Abbassa Int. J. Aqua., V0l.5 No.(1) 2012. *500-527*

EFFECT OF FFERTILIZATION AND ARTIFICIAL FEED ON PRODUCTIVITY OF EARTHEN PONDS STOKED UNDER POLYCULTURE SYSTEM

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Received 6/ 11/ 2012 *Accepted 18/ 12/ 2012*

Abstract

This experiment was designed to evaluate the effect of fertilization and artificial feeding on earthen ponds productivity stocked with different fish species. Five ponds (21×100 m) were stocked by different fish species; *Oreochromis niloticus* (ON), grey mullet (*Mugil cephalus*) (GM) and common carp (*Cyprinus carpio*) (CC). The five ponds were designed for five treatments and stocked with *Oreochromis niloticus* (4000 fish/pond), grey mullet (1500 fish/pond) and common carp (500 fish/pond). The experimental earthen ponds used in the study were Treatment 1 (control): artificial feeding (AF), Treatment 2: artificial feeding and organic fertilizer (poultry manure) (AFO), Treatment 3: artificial feeding + organic fertilizers (poultry manure) and inorganic fertilizers (urea and Triple super phosphate) (AFOI), Treatment 4: artificial feeding and inorganic fertilizer (urea, Triple super phosphate) (AFI) and Treatment 5: organic and inorganic fertilizer (urea, Triple super phosphate) (OI).

Results obtained are summarized in the following:

Treatment 3 (AFOI) recorded the highest ranges of body weight (BW), body length (BL), daily weight gain (DWG) and specific growth rate (SGR), while Treatment 5 (OI) recorded the highest range for condition factors (K).

Chemical composition: Treatment 4 (AFI) recorded the highest ranges for dry matter and protein content. While Treatment 1 (AF) recorded the highest ranges for ether extract and ash.

Based on results obtained in this study and on the economical evaluation, it could be concluded that tilapia, G. mullet and common carp can be cultured together in earthen ponds and growth parameters of the three species improved when fish fed the diet 25% protein plus organic and inorganic fertilizers. The favored economics of this treatment was reflected in the best ratio of returns to total costs.

INTRODUCTION

The present world population is expected to grow up to 6.1 billion by 2050 (UN, 2000). As a result, the demand for food including fish is increasing. The demand of aquatic products for human consumption will grow to 123.5 million metric tons by 2015 (WijkstrÖm, 2003), while its present production level in 101 million metric tons (FAO, 2004). This goes beyond total capture fisheries supply. The shortfall in supply will largely filled in through aquaculture. Since 1970, aquaculture is the fastest growing animal production sector in the world expanding at an average 9.2% per year compared to only 1.4 for capture fisheries (FAO, 2004).

Polyculture, between tilapia and other aquatic species, is an established option when natural food from different pond niches are independently exploited by fish, when there is a market for all species in culture and when their combination provides an economic benefit which is high enough to cover extra labour expenses required to grade and sort fish at sampling and harvesting (Ibrahim *et al.*, 2001).

The aim of this work was to study the effect of fertilization and artificial feeding on earthen ponds production under polyculture system of aquaculture.

MATERIALS AND METHODS

The study had been done in a private farm (in Tollumbat No. 7 in Riyad City, Kafr El-Sheikh governorate, Delta district at the Northern part of Egypt) to evaluate the effect of fertilization and artificial feeding on earthen ponds productivity stocked with different fish species. The procedures done in this study such as fertilizers application per treatment, pond preparation, stocking density and pond daily management are described in details. Also water quality measurements, fish sampling and data collected during harvest are recorded too.

Equations and statistical methods for analyzing the specific growth rate, daily weight gain and the condition factor are given.

Experimental design:

The current experiment was conducted using randomized block design for five treatments of similar surface area (2100 m^2) each

Ponds description and preparation:

The experimental ponds were equal in water volume (2625 m^3) and dimensions (21x100 m) with the same average water depth of 125 cm. Before beginning the experiment, ponds were drained, weeded and exposed to the sun for one month for complete dryness. Each pond had inlet and outlet water gates through which the water level was controlled.

The farm water source was mainly agricultural drainage water and comes from El-Gharbia drainage canal. The water system of the experimental ponds is maintained by gravity. Ponds inlet and outlet pipes were covered with narrow mesh screen to prevent unwanted fish or predators to get into ponds. Partial filling of the ponds to 50% of target level started on the following day after applying the initial fertilization dose from relevant fertilizers. Two days prior to stocking fingerlings fish, ponds water level increased and reached the maximum target water depth.

Experimental fish:

Fish species:

The experimental ponds were stocked with different fish species; *O. niloticus* (mixed sex), Grey mullet (*Mugil cephalus*) and common carp (*cyprinus carpio*). *O. niloticus* fingerlings were stocked at an average initial total length of 5.76 cm and an average initial total weight of 17.18 g for all treatments. Common carp fingerlings were collected from the same farm, stocked with an average total length of 8.43 cm and an average total weight of 18.15 g for all treatments. The average initial total length of G. mullet fingerlings were 8.26 cm and an average initial total weight of 16.04 g for all treatments. The fingerlings of *O. niloticus*, G. mullet and C. carp were collected from different fish farms Riyad City, Kafer El-Shiek Governorate.

Stocking rate:

Each pond was stocked with 6000 fish (4000 *O. niloticus*, 1500 G. mullet and 500 common carp) corresponding to the rate of 12000 fish/ feddan.

Pond management:

The trial lasted for 140 days started on the 5th of May and harvested on 21st September 2012. In which the following culture practices were done:

Fertilizers applications:

Ponds were fertilized for the twentieth week as shown in Tables 1 and Table 2. Fertilization occurred once a week by broadcasting of:

-Organic fertilizer (poultry manure 65 kg/feddan/week): at the beginning of the experimental period on pond surface.

