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COMPARATIVE EFFECTS OF LIVE FOOD AND ARTIFICIAL FEED IN POLYCULTURE IN CONCRETE PONDS

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ABSTRACT

Many fish and crustacean larvae and fingerlings require live food at the onset of exogenous feeding. This experiment has been conducted to evaluate zooplankton and phytoplankton alone or their mixtare as live food for fingerlings of Nile tilapia *(Oreochromis niloticus*); common carp *(Cyprinus carpio)*; silver carp, *(Hypophthalmichtys molitrix)* and catfish *(Clarias gariepinus*).In fifteen concrete ponds. The experimental period was 150 days. The water quality parameters were significantly differing by different feeding types. The using of zooplankton alone as live food or mixed with phytoplankton or mixed with phytoplankton and artificial feed for different fish species improved water quality and fish performance. The results indicated that the using of phytoplankton and zooplankton as live food for fish species led to significante increase in growth performance than artificial feed only. The growth performance of catfish was significantly increased than Nile tilapia. Also, zooplankton was enough for fry and fingerlings to achieve suitable growth more than artificial feed. The stomach content of detritus was increased significantly in case of fish species fed with artificial feed treatments, while, zooplankton increased significantly in zooplankton live food treatments. The use of live food decreased artificial feed and improved the digestive enzyme activity.

Key words:live food, Phytoplankton, Zooplankton, Artificial food, Polyculture, Tilapia, carp, Tatfish, and Toncrete ponds.

INTRODUCTION

Live food sources are essential in both marine and freshwater fish rearing especially during larval stages, although various mixed dry foods are also being used for feeding fish of both media. The most probable candidates as live foods for fish larvae are the single-cell and/or colonial phytoplanktonic algae and the zooplanktonic organisms. Rotifers are important in freshwater larvae feeding (Shaker *et al.*, 2009a&b). It is known that lipids are essential for fish, especially for producing their metabolic energy. Live food seems to provide a good source of exogenous enzymes. Zooplankton occupy a central position between the autotrophs and other heterotrophs maintaining an important link in the sustainability of the food chain forming one of the most important components of freshwater aquaculture species (Shaker,2008). In semi-intensive or intensive culture conditions, aquaculture species derive a substantial part of their dietary nutrient needs from naturally available zooplankton as they are a valuable source of protein, amino acids, lipid, fatty acids, vitamins and enzymes (Shaker, 2008).

Many fish and crustacean require live food at the onset of exogenous feeding. It is generally difficult to include chemical or isotopic markers in live food for nutrient studies. Nutrient assimilation studies in fish at the onset of exogenous feeding are limited by a number of factors. The composition of artificial diets can be modified easily but their acceptance by the larvae is often low.

Shaker *et al.* (2008) reported that the use of zooplankton as live food for fish improved the quality of fish. They found that using the zooplankton as live food for fry fish species significantly increased its growth performance than fingerlings. Also, they added that the fed by zooplankton was enough for fry and fingerlings to achieve suitable growth more than artificial feed.

Success of larval rearing depends mainly on the availability of suitable diets that are readily consumed, efficiently digested and provides the required nutrients to support good growth and health (Giri *et al.*, 2002). Limited success has been achieved in first-feeding larvae with the complete replacement of live feeds. In freshwater zooplankton, cyclopoid copepods are important because many of them are voracious predators, feeding on algae, ciliates, rotifers, larval insects, and small cladocerans (Monakov, 2003), thereby structuring plankton communities. Phytoplankton genera such as Pediastrum, Eudorina and Ceratium are difficult for zooplankton to digest compared with Chlorella, Scenedesmus and Chlamydomonas (Downing and Rigler, 1984). Several copepods, particularly cyclopoids, are facultative predators and grow better on animal diets (Williamson and Reid, 2001).

Wang *et al.*(2005) and Shaker *et al.*(2009a&b) found that the growth performance of fish was significantly higher on live food than on formulated diets. The present study has been conducted to: I- evaluate the phytoplankton and zooplankton as live foods alone for different fish species in polyculture, II- evaluate the mixed phytoplankton and zooplankton as live food for fish compared with formulated diets on growth performance,and III- stady the effect of different feeding types on growth performance of different species and stomach index data of different fish species in polyculture.

MATERIALS AND METHODS

Experimental facilities and set up:

This study was carried out at the Central Laboratory for Aquaculture Research, Abbassa, Abou-Hammad, Sharkia Governorate, Egypt. Nile tilapia (*Oreochromis niloticus*); common carp, *(Cyprinus carpio)*; silver carp, *(Hypophthalmichtys molitrix)* and catfish, *(Clarias gariepinus)* were obtained from research hatchery, at Abbassa, Abou-Hammad, Sharkia Governorate as fingerlings. The average weight was 10.0 g for all fish species. Each fish species was randomly distributed into five group's concrete ponds (2.5m long **x** 1.5m wide **x** 1.2m depth) (first group fed by 100% live zooplankton , second group fed by 100% live phytoplankton, third group fed by 100% artificial feed 25%protein as 5% of total body weight, forth group fed by 50% live zooplankton and 50% live phytoplankton and finally fifth group fed by 33.3% live zooplankton+33.3% live phytoplankton+33.3% artificial feed 25% protein). The experimental period was 150 days during 15th May to 15th October 2008. Experimental fish were stocked at the rate of 50 fish/ pond. All ponds had been stocked with the same fish species, namely, Nile tilapia (*Oreochromis niloticus)* 75%, mixed sex; common carp *(Cyprinus carpio)* 10%, silver carp *(Hypophthalmichtys molitrix)* 10% and 5% catfish *(Clarias gariepinus,* mean body weight 10±1.1g) were stocked at 50fish/pond. The total numbers of different fish species were 37,5, 5 and 3 for tilapia, common carp, silver carp and catfish, respectively in each pond. All ponds were supplied with an aerator compressor with timer, six hours work and one hour rest. A sample of different fish species was taken monthly from each pond for measuring the growth performance and calculating the amount of the artificial feed. At the end of the experiment, . fish were harvested, counted and weighed

