Effect of extruded and trash fish diets on growth performance and pond productivity of the sea bream (*Sparus aurata*), the sea bass (*Dicentrarchus labrax*) and the flat head grey mullet (*Mugil cephalus*) reared in polyculture system in earthen ponds

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ABSTRACT

A field trial was conducted in a private fish farm consisting of six earthen ponds in order to investigate the growth performance of the sea bream, the sea bass and the feat head mullet as well as pond productivity as affected with extruded and whole fish body feeds. Sex earthen ponds each of total area of 4200m^2 (feddan) represented two diets, extruded diets and whole fish bodies diet, both contained 44% protein, with three replicates for each. Fish species were stocked in each pond at densities of 3000; 1000 and 500 with an average initial weight of 11.6; 18 and 51.5g for sea bream; sea bass and mullet respectively. The experiment lasted for 14 months from start.

Results obtained are summarized in the following:

1- Final body weights of sea bream and sea bass increased significantly for fish fed extruded and trash fish diets. However, for mullet final weights of fish fed on extruded and trash fish diets were insignificantly increased.

2- Final body length of both sea bream and sea bass increased significantly for fish fed extruded and trash fish diets. However, for mullet final body length of fish fed on extruded and trash fish diets were insignificantly increased.

3- Specific growth rate, food conversion ratio and total fish production were improved with extruded diet compared with trash fish diet.

4- The highest net returns were obtained using the extruded diet.

Key words: Sea bream (*Sparus aurata*), sea bass (*Dicentrarchus labrax*), grey mullet (*Mugil cephalus*), earthen ponds, polyculture, growth.

INTRODUCTION

The Sea bream (*Sparus aurata*), the sea bass (*Dicentrarchus labrax*) and the feat head grey mullet (*Mugil cephalus*) are considered as fish species of high market value in Egypt.

During the last decade, there has been a marked increase in the use of extruded diets for feeding fish. These diets have superior water stability, better floating properties and a higher energy than pelleted diets (Hilton *et al.*, 1981;

Johnsen and Wandsvik, 1991). The main effects on fish are: an increase in fish growth and an improvement in feed conversion (Robert *et al.*, 1993; Lanari *et al.*, 1995)

Fish feeding is one of the most important factors in commercial fish farming because feeding regime may have consequences on both growth efficiency and feed wastage (Tsevis *et al.*, 1992; Azzaydi *et al.*, 2000). Moreover, knowledge of the optimum feeding rate is important not only for promoting best growth and feed efficiency, but also for preventing water quality deterioration as a result of excess feeding (Ng *et al.*, 2000; Mihelakakis *et al.*, 2002; Webster *et al.*, 2002). In this context, it is useful to know the optimum feeding rate of the cultured species and how feed efficiency, feed consumption and composition of flesh are affected by it.

Carbohydrates are cheap energy sources and good binding agents (Amesen and Krogdahl.1993), and their utilization in fish diets has been studied for many species (Kaushik *et al.*, 1989; Bergot, 1993; Vergara and Jauncey, 1993; Hemre *et al.*, 1995). One of the limitations for the use of raw carbohydrates in fish is their digestibility, which is usually low (Wilson, 1994), limiting their availability. Digestibility of raw starch depends however on the nature of starch (Bergot, 1993).

In the wild, gilthead sea bream feed on prey such as crustaceans, molluscs, polychaetes, and echinoderms (Wassef and Eisawy, 1985;) using a complex heterodont system of canine-like and molariform-plated teeth (Cataldi *et al.*, 1987), which allows the crushing of hard-textured prey. However, farmed gilthead sea bream have been observed to chew, and occasionally eject, whole or parts of dry pellets during feeding (Andew *et al.*, 2003). The injection of intact pellets and loss of particles from crushed pellets during handling may result in an increase in feed waste and bad feed conversion ratios in aquaculture.

The use of extruded diets has grown enormously in the past few years in marine farms of the Mediterranean Sea, but little data are available for sea bass and other marine species (sea bream, dentex, etc.). There is a need to have a better understanding of the optimal feeding levels of extruded diets for these species, due to their different feeding behavior and voluntary feed intake.