-Inorganic fertilizers (Triple super phosphate; 20% P_2O_5 and urea containing 46% nitrogen) were added as sources of phosphorus and nitrogen to ponds weekly at a rate of 8 kg/feddan of Triple super-phosphate, by dissolving it in water and splashed all over the experimental ponds water. While 2 kg urea /feddan were broadcasted at pond water surface.

Table 1: Approximate chemical composition (%) of organic fertilizer (poultry manure) as dry matter basis.

Treatment	Organic fertilizer
Crude protein (CP)	26.62
NFE	25.26
Nitrogen	2.18
Phosphorus	3.00

Supplementary feed:

The main goal of this study was to evaluate the impact of one source of supplementary feed on water quality and biological productivity of the experimental ponds through one successive rearing season. The use of fertilizers may greatly increase fish growth rate or, in over stocked ponds to improve productivity. But in fish culture, it is usual to add artificial feed 25% protein to obtain even higher yields.

Table 2: Composition and proximate chemical analysis of the experimental ration.

Ingredients	**%**
Yellow corn	33
Wheat bran	17
Fish meal (72% CP)	10
Meat meal	7
Soybean meal (44% CP)	10
Decorticated cotton seed meal	7
Poultry slaughter by-products	8
Fat	5
Vitamin premix*	1.5
Mineral premix**.	1.5
Total	**100**
Proximate analysis (% of dry weight)	
Moisture	10.20
Crude protein	20.08
Ether extract	6.54
Crude fiber	6.72
Ash	6.06

* Each gram of vitamin premix contains 20000 IU vit. A , 2000 IU vit.D_3, 400 IU vit E, 20 mg Niacin, 4.5 mg riboflavin, 3 mg pyridoxine, 0.013 mg vit. B12, 100 mg choline chloride and 2 mg vit K.

** each gram contains 0.83 mg Ca, 0.63 mg P, 0.78 mg Na, 0.018 mg Zn and 0.001 mg Cu. The Mixture was prepared by mixing 35 parts of dicalcium phosphate, 3 parts of mineral premix and 2 parts of common salt

Commercial diet was manufactured by Sherbeen-Domiatte, local factory. Sample of fish feed was collected from several sacks and send for proximate analysis at the Central Laboratory for Aquaculture Research at Abbassa. Chemical analysis of experimental artificial feed is presented in Table (2). The fingerlings were fed commercial floating diet to keep the diets available for fish contain 25% crude protein (pellets 3 mm in diameter), and fed six days per week at a daily feeding rate of 3% of the estimated fish-weight twice at 10.00am and 2.00pm during the experimental period. Feed was applied by broadcasting over pond water surface in the same place and fish were considered satiated when they did not show an interest on the feed.

Feed quantity was adjusted according to average body weight of the sample in each pond. In order to determine the average weight of fish, biweekly samples were taken by seining where 30 fishes / species from each pond were collected and then released again in the pond after individual measuring the weight and length.

Fish samples and measurements:

Random samples (30 fish from each species for each pond) were taken biweekly during the experimental period. During this experiment, body measurements (body weight in g and body length in cm) were recorded 8 times, at biweekly interval throughout the whole experiment period.

Condition factor was determined by using the following formula:

$$K = [\text{ weight (g) / length (cm)}^{3}] \times 100$$

Specific growth rate was calculated according to Jauncey and Rose (1982).

Harvesting:

At the end of the experiment (21st of September, 2012), ponds were gradually drained from the water and fish were harvested by seining and transferred to fibreglass tanks and carried to the processing centre where they washed, and the fish of the different fish species were sorted and collectively weighed.

Chemical analysis of fish:

At the end of the experiment, five fish were chosen from each species from each pond and exposed to the chemical composition of whole fish body according to the methods of A.O.A.C. (1990).

Statistical analysis:

The statistical analysis of data collected was carried out by applying the computer program (SAS, 1996) by adopting the following fixed model:

$$Y_{ijk} = \mu + T_i + S_j + (TS)_{ij} + e_{ijk}$$

Where:

Y_{ijk} = observation of the ijk-th fish; μ = overall mean; Ti = fixed effect of the i-th treatment; Sj = fixed effect of the j-th stocking density within the i-th treatment.

$TS)_{ij}$ = interaction between the effect of i-th treatment and j-th stocking density and e_{ijk} = a random error.

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

RESULTS AND DISCUSSION

Body weight:

Table 3 shows means of body weights, at the start and the end of the experiment as affected by stocking density. As described in this table, the averages of initial weights of ON, GM and CC were 17.16, 16.04 and 18.15g respectively; while at the end of the experiment, the means of body weight for fish species were 235.16, 314.56 and 345.72g, respectively. These results indicate that, the body weight for CC was higher than obtained in GM and ON. The differences between fish species were significant ($P<0.05$). These results may be attributed to the feeding habits of the three species as tilapia fish is an efficient converter of phytoplankton and can utilize a wide varity of food, especially artificial feeds, while silver carp feeds primary on phytoplankton (Bitterlich and Gnaiger, 1984).

With regard to the effect of pond treatments (fertilization/artificial feeding) on body weight, Table 3 showed that, the initial body weight was 17.51, 17.20, 16.84, 16.52 and 16.19 for five treatments artificial feeding (AF), artificial feeding and organic fertilizer (poultry manure) (AFO), artificial feeding + organic fertilizers (poultry manure) and inorganic fertilizers (urea and Triple super phosphate) (AFOI), artificial feeding and inorganic fertilizer (urea, Triple super phosphate) (AFI) and poultry manure and fertilizer (urea, Triple super phosphate) (OI), respectively. While at the end of experiment the means of body weight for treatments were 272.74, 311.20, 385.51, 316.85 and 205.86g for the five treatments, respectively. These results indicate that, the average body weight for treatment (AFOI) was higher than other treatments.