Water quality monitoring:

Water sampling was carried out for measuring several parameters of concern to aquaculture. Physico-chemical parameters were monitored biweekly. Temperature (°C), dissolved oxygen (DO mg/l) were measured by oxygen-meter

(Aqua Lytic OX 24), pH by pH meter Orion 543, salinity(g/l) was measured using a conductivity meter (Orion). Secchi disk visibilities (SD, cm)were recorded, ammonia (NH_4, mg/l) were determined using a HACH comparison, nitrite (NO_2 mg/l) and chlorophyll a µg/l were measured using standard methods (APHA 2000). Qualitative and quantitative estimates of phytoplankton and zooplankton were also recorded monthly according to APHA (2000).

Stomach contents analysis:

The fish were dissected and stomachs removed and stored in 10% formalin solution. The stomachs were weighed, dissected and the constituent food items separated, enumerated under light microscope and weighed. The stomach contents were grouped as detritus, higher plant, phytoplankton, zooplankton, insects and 'others' categories which could not be well identified. The numerical percentages of the total particles in the stomach content were calculated based on weight (Meschiatti and Arcifa, 2002).

Mass production of live food organisms:

The freshwater phytoplankton and zooplankton were mass produced in lab until transfer to fiberglass tank 1-ton (t) filled with filtered tap water. Each tank was inoculated with 2 million organisms obtained from pure stock of zooplankton maintained in the laboratory and 10-50 x 10^6 cells ml/1 phytoplankton. Batch cultures of zooplankton were fed *Chlorella sp.* (10-50 x 10^6 cells ml/1) according to Shaker and Hamed(2008) which was mass-produced using a commercial grade complete fertilizer (18-18-18) at 100 g/ton (tank). Every week, 2 tanks transfered from lab to outdoor concrete ponds to be used as live food. Zooplanktons (150-250 µm) were harvested with plankton net after 1-2 weeks of culture.

There were five feeding treatments with three replicates each in a completely randomized design. Zooplankton, phytoplankton, artificial diet (containing 25% protein), mixed phytoplankton and zooplankton and finally mixed of phytoplankton, zooplankton and artificial diets were provided in five treatments. The phytoplankton and zooplankton treatments were fed live organisms daily at a range of 60, 80, 100, 120 and 140 l/pond, at May, June, July, August and September, respectively throughout the experiment. The artificial diet (25%) protein was given daily at 5%

of the fish biomass. All diets (phytoplankton, zooplankton and artificial feed) provided twice daily, 5 days/week.

Statistical analysis:

The data were first checked for assumptions for analysis of variance. The data were then subjected to analysis of variance (one-way ANOVA). If significant ($P<0.05$) differences were found in the ANOVA test, Duncan's multiple range test (Duncan,1955) was used to rank the groups. The data are presented as mean ±SE or otherwise stated, of three replicate groups. All statistical analyses were carried out using (SAS,2000).

RESULTS AND DISCUSSION

In the natural food web, phytoplankton and zooplankton constitutes a major part of the diet for fish.Data of kiater analysis (Temperature; dissolved oxygen, nitrogen compound and chlorophyll "a") were presented in Table 1and Fig.1. Water temperature did not significantly differ among treatment during the whole period. The pH values were significantly increased in the mixture of the three diets. The average values of pH were 8; 8.6; 8.2; 8.6 and 8.8 for live zooplankton, live phytoplankton, artificial feed, zooplankton + phytoplankton and zooplankton + phytoplankton + artificial feed treatments, respectively. These results are due to the increase of phytoplankton which led to increase photosynthetic uptake of CO_2 and that substituted hydroxyl ions. These results are in agreement with those obtained by Shaker and Mahmoud (2007). As presented in Table (1), water characteristics (temperature, dissolved oxygen concentration, pH and transparency) measured during the experimental period were within the range recommended for aquaculture (Boyd and Tucker, 1998). The dissolved oxygen concentrations were significantly ($P<0.05$) decreased in phytoplankton treatment than other treatments. These finding may be due to the consumptions of DO by phytoplankton. The nitrogen compound reflected a significantly increased in treatment fed artificial feed than others. The highest values of ammonia recorded in artificial feed followed by treatment fed by phytoplankton plus zooplankton plus artificial feed and then fed by phytoplankton. These results may be due to the waste of artificial feed which is considered as organic matter and consequently a source of nutrient in these ponds which led to increase the phytoplankton then the decomposition of organic matter (waste of feed) and via the direct excretion of ammonia by the large biomass of fish.

