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SOME STUDIES ON THE EFFECT OF WATER QUALITY AND STOCKING RATE ON THE GROWTH AND BIOCHEMICAL COMPOSITION OF NILE TILAPIA.(*OREOCHROMIS NILOTICUS*) AND COMMON CARP, (*CYPRINUS CARPIO*), REARED IN FRESH-WATER BARRAGE FISH FARM. EGYPT.

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SUMMARY

This study. Presents data on some physico-chemical parameters associated with primary productivity, as an indicator of water quality, in three earthen ponds with the object of estimating the effects of these parameters on the growth of *Oreochromis niloticus* and *Cyprinus carpio*, depending only on natural foods, including epiphytes found on some branches overhang the ponds and the dead leaves provides some detritus.

This study also, presents some information on the effects of fish stock and water quality on the growth and biochemical composition of species. Generally, the water quality was found to be satisfactory for rearing and well growing of both selected species in a mixed-culture system.

The water quality and stocking rate of fish were found to have marked effects on the specific growth rate and biochemical composition of both species.

INTRODUCTION

Fish as a source of protein for human consumption, is essential to help considerably in correcting the state of malnutrition, especially in over populated countries.

The progress and development of fish culture in different parts of the world has been reviewed by many investigators, among them (Imam, 1973; Wassef, 1978; Assen, 1984; Corason and Santiago, 1988 and Shahata, 1991).

Nile Tilapia *(Oreochromis niloticus)*, is considered as the most common and popular fish in Egypt, and has proved to be of great importance, contributing from 30-40% of the total production of the Lake Nasser in Egypt (Latif and Rashid, 1983).

In general. Tilapia species are primarily omnivorous taking phytoplankton, periphyton or detritus (Jauncey and Ross, 1982). Also. It was reported by Schroeder (1982), that Tilapias are consumers of detritus and feed efficiently on natural foods . The mirror carp (Cyprinus carpio)., represents an acceptable human food and has been reared by many aquaculturists in combinaiton with other species (Assen, 1984). This species is easy to spawn. controllable under farm conditions, utilizes planktonic organisms and it tolerates a wide range of temperatures and dissolved oxygen (Lovell et al., 1978).

A detailed knowledge on the water quality as well as the primary productivity of water are the most important factors affecting the fish growth (Wood and Ghanned, 1985).

The effects of stocking rate are studied by many investigators, among them (Eisawy et al., 1974; Hoogendoorn and Koops. 1983; Ben-Tuvia and Reich, 1983 and Shehata, 1991).

Several studies showed the very need of information about the biochemical composition of fish body in any fish culture programme which can be used to estimate their nutritional value (Imam. 1973; Foda et al., 1986 and Shehata, 1989).

In the line of previously reported studies the present work is directed to study the water quality and biochemical composition of reared fishes with relation to the natural fish food, in a trial to overcome the problem resulting from the use of expensive artificial feed.
The present work aims to investigate the following objectives:

1- Rearing Oreochromis niloticus and Cyprinus carpio in apolyculture system, depending only on the natural food and some detritus, of find out to what extent the specific growth rate can be affected.

2- The effects of water quality and primary productivity on the specific growth rate and biochemical composition of fish.

3- The effect of stocking rates on the specific growth rate and biochemical composition of fish, which help in selecting the maximum stocking rate to produce a desirable size of fish in a maximum time.

MATERIALS AND METHODS

1- Ponds Description

Only three earthen ponds were used for this study at Barrage Fish Farm (a research station affiliated to the Division of Inland Waters of National Institute of Oceangoraphy and Fisheries, Fgypt). The size of these ponds No. 2, 3, 4 are 850 m^2, 200 m^2 and 420 m^2 respectively and the mean depth is about 90 cm for each. The ponds are supplied with water from Al-Menoufy canal (mainly Nile River fresh water). The ponds are shaded by short grasses and some emerged plants (mainly Phragmites communis). Some branches overhang the ponds, and dead leaves provide a source of some detritus.

2- Experimental Procedure

The ponds were drained during the previous winter season, dried thereafter and filled with water. The experiment was extended for one growing season (from April to November 1991). Young fish *Oreochromis niloticus* and *Cyprinus carpio* (average total length 14.2 and 14.8 cm), average total weight (65.2 and 68.6 g) respectively, were used to be reared depending only on natural food. The number of fish used each pond was 2 fish/m^2.
The stocking rates used were 1.4, 0.8 fish/m^2, 0.7, 0.7 fish/m^2 and 1.08, 0.5 fish/m^2, *Oreochromis niloticus* and *Cyprinus carpio* ponds 2,3 and 4 respectively.
2.1- Water Analysis

subsurface water samples (10 Cm below surface) were collected monthly from each pond (from 3 different altes and mixed), then analyzed Physico-chemical parameters in addition primary productivity determined according to the recommended methods of the American Public Health Association (PAPEA, 1980).