Most researchers have reported optimal protein levels of 50% crude protein (CP) or more for growth of European sea bass juveniles and grow-out (Metailler *et al.*, 1981; Hidalgo and Alliot. 1988; Tibaldi *et al.*, 1991; Ballestrazzi *et al.*, 1994), however they did not obtain any differences for diets containing 45 or 60% CP.

This study was conducted to compare the effect of feeding source (extruded complete diet or a diet containing trash fish only) on growth performance of sea bream, sea bass and mullet reared in earthen ponds.

MATERIAL AND METHODS

This study was carried out at a private fish farm, located at Deibba Triangle area between Port Said and Dammetta, Dammitta Governorate, Egypt during the period from 21 May 2004 to 21 July 2005.

Experimental ponds: A total number of six earthen ponds, each of one feddan area with a water depth of one and half –meter were used in this study. Each three ponds represented a feeding form (extruded and whole fish). The six ponds were stocked with the sea bream (*Sparus aurata*) at a rate of 3000 fingerlings/feddan, the sea bass (*Dicentrarchus labrax*, L.) at a rate of 1000 fingerlings/feddan and the grey mullet (*Mugil cephalus*) at a rate of 500 fingelings/feddan for each pond. Earlier to experimental start, ponds were dried completely and exposed to sunrays for about 15 days till complete drying. After that, all experimental ponds were filled with water (drainage water) coming from Manzala Lake. Ponds water was changed to keep water quality suiTable for fish growth.

Experimental fish: every experimental pond was stocked with 3000 fingerlings of sea bream (*Sparus aurata*) within average initial weight ranging between 10.4 to 11.6g, 1000 sea bass (*Dicentrarchus labrax*, L.) with initial weight 17.9 to 18.0g and 500 grey mullet (*Mugil cephalus*) with initial weight 50.5 to 50.6g.

Experimental Diets: the six experimental ponds represented two dietary types (extruded and trash fish whole bodies) and each treatment was tested in three replicates (triplicates). The composition of the extruded experimental diets is illustrated in Table (1).The whole fish bodies were offered fresh or frozen diet. Experimental diets were offered at a rate of 3% of total pond fish biomass from the experimental start till the end of April 2005. Thereafter, it was reduced to 2% till the end of the experiment at 21st July 2005. The experimental diets were offered in two equal parts twice daily at 10 a.m. and at 2 p.m. Feed was offered in floating feeder made of P.V.C pipes as a frame with a net inside the frame to keep the feeds available for the fish.

Table (1): Composition, approximate chemical analysis and gross energy of the extruded Experimental diet.

Ingredients:	Crude protein %
Fish meal (72.3% C.P)	30
Soybean meal (44% C.P)	25
Yellow corn	10
Meat meal	30
Fat	2
Vitamin premix	1.5
Mineral premix	1.5
Total	100
Calculated diet composition:	
Crude protein (C.P.)	44
Gross energy k cal/kg	4155
Analyzed % on dry matter basis:	
Moisture	3.61
Crude protein (C.P)	44.1
Ether extract (E.E)	10.16
Crude fibers	4.36
Ash	11.03

* GE= Gross energy based on 5.65 K. Cal/g for protein 9.45 K. cal/g for Fat, 4.1 K.cal/g for Carbohydrate.

** Calorie/ protein ratio expressed as kcal GE L 100/g crude protein.

Water quality: water samples were taken monthly for determination of temperature; secki disk reading (transparency); pH; dissolved oxygen; salinity; hardness; alkalinity; contents of nitrite; nitrate and ammonia. Average water quality parameters are illustrated in Table (2). Analytical methods were done according to the American Public Health Association (APHA, 1985). The pH values were determined by digital pH meter model 68 Engineered Systems and Designs. The water temperature and oxygen content were measured daily at 8:00 a.m. by an oxygen meter, WPA 20 Scientific Instrument. The levels of salinity; hardness; alkalinity; nitrite; nitrate and ammonia were measured monthly in pond water samples.