Table (1): Average means of water quality parameters in concrete ponds under different food types in polyculture system during the experimental period.

Items / Treat.	Temp. °C	pH	SD cm	DO mg/l	NH_4 mg/l	NO_2 mg/l	NO_3 mg/l	Sal. g/l	Chlorophyll a µg/l
Live Zooplankton	27.5 ± 1.5^a	8.0 ± 0.5^b	25 ± 4^a	6.8 ± 1^a	0.3 ± 0.2^c	0.03 ± 0.001^c	0.02 ± 0.001^c	1.2 ± 0.1^a	32.28 ± 3.2^c
live Phytoplankton	28 ± 1^a	8.6 ± 0.5^a	16 ± 4^a	4.2 ± 1^b	1.0 ± 0.2^b	0.03 ± 0.002^c	$0.05 \pm 0.01b^c$	1.2 ± 0.1^a	64.66 ± 3.4^b
Artificial feed	27.5 ± 1.5^a	8.2 ± 0.5^b	26 ± 2^b	5.5 ± 1^a	1.5 ± 0.2^a	0.08 ± 0.01^a	0.1 ± 0.02^a	1.3 ± 0.1^a	38.38 ± 6.6^c
Zooplankton + Phytoplankton	27.5 ± 1.5^a	8.6 ± 0.5^a	14 ± 3^b	$5.2 \pm 1a^b$	0.8 ± 0.2^b	0.06 ± 0.01^b	0.08 ± 0.01^b	1.3 ± 0.1^a	86.66 ± 6.4^b
Zooplankton + Phytoplankton + Artificial Feed	27.5 ± 1.5^a	8.8 ± 0.5^a	10 ± 2^a	4.6 ± 1^b	1.2 ± 0.1^a	0.1 ± 0.02^a	0.14 ± 0.02^a	1.3 ± 0.1^a	125.18 ± 2.2^a

Means in the column followed by different letters are significantly different ($P<0.05$).

These results are in agreement with those obtained by Shaker *et al.*(2008). Significantly higher amounts of chlorophyll a were recorded in all ponds fed by zoo, phyto and artificial feed indicating that there was a higher level of phytoplankton production.

Generally, the increase of nutrient in water led to increase of phytoplankton and zooplankton abundant and then increase of biological load in water. The average total numbers of phytoplankton (Table 2 and Fig.2) were 206; 433; 786; 383 and 522 org $x10^3$/l for the same treatments, respectively. Also, zooplanktons (Table 3 and Fig.2) were 244; 203; 670; 638 and 196 organism/l in the same treatments respectively. The highest number of phytoplankton and zooplankton was found in the accumulation of organic compounds and macronutrient. These results clear that there is high correlation between organic compounds, macronutrient and phytoplankton / zooplankton abundance. These results are in agreement with those obtained by Shaker and Mahmoud (2007).