2.2- Growth Measurements

Monthly random samples of 30 fish of each species were taken from each pond. Individual measurements of fish were recorded (length and weight). The specific growth rate percentage (SGR/0%) for each species was estimated monthly, ising the equation suggested by Om (1984) as follow:

$$SGR/D\ (5) = \frac{100\ (Ln\ W_i - Ln\ W_o)}{T}$$

in which SGR/D is the specific growth rate per day.

W_i is the final body weight.
W_o is the initial body weight.
T is the period in day.

2.3- Biochemical analysis

Biochemical analysis of whole fish fiesh was carried out in the chemical Lab. at Barrage Fish Farm by random collection of 20 fish from each pond. The miosture percentage was determined by oven drying.The crude fat percentage was estimated by ether extraction using the soxhlet method. The nitrogen free extracts by calculation while the crude protein content percentage was

...mined by Kjeldahl analysis (AOAC, 1980).

...Statistical Analysis.

...istical analysis folowed those of Steel and ...ie (1980). All values are expressed as mean ± ...ndard deviation.

...SULTS AND DISCUSSION

...Water Quality

...ferent physico-chemical parameters of water in ...ition to primary productivity were determined. ...an, range, standard deviation and correlation of ...iance of these parameters as well as gross ...mary productivity in the studied ponds are ...esented in Table 1.

Table (1): Means, Range, Standard deviation and Correlation of variation of Physico-Chemical Parameters in the experimental Ponds and Feed water during one growing season (April to November, 1991).

Physico-Chemical Parameters	Feed water				Feed water				Feed water				Feed water			
	Mean	Range	Sdx	Cv	Mean	Range	Sdx	Cv	Mean	Range	Sdx	Cv	Mean	Range	Sdx	Cv
[illegible]	26.9	[illegible]	3.50	13.1	27.0	21.5-32.5	3.40	12.9	27.0	21.4-32.5	3.5	13	27.0	21.5-32.5	3.50	13.0
[illegible]	7.78	7.25-8.20	0.29	3.70	7.60	7.3-8.10	0.29	3.8	7.21	7.2-8.2	0.27	3.7	7.60	7.2-8.0	0.23	3.00
[illegible]	[illegible]	135-192	15.8	10.0	149.6	132-168.5	16.0	11.0	152	130-190	16.2	10.6	148	132-182.6	14.4	9.700
[illegible]	27.00	[illegible]	0.004	17.6	28.0	19-38.06	0.005	20.3	25.0	19-32	0.004	18.8	24.0	19.32.0	0.004	19.50
[illegible]	6.50	[illegible]	0.96	14.8	6.53	5.11-7.90	0.97	14.8	6.50	5.8-8.1	0.97	14.8	6.47	5-7.90	0.91	13.99
[illegible]	[illegible]	[illegible]	0.04	15.3	0.11	0.02-0.19	0.1	48.2	0.13	0.02-0.24	0.10	53.0	0.12	0.01-0.20	0.05	48.70
[illegible]	[illegible]	[illegible]	0.01	8.69	0.14	0.13-0.16	0.01	6.94	0.16	0.14-0.19	0.01	8.20	0.10	0.12-0.19	0.01	10.30
[illegible]	1.96	1.3-4.20	0.94	47.9	4.90	2.2-6.90	1.42	25.1	4.8	2.9-6.8	1.30	27.2	3.30	2.28-6.60	1.5	35.40
[illegible]	[illegible]	[illegible]	4.7	14.3	35.1	31.6-38.4	2.3	6.4	32.2	29.6-35.6	2.02	6.30	33.30	31.2-37.6	1.89	5.600
[illegible]	[illegible]	[illegible]	3.06	24.1	11.3	6.8-15.5	3.04	26.8	11.4	8.5-14.6	1.90	17.0	11.25	6.8-17.5	2.8	25.50
[illegible]	[illegible]	[illegible]	0.07	14.6	0.44	0.36-0.53	0.05	11.3	0.48	0.37-0.59	0.06	12.4	0.400	0.356-0.69	0.09	20.50

...1- Air and Water temperatures

...e present data (Table, 1), showed that, in ...neral the climate at El-Kanater region is ...mperate. The minimum and maximum values of ...ater temperature were not reduced below 21°C ...d not raised above 32°C respectively. This ...ems to be an optimum level for rearing tilapia. ...ing (1983), reported that. If temperature below ...°C appear for more than 5-8 days continuously. ...lapias lose their natural resistance, are stressed ...d become susceptible to parasitics and fungal ...fections. Kirk (1972), pointed out that all Tilapia species are tolerant of temperature up to 32°C, although vital activity is affected above 38°C. Lovell et al., (1978), showed that. *Cyprinus carpio* grows rapidly and can tolerate a wide range of temperatures. The present results showed that temperature during the whole growing season is suitable for well growing of both species.