The analysis of variance of these results indicates that, the differences between treatments were significant ($P<0.05$). These results are in agreement with Reich (1975). He reported that, in the polyculture system of three species, common carp, silver carp and tilapia, with supplementary feed, the fertilization increased the common carp yield by 35%, silver carp by 31% but had no effect on the yield of tilapia fish. Jasmine *et al.,* (2011) found that, average gain in body weight of all the fish species together was less in the pond without fertilizer than that in the pond with fertilizer. The fertilizer increased the primary productivity and finally caused a significant increase in fish yield in ponds.

Keshavanath *et al.* (2006) and Islam *et al.* (2008) studied the effects of fertilization and supplementary feed on growth performance of the three major carps. They reported that, the artificial diets with caw manure influenced the growth and survival rate and harvested fish biomass.

Table 3: Least-square means and standard error of the tested factors affecting on body weight (gm).

Variable	No.	Initial weight	Final weight
Fish species (FS)			
ON	150	17.16±0.07^{ab}	235.16±1.56^{c}
GM	150	16.04±0.07^{b}	314.56±1.56^{b}
CC	150	18.15±0.07^{a}	345.72±1.56^{a}
Treatments (T)			
AF	90	17.51±0.08^{a}	272.74±0.62^{b}
AFO	90	17.20±0.08^{a}	311.20±0.62^{ab}
AFOI	90	16.84±0.08^{b}	385.51±0.62^{a}
AFI	90	16.52±0.08^{b}	316.85±0.62a^{b}
OI	90	16.19±0.08^{b}	205.86±0.62^{c}
T* FS			
AF * ON	30	17.15±0.16^{b}	226.78±1.27^{d}
AF * GM	30	17.97±0.16a^{b}	293.71±1.27^{c}
AF * CC	30	16.95±0.16^{b}	297.73±1.27^{c}
AFO * ON	30	17.21±0.16^{b}	239.56±1.27^{d}
AFO * GM	30	17.01±0.16^{b}	340.72±1.27b^{c}
AFO * CC	30	17.55±0.16^{b}	353.33±1.27^{bc}
AFOI * ON	30	17.09±0.16^{b}	309.63±1.27^{c}
AFOI * GM	30	16.05±0.16b^{c}	380.43±1.27^{b}
AFOI * CC	30	18.15±0.16^{ab}	466.46±1.27^{a}
AFI * ON	30	17.16±0.16^{b}	207.42±1.27^{e}
AFI * GM	30	15.09±0.16^{c}	346.21±1.27^{bc}
AFI * CC	30	18.75±0.16^{a}	396.92±1.27^{b}
OI * ON	30	17.17±0.16^{b}	192.42±1.27^{e}
OI * GM	30	14.13±0.16^{c}	211.75±1.27de
OI * CC	30	19.35±0.16^{a}	213.42±1.27^{de}

± Means with the same letter in each column are not significantly different (P≥0.05)

Results presented in Table (3) show that variations were significant (P<0.05) due to the interaction between feeding/fertilization treatments and fish species which indicated that these two factors act dependently on each other and also each of them had its own significant effect. As showed in this Table, the best final weight was obtained for carp farmed 3rd treatment (AFOI, being 466.46g), followed by carp from 4th treatment (AFI, being 396.22), the G. mullet from 3rd (380.43g).

Body length:

Table 4 shows means of total body length, at the start and the end of experiment. As described in this Table the initial averages of ON, GM and CC were 5.76, 8.26 and 8.43cm, respectively while at the end of experiment, the means of total body length for fish species were 23.56, 33.59 and 37.80cm, respectively. These results indicate that body length for CC was significantly higher than ON and GM, and the differences between fish species were highly significant (P>0.05).

Abdel–Hakim *et al.* (2001) and Hassan *et al.* (2008) studied the effect of fertilization and feeding on body length they found negative relation to the increasing stocking density of grass carp. However, total fish yield at harvesting increased. These results may lead to recommend lower stocking densities of grass carp with tilapia up to the marketable size for short rearing period with using supplementary feed otherwise higher stocking densities should be need longer time during the culture season of fish**.**

Concerning the effect of treatments on body length Table 4, the initial body length was 7.91, 7.89, 7.52, 7.69 and 7.36cm for five treatments (AF), (AFO), (AFOI), (AFI) and (OI) respectively. While at the end of the experiment, the means of body length for treatments were 30.56, 32.32, 37.56, 33.02 and 27.21cm for five treatments, respectively. These results indicate that the total body length for treatment (AFOI) was higher than other treatments.

Table 4: Least-square means and standard errors of the tested factors affecting total body length (cm).

Variable	No.	Initial length	Final length
Fish species (FS)			
ON	150	5.76±0.03[b]	23.56±0.12[c]
GM	150	8.26±0.03[a]	33.59±0.12[b]
CC	150	8.43±0.03[a]	37.80±0.12[a]
Treatments (T)			
AF	90	7.91±0.037[a]	30.56±0.13[c]
AFO	90	7.89±0.037[a]	32.32±0.13[b]
AFMOI	90	7.52±0.037[a]	37.56±0.13[a]
AFI	90	7.69±0.037[a]	33.02±0.13[b]
OI	90	7.36±0.037[a]	27.21±0.13[d]
T* FS			
AF * ON	30	5.86±0.07[c]	23.31±0.26[d]
AF * GM	30	8.98±0.07[a]	32.91±0.26[c]
AF * CC	30	7.83±0.07[b]	34.11±0.26[bc]
AFO * ON	30	6.22±0.07[c]	23.18±0.26[d]
AFO * GM	30	8.62±0.07[a]	33.36±0.26[c]
AFO * CC	30	8.13±0.07[ab]	39.39±0.26[b]
AFOI * ON	30	5.15±0.07[d]	29.53±0.26[cd]
AFOI * GM	30	8.53±0.07[a]	37.39±0.26[b]
AFOI * CC	30	8.42±0.07[a]	45.94±0.26[a]
AFI * ON	30	6.25±0.07[c]	20.89±0.26[e]
AFI * GM	30	7.90±0.07[b]	35.15±0.26[b]
AFI * CC	30	8.73±0.07[a]	40.88±0.26[ab]
OI * ON	30	5.34±0.07[d]	20.89±0.26[e]
OI * GM	30	7.54±0.07[b]	29.61±0.26[c]
OI * CC	30	9.03±0.07[a]	28.69±0.26[cd]

± Means with the same letter in each column are not significantly different ($P \geq 0.05$).