Growth performance parameters:

1- Live body weight and body length:

Live body weight (LBW) in g and body length (BL) in cm of individual fish of each experimental pond were measured at the start of experiment in samples of 100 fish from sea bream 50 fish from sea bass and 25 fish from mullet, and repeated every four weeks throughout the experimental period.

2- Weight gain:

Weight gain (WG)= final weight – initial weight

3- Condition factor (K):

This measure represents the relationship between LBW and BL of the fish. It was calculated as follows:

K= LBW/ (BL) 3 X 100

Where: LBW= fish weight "grams"

BL = fish length "cm"

Specific growth rate (SGR):

Specific growth rate (SGR) = LnW2-LnW1/t X 100

Where: Ln = the natural log

W2= Final weight at certain period (g)

W1= Initial weight at the same period (g)

T = Period (d)

Statistical analysis: the statistical evaluation of results was performed according to the methods described by Snedecor and Cochran (1976) whele Duncan's multiple range test (Duncan, 1955) was carried out to detect the significant differences among means.

RESULTS AND DISCUSSION

Water quality parameters: physical and chemical water quality parameters are presented in Table (2). Results revealed that the lowest water temperature was recorded during December and January (14.9°C), while the highest was during June and July (32.6°C). Secki disc readings ranged between 15 cm and 17 cm during the experimental period, which reflects the insufficiency of nutrients required for plankton growth. Water pH values ranged between 8.8 and 9.5 during the experimental period. On the other hand, salinity of water ranged between 7 to 28 parts per thousand. Alkalinity mg/L ranged from 330 mg/L to 380 mg/L. As presented in the same Table average nitrite levels ranged between 0.02 and 0.63 mg/L and ammonia between 0.4 and 1.2 mg/L. Nitrate concentration was fluctuated between 0.12 and 0.76 mg/L during the experimental period. The dissolved oxygen concentration ranged from 7.2 to 10.4 mg/L, which was sufficient for normal growth and development of the fish. All tested physical and chemical parameters were within the permissible levels required for sea bream (*Sparus aurata*), sea bass (*Dicentrarchus Labrax*) and grey mullet (*Mugil cephalus*) growth.

Table (2) Average of physical and chemical properties of pond water during experimental period through intervals (2 months) (mean ± SE)* from 21st of May 2004 to 21st of July (2005).

Items of	21/05 to 21/07	21/07 to 21/09	21/09 to 21/11/04	21/11 to 21/01	21/01 to 21/03	21/03 to 21/05	21/05 to 21/07/05
Temp (C^0)	32.6	31.4	25.9	14.9	21.3	25.2	32.2
Secki Disk (cm)	17.0	17.0	15	17	15	15.0	17.0
pH values Unit)	8.9	8.8	9.5	9.5	9.5	9.1	9.0
D. Oxygen(mg/L)	7.8	8.0	7.2	10.4	8.1	8.3	8.0
Salinity (g/L)	23	28	22	7	22	25	27
Alkalinity (mg/l)	330	340	380	350	375	340	350
NO_3 (mg/L)	0.6311	0.5724	0.5414	0.0704	0.0307	0.0288	0.0268
NH_4 (mg/L)	1.2	1.0	0.8	1.0	1.0	0.6	0.4
NH_3 (mg/L)	0.18363	0.29654	0.17873	0.64968	0.76968	0.12284	0.12353

The time of measuring dissolved oxygen test was 11:0

Growth performance

Body weight and length:

Results presented in Table (3) show the effect of extruded and whole fish on body weight and length of sea bream, sea bass and mullet. At the start of the experiment, averages of initial weight of sea bream; sea bass and mullet fish had recorded 11.6a±0.45, 18.0a±0.43 and 51.6a±1.38, respectively for extruded feed groups, and recorded 10.4b±0.35, 17.9a±0.44 and 50.5a±1.40, respectively for whole fish bodies feed. For sea bream, average of body weights after 2 months of the experimental start reached 31.1 and 24.2 g for groups fed extruded feed and whole fish respectively (Table 3). Analysis of variance for results at this period indicated that groups fed extruded diet had significantly ($p<0.05$) superior body weights compared to those fed on the whole trash fish bodies. During the periods of 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 13 and 14 months after experimental start the averages of sea bream body weights increased significantly ($p<0.05$) using extruded diets (Table 3). At the end of the experimental period (14 months after start) the finally body weights of sea bream reached 268.7 and 228.5g for extruded and whole fish diets respectively.