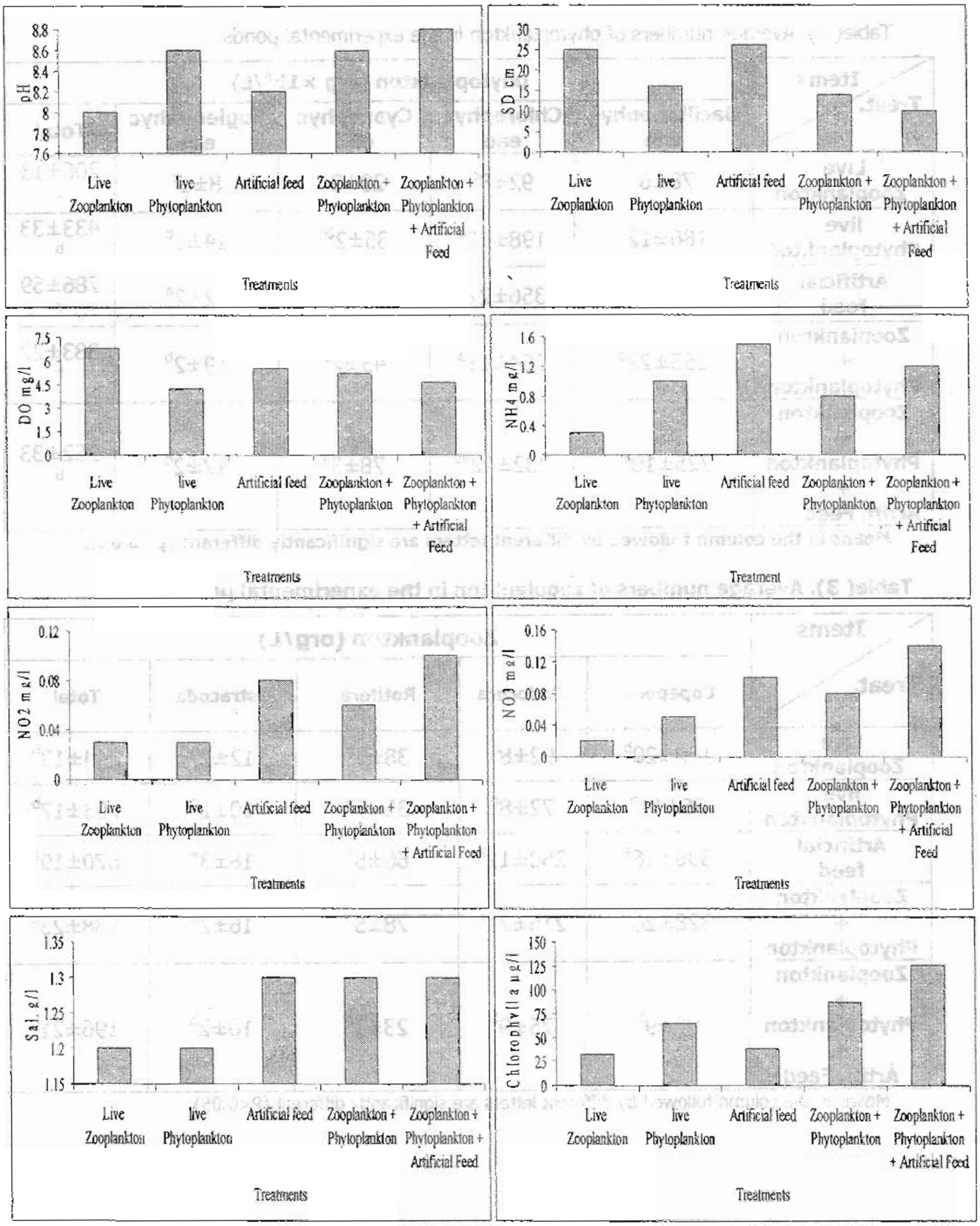

Fig (1): Average means of water quality parameters in concrete ponds under different food types in polyculture system during the experimental period.

Table(2). Average numbers of phytoplankton in the experimental ponds.

Items / Treat.	phytoplankton (org $\times 10^3$/L)				
	Bacillariophyceae	Chlorophyceae	Cyanophyceae	Euglenophyceae	Total
Live Zooplankton	78 ± 6^{c}	92 ± 8^{c}	28 ± 2^{c}	8 ± 1^{c}	206 ± 13^{c}
live Phytoplankton	186 ± 12^{b}	198 ± 12^{b}	35 ± 2^{bc}	14 ± 1^{b}	433 ± 33^{b}
Artificial feed	336 ± 22^{a}	356 ± 22^{a}	62 ± 3^{a}	32 ± 2^{a}	786 ± 59^{a}
Zooplankton + Phytoplankton	155 ± 22^{b}	164 ± 11^{a}	45 ± 2^{b}	19 ± 2^{b}	383 ± 27^{b}
Zooplankton + Phytoplankton + Artifi. Feed	225 ± 10^{ab}	232 ± 12^{ab}	78 ± 3^{a}	17 ± 2^{b}	552 ± 33^{b}

Means in the column followed by different letters are significantly different ($p\leq 0.05$).

Table(3). Average numbers of zooplankton in the experimental pond.

Items / Treat.	Zooplankton (org/L)				
	Copepoda	Cladocera	Rotifera	Ostracoda	Total
Live Zooplankton	102 ± 20^{b}	92 ± 8^{b}	38 ± 4^{b}	12 ± 2^{b}	244 ± 13^{b}
live Phytoplankton	86 ± 11^{b}	72 ± 8^{b}	35 ± 6^{b}	10 ± 2^{b}	203 ± 17^{b}
Artificial feed	336 ± 16^{a}	250 ± 11^{a}	66 ± 5^{a}	18 ± 3^{a}	670 ± 19^{a}
Zooplankton + Phytoplankton	328 ± 26^{a}	216 ± 21^{a}	78 ± 5^{a}	16 ± 2^{a}	638 ± 23^{a}
Zooplankton + Phytoplankton + Artifi. Feed	88 ± 9^{b}	75 ± 9^{b}	23 ± 3^{b}	10 ± 2^{b}	196 ± 21^{b}

Means in the column followed by different letters are significantly different ($P<0.05$).

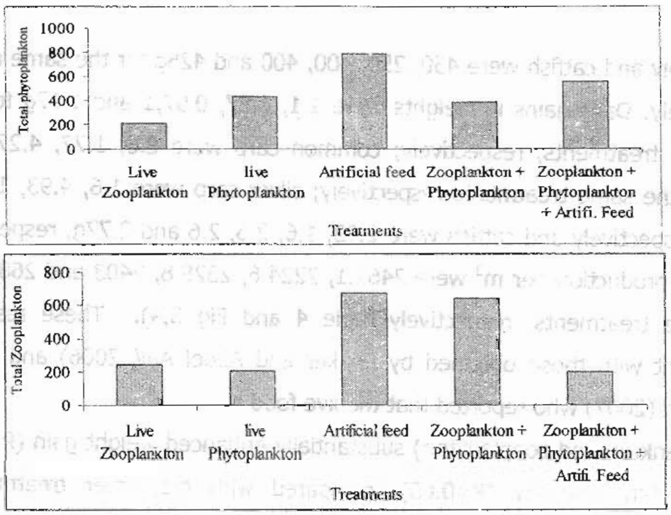

Fig. (2): Total numbers of phytoplankton and zooplankton in the experimental ponds under different feeding types.