Analysis of variance of results indicated that the differences among treatments were significant ($P<0.05$). Prabahar and Senthil Murugan (2012) found increasing body length when major carp, fed on artificial feed plus organic fertilizer and inorganic fertilizers.

The interaction (T*FS) was significant too, where the longest total body length was for AFOI * CC (45.94cm) followed by AFI * CC (40.88cm) and AFO * CC (39.39cm).

Condition factor (K):

Condition factor (K) of fish is essentially a measure of relative muscle to bone growth and the differing growth responses of these tissues to dietary treatment may be reflected by changes in condition factor (Ostrowski and Garling, 1988). Condition factor (K) was considered to be a sufficient measure of shape, although shape is usually not considered as a character of interest to breeding programs, since it has no obvious economic value (Nilsson, 1992).

Table 5 presents means of K at the start and the end of the experiment as affected treatments and fish species. As described in this Table the averages of K values at the start for ON, GM and CC was 9.45, 2.10, and 3.06, respectively while at the end of experiment the means of K for fish species were 1.88, 0.93 and 0.73, respectively and the differences among fish species were significant ($P<0.05$).

With regard to the effect of treatments on condition factor, Table 5 showed that, the initial condition factor was 4.42, 4.40, 5.12, 4.13 and 5.22 for five treatments (AF), (AFO), (AFOI), (AFI) and (OI) respectively. While at the experimental end, the means of condition factor for treatments were 1.07, 1.10, 0.78, 1.12 and 1.37, respectively. These results indicate that, the condition factor for treatments (OI) was higher than other treatments.

Analysis of variance of results indicates that, the differences among treatments were significant ($P<0.05$). Feeding treatment in adequate quantities and the increase in feeding rate resulted in higher condition factor since the fish grow well when the supply of food is adequate. Similar results in which condition factors increased with the feeding rate have been reported by Chua and Teng (1982) and Ibrahim *et al.* (2001). Dioundick and Stom (1990) demonstrated that, for *O. massambicus*, the values of condition factors decreased with increasing the $\propto$-cellulose percent from 0 to 10% of the diet.

Results presented in Table 5 show that variations are significant ($P<0.05$) due to the interaction between treatments and stoking fish species which indicated that these two factors act dependently on each other and also each of them had its own significant effect. As showed in this Table, interactions between fourth and fifth treatments (AFI) and (OI) with fish species (ON) were higher than obtained for other treatments and fish species.

Ibrahim *et al.* (2001) reported that, the effect of stocking rate on condition factor of silver carp was different throughout the whole period of experiment.

Table 5: Least-square means and standard error of the tested factors affecting on condition factor (K).

Variable	No.	Initial K	Final k
Fish species (FS)			
ON	150	9.45±0.37[a]	1.88±0.018[a]
GM	150	2.10±0.37[d]	0.93±0.018[b]
CC	150	3.06±0.37[c]	0.73±0.018[c]
Treatments (T)			
AF	90	4.42±0. 39[b]	1.07±0.02[b]
AFO	90	4.40±0. 39[b]	1.10±0.02[b]
AFOI	90	5.12±0. 39[a]	0.78±0.02[c]
AFI	90	4.13±0. 39[c]	1.12±0.02[b]
OI	90	5.22±0. 39[a]	1.37±0.02[a]
T* FS			
AF * ON	30	6.94±0.12[a]	1.98± 0.04[a]
AF * GM	30	3.76±0.12[c]	0.86± 0.04[c]
AF * CC	30	3.74±0.12[c]	0.75± 0.04[cd]
AFO * ON	30	6.93±0.12[a]	1.97± 0.04[a]
AFO * GM	30	3.75±0.12[c]	0.93± 0.04[c]
AFO * CC	30	3.73±0.12[c]	0.58± 0.04[d]
AFOI * ON	30	7.33±0.12[a]	1.21± 0.04[b]
AFOI * GM	30	4.11±0.12[bc]	0.72± 0.04[cd]
AFOI * CC	30	4.09 ±0.12[bc]	0.48± 0.04[e]
AFI * ON	30	6.79±0.12[a]	2.32± 0.04[a]
AFI * GM	30	3.63±0.12[c]	0.8± 0.04[cd]
AFI * CC	30	3.60±0.12[c]	0.58± 0.04[d]
OI * ON	30	7.34±0.12[a]	2.11± 0.04[a]
OI * GM	30	4.16±0.12[b]	1.06± 0.04[c]
OI * CC	30	4.14±0.12[b]	1.24± 0.04[b]

± Means with the same letter in each column are not significantly different ($P \geq 0.05$).

Daily weight gain (DWG):

Table 6 shows means of daily weight gain, throughout the experiment as affected by treatments and fish species. As described in this table the averages between each of (ON), (GM) and (CC) were 1.56, 2.22 and 2.45g/fish respectively. These results indicate the daily weight gain for CC was higher than obtained for GM and ON. The differences among fish species were significant (P<0.05).

According to Kstmont (1995), the growth and yield of each species may be high in polyculture than in monoculture because of positive interactions among species. De Silva (2006) reported that, Nile tilapia grew better in polyculture system with no common carp, probably because these species compete for artificial feed. This could explain the superiority of grass carp yield in treatments which achieved rabbit manure as organic fertilizer.

Concerning the effect of treatments on daily weight gain of table 6 showed that, the Daily weight gain was 1.86, 2.15, 2.62, 2.20 and 1.72g/fish for five treatments (AF), (AFO), (AFOI), (AFI) and (OI) respectively. These results indicate that, the daily weight gain for treatments (AFO), (AFOI) and (AFI) were higher than other treatments. Analysis of variance of results indicates that the differences among treatments were significant (P<0.05).

