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**المؤتمر الدولي**  
**الثروة السمكية والأمن الغذائي في الدول العربية والإسلامية**  
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**دراسات بيولوجية على الأسماك في الأستزراع المختلط:**  
**العلاقة بين النمو ونظام التغذية**

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## الملخص العربى

# دراسات بيولوجية على الأسماك فى الأستزراع المختلط: العلاقة بين النمو ونظام التغذية

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فى هذه الدراسة، تم استزراع أسماك البلطى النيلى، المبروك الفضى والبورى فى أحواض، مساحة كل منه ١٠٠٠ متر مربع، بكثافات ١٥٠، ١٥٠٠، ٥٠٠ سمكة بالحوض على التوالي. كان يتم تسميد كل حوض بكمية ٧،٥ كجم تر ييل سوبر فوسفات، ٢،٥ كجم سلفات أمونيوم، ٧،٥ زرق دواجن. تم معاملة الأحواض بأربع نظم مختلفة من التغذية الصناعية، لمدة أربع شهور. إشملت التجربة على أربع معاملات (م١- م٤)، المعاملة الأولى (م١) أضيفت التغذية الصناعية لمدة ثلاثة شهور، أما المعاملة الثانية (م٢) تم إضافة التغذية الصناعية لمدة شهرين، وكانت المعاملة الثالثة التغذية الصناعية لمدة شهر واحد، وأما المعاملة الرابعة (م٤) فتركت بدون تغذية صناعية (كونترول).

كان التوسط النهائى لوزن سمكة البلطى ١٢٩، ١٢٣، ١١٦، ٨٨ جرام/السمكة بالنسبة للمعاملات الأربعة على الترتيب، أما بالنسبة لسمكة المبروك الفضى فكانت ٩١، ٩٤، ٧٩، ٦٨ جرام/ السمكة على الترتيب، بينما كان متوسط الوزن النهائى لسمكة البورى هو ١٧٦، ١٨٣، ١٦٣، ١٤١ جرام/السمكة على الترتيب. كان متوسط الإنتاج الكلى للحوض ٢٥٦، ٢٥٢، ٢٢٧، ١٧٨ كيلو جرام بالنسبة للمعاملات (م١، م٢، م٣، م٤) على الترتيب.

متوسط الإنتاج الكلى للمعاملة الثانية (م٢) - والتي تم تغذيتها بالغذاء الصناعى لمدة شهرين - يكاد أن يكون مثل متوسط الإنتاج الكلى للمعاملة الأولى (م٤) والتي تم تغذيتها صناعيا لمدة ثلاثة شهور. ومن ذلك، فإن المعاملة الثانية تكون هى الأفضل إقتصاديا.

وعلى ذلك، فإن توصيتنا هى، أن النظام المستخدم فى المعاملة الثانية (م٢) هى الأنسب لإستخدامها فى الإستزراع السمكى المحلى بالطرق العادية.

# IOLOGICAL STUDIES OF FISH REARED UNDER POLYCULTURE SYSTEM : RELATIONSHIP BETWEEN GROWTH PERFORMANCE AND FEEDING REGIME

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## ABSTRACT

In the present study, Nile tilapia, silver carp and mullet were cultured in ponds (1000m<sup>2</sup> each) in densities of 1500, 150 and 500 fish/pond, respectively. Each ponds was fertilized biweekly 7.5 kg Triple superphosphate and 2.5 kg ammonium sulphate plus 7.5 kg chicken manure. Ponds were treated with 4 different treatments (T1-T4), treatment (T1), three months feeding, (T2) two months feeding, (T3) one month feeding and the controlled treatment of (T4) that was without commercial pelleted feed.

The average final body weight of tilapia was 129, 123, 116 and 88 g/fish respectively. The silver carp was 91, 94, 79 and 68 g/fish respectively. However mullet was 176, 183, 163 and 141 fish respectively. The total average fish production per pond was 256, 252, 227 and 178 kg/pond for each treatment T1, T2, T3 and T4 respectively.