The statistical evaluation of results shows that averages body weights increased in a significant manner with extruded diet than whole fish diet. Those results indicate that the extruded diet of growing sea bream seemed to cover its dietary requirement. These results are in accordance with those reported by Wassef and Eisawy (1985); Aksnes *et al.* (1997); Deguara (1997); who showed that extruded diet of sea bream increased significantly the body weight and growth rate. Also, Stradmeyer *et al* (1988) reported that extruded pellet and pellet texture had an effect on the fish growth performance of sea bream. Results of Table (3), show that the average of sea bass body weight , for groups fed on extruded diet at periods of one month and 2 months after experimental start were significantly ($P<0.05$) heavier compared to those fed the whole fish bodies diet. During periods of 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 13 and 14 months after start the averages body weight of sea bass increased significantly ($P<0.05$) using the extruded diet. At the end of the experimental period i.e. 14 months after start the averages of sea bass body weights for groups fed on extruded and whole fish diets reached 400.0 and 341.0g. respectively and the final body weights increased significantly ($P<0.05$) with extruded diet. These results indicate that sea bass grow better in polycultured ponds with extruded diet. Whole fish diet may require longer periods than 14 months to achieve reasonable market weights; however this depends completely on the sea bass size demand. Those results indicate that the extruded diet of growing sea bass seemed to cover its dietary requirement. These results are in accordance with those reported by Perez *et al.* (1997); Azzaydi *et al.*(1998); Paspatis *et al.* (1999); who showed that extruded diet of sea bass increased significantly its body weight and growth rate. Concerning the mullet, at the end of the experimental period the averages of body weight for the groups fed extruded and whole fish diets were 407.3; 403.0g respectively (Table 3) and differences among groups in final weights were insignificant. Bakeer (2006) and Eid (2006) reported that in mullet monoculture system with supplemental feeding, the highest profitability was recorded for the lowest stocking density which had the rate of 1 fish/m3. Also, Abdel-Gawad *et al.* (2007) reported that the highest result was received at stocking density of 1050 fish/fingerling/feddan without supplemental feed.

Results of sea bream; sea bass and mullet body length (cm) as affected with diet fed in polyculture system are presented in Table (4).

At the experimental start, differences in body length among treatment groups within each species were insignificant. As presented in the same Table, in sea bream averages of body length, 2 months after experimental start of groups fed on extruded diet, were significantly ($p<0.05$) higher than those fed on the whole trash fish diet. At periods of 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 13 and 14 months after experimental start, averages of final body length for sea bream groups for extruded and whole fish diets recorded 23.8 and 21.8 cm respectively, and the statistical evaluation of results revealed that sea bream final length increased significantly ($p<0.05$) with extruded diet than whole fish diet. These results are in accordance with those reported by Efthimous *et al.* (1994); Aksnes *et al.* (1997) and Deguara (1997).

Table (3): least square means and standard error for the effect of extruded and trash fish diets for body weight of sea bream, sea bass and mullet