Pond management (feeding types) is one of the most important variables in aquaculture because it directly influences survival, growth, behaviour, health, water quality, feeding and production. The highest values of survival rate were recorded in feeding by zooplankton, feeding by three types, feeding by phytoplankton and then artificial feed (Table 4and Fig 4). These results clear that the feeding by zooplankton improved water quality and survival rate according to Shaker *et al.*(2008). Also, the highest survival rate was recorded by catfish follwed by tilapia and then common carp, while the lowest survival rate was recorded by silver carp. These results may be due to the behaviour of fish species and water quality. The silver carp were had more activities and liveliness than in tilapia and catfish, also silver carp needs good water quality. The Nile tilapia and catfish may tolerate the poor quality of water than silver carp. Also, the catfish and Nile tilapia may tolerate high stocking density in these water more than mullet and silver carp. These results are in agreement with those obtained by Shaker *et al.*, (2008). The survival rates of catfish was 100% for all treatments.

The final weight of individual tilapia were 175,140,155; 160 and 185g for the same treatments, respectively; common carp were 400, 275, 650; 375 and 475g for the same treatments, respectively; silver carp were 250, 750, 175, 400 and 375g, respectively and catfish were 450, 250, 400, 400 and 425g for the same treatments, respectively. Daily gains in weights were 1.1, 0.87, 0.97,1 and 1.17g for tilapia in the same treatments, respectively; common carp were 2.6, 1.77, 4.27, 2.43 and 3.1g for the same treatments respectively; silver carp were 1.6, 4.93, 1.1, 2.6 and 2.43g, respectively and catfish were 2.93, 1.6, 2.6, 2.6 and 2.77g, respectively. The total fish production per m^3 were 2461.1, 2224.6, 2328.8, 2403 and 2682.4g/m^3 for the same treatments, respectively(Table 4 and Fig 3,4). These results are in agreement with those obtained by Shaker and Abdel Aal(2006) and Shaker and Mahmoud (2007) who reported that the live food (phytoplankton and zooplankton) substantially enhanced weight gain ($P < 0.05$) and reduced fish mortality ($P<0.05$), compared with the other treatments. Many compounds present in phytoplankton and zooplankton could potentially influence digestive enzyme activity in fish. A direct cause and effect relationship cannot be elucidated from this study. Further and more detailed research is required to identify the mechanism through which algae stimulate the production and/or secretion of digestive enzymes, in addition to increasing growth and survival of fish species.

The algae provided a direct supply of nutrients. According to Moffatt (1981), it is possible that algae may provide nutrients directly to the fish. During early development, free amino acids play an important role in energy production and protein synthesis (Fyhn, 1993) and are contained in large amounts in algae. Another reason could be the water quality different among treatments.Studies on life history parameters of several phytoplankton and zooplz,nktonabundance (Urabe and Watanabe, 1992) suggest that growth and reproductive potentials are affected by the nutrient conditions of the culture media. Maximum concentration of phytoplankton and zooplankton in the artificial feed treatment could be a consequence of improved water quality, expressed in terms of higher values of NH4-N and medium values of DO and pH, which is conducive to fast reproduction of some of the major zooplankton constituting the main food item of carp (Jana and Chakrabarti, 1993). In general, plankton intake by tilapia, carp and catfish tends to rise with increasing food availabilit

Table(4). Growth performance of different fish species fed on phytoplankton and zooplankton as live food and artificial food in concrete pond.

Items / Treat.	Fish species	Survival %	Final weight g	Net gain g	Daily gain g	T. prod. g/pond	T. prod. $g/m^3/sp$	T.Prod. g/m^3
Live Zooplankton	Tilapia	100±0[a]	175±10[c]	165±10[c]	1.1±0.1[c]	6475±200[a]	1438.9±100[a]	2461.1 ± 170[ab]
	Common	100±0[a]	400±25[b]	390±20[b]	2.6±0.2[b]	2000±150[b]	444.4±30[b]	
	Silver	100±0[a]	250±20[b]	240±20[b]	1.6±0.2[b]	1250±100 [c]	277.8±20[c]	
	Catfish	100±0[a]	450±30[b]	440±25[b]	2.93±0.2[b]	1350±100[c]	300±20[c]	
live Phytoplankton	Tilapia	90±2[b]	140±10[c]	130±10[c]	0.87±0.1[c]	4662±200[b]	1036±60[b]	2224.6 ± 150[b]
	Common	95±0[ab]	275±20[b]	265±20[b]	1.77±0.1[b]	1036.3±80[c]	230.3±15[c]	
	Silver	95±3[ab]	750±50[a]	740±40[a]	4.93±0.2[a]	3562.5±200[b]	791.7±40[b]	
	Catfish	100±0[a]	250±20[b]	240±20[b]	1.6±0.2[b]	750±50[c]	166.7±12[c]	
Artificial feed	Tilapia	95±2[ab]	155±10[c]	145±10[c]	0.97±0.1[c]	5448.3±300[a]	1210.7±70[a]	2328.8 ± 170[b]
	Common	95±0[ab]	650±40[a]	640±40[a]	4.27±0.2[a]	3087.5±200[b]	686.1±50[b]	
	Silver	85±5[c]	175±12[c]	165±12[c]	1.1±0.1[c]	743.8±50[c]	165.3±11[c]	
	Catfish	100±0[a]	400±2 [b]	390±20[b]	2.6±0.2[b]	1200±70[c]	266.7±18[c]	
Zooplankton + Phytoplankton	Tilapia	100±1[b]	160±1[c]	150±12[c]	1±0.1[c]	5920±100[a]	1315.6±80[a]	2400.3 ± 175[b]
	Common	95±3[ab]	375±20[b]	365±20[b]	2.43±0.1[b]	1781.3±100[b]	395.8±20[b]	
	Silver	95±2[ab]	400±25[b]	390±25[b]	2.6±0.1[b]	1900±100[b]	422.2±20[b]	
	Catfish	100±0[a]	400±25[b]	390±25[b]	2.6±0.2[b]	1200±70[c]	266.7±20[c]	
Zooplankton + Phytoplankton + Artifi. Feed	Tilapia	97±1[a]	185±12[c]	175±15[c]	1.17±0.1[c]	6639.7±100[a]	1475.5±80[a]	2682.4 ± 180[a]
	Common	100±0[a]	475±30[b]	465±25[b]	3.1±0.2[b]	2375±100[b]	527.8±35[b]	
	Silver	95±5[ab]	375±30[b]	365±25[b]	2.43±0.2[b]	1781.3±100[b]	395.8±25[b]	
	Catfish	100±0[a]	425±30[b]	415±25[b]	2.77±0.2[b]	1275±75[c]	283.3±15[c]	