The total average production for Treatment (T2) that received pelleted fish feed for 2 months was near much in fish production to treatment (T1) that had feeding for 3 months, thus (T2) is the best in economically wise. However our recommendation is the system of (T2) that most suitable for our local fish farming.

## INTRODUCTION

Traditional Egyptian aquaculture involves a polyculture of mixed sexed tilapia, common carp, silver carp, and mullet. Ponds are fertilized with organic and chemical fertilizers, and artificial feed is added at a rate of 3% of body weight. (Green *et al.* 1995).

The use of artificial feed in traditional aquaculture the potential for return, its efficiency, and the access of farms to operating capital are all economic consideration for the use of artificial feed in traditional aquaculture. An economic evaluation of the aquaculture production system in Egypt is reported by Soliman and Gaber (1988) who compared production level, production variability and economic efficiency for two different fish culture systems.

Supplementary feed for fish culture represent 60% or more of the total production costs (Collis and Smitherman, 1978; Nerrie, 1979; Stone, 1980; Peralta and teichert-Coddington, 1989). Nile tilapia (*Oreochromis niloticus*) feeds on a wide variety of natural food organisms found in organic fertilized ponds (Browen, 1982) as well as (Green *et al.*, 1995) mentioned that the application of feed only treatment which was carried out at CLAR appeared poor performance of fish and not sufficient economically viable.

So the role of organic and inorganic fertilizers should be maximized to reduce the total production costs.

Green *et al.*, (1995). Reported that fertilization for the first 60 days followed by artificial feeding of a rate of 3% of body weight appeared more economically viable and produced the greatest gross fish yields and net returns among five treatments for tilapia monoculture. They found that application of fertilizes after 60 days did not affect tilapia yield significantly. However Nile tilapia are recently reared in polyculture systems in Egyptian aquaculture. They have been cultured with a number of freshwater species including carps, grey mullets and catfish (Pillay, 1990). In Israel, all male tilapia (*T. nilotica* and *T. aurea*) or hybrid tilapia are commonly cultured with common carp, mullet and silver carp (Hepher and Pruginin, 1981).

This result may be changed when where a combination of tilapia, mullet and silver carp. Such a combination is believed to contribute to the maximum utilization of feed and improvement in the chemical regime (dissolved oxygen, ammonia and nitrite levels in ponds, due to a proper balance of phytoplankton communities and detritus (Hepher and Pruginin, 1982). The application of chemical fertilization treatment at which monosex tilapia was cultured as monoculture showed the least economically viable and produced the lowest gross fish yields in comparison with other treatments as previously explained by (Green,

1995). Experience so far seems to indicate great efficiency of organic manuring in comparison with organic fertilizers.

Animal manure have been widely used as a nutrient source for tilapia production ponds (Hopking and Gruz, 1982; Green, *et al.* 1990). And tilapia yield was increased significantly by increasing manure application (Green *et al.*, 1990).

As it known, organic manures increase detritus in ponds which stimulates growth of bacteria and zooplankton (Pillay, 1990). In manured ponds, high yields of tilapia have been obtained with high densities and without supplementary feeding (Lovshin, 1980).

## Objectives

The aim of this study is to evaluate the effect of partial supplementary food on fish production using the traditional Egyptian polyculture system and to determine economic potential and profitability of an enterprise budget analysis.

## Material and Methods

Eight earthen ponds, 1000 m<sup>2</sup> each with one meter depth are located at the central laboratory for aquaculture research (CLAR). They were used in our study and were supplied by fresh water. The period of experiment was 4 months (from August to December). Each pond was fertilized biweekly with 7.5 kg Triple superphosphate and 2.5 kg ammonium sulphate plus 7.5 kg chicken manure. Nile tilapia *Oreochromis niloticus*, silver carp, *Hypophthalmichthys molitrix* and mullet, *Mugil cephalus* were stocked in densities of 1500, 150 and 500 fish/pond respectively.

Four treatments were applied in our study, each was carried out in two ponds replicates.

The first treatment (T1) received commercial pelleted fish feed (17% protein) for 3 months, starting from the second month to the end of experiment. The second treatment (T2) received commercial pelleted fish feed for two months, starting from the third month to experiment (T2). The third treatment (T3) received commercial pelleted fish feed for one month only. In the final month of the experiment (T2). The fourth treatment (control) did not receive any commercial feed (T4).