	Treatment 1			Treatment 2		
	bream	bass	mullet	bream	bass	Mullet
21/05/2004	11.6a±0.45	18.0a±0.43	51.6a±1.38	10.4b±0.35	17.9a±0.44	50.5a±1.40
21/06/2004	16.2a±0.55	30.0a±0.85	71.0a±1.95	16.0a±0.61	27.5a±1.21	67.5a±2.68
21/07/2004	31.1a±0.72	43.0a±0.79	90.3a±2.12	24.2b±0.76	37.9b±1.04	91.5a±1.96
21/08/2004	58.7a±0.78	64.0a±1.20	113.4a±3.93	34.5b±1.17	57.9b±1.58	113.9a±3.54
21/09/2004	81.5a±1.15	97.0a±1.35	134.9a±1.79	58.3b±1.43	83.7b±1.20	138.0a±1.56
21/10/2004	106.9a±1.33	119.5a±1.61	161.2a±2.87	71.9b±1.33	103.0b±1.41	160.0a±3.73
21/11/2004	123.5a±1.36	136.0a±2.09	185.4a±2.95	103.5b±1.36	117.0b±3.33	184.8a±5.80
21/12/2004	139.9a±1.81	156.0a±1.97	215.3a±3.10	116.5b±1.36	135.0b±1.42	215.8a±2.93
21/01/2005	173.0a±1.30	181.5a±2.71	239.8a±3.72	125.5b±1.20	150.0b±1.76	236.6a±2.92
21/02/2005	197.9a±1.90	206.0a±2.68	267.3a±2.99	138.2b±1.28	174.0b±2.10	270.0a±3.66
21/03/2005	203.7a±1.64	216.0a±2.54	288.8a±3.24	151.3b±1.76	214.0a±2.27	291.0a±3.03
21/04/2005	214.0a±2.29	331.5a±4.69	319.4a±5.25	172.4b±1.45	262.0b±2.61	319.6a±3.30
21/05/2005	229.1a±1.86	343.0a±4.98	345.8a±5.27	190.5b±2.31	283.1b±4.36	346.0a±5.29
21/06/2005	243.6a±1.99	376.0a±4.60	368.2a±4.14	211.3b±1.75	314.0b±5.02	365.6a±5.61
21/07/2005	268.7a±1.95	400.0a±4.53	407.3a±4.40	228.5b±2.01	341.0b±5.74	403.0a±4.38

Concerning body length of sea bass as affected with diet type, at period one month after experimental start, results show that the group fed on the extruded diet had significantly ($p<0.05$) longer bodies compared to those fed on whole fish diet. During periods 2; 3; 4; 5; 6; 7; 8; 9; 11; 12; 13 and 14 months after experimental start body length of sea bass increased significantly ($p<0.05$) as compared with whole fish diet. These results are in accordance with those reported by Divanch *et al.* (1993) and Ballestrazzi *et al.* (1996).

Concerning body length of mullet as affected with diet type, at the end of the experimental period the averages of mullet body length for the groups fed extruded and whole fish diets were 37.8 and 38.1cm respectively (Table 4) and differences among groups in final length were insignificant.

Table (4): least square means and standard error for the effect extruded and trash fish diet for body length of sea bream, sea bass and mullet

	Treatment 1			Treatment 2		
	bream	bass	mullet	bream	bass	Mullet
21/05/2004	8.3a±0.17	11.1a±0.19	15.5a±0.11	8.2a±0.14	10.9a±0.22	15.2a±0.17
21/06/2004	9.6a±0.17	13.2a±0.13	16.9a±0.15	10.1a±0.18	12.3b±0.11	16.6a±0.25
21/07/2004	12.6a±0.17	14.9a±0.10	18.7a±0.20	10.7b±0.11	13.0b±0.14	18.0b±0.13
21/08/2004	15.7a±0.17	17.4a±0.15	20.1a±0.25	11.4b±0.09	15.0b±0.15	19.6a±0.24
21/09/2004	17.3a±0.06	19.6a±0.10	21.2a±0.13	14.0b±0.13	16.8b±0.09	21.1a±0.12
21/10/2004	18.1a±0.08	21.1a±0.11	23.8a±0.27	15.7b±0.10	18.0b±0.11	23.0a±0.24
21/11/2004	20.3a±0.17	21.9a±0.15	26.0a±0.18	16.8b±0.08	17.8b±0.09	25.1a±0.41
21/12/2004	21.0a±0.10	23.1a±0.13	27.6a±0.19	17.7b±0.08	19.9b±0.14	27.3a±0.17
21/01/2005	21.8a±0.04	24.8a±0.18	28.7a±0.24	19.7b±0.17	20.7b±0.11	28.4a±0.19
21/02/2005	22.2a±0.06	26.8a±0.19	30.9a±0.27	20.6b±0.08	22.b±0.13	30.7a±0.25
21/03/2005	22.3a±0.06	26.6a±0.14	32.9a±0.16	20.8b±0.07	26.8a±0.19	32.0b±0.24
21/04/2005	22.5a±0.06	30.9a±0.19	34.3a±0.26	21.5b±0.10	28.9b±0.09	34.3a±0.25
21/05/2005	22.6a±0.05	31.7a±0.15	35.6a±0.26	21.6b±0.07	29.0b±0.11	35.5a±0.24
21/06/2005	23.4a±0.10	32.5a±0.12	36.5a±0.17	21.6b±0.06	29.1b±0.13	36.6a±0.29
21/07/2005	23.8a±0.13	32.5a±0.12	37.8a±0.13	21.8b±0.11	29.3b±0.13	38.1a±0.19