Hassan *et al.* (2008) revealed that artificial feed application to blue tilapia reared in earthen ponds improved specific growth rate values as compared with other treatments in fertilized ponds at lower stocking densities. Increasing was recorded in the growth performance by using supplemental feeding compared with other treatments (fertilized ponds). They found also that, blue tilapia was the fastest growing fish under these treatment conditions. On the other hand, growth performance of grass carp was higher in fertilized ponds.

Results presented in Table 6 show that variations are significant (P<0.05) due to the interaction between treatments and fish species which indicated that these two factors act dependently on each other and also each of them had its own significant effect. As showed in this Table, interactions between third

(AFOI) and fourth (AFI) treatments with fish species CC were higher average than obtained with other treatments and fish species.

Specific growth rate (SGR):

Table 6 shows means of SGR, at the end of experiment as affected by treatments and fish specie. As described in this Table, the averages of ON, GM and CC were 1.86, 2.14, and 2.13%/d, respectively. These results indicate that SGR for GM and CC was higher than that obtained for ON. The differences between fish species were significant (P>0.05).

With regard to the effect of treatments on SGR, table 6 showed that, the specific growth rate at the end of this experiment was 1.97, 2.07, 2.22, 2.11 and 1.97 for five treatments (AF), (AFO), (AFOI), (AFI) and (OI) respectively. These results indicate that, the Specific growth rate for treatments No. 3, 4 and 2 were higher than those obtained with other treatments. Analysis of variance indicates that the differences between treatments were significant (P<0.05).

Abdel-Wares (1993) and (Ibrahim *et al.,* 2001) found that, increasing of stocking rate by silver carp was followed by increasing the amount of supplementary feeding which was more suitable for Nile tilapia in the presence of natural food. Therefore, with increasing stocking rate, SGR of Nile tilapia increased while SGR of silver carp decreased. These results are in agreement, partially, with those obtained by Hassan *et al.* (2008) who reported that, the SGR values of blue tilapia indicated that supplementary feed increased the availability of all nutrients to fish when stocked in un-fertilized ponds; the lowest value was obtained by grass carp with high stocking density in un-fertilized ponds. Also, the higher value of SGR was observed in T6 for blue tilapia but lower value was obtained in un-fertilized pond, on spite of low stocking density of grass cap in this treatment.

Results presented in Table 6 show that variations are significant (P<0.05) due to the interaction between feeding treatments and fish species which indicated that these two factors act dependently on each other and also each of them had its own significant effect. As showed in this Table, interaction between third (AFOI) and fourth (AFI) treatments with fish species CC and GM were higher significantly than obtained other treatments and fish species.

Table 6: Least-square means and standard error of the tested factors affecting on DWG and SGR.

Variable	No.	DWG, g/fish	SGR, %/d
Fish species (FS)			
ON	150	1.56±0.40^{c}	1.86±0.37^{b}
GM	150	2.22±0.40^{b}	2.14±0.37^{a}
CC	150	2.45±0.40^{a}	2.13±0.37^{a}
Treatments (T)			
AF	90	1.86±0. 46^{b}	1.97±0. 41^{b}
AFO	90	2.15±0. 46^{a}	2.07±0. 41^{a}
AFOI	90	2.62±0. 46^{a}	2.22±0. 41^{a}
AFI	90	2.2±0. 46^{a}	2.11±0. 41^{a}
OI	90	1.72±0. 46^{b}	1.97±0. 41^{b}
T* FS			
AF * ON	30	1.50±0.09^{cd}	1.84±0.08^{bc}
AF * GM	30	1.97±0.09^{c}	1.99±0.08^{b}
AF * CC	30	2.01±0.09^{bc}	2.05±0.08^{b}
AFO * ON	30	1.59±0.09^{c}	1.88±0.08^{bc}
AFO * GM	30	2.32±0.09^{b}	2.14±0.08^{a}
AFO * CC	30	2.40±0.09^{b}	2.14±0.08^{ab}
AFOI * ON	30	2.09±0.09^{bc}	2.07±0.08^{ab}
AFOI * GM	30	2.65±0.09^{b}	2.25±0.08^{a}
AFOI * CC	30	3.20±0.09^{a}	2.32 ±0.08^{a}
AFI * ON	30	1.36±0.09^{d}	1.78±0.08^{c}
AFI * GM	30	2.37±0.09^{b}	2.23±0.08^{a}
AFI * CC	30	2.70±0.09^{b}	2.18±0.08^{a}
OI * ON	30	1.25±0.09^{d}	1.73±0.08^{c}
OI * GM	30	2.10±0.09^{bc}	2.11±0.08^{ab}
OI * CC	30	1.97±0.09^{c}	1.94±0.08^{b}

± Means with the same letter in each column are not significantly different ($P \geq 0.05$).

Ibrahim *at al.* (2001) found that, SGR of tilapia and silver carp, in polyculture system, during the experimental intervals decreased due to the interaction between first treatment (poultry litter) and increasing stocking rates.

While due to the interaction between second treatment and increasing stocking rate, SGR of Nile tilapia increased and SGR of silver crap decreased.

Chemical composition:

Dry matter:

Table 7 showed dry matter averages at the end of experiment as affected by treatments and fish species. As described in this Table, the averages between each of (ON), (GM) and (CC) were 27.88, 29.11 and 29.18% respectively. These results indicated that, the dry matter for GM and CC was higher than that obtained for ON. The differences between fish species were significant ($P<0.05$). This result are agreement with Yousif (1996) who found that stocking density of *O.niloticus* had significant effect on the chemical composition of the whole fish, but Hafez *et al.* (2001) found that, stocking rate had insignificant effect on percentages of moisture and dry matter.