Pelleted feed was submitted six days a week and readjusted biweekly according to the fish biomass as estimated by sampling the fish ponds fish

(20 fish from each species) to keep the feed supply rate at 3% of fish body weight.

The physical properties (temperature, electrical conductivity, Ph and Secchi disk) of pond water were determined biweekly after 7 days following application of the fertilizer at 5 cm. Depth from pond surface water.

Chemical properties (Oxygen, Salinity, total hardness, total alkalinity and orthophosphate) of ponds water were determined biweekly after 7 days following application of the fertilizer. Samples were collected (one liter/pond) from four constant sites at two depth in water (at surface and at 25 cm depth). The chemical properties were calculated according to Boyd (1992).

Number of phytoplankton/ml =  $c \times 100 \text{ mm}^3/\text{LDWS}$ .

The number of zooplankton per litre of the pond water was determined biweekly using the following equation according to Boyd (1992).

Number of zooplankton/L =  $\text{SN}/\text{D}$ .

Fish were sampled biweekly from each pond to estimate fish growth and calculate the fish biomass in the pond and at the harvesting, fish yield was weighed and total production of each fish species was determined.

Body gain was calculated as:

Body gain = final mean weight – initial mean weight

Relative Growth Rate (RGR%) was calculated as:  $\text{Wt} - \text{Wo}/\text{Wo} \times 100$

Statistical analysis of the data collected through the experimental period was carried out according to SAS (1985).

## Results and Discussion

Effect of artificial feeding on phytoplankton is shown by (Table, 1) we find that the average number and the total average of phytoplankton organisms per litre of ponds water is the lowest in the control ponds (T4) that its total average of phytoplankton density is  $(765 \times 10^4 \text{ cell/litre})$ . That with non artificial feeding. This supposed to be due to grazing of phytoplankton by zooplankton and fish as suggested by Fogg (1965).

The highest total average of phytoplankton organisms  $(3248 \times 10^4 \text{ cell/litre})$  was found in ponds of treatment of (T2) which received commercial pelleted feed for two months. The number of organisms were gradually increased up to the 9<sup>th</sup> interval therefore it decreased gradually up to the end of experiment, most probably, due to the decrease in water temperature than 20 °C. Tilman et al. (1986) found that phytoplankton was dominant at temperature higher than 20 °C.

Table (2) shows the average number and the total average of zooplankton organisms per litre of ponds water, since the lowest average

of total density (151 unit/litre) was found in the control ponds (T4) that with non artificial feeding, because of enhanced grazing zooplankton by fish.

The highest total average (222 unit/litre) was determined in ponds of treatment (T2) that received commercial feed for two months. The numbers of organisms were gradually increased up to the end of experiment because of the decrease in temperature than 20 °C. Munaware (1970) found that zooplankton was dominant at temperature ranging from 21 to 29 °C.

The effect of different management regimes on result of counting number of fish recovered at the end of experiment and livability % of whole fish, is presented in table (3). The highest number of fish and livability % in all species was obtained in the treatment receiving feed for two months (T2), while the lowest number was found in (T4) that with no commercial feeding.

Effect of different feeding regimes on growth performance is presented in table (4). Final weights and SGR of fish species through the experimental period are presented also in table (4).

The highest body weight of tilapia was obtained in the treatment receiving commercial feed for three months (T1), while the highest body weight of silver carp and mullet was obtained in the treatment receiving commercial feed for two months (T2). Statistical analysis showed that the treatments exerted significantly ( $p < 0.05$ ) different responses in each fish species. These results indicated that tilapia growth increased with increasing feeding supply (T1), while silver carp and mullet grow and gain more weight in ponds with higher plankton concentration (T2), indicating that daily feeding may not necessarily promote best growth in silver carp and mullet.