1.2- Transparency.

According to the shallowness of water in the studied ponds, the transparency did not exceed 90 cm.

1.3- Hydrogen Ion Concentration (pH).

The present data (Table 1). showed that pH values are always within alkaline side during the whole period of the growing season, being over 7.2 and remained between 7.2 and 8.2.

1,4- Total AlkaLinity.

Alkalinity is represented in natural waters by calcium salt of bicarbonate and carbonate ions. It is established that its value is usually proportional to the productivity of aquatic ecosystems. The present data (Table 1), showed that,in different studied ponds the values of total alkalinity fluctuated between minimum of 130 mg.L-1 and a

Table (2): Specific Growth Rate (SGR/0%) of Oreochromis and Cyprinus carpio during one growing season from Apil to November 1991.

Date	Pond 2		Pond 3		Pond 4	
	1.4 f/m² Oreochromic niloticus	0.81/m² Cyprinus carpio	0.7 f/m² Oreochromic niloticus	0.81/m² Cyprinus carpio	0.7 f/m² Oreochromic niloticus	0.81/m² Cyprinus carpio
Apr.	0.462	0.566	0.698	0.759	0.524	0.522
May	0.422	0.542	0.692	0.694	0.448	0.498
Jun.	0.395	0.421	0.688	0.668	0.426	0.362
Jul.	0.462	0.522	0.542	0.482	0.466	0.422
Aug.	0.324	0.335	0.380	0.362	0.368	0.322
Sep.	0.326	0.450	0.368	0.466	0.352	0.298
Oct.	0.340	0.382	0.442	0.462	0.388	0.312
Nov.	0.390	0.366	0.398	0.368	0.396	0.366
Average	0.390	0.448	0.526	0.533	0.421	0.388
±SD*	0.057	0.08	0.198	0.14	0.057	0.08

* Standard deviation.

Table (3): Proximate analysis of fish flesh of Oreochromis niloticus and *Cyprinus carpio* auvalues are expressed as % dry weight (Mean with Standard deviation in parantheses).

Pond no.	Dry matter In.	Dry matter Fin.	Cry protein In.	Cry protein Fin.	*Ether extract In.	*Ether extract Fin.	Ash content In.	Ash content Fin.	**Mitrogen free extract In.	**Mitrogen free extract Fin.	Gross energy Kcal/kg In.	Gross energy Kcal/kg fin.
	1. O. niloticus											
2	20.1± (0.15)	21.01± (0.18)	59.1± (1.01)	60.9± (1.62)	12.9± (0.92)	20.4± (0.66)	18.0± (0.45)	10.6± (0.62)	10.6± (0.22)	6.58± (0.26)	4400± (0.72)	5257± ([illegible]
3	23.7± (0.22)	24.6± (0.16)	60.4± (1.2)	60.9± (1.6)	11.7±(0.82)	20.9± (0.92)	15.2± (0.33)	18.1± (0.42)	11.59± (0.15)	0.42± (0.24)	4519± (0.65)	5264± ([illegible]
4	23.5± (0.32)	24.6± (0.24)	60.7± (0.82)	61.0± (1.2)	12.0± (0.98)	20.4± (0.65)	17.1± (0.22)	18.0± (0.32)	10.1± (0.32)	0.75± (0.36)	4567± (0.75)	5233± ([illegible]
	2. C. Carpio											
2	21.9± (0.32)	23.7± (0.36)	55.3± (1.1)	58.5± (1.7)	17.8± (0.85)	17.9± (0.66)	16.2± (0.44)	16.5± (0.32)	10.5± (0.22)	6.9± (0.35)	4767± (0.65)	5014± ([illegible]
3	21.8± (0.33)	23± (0.26)	57.5± (1.6)	59± (1.2)	16.2± (0.9)	17.5± (0.65)	16.8± (0.33)	16.2± (0.25)	9.4± (0.62)	6.6± (0.24)	4775± (0.66)	5016± ([illegible]
4	20.8± (0.62)	23.1± (0.32)	56.4± (1.04)	58.8± (1.5)	18.2± (0.75)	17.2± (0.52)	15.8± (0.24)	16.2± (0.25)	9.4± (0.42)	7.7± (0.25)	4916± (0.52)	494[illegible] ([illegible]

In = Initial Value
Fin = Final Value
* Lipids
** Carbohydrate

maximum of 190.2 mg.L-1. The values of total alkalinity in the present study are correlated significantly with gross primary productivity of water being 0.807, 0.760; 0.804 and 0.815 at p<0.05 for feed water and ponds no. 2,3 and 4 respectively.