Growth parameters:

Growth parameters of sea bream, sea bass and mullet cultured in earthen ponds as affected with diet form are presented in Table (5). Results revealed that the initial biomass (kg) stocked in pond one feddan area were 34.8; 18.0 and 25.8kg respectively for extruded feed and 31.2; 17.9 and 25.3kg respectively for whole fish diet. The statistical evaluation of results revealed that sea bream and sea bass fed extruded diet showed significantly ($p<0.05$) higher final weights, compared to those at the whole fish diet. Total gain in weight of sea bream and sea bass on extruded diet was significantly ($p<0.05$) higher than that on the whole fish diet, however differences in total gain in weight among mullet in extruded and whole fish diet were insignificant. Results of specific growth rate (SGR) and condition factor (K) as affected with diet form (Table 5), revealed that sea bream and sea bass fed on extruded diet showed significantly (p<0/05) higher SGR values than those feed whole fish diet, however the mullet showed insignificant differance at extruded and whole fish diet.

Results of SGR in the present study are also in agreement with the findings of Abdel-Gawad *et al.* (2007), who showed that SGR of mullet reared in earthen ponds at density less than 1050 fish/feddan was insignificant. As presented in the same Table, the average of condition factor (K) during the whole experimental period for sea bream, sea bass and mullet fed extruded diet were found to be 1.990a±0.021; 1.180a±0.009 and 0.780a±0.013 respectively while the fish whole fish diet showed 2.200b±0.017; 1.360b±0.015 and 0.700a±0.000 respectively. These result show that sea bream and sea bass fed extruded diet had significantly ($p<0.05$) higher K values than those fed the whole fish diet. These results indicate that sea bream and sea bass fed extruded diet grow more in weight than in length as similarly reported by Aksnes *et al.* (1997), who used whole fish diet to feed sea bream and sea bass.

Concerning feed consumption (FC) and feed conversion ratio (FCR) as affected with diet form, results in Table (5) revealed that the total amounts of feed consumed during the whole experimental period for the extruded and whole fish diets were 3383.5 and 5034.8kg, respectively. The corresponding FCR values for the above extruded and whole fish diets were 2.4 and 4.1 kg feed for each kg gain in weight respectively. These results indicate that the best feed conversion ratio was obtained by extruded diet. Agree with the findings of Venou *et al.* (2003), who reported that extrusion improved significantly all apparent digestibility coefficients (ADC), and Andrew *et al.* (2004) who reported that softer pellets increased consumption and reduced waste from handling.

Concerning total fish production per feddan the average weights of sea bream; sea bass and mullet fed extruded diet were 806.1; 400.0 and 203.7kg/feddan respectively with total production of 1409.8kg/fed, while for treatments of fed whole fish diet the total fish production were 685.5; 341.0 and 201.5kg/feddan respectively with total production of 1228kg/fed. Total pond production calculated as percentages of the lowest pond production (whole fish diet) was 114.8% for extruded diet. These results indicate in general that the highest experimental pond productivity was obtained by extruded diet.