The present results are in agreement with those of Green *et al.* (1989) who found that *Oreochromis niloticus* growth increased with increasing feeding supply. Winfield and Nelson (1991) found that carp feed predominantly on phytoplankton and zooplankton. Hussein (1995) found that the feeding habits of mullet, *Mugil cephalus* is omnivorous. The main food items in the gut of *Mugil cephalus* were diatoms, plant detritus, filamentous algae and small invertebrates. Body weight of the three cultured fish species in the experimental ponds was the lowest in ponds with no commercial feeding (T4) ( $p < 0.05$ ).

Fluctuation in fish weight gain were observed through out rearing period of the three cultured fish species in the experimental ponds (Table 4). The greatest total weight gain was obtained with mullet followed by tilapia and silver carp, respectively. A general trend of greater decrease in weight gain of tilapia and silver carp started when temperature started to

decrease down 20°C. This indicating that low temperature affected metabolic rate. These results are in agreement with those of Hephher (1988) and Jeremy *et al.* (1996) who found that body gain weight of Nile tilapia *Oreochromis niloticus* decreases with decrease in temperature.

Specific Growth Rates (SGR) ;as shown in Table (4), the highest specific growth rate was obtained with Silver carp, Mullet and Tilapia, respectively. SGR for tilapia (1.78%) was obtained in treatment receiving commercial feed for three months (T1), while the highest (SGR) of Silver carp and Mullet (3.77 and 2.21%, respectively) was obtained in treatment receiving commercial feed for two months (T2) ( $P < 0.05$ ). The lowest rate was that of the control, with no commercial feeding (T4).

Total Fish production of three cultured species in the experimental pond (Table 5) was great in ponds receiving pelleted feed for three months (T1) and lower in ponds with no commercial feeding (T4). Total fish production at harvest from the different treatments ponds averaged 226,252,227 and 178 kg/pond (1000 m<sup>2</sup>) for treatment T1, T2, T3 and T4, respectively. Data presented in table (5) shows the effect of the treatment on the growth of Tilapia, Silver carp and Mullet respectively. The total production of silver carp and Mullet was higher in pond receiving pelleted feed for two months (T2). Total production of tilapia was higher in ponds receiving "Pelleted Feed" for three months (T1). This result indicates that tilapia production responded positively to application of "Pelleted Feed", with Silver carp and Mullet grows and gains more production showed ascending order of response to; non feeding feed for one month, feed for two months and feed for three months. The highest pond production (226 kg/pond) was obtained by pelleted feed for three months (T1) whereas the least production (178 kg/pond) was obtained in ponds with no feeding (T4). These results are shown in figures 1 & 2.

These findings are in agreement with Parther and Lovell (1973) who found that maximum production of catfish is about 312.5 kg/1000m<sup>2</sup> may be achieved in ponds by feeding. Zonneveled and Fadholi (1991) found that the relation between production and feed intake is linear.

### **Conclusion**

The economic evaluation of the treatment systems revealed that the most economic system is the applying pelleted feed for two months (T2) before harvesting. The highest production (256 kg/pond) obtained by pelleted fish feed for three months (T1) had no considerable excess than feeding for two months (252 kg/pond) (table, 5). This minute excess of production can not compensate for the cost of feed in the third month. Hephher and Pruginin (1981) stated that cost of feed in intensive culture

systems may comprise 50% or more of the total production cost. In the present study, feed cost represented 33.14 % of the total running costs for T1 (3 months feeding), while that of the T2 (2 months feeding) was 26.1% consequently the net economic return was less in case of extending feeding for three months.

The net return (total return – total cost) was 952.78, 1009.59, 931.54 and 738.33 L.E./pond for T1, T2, T3 and T4 treatment respectively (table, 6). The best net return (1009.59 L.E./pond) was obtained with T2 receiving pelleted feed for two months. In conclusion, a system based on receiving pelleted feed for two months, before harvesting in four months rearing period, is recommended for local fish farming. Further studies are needed for polyculture of relative and proportionally species number. The integral effect of feeding conditions (quality, quantity and frequency) with season of the year and length of rearing time has to be given comprehensive consideration.