Means in the column followed by different letters are significantly different ($P<0.05$).

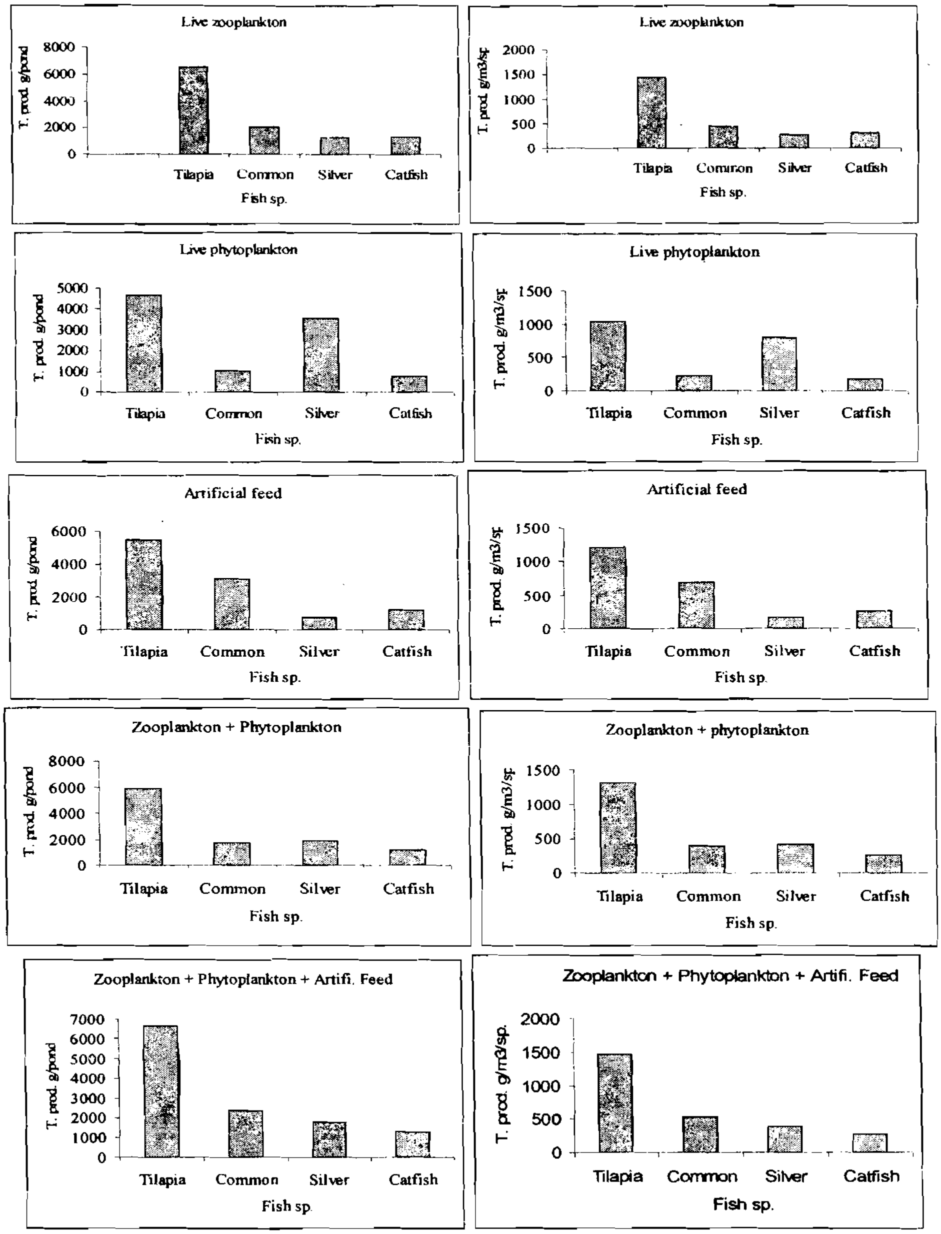

Fig. (3): Growth performance different fish species feed by phytoplankton and zooplankton as live food and artificial food in concrete pond.