Table (5) *Final body weight, number, of live fish, survival %, final weight gain, consumed* Extruded and whole fish diet, and total production per pond and per feddan of sea bream, sea bass and mullet

Parameter		Treatment 1	Treatment 2
Average area of pond	M2	4200	4200
No. of stocked fish at start of exp.	Fish/pond		
Sea bream		3000	3000
Sea bass		1000	1000
Mullet		500	500
Average initial body weight,	G/fish		
Sea bream		11.6a±0.45	10.4b±0.35
Sea bass		18.0a±0.43	17.9a±0.44
Mullet		51.6a±1.38	50.5a±1.40
Initial biomass, .Sea bream	Kg/pond	34.8	31.2
Sea bass		18.0	17.9
Mullet		25.8	25.3
Average final body weight,	G/fish		
Sea bream		268.7a±1.95	228.5b±2.01
Sea bass		400.0a±4.53	341.0b±5.74
Mullet		407.3a±4.40	403.0a±4.38
Gain in weight, Sea bream	G/fish	257.1	218.1
Sea bass		382.0	323.1
Mullet		355.7	352.5
Finial biomass, .Sea bream	Kg/pond	806.1	685.5
Sea bass		400.0	341

Mullet		203.7	201.5
Specific growth rate, Sea bream Sea bass Mullet	SGR	1.333a±0.048 1.693a±0.035 1.086a±0.041	1.449b±0.042 1.386b±0.082 0.955a±0.057
Condition factor, Sea bream Sea bass Mullet	K	1.990a±0.021 1.180a±0.009 0.780a±0.013	2.200b±0.017 1.360b±0.015 0.700a±0.000
Average initial body length, Sea bream Sea bass Mullet	Cm	 8.3a±0.17 11.1a±0.19 15.5a±0.11	 8.2a±0.14 10.9a±0.22 15.2a±0.17
Average final body length, Sea bream Sea bass Mullet	Cm	 23.8a±0.13 32.5a±0.12 37.8a±0.13	 21.8b±0.11 29.3b±0.13 38.1a±0.19
Total production/pond,	Kg/pond.	1409.8	1228.0
Total of costumed food	Kg/fish	3383.5	5034.8
Food conversion ratio	FCR	2.4	4.1

Economical efficiency of feed form:

Results of costs including variable and fixed costs for the applied treatments are shown in Table (6).

Table (6) Effect of dietary treatments stocking density on economical efficiency of sea bream, sea bass and mullet reared in earthen ponds

Item	TREAT 1	TREAT 2
1- Variable costs LE per pond		
a- fingerlings/feddan	9000	9000
b- Artificial food	14549.0	14601.0
Labor	1400	1400
Harvest	422.9	368.4
Total variable costs, LE	25371.9	25369.4
2-Fixed costs, LE a-Depreciation (materials and others) b- Taxes	 1200 200	 1200 200
Total fixed costs, LE	1400	1400
Total operating costs (variable and fixed)	26771.9	26769.4
3-Return a-Fish sales, LE Sea bream Sea bass Mullet	 27407.4 13600 2851.8	 23307 11594 2821
b-Total return/ feddan, LE	43859.2	37722
Net Returns (total returns – costs	17087.3	10952.6
% Returns relative to costs	63.8	40.9

Results revealed that costs of fish fingerlings and labor are similar in the applied treatments (Table 6); however the feed costs differed according to the type of diet, which were 14549.0 LE and 14601.0 LE respectively. Total operating costs (variable and fixed costs) per feddan for extruded and whole fish diets were 26771.9 LE and 26769.4 LE respectively where the slight difference in the total costs was attributed to the differences in feed costs. Total returns in LE feddan for extruded and whole fish diets were 43859.2 LE and 37722 LE respectively (Table 6). Net returns per feddan in LE for extruded and trash fish diets were 17087.3 LE and 10952.6 LE respectively. The percentages of net return to total costs for extruded and trash fish diets were 63.8% and 40.09% respectively. These results indicate that feeding sea bream in polyculture with sea bass and mullet in earthen ponds on extruded diet resulted in best economic efficiency.

CONCLUSION

Based on results obtained in this study and on the economical evaluation, it could be concluded that sea bream; sea bass and mullet can be cultured together in earthen ponds where the growth parameters of the three species improved with each other using extruded diet. However, from the economical point of view, the extruded diet seemed to be the best in terms of the ratio of returns to total costs.

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