With regard to the effect of treatment on dry matter table 7 showed that, the dry matter at the end of this experiment was 28.71, 28.79, 29.01, 30.07 and 27.71% for five treatments (AF), (AFO), (AFOI), (AFI) and (OI), respectively. These results indicate the dry matter for treatment fourth (AFI) was higher than obtained for other treatments. Analysis of variance of results indicates that the differences between treatments were significant ($P<0.05$).

Results presented in Table 7 showed that variations are significant ($P<0.05$) due to the interaction between treatments fish species which indicated that these two factors act dependently on each other and also each of them had its own significant effect. As showed in this table, interaction between fourth (AFI) and third (AFOI) treatments with fish species GM and CC, respectively were higher than obtained with other treatments and fish species.

Protein:

Table 7 showed that means of protein %, at the end of experiment as affected by treatments and fish species. As described in this Table, the averages of (ON), (GM) and (CC) were 52.70, 61.73 and 49.50% respectively. These results indicate that, the protein % for GM was higher than obtained in CC and

ON. The differences between fish species were significant (P<0.05). (Hafez *et al.,* 2001) reported that, significant effect was found with percentage of protein (P<0.001)

Table 7: Least-square means and standard error of the tested factors affecting chemical composition (Dry matter and Protein).

Variable	No.	Dry matter	Protein	Ether extract	ASH
Fish species (FS)					
ON	25	27.88±0.33[b]	52.70±1.18[b]	16.62±0.57[b]	10.98±0.39[b]
GM	25	29.18±0.33[a]	61.73±1.18[a]	11.53±0.57[d]	8.41±0.39[c]
CC	25	29.11±0.33[a]	49.50±1.18[c]	17.80±0.57[a]	11.78±0.39[a]
Treatments (T)					
AF	15	28.71±0.37[c]	56.54±1.32[c]	15.53±0.64[a]	12.14±0.44[a]
AFO	15	28.79±0.37[c]	61.78±1.32[a]	13.80±0.64[c]	9.11±0.44[c]
AFOI	15	29.01±0.37[b]	58.85±1.32[b]	14.55±0.64[b]	10.41±0.44[b]
AFI	15	30.07±0.37[a]	62.85±1.32a	14.33±0.64[b]	9.18±0.44c
OI	15	27.71±0.37[d]	54.57±1.32[d]	13.64±0.64[c]	10.26±0.44[b]
T* FS					
AF * ON	5	27.7 ± 0.74[c]	52.27±2.64[c]	16.08±0.32[ab]	11.56±0.28[a]
AF * GM	5	29.52± 0.74[b]	61.02±2.64[b]	13.53±0.32[c]	10.27±0.28[b]
AF * CC	5	28.4± 0.74[bc]	51.85±2.64[cd]	17.17±0.32[a]	11.96±0.28[a]
AFO * ON	5	27.84± 0.74[c]	54.04±2.64[c]	15.21±0.32[b]	10.05±0.28[b]
AFO * GM	5	28.97± 0.74[bc]	63.03±2.64[a]	12.67±0.32[d]	8.76±0.28[d]
AFO * CC	5	29.40± 0.74[b]	50.04±2.64[cd]	16.30±0.32[a]	10.45±0.28[b]
AFOI * ON	5	28.23± 0.74b[c]	53.26±2.64[c]	15.59±0.32[b]	10.70±0.28[b]
AFOI * GM	5	28.17± 0.74[c]	63.73±2.64[a]	13.04±0.32[cd]	9.41±0.28[c]
AFOI * CC	5	30.95± 0.74[a]	44.20±2.64[e]	16.68±0.32[a]	11.10±0.28[a]
AFI * ON	5	29.33± 0.74[b]	57.22±2.64[bc]	15.48±0.32[b]	10.08±0.28[b]
AFI * GM	5	31.86± 0.74[a]	63.37±2.64[a]	12.93±0.32[d]	8.80±0.28[d]
AFI * CC	5	27.16± 0.74[c]	54.43±2.64[c]	16.57±0.32[a]	10.48±0.28[b]
OI * ON	5	26.29± 0.74[d]	46.73±2.64[d]	15.13±0.32[b]	10.62±0.28[b]
OI * GM	5	27.45± 0.74[c]	60.77±2.64[b]	12.59±0.32[d]	9.34±0.28[c]
OI * CC	5	29.65± 0.74[ab]	47.01±2.64[d]	16.22±0.32[ab]	11.02±0.28[a]

± Means with the same letter in each column are not significantly different (P≥0.05)

With regard to the effect of treatments on protein %, Table 7 showed that, protein % at the end of this experiment was 56.54, 61.78, 58.85, 62.82 and 54.57% for five treatments (AF), (AFO), (AFOI), (AFI) and (OI) respectively. These results indicated that, protein % for fourth (AFI) and second (AFO) treatments were higher than obtained with other treatments. The analysis of variance of results indicates that the differences between treatments were significant ($P<0.05$).

Hafez *et al.* (2001) found that, fish flesh from fish fed the first feeding treatment (organic fertilization) had higher percentages of protein, ash and lower percentages of fat compared with flesh obtained from the second feeding treatment (supplementary feeds).

As showed in Table 7, interactions between second, third and fourth treatments of artificial feeding, with fish species, GM were higher average than obtained with other treatments and fish species.

Ether extract:

Table 7 shows means of ether extract (for estimating lipid in fish species), at the end of experiment as affected by treatments and fish species. As described in this Table the averages between each of (ON), (GM) and (CC) were 16.62, 17.80 and 11.53% respectively. These results indicate the ether extract for CC and ON were higher than that obtained for GM. The differences between fish species were significant ($P>0.05$).

With regard to the effect of treatments on ether extract Table 7 showed that, ether extract at the end of this experiment was 15.53, 13.80, 14.55, 14.33 and 13.64% for five treatments (AF), (AFO), (AFOI), (AFI) and (OI) respectively. These results indicate that ether extract for first treatment (OI) was higher than obtained other treatments, and by increasing fat percentage there was decreasing protein percentage. These results are comparable with Yousif (1996). He found lowest protein percentage with the largest fat percentage whereas he recorded largest percentage of protein with the lowest percentage of ash. Analysis of variance indicates that the differences between treatments were significant ($P>0.05$).