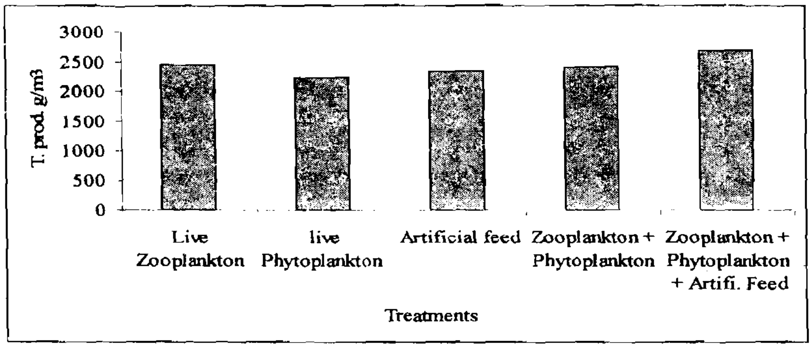

Fig. (4): average total fish production g/m^3 under different feeding types.

and ultimately attains a distinct plateau level (Jana and Chakrabarti, 1988). Goldblatt *et al.* (1979) demonstrated that pelleted diets exhibit a remarkable loss of vital nutrients, such as vitamins and amino acids, within a short period of exposure to water.

Stomach contents:

The stomach contents of fish (Table 5) represent variable and varied values which significantly ($P<0.05$) depending on the type of feed used and feeding habits of fish. The detritus percentage in common carp were 20.4, 25.3, 55.25, 26.66 and 38.12 for live zoo, live phyto, artificial, phyto plus zoo and phyto plus zoo plus artificial feed treatments respectively. The catfish from the all treatments had significantly higher percentages of detritus (10.65, 28.02, 45.12, 12.22 and 36.22) in the same treatments, respectively. The detritus percentage significantly increased with increasing artificial feed. These results are in agreement with those obtained by Shaker(2008). The detritus percentage had significantly higher percentages in common carp stomachs followed by catfish and tilapia. The lowest values of detritus percentage recorded in silver carp in all treatments. These results clear that the detritus content depending

feeding habit of fish. Higher plant, zooplankton and phytoplankton contents in fish stomachs had significant differences among treatments and were predominant in fish stomachs from live phytoplankton treated ponds. The lowest amounts of phytoplankton were found in stomachs of catfish and common carp. Insects were significantly ($P<0.05$) higher in stomachs of catfish and common carp cultured in all treatments than other fish species. Insects and detritus were not consumed in large amounts by silver carp in all treatments. Insects were not consumed in large amounts. The stomach contents of fish in this experiment ranged from detritus, higher plants, zooplanktons, phytoplankton to insects and others. Jeremiah *et al.* (2006) found the same categories of stomach contents in T. rendalli but insects and plankton were absent in fish ranging from 21to 40 g, which was not the case in the present experiment, where the fish cultured in the artificial feed and three types treatment all fish species consumed significantly higher amounts of detritus than other treatments. Tilapia is believed to change feeding habits as they grow. They change from carnivorous when young (7-33mm) and consume lots of zooplankton, aquatic insects and detritus, which make up about 26% of their stomach contents in the wild (Meschiatti and Arcifa, 2002). They turn herbivorous as they grow (Brummett, 2000). Detritus was one of the important stomach contents encountered during the analysis. The nutritional quality of detritus from various environments (tropical and temperate) is variable in terms of protein level, which range from 2.9% to 24.2% with good amino acid profiles (Bowen, 1987).