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**Table (1): Average number of phytoplankton ( $10^6$  organism/L) of ponds water during the experimental.**

Intervals	Treatment																	
	T1			T2			T3			T4								
(weeks)	Cyano	Chloro	Bacill	Eugleno	Cyano	Chloro	Bacill	Eugleno	Cyano	Chloro	Bacill	Eugleno	Cyano	Chloro	Bacill	Eugleno		
1	610	805	105	280	375	635	485	530	108	430	53	315	149	155	43	143		
3	865	845	110	530	470	980	600	610	260	438	98	498	158	160	45	160		
5	925	975	126	590	525	1100	630	650	263	590	103	568	225	216	65	233		
7	1130	1178	169	638	727	1306	729	777	399	888	123	755	255	234	74	264		
9	1350	1375	200	850	875	1600	850	900	625	1105	255	938	328	285	93	303		
11	1150	1250	175	740	800	1435	750	800	493	950	175	828	280	250	80	275		
13	1140	1193	172	653	777	1375	734	785	405	890	168	775	268	243	77	269		
15	1060	1005	145	625	675	1085	680	730	308	885	110	615	243	222	73	245		
Sp Average	1029	1078	150	613	653	1190	682	723	358	772	177	662	238	221	69	233		
Total	2870																1969	765
Average	3248																	

Table (2): Average number of zooplankton organisms per liter of ponds' water during the experimental period.

Intervals	Treatment								
	T1		T2		T3		T4		
(weeks)	Copepods	Rotifera	Cladocera	Copepods	Rotifera	Cladocera	Copepods	Rotifera	Cladocera
1	2	5	7	5	4	6	3	9	11
2	3	5	15	10	7	11	8	13	16
3	110	60	215	100	54	250	173	31	83
4	148	79	276	118	43	363	186	22	97
5	135	155	335	119	71	410	160	39	108
6	18	25	66	33	33	38	33	28	35
7	11	8	30	24	25	15	24	20	22
8	3	5	14	11	8	12	8	14	18
9	53	43	120	53	31	138	74	48	63
Sp. Average	216		222		185		151		
Total Average	216		222		185		151		

Table (5): Total production (kg/pond) and number of fish recovered from polycultured species under different feeding systems

Treatment	Number of Fish and Yield									
	Tilapia		Silver carp		Mullet		total			
	No/pond*	Kg/pond	No/pond*	Kg/pond	No/pond*	Kg/pond	No/pond*	Kg/pond	No/pond*	Kg/pond
Feeding For:										
3 month	1368	176.47	123	11.16	387	68.05	1878	255.68		
2 month	1375	168.82	133	12.55	387	70.81	1995	252.18		
1 month	1355	156.35	121	9.53	374	61.13	1838	227.01		
Non (T+)	1350	118.80	118	8.00	365	51.55	1833	178.35		

\*Number of fish recovered from the pond (pond size = 1000m<sup>2</sup>)

The initial No of fish in each treatment was 1500 Tilapia+150 Silver carp+500 Mullet, total=2150

Table (3): Number of fish recovered at the end of experiment (4 month) from polycultured species under different feeding treatments, and livability (liv.)percentage.

Treatment	Number of Fish/pond and Livability %									
	Tilapia		Silver carp		Mullet		total			
	No *	Liv. %	No *	Liv. %	No *	Liv. %	No *	Liv. %	No *	Liv. %
T1	1368	91.2	123	82.0	387	77.4	1878	87.3		
T2	1375	91.6	133	88.6	387	77.4	1895	88.1		
T3	1355	90.3	121	80.6	374	74.8	1950	86.0		
T4	1350	90.0	118	78.6	365	73.0	1833	85.2		

\*Number of fish recovered from the pond (pond size = 1000m<sup>2</sup>)  
 The initial No of fish in each treatment pond was 1500 Tilapia+150 Silver carp+500 Mullet, total=2150

**Table (6) : Profitability of different feeding treatments.**

<b>Treatments Feeding For :</b>	<b>Total production (Kg/pond)</b>	<b>Total cost (L.E./pond)</b>	<b>Total return (L.E./pond)</b>	<b>Net return (L.E./pond)</b>
<b>3 month (T1)</b>	255.68	601.26	1554.04	952.78
<b>2 month (T2)</b>	252.18	529.32	1538.91	1009.59
<b>1 month (T3)</b>	227.01	450.77z	1382.31	931.54
<b>Non (T4)</b>	178.35	355.47	1093.80	738.33