As presented in Table 7, interaction between first, second, third and fourth treatments with fish species CC were higher than obtained with other treatments and all fish species

Ash:

Table 7 shows means of ash, at the end of experiment as affected by fish species (ON), (GM) and (CC). As described in this table the averages of (ON), (GM) and (CC) were 10.98, 8.41 and 11.78% respectively. These results indicate the ash for CC was higher than obtained for ON and GM. The differences among fish species were significant (P>0.05).

With regard to the effect of treatments on ash, table 7 showed that ash at the end of this experiment was 12.14, 9.11, 10.41, 9.18 and 10.26% for five treatments (AF), (AFO), (AFOI), (AFI) and (OI), respectively. These results indicate that ash for first treatment (AF) was higher than obtained for other treatments, and the differences among treatments were significant (P>0.05).

Results presented in Table 7 show that variations are significant (P<0.05) due to the interaction between treatments and fish species which indicated that these two factors act dependently on each other and also each of them had its own significant effect.

As showed in this table, interaction between first treatments, with fish species (CC) was higher average than obtained for other treatments and fish species.

Total yield:

Averages of total yield at the end of the experiment were listed in table (8). As described in this Table 8 *Oreochromis niloticus* gained the highest yield (4298 kg -100%) compared with 2169 kg gained by grey mullet and 930 kg gained by common carp. These results may be attributed to the feeding habits of the three species as described previously. The total fish production (tilapia fish + grey mullet + common carp) for all feeding treatments (organic fertilization) was 7397 kg.

Table 8: Total yield of different fish species as affected by feeding treatments.

Independent variable	Yield (kg)	%
Fish species (FS)		
ON	4298	100
GM	2169	50.47
CC	930	42.88
Treatments (T)		
AF	1492	75.09
AFO	1620	81.53
AFOI	1987	100
AFI	1599	80.47
OI	699	35.18
T* FS		
AF * ON	882	76.23
AF * GM	440	38.03
AF * CC	170	14.69
AFO * ON	949	82.02
AFO * GM	483	41.75
AFO * CC	188	16.25
AFOI * ON	1157	100.00
AFOI * GM	578	43.60
AFOI * CC	252	21.78
AFI * ON	855	73.90
AFI * GM	523	45.20
AFI * CC	221	19.10
OI * ON	455	39.33
OI * GM	145	12.53
OI * CC	99	8.56

*The fish catch attributed to the highest value for the same factor

As in this Table 8, third treatment (AFOI) gained the highest yield (1987 kg -100%), compared with (AF) (1492 kg - 75.09%), (AFO) (1620 kg – 81.53%), (AFI) (1599 kg – 80.47%) and (OI) (699 kg – 35.18%). These results are in partial agreement with those obtained by Collis and Smitherman (1978), they found that hybrid tilapia when fed on manure, grew 62% compared to hybrids fed on a high protein diet. Barash and Schroeder (1984) found that the substitution of 46% of the pellets by fermented cow manure did not reduce the total fish yield but the complete substitution of the pellets by fermented cow manure caused a 47% decrease in the total yield.

The interaction between type of feeding and fish species was found to be significant. This may indicate that, for tilapia fish under the artificial feed with organic and in-organic fertilizer system, the total yield of tilapia increased compared with other feed treatments. These findings may be due to the fact that under organic and in-organic system an interspecies competition on natural food occurred and this is reflected on total yield of tilapia. This phenomenon appeared too with other fish species through the same treatment

Economic evaluation:

Results of costs including variable, fixed and interest on working capital for the treatments applied are shown in Table (9). Results of this table revealed that costs of fish fingerlings are similar in all treatments applied, however the feed costs differed according to poultry manure, Triple supper phosphate and urea additive with some diets and were the lowest for treatment 5, poultry manure and fertilizer (urea, Triple super phosphate) (OI) (2672.9 LE) and increased to 6126.44, 5967.60, 7870.98 and 5245.38 LE for other diets treatment 1, treatment 2, treatment 3 and treatment 4, respectively.

Total costs per pond (½ feddan) increased from 3074.85 LE (100%) for treatment 5 (IO) to 13646.56 LE (443.81%), 15575.40 (506.54%), 18304.02 LE (595.28%) and 15613.12 LE (507.77%) for treatment 2 (AFO), treatment 3 (AFOI) and treatment 4 (AFI), respectively. Differences in total costs were attributed to the differences in feed costs and organic and inorganic fertilizer additives.

Total returns in LE/pond (½ feddan) for treatment 1, treatment 2, treatment 3, treatment 4 and treatment 5 were 19773, 21543, 26175, 20858.5 and 5747.75 LE, respectively (Table 11). Net returns/pond in LE were found to be. 6126.44, 5967.60, 7870.98, 5245.38 and 2672.90 LE for the five treatments (IO), (AFO), (AFOI), (AFI) and (IO), respectively. The percentage of net return to total costs were 44.89, 38.31, 43.00, 33.60 and 86.93% for treatments (IO), (AFO), (AFOI), (AFI) and (IO), respectively.