Table(5). Effect of different food types on stomach index different fish species

Items / Treat.	Fish Species	detritus	Higher plant	Zoo.	Phyto.	insects	others
Live Zooplankton	Tilapia	13±1[c]	9.7±0.7[b]	43.8±7.5[a]	18.5±1.5[b]	10.5±0.8[b]	2.5±1.1[b]
	Common	20.4±1.2[b]	16.24±1.2[a]	28.56±2.4[b]	6.5±0.4[c]	25.5±2.1[a]	5.8±0.4[a]
	Silver	2.08±0.1[d]	12.26±1[a]	3.5±0.2[c]	78.66±6.6[a]	1.5±0.1[c]	2±0.1[b]
	catfish	10.65±1[c]	8.5±0.6[b]	35.5±3[a]	4.5±0.3[c]	35.25±3[a]	5.6±0.3[a]
live Phytoplankton	Tilapia	11.8±1[c]	10.2±0.4[a]	30.1±2.7[a]	40±3.2[a]	5.8±0.3[c]	2.1±0.1[b]
	Common	25.3±2	15.2±1[a]	20.2±1.5[b]	8±0.6[c]	26.6±2[a]	4.68±0.4[a]
	Silver	1.66±0.1[d]	14.25±1[a]	2.22±0.1[c]	78.98±7[a]	1.44±0.1	1.45±0.1[b]
	catfish	28.02±2[b]	13.2±1[a]	20.8±2[b]	5.12±0.4[c]	30.92±2[a]	1.94±0.1[b]
Artificial feed	Tilapia	40±3.5[a]	3.7±0.5[c]	10.5±2.3[b]	26.5±4.3[b]	15.8±1.8[b]	3.5±0.4[a]
	Common	55.25±4[a]	5.65±0.4[b]	10.12±1[b]	2.48±0.2[c]	24.44±2[a]	2.06±0.1[b]
	Silver	10.2±1[c]	8.88±0.4[b]	5.66±0.4[c]	72.02±6[a]	1.7±0.3[c]	1.54±0.1[b]
	catfish	45.15±3[a]	6.12±0.1[b]	26.14±2[b]	4.02±0.3[c]	17.9±1[b]	0.67±0.1[b]
Zooplankton + Phytoplankton	Tilapia	11.5±1[c]	3.5±0.4[c]	44.2±2.2[a]	27.5±4.4[b]	10.8±1.2[b]	2.5±0.4[b]
	Common	26.66±2[b]	15.55±1[a]	26.96±2[b]	5.2±0.3[c]	24.61±2[a]	1.02±0.1[b]
	Silver	2.22±0.1[d]	18.75±1[a]	3.32±0.2[c]	70.96±5[a]	3.22±0.2[c]	1.53±0.1[b]
	catfish	12.22±1[c]	5.55±0.4[b]	41.44±3[a]	4.02±0.3[c]	35.94±3[a]	0.83±0.1
Zooplankton + Phytoplankton + Artifi. Feed	Tilapia	27.8±2[b]	3.1±2.5[c]	35.4±3.1[a]	21.1±1.7[b]	10.5±1[b]	2.1±0.2[b]
	Common	38.12±3[a]	10.88±1[a]	16.86±1[b]	5.55±0.3[c]	26.85±2[a]	1.74±0.1[b]
	Silver	5.82±0.4[c]	20.22±1.5[a]	2.72±0.2[c]	67.92±6[a]	1.66±0.1[c]	1.66±0.1[b]
	Catfish	36.22±3[ab]	4.02±0.3[c]	32.2±2[a]	2.2±0.1[c]	22.66±2[a]	2.7±0.1[b]

Means in the column followed by different letters are significantly different ($P<0.05$).

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التأثيرات المقارنة للغذاء الحى والعلف الصناعى فى الاستزراع المختلط بالأحواض الخرسانية

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الملخص العربى

العديد من الأسماك والقشريات تحتاج الى الغذاء الحى فى مراحلها المختلفة لذا أجريت هذه الدراسة لتقييم استخدام الطحالب و الزوبلانكتون بصورة منفردة أو معا أو مع العلف الصناعى فى الأحواض الخرسانية تحت ظروف الاستزراع السمكي المختلط لأسماك البلطي النيلي – المبروك العادى – المبروك الفضى– القراميط. استخدم عدد ١٥ حوض خرسانى وزعت عشوائيا على خمس معاملات لكل منها ثلاث مكررات الأولى تغذية بالزوبلانكتون فقط والثانية تغذية بالفيتوبلانكتون فقط والثالثة تغذية بالعلف الصناعى 25% بروتين فقط والرابعة ٥٠% فيتوبلانكتون+٥٠% زوبلانكتون والأخيرة ٣٣,٣% فيتوبلانكتون+٣٣,٣% زوبلانكتون +٣٣,٣ % علف صناعى، وإستمرت الدراسة ١٥٠ يوماً. وكانت أهم النتائج المتحصل عليها هى إختلاف خواص جودة المياه باختلاف نوعية الغذاء المستخدم. وأن استخدام الزو بلانكتون كغذاء حى سواء بمفردة أو مع الفيتوبلانكتون أو مع الفيتوبلانكتون والعلف الصناعى يعمل على تحسين خواص المياة. وأن إستخدام الفيتوبلانكتون والزوبلانكتون فى تغذية الأسماك بمفردها أو مختلطة معا أو مختلطة مع العلف الصناعى تؤدى إلى تحسين النمو فى الأسماك بشكل معنوى. لوحظ أيضا أن أعلى معدل نمو يومى كان فى أسماك القراميط وكذلك أعلى نسبة للأسماك الحية. وأشارت النتائج أيضا أن التغذية بالفيتوبلانكتون أو الزوبلانكتون كافية لتغذية الأسماك للوصول للحجم التسويقى وأن إضافة الطحالب والزوبلانكتون مع العلف الصناعى يحسن من الاستفادة من العلف الصناعى وذلك ربما لوجود مواد بالفيتوبلانكتون تحسن من نشاط إنزيمات الهضم وتزيد الاستفادة منها. وكذلك أشارت نتائج تحليل الأمعاء الى زيادة وجود المخلفات والبقايا بالأمعاء فى التغذية الصناعية وزيادة الطحالب والزوبلانكتون فى حالة التغذية بهما. وكانت إنتاجية المتر المكعب هى ٢٤٦١,١– ٢٢٢٤,٦– ٢٣٢٨,٨– ٢٤٠٠,٧– ٢٦٨٢,٤٨ جرام/م للمعاملات على الترتيب. مما يؤكد أن استعمال المصادر الثلاثة معا يحسن النمو والإنتاج. لذا توصى الدراسة أن إستخدام الغذاء الطبيعى مع الغذاء الصناعى يقلل من كميات الأعلاف الصناعية المستخدمة مما يقلل من تكلفة الإنتاج بنسبة كبيرة وذلك فى الاستزراع العادى وشبه المكثف.