1.5- Chlorosity.

The chlorosity has a great effect on survival and composition of aquatic organisms. Kirk (1972), reported that Tilapia species are able to tolerate wide range of chlorosity. In feed water, the values ranged between 21 to 35 mg. L, and in experimental ponds from 19 to 32 mg.L-1 except in pond 2 were in the range (19-58 mg.L-1). It is to be noted that values of chlorosity were not correlated with primary productivity of water.

1.6- Dissolved oxygen. (D O):

Dissolved oxygen is the most critical water quality parameter in fish culture. It is widely appreciated that low dissolved oxygen levels limit respiration. growth and other activities and severely limit scope for activity (Jobling, 1981).

The present data (table, 1). showed a general inverse relationship with water temperatures in all studied ponds as well as feed water . The average values during the whole growing season were found to be 6.50, 6.53, 6.50 and 6.47 mg.L^{-1}, for feed water and studied pond 2,3 and 4 respectively.

The present data also showed that the minimum values of (DO) never reduced below 5.00 mg.L-1 and this may be attributed to the continuous supply with fresh Nile water from the adjacent Al-Menoufy Canal. Stewart et al., 1967, showed that the critical oxygen level for most fishes is below 5.00 mg. L-1.

The present data showed that , the DO. values are negatively correlated, highly significant with water temperature (being r= -0.971; -0.971; 0.954 at ≤0.05). No correlation was found with productivity of water.

1.7. Nutrient Salts.

Nitrate (NO3 -N), Orthophosphate (PO3-P) and reactive Silicate (SIO3), were determined and the results are presented in table 1.

Nitrogen is one of the major nutrientirequired in moderate quantities to aquatic ecosystems. Nitrate-nitrogen is usually the most important and stable nitrogenous compound in that nitrification process, Touliabah (1992).

Orthophosphate is one of the growth-limiting nutrient especially in fresh water. Also, reactive silicate is considered to be one of the most important nutrients in aquatic ecosystems.

The present results showed that no correlations were found between parameters with the productivity of water, as these relations are dependent on many complex factors (Seymour, 1980).

Generally the present results of the nutrient salts (table 1) were found to be closely related to that found in Serw fish farm (Touliabah, 1992).

1.8- Calcium and Magnesium.

Calcium is considered to be an essential element for morabolic processes in all living organisms. Magnesium is mostly associated with calcium. Unlike terrestrial vertebrates, teleost fish can absorb calcium directly from ambient water. Thus fish can continue normal growth bone deformity in dietary calcium deficiency (Ogino and Takeda, 1976). In carp, magnesium deficiency causes loss of appetite and poor growth (Jauncoy and Ross, 1982).

The results were found to be satisfactory for fish growth, when compared with that found in Serw fish afrm by Touliabah, 1992.

1.9- Gross Primary Productivity of water (GPP).

This parameter can be used as indicator of state of eutrophication. It is greatly affected by various physical and chemical parameters, directly or indirectly. The most effective of these parameters are temperature, chlorosity, photosynthetic activity of phytoplankton which in turn could be affected by intensityof solar radiation and respiration of aquatic organisms (Boyd, 1973).

The present results for gross productivity table 1, positively correlated with total alkalinity being r= 0.807; 0.760; 0.804 and 0.815 for feed and pond water no. (2,3 and 4) respectively. Also values of this parameter were correlated positively with the pH of water being r=0.854; 0.876; 0.925 and 0.826 for feed and ponds on. 2,3, & 4 respectively. However,other patameters of water are not correlated with gross productivity.

2- Correlation of variance (CV.).

For comparing the variations in the concentration of different physico-chemical parameters as well as the productivity of water, the computed values of the coefficient of variation CVare shown in table (1). From this table it can be seen that the highest CV values were estimated for the nitrate-nitrogen, followed by reactive silicate, calcium, chlorosity, dissolved oxygen, Gross primary productivity, temperature, total alkalinity and finally the pH. These results showed that the great variation was occurred in nitrate-nitrogen and silicate (nutrient salts). While the lowest variation occurred in the pH of water. Variation in the other parameters were found in between.

2- Effect of Stocking Rate

Stocking rates of fish are extremely important at all levels of fish culture (Viola and Zohar, 1984). They reported that, if stocking rates are too few, the results are large fish and low production, but if too many are stocked, the results may be bigh production with fish of undesirable size.
In the present study, values of specific growth rates for both species are presented in table (2) and represented graphicallv by Fig. (1). It can be seen that the growing season in

Characterized by four different growth periods:

a- The first period from April to May values of the specific growth rate were found to be higher than that corresponding to the following periods. The highest mean values were achieved in pond 3 being 0.698 and 0.759 for *Oreochromis niloticus* and *Cyprinus carpio* respectively (stocking rates were 0.7 fish/m^2 for both species), followed by pond 2 for C. carpio (0.8 fish/m^2) and then pond 4, for O. niloticus (0.5 fish/m^2). (Table 2 and Fig.,1).

b- The second period from June to July was distinguished with a slight decrease in the growth rates for both species with some higher decrease for *O. niloticus* and *C.* ... ponds 2 and 4 (with higher stock in the ... for both species respectively).

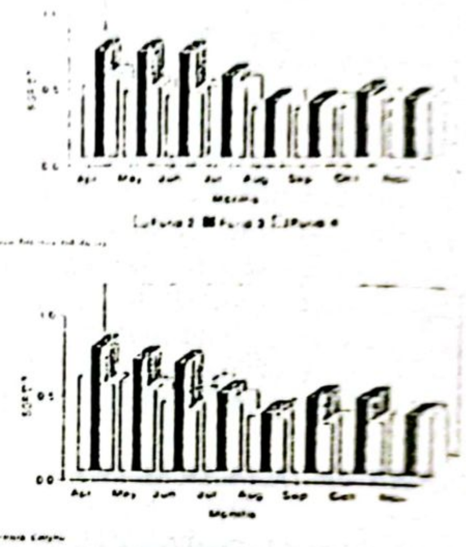

Fig. (1): Specific Growth Rate (SGR %) of *O. nilotius* and *C. carpio.*

c- The period from August to Septem... characterized by another decrease in the ... growth rates for both species. (Table 2 and ...

d- The period from October to November ... of the growing season) was characteri... slight increase in the Specific growth ... both species species specially in pond 3 ... water qualiyt than other ponds and with ... stock (0.7 fish/m2 Oreochromis niloticus ... fish/m2 Cyprinus carpio).

The present results showed clearly a ... effect of the stocking rates and water qu... the specific growth rate during the whole ... season, but pond size showed a min... There was no marked effect of inte... competition. The present results, genera... agreement with the previous find... Hoogendoorn and Koops (1983) and V... Zohar (1984), on the marked effect of ... or reducing the stocking rate, but disag... the second investigators about the effect ... size on the growth. The present results ... that the pond size have no effect o...

growth.

Concerning the interspecific competition factor, the present results agrees with the findings of Wilson and Hilton (1982), as the growth of both species was not affected by the presence of each other.

From the water quality point of view the following points were observed:

Generally, the fish growth was affected by the physicochemical characteristics of water (water quality), such as water temperature, dissolved oxygen, nutrient salts and productivity of water. The present results showed that the higher growth rates for both species were observed during the first period, (water temperature ranging between 26.2°C to 28.4°C) which is considered to be very sutable for fish growth (Kirk, 1972), in addition to high dissolved oxygen, and high productivity of water during this period especially in pond 3.

The second and third periods, which showed a relatively low growth rates may be attributed to the decrease in dissolved oxygen as a results of increased water temperature. These results are agreed with the findings of Andrews et al., (1973), who showed that in polyculture treatments of fish the low dissolved oxygen have had a marked effect of fish growth.

The fourth period showed a slight increase in specific growth rates whichmay be attributed to the moderate water temperature (12.2 5°C), and also to obseved increase in dissolved oxygen during this period.

3- Biochemical Composition of Fish Body.

The present results of body composition are given on a dry mass basis (at the beginning and the end of the experiment) in table (3).

3.1 Dry Matter.

The present results showed that, there was a slight increase in the dry matter for both species. (Tbale, 3), in all ponds.

3.2- Crud Protein.

Concerning the crude protein content, the present results showed more or less slight variations, but in case of *C. carpio*. the final protein content was relatively higher than that corresponding to the initial value.

3.3 - Carbohydrate (NFE).

A great decrease in carbohydrate content was observed at the end of the experiment especially in case of *O. niloticus*.

3.4- Lipid and rose energy contents.

The present results showed that the marked variations wre in the lipid and gross energy contents especially in case of *O. niloticus.