	4.35
Daily weight gain (mg/day)	56.67	52.51	51.03	51.76	41.25	41.24	41.40
Specific growth rate (SGR%)	3.16	3.12	0.97	2.45	2.84	1.60	2.26
Total fish weight gain (g/ m^3)	148.76	94.74	42.86	135.75	64.96	34.64	100.00

On the other hand, data in Table (9) showed the same trend for survival rate , whereas sea bass advanced fry reared in monoculture had the highest survival rate (83.3%) .Sea bass and golden grey mullet reared jointly in polyculture possessed similar value of survival (83.3%) . While sea bass and sea bream advanced fry reared jointly in polyculture possessed the lowest value of survival (76.7%).

Cannibalism was the main cause of death in the sea bass and sea bream polyculture condition. Two types of cannibalism were detected: Type I, attack from tail (observed at the beginning of the experiment) and type I I, attack from head (observed at the end of the experiment.)

Table (9): Survival rate of advanced fry sea bass, *Dicentrarchus labrax* reared in monoculture and polyculture with either golden grey mullet *Liza aurata*, or sea bream *Sparus aurata*.

Culture methods	No. of advanced fry stocked /m^3	No. of advanced fry harvested /m^3	Survival rate(%)*
Monoculture (control)	30.00	25.00	83.33 ± 6.64^a
Polyculture (1) (sea bass + mullet)	30.00	25.00	83.33 ± 6.65^a
Polyculture (2) (sea bass + sea bream)	30.00	23.00	76.66 ± 12.25^b

* Different superscript indicates significant differences ($P < 0.05$)

The results of the present experiment showed also a positive (synergistic) interaction between golden grey mullet and sea bass advanced fry; Golden grey mullet eat algae growing on the substrate and decayed organic matter which otherwise could not utilize artificial diet and trash fish efficiently like sea bass.(Sarig,1981; Reinertsen *et al.*,1993 and Siliem1998). Thereby, golden grey mullet do not affect the growth, survival and production of sea bass advanced fry. In contrast, feed competition may exist between sea bass and sea bream, (carnivorous fishes). (Izquierdo and Fernandz-Palacios,1997;Essa,2000) which resulted in a considerable decline in sea bass growth, survival and production performance. The results of feed utilization parameters in Table (10) supported also these finding. Sea bass advanced fry reared in monoculture had the best feed conversion ratio (2.09) , protein production value(2.5%) , protein efficiency ratio (1.73) and energy utilization (10.86%). While sea bass and sea bream reared jointly in polyculture possessed the poorest values(4.47,0.56%,0.81 and 5.65%, respectively)(Table10).

Table (10): Feed utilization parameters [feed conversion ratio (FCR),protein efficiency ratio (PER), protein productive value (PPV), energy utilization(EU)] of sea bass, *Dicentrarchus labrax* advanced fry reared in monoculture and polyculture with mullet *Liza aurata*, or sea bream *Sparus aurata*. *

Culture methods	Total weight gain (g/m^3)	Total feed consumed (g/m^3)	(FCR)	PROTEIN UTILIZATION		EU (%)
				PPV (%)	PER	
Mono culture (control)	148.76 $\pm 4.67^a$	311.68 $\pm 5.61^a$	2.09 $\pm 0.19^a$	2.54 $\pm 0.03^a$	0.99 $\pm 0.06^a$	10.86 $\pm 1.35^a$
Polyculture (1) (sea bass + mullet)	135.75 $\pm 4.65^a$	577.77 $\pm 8.92^b$	4.25 $\pm 0.61^b$	0.64 $\pm 0.36^b$	0.23 $\pm 0.03^b$	7.95 $\pm 0.36^b$
Polyculture (2) (sea bass + sea bream)	100.00 $\pm 5.74^b$	447.45 $\pm 7.61^c$	4.47 $\pm 0.81^b$	0.56 $\pm 0.21^b$	0.46 $\pm 0.02^b$	5.65 $\pm 0.41^b$

* Different superscript in the same column indicates significant differences ($P < 0.05$)

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٢- رعاية صغار أسماك القاروص بمعدلات تخزين و نظم تربية مختلفة

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أجريت هذه الدراسة بمعمل تربية الأسماك بالمعهد القومى لعلـــوم البحـــار و المصـــايد بالإسكندرية باستخدام صغار القاروص (٠,٢٦ جرام) المرباة فى أحـــواض فيـــبرجلاس قمعيـــة الشكل(٥٠٠ لتر للوحدة) بغرض دراسة تأثير معدل التخزيـــن (٣٠ ، ٤٠ ســمكة /م٣) و أيضـــا طريقة التربية (النظام الأحادى أو النظام المتعدد الأنواع) على معايير النمو و الإعاشة و الاستفادة الغذائية خلال ١٠٥ يوما فترة رعاية . و لقد أظهرت الدراسة النتائج الآتية:

١- حققت الأسماك المرباة تحت ظروف الكثافة العددية المعتدلة (٣٠ سمكة/م٣) أعلى معـــدلات نمو و إعاشة (٥٦,٧ مجم / يوميا ، ٨٣,٣ % على التوالى) كما أن أسماك هذه المجموعـــة استفادت من الغذاء الصناعى (٤٨ % بروتين) بكفاءة أعلى من نظيرها فى المجموعة المرباة تحت ظروف الكثافة العددية العالية (٤٠ سمكة/ م٣) و التى حققت معدل نمـــو قـــدره ٤٠,٨ مجم / يومياً و نسبة إعاشة ٦٥ % فقط.

٢-حققت صغار القاروص أفضل معايير للنمو (٥٦,٧ مجم/ يوميا) و نسبة اعاشة (٨٣,٣ %) عند تربيتها بالنظام الإحادى أو عند تربيتها بالنظام المتعدد الأنواع مع أحد أســـماك العائلـــة البورية. (أسماك الدهبانة) . و العكس عند تربية صغار القاروص مع الدنيس حدث صـــواع و تنافس على الغذاء بينهما لتشابه عاداتهما الغذائية و بالتالى حققت أسماك هذه المجموعة أقـــل معايير للنمو (٤١,٤ مجم/ لتر) و نسبة الإعاشة (٧٦,٧ %) كما أن أسماك هذه المجموعـــة استهلكت كميات أكبر من الغذاء (حوالى ٤,٤٧ وحدة) لإنتاج وحدة وزن واحدة.