Table 9: The effect of the experimental diets on economic efficiency (LE/pond)

Items		Treatments				
		Diet1 (AF)	**Diet2 (AFO)**	**Diet3 (AFOI)**	**Diet4 (AFI)**	**Diet5 (OI)**
1- Variable costs (LE/½Feddan)						
a. costs of fish fingerlings:						
O. niloticus		520	520	520	520	520
G. Mullet		1200	1200	1200	1200	1200
C. carp		125	125	125	125	125
b. Feeds		10611.05	12058.22	14402.78	12234.9	0
c. Poultry manure		0	377	377	0	377
d. Triple supper phosphate		0	0	176	176	176
e. urea		0	0	60	60	60
Total variable costs (LE½/Feddan)		12456.05	14280.22	16860.78	14315.9	2458
2- Fixed costs (LE/½Feddan)						
. Depreciation (materials&others) 10%		250	250	250	250	250
b. Taxes		200	200	200	200	200
Total fixed costs (LE/½Feddan)		450	450	450	450	450
Total operating costs (variable&fixed)		12906.05	14730.22	17310.78	14765.9	2908
Interest on working capital *		740.51	845.18	993.24	847.22	166.85
Total costs		13646.56	15575.40	18304.02	15613.12	3074.85
% of the smallest value		443.81	506.54	595.28	507.77	100%
Returns						
Total return (LE) **	O N	7938	8541	10413	7695	2957.5
	G M	10560	11592	13872	11506	2320
	C C	1275	1410	1890	1657.5	470.25
		19773	21543	26175	20858.5	5747.75
Net return (LE/½Feddan)		6126.44	5967.60	7870.98	5245.38	2672.90
% of the smallest value of net return		158.61	154.50	203.77	135.80	100.00
% Net returns to total costs		44.89	38.31	43.00	33.60	86.93

* 15% × total operating costs × 140/365 days.

** The economical evaluation of results was carried out according to market prices in 2012 in LE.

O. niloticus = LE 130 /1000 fry. G. mullet = LE 800 /1000 fry c. carp = LE 250 /1000 fry

Urea =LE 1500/1000 Kg. Triple supper phosphate = LE 1100/1000 Kg. manure = LE 580 /1000 Kg.

Fish feed (25% protein) = LE 2850 /1000 Kg

These results indicated that feeding of *Oreochromis niloticus* in polyculture with grey mullet and common carp in earthen ponds on diets containing 25% crude protein with manure, tripl supper phosphate and urea additive resulted in best economic efficiency compared to the other treatments. These results are in complete agreement with results of Abdel-Hakim *et al.* (2001).

Conclusion:

Based on results obtained in this study and on the economical evaluation, it could be concluded that *Oreochromis niloticus*, grey mullet and common carp can be cultured together in earthen ponds and growth parameters of the three species improved when fish fed on the diet 25% protein with organic and inorganic fertilizer. From the economical point of view, this treatment seemed to be the best in terms of ratio of returns to total costs.

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تأثير التسميد والتغذية الصناعية على إنتاجية الأحواض الترابية تحت نظام الاستزراع المتعدد

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الملخص العربى

أجريت هذه التجربة فى مزرعة سمكية بمدينة الرياض بمحافظة كفر الشيخ، جمهورية مصر العربية. وذلك لدراسة تأثير التسميد والتغذية الصناعية على إنتاجية الأحواض الترابية المخزنة تحت نظام الاستزراع المتعدد. تم استخدام خمسة أحواض ترابية بأبعاد ٢١ × ١٠٠م لتربية أسماك البلطي النيلي،البوري و المبروك العادى. تم تصميم الأحواض الترابية بمعدل تخزين ٤٠٠٠ من اصبعيات أسماك البلطي النيلي و ١٥٠٠ من اصبعيات أسماك البوري و ٥٠٠ من اصبعيات أسماك المبروك العادى فى كل حوض ترابى بمتوسط أوزان ١٧.١٦، ١٦.٠٤ و١٨.١٥جم لأسماك البلطى والبورى والمبوك العادى على التوالى. تم اجراء خمس معاملات فى الخمس احواض، فى المعاملة الأولى تمت التغذية على عليقة صناعية تحتوى على ٢٥% بروتين خام، المعاملة الثانية تم فيها التغذية بنفس العليقة الصناعية والتسميد بزرق الدواجن، المعاملة الثالثة تم فيها استخدام العليقة الصناعية وزرق الدواجن وثلاثى سوبر فوسفات ويوريا، والمعاملة الرابعة تم فيها استخدام العليقة الصناعية والتسميد بثلاثى سوبر فوسفات واليوريا والمعاملة الخامسة تم فيها استخدام التسميد بزرق الدواجن و ثلاثى سوبر فوسفات واليوريا. تم اجراء التجربة فى ٥ مايو ٢٠١٢م وانتهت فى ٢١ سبتمبر من نفس العام واستمرت لمدة ٢٠ أسبوعا، وكان من أهم النتائج المتحصل عليها مايأتى:

- سجلت المعاملة الثالثة والمستخدم فيها العليقة الصناعية وزرق الدواجن وثلاثى سوبر فوسفات واليوريا أعلى معدل لوزن الجسم، طول الجسم، وزيادة اليومية فى الوزن ومعدل النمو النوعى.
- سجلت المعاملة الخامسة والمستخدم فيها التسميد بزرق الدواجن و ثلاثى سوبر فوسفات واليوريا أعلى معدل لمعامل الحالة.
- وبالنسبة للتركيب الكيماوى، سجلت المعاملة الرابعة والمستخدم فيها العليقة الصناعية والتسميد بثلاثى سوبر فوسفات واليوريا أعلى نسبة للمادة الجافة ونسبة البروتين.
- سجلت المعاملة الاولى والمستخدم فيها التغذية على عليقة صناعية تحتوى على ٢٥% بروتين خام أعلى نسبة لمستخلص الايثير ونسبة الرماد.

بناء على نتائج هذه الدراسة، وكذلك التقييم الإقتصادى، يمكن إستنتاج أنه يمكن إستزراع أسماك البلطى والبورى والمبروك العادى إستزراع مختلط فى الأحواض الترابية مع تحسن النمو عندما تتغذى الأسماك على عليقة صناعية (بروتين ٢٥٪) والأسمدة العضوية و الأسمدة غير العضوية.، وانعكس ذلك على الناحية الاقتصادية حيث كان هذا النظام أفضل من حيث نسبة العوائد إلى التكاليف الإجمالية.