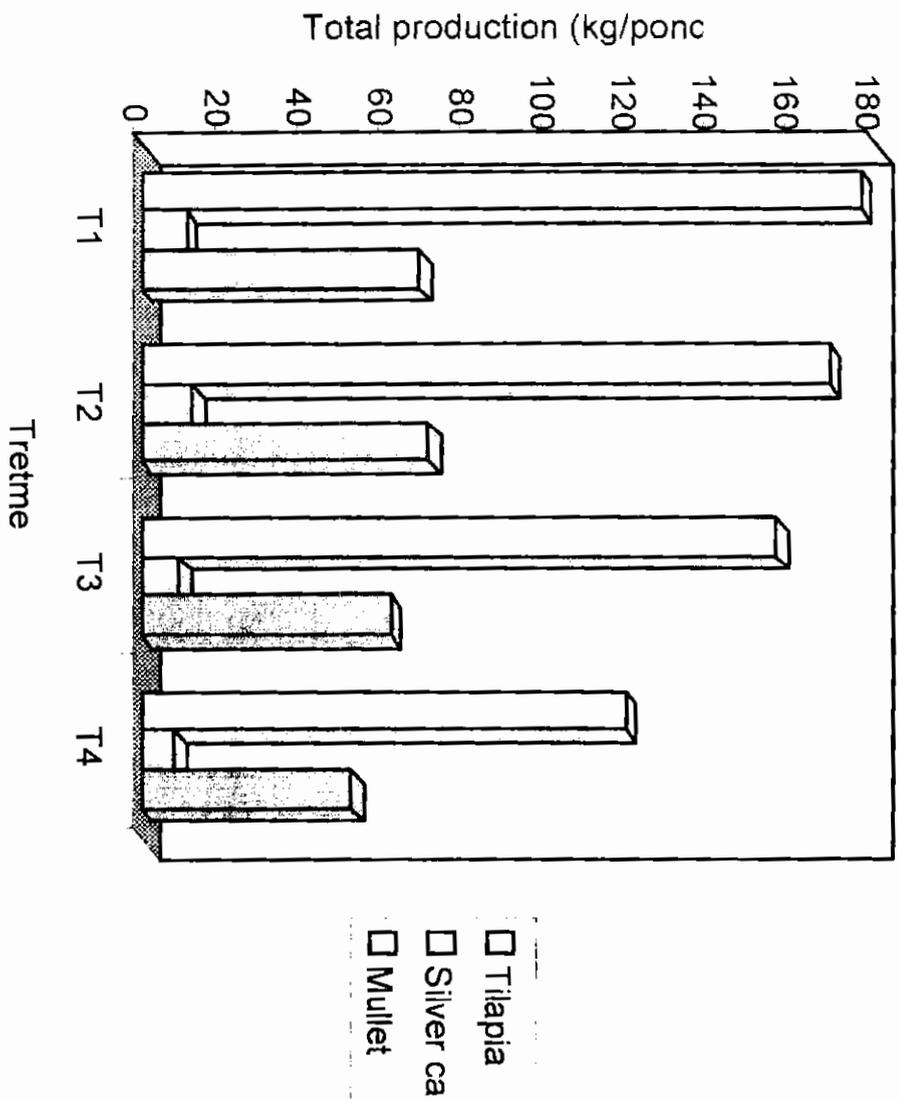
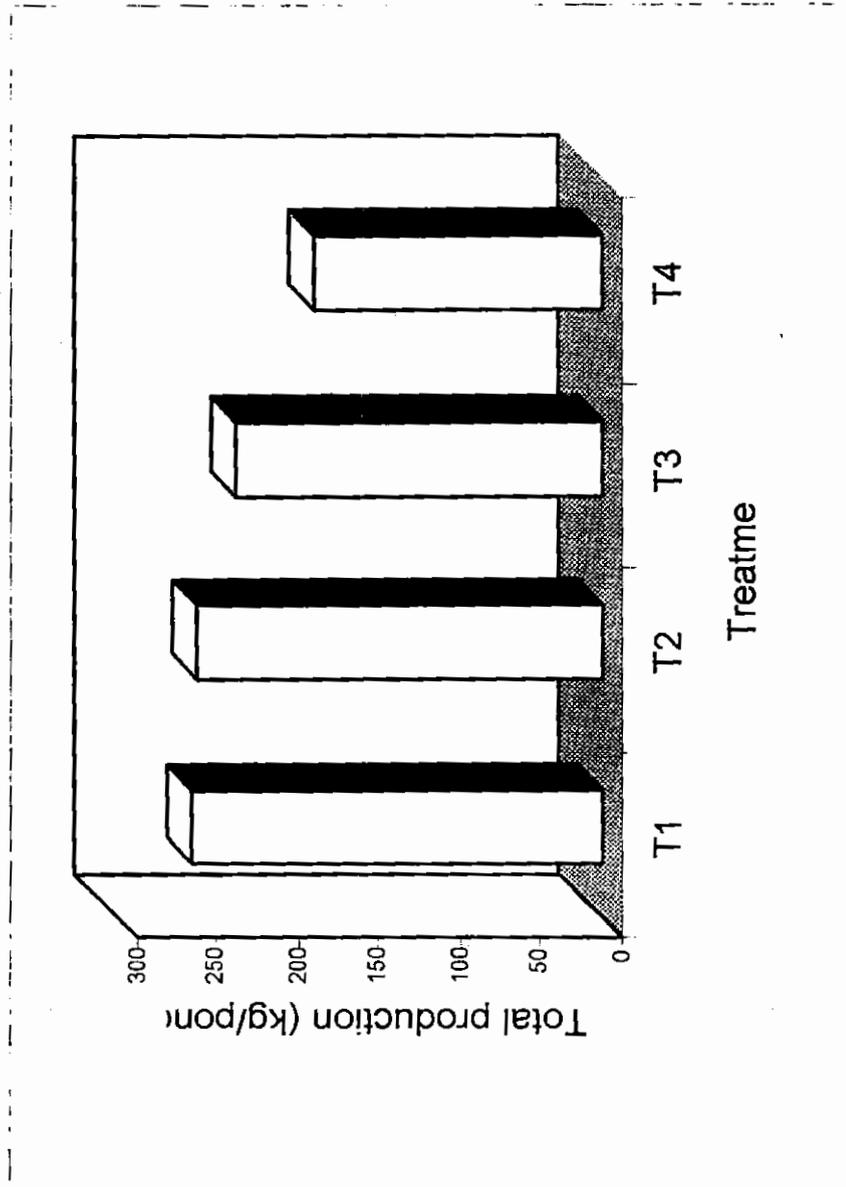


Fig.1 : Total production of tilapia, carp and mullet reared under different feeding treatments



**Fig.2:** Total production of combined fish species reared under different feeding treatments

Table (4) : calculated specific growth rate (SGR%) and total weight gain of tilapia, silver carp and mullet reared (4 months) under different feeding treatments

Species	Treatment	Average Fish Weight (g)		SGR (%)	Total weight Gain (g/fish)
		Initial (g/fish)	final (g /fish)		
Tilapia	T1	14.12 a	129	1.78 a	114.88
	T2	15.29 a	122.78	1.67 b	107.49
	T3	16.62 a	116.42	1.56 c	99.80
	T4	16.25 a	88	1.36 d	71.75
Silver carp	T1	1.09 a	90.77	4.56 b	89.68
	T2	0.87 a	94.40	4.77 a	93.53
	T3	1.07 a	78.89	3.46 c	77.77
	T4	1.02 a	67.86	3.38 d	66.84
Mullet	T1	16.05 a	175.85	1.93 b	159.80
	T2	15.15 a	182.98	2.12 a	167.83
	T3	15.60 a	163.46	1.89 c	147.86
	T4	15.26 a	141.25	1.79 d	125.99

Means within each column with no common subscript differ significantly (P<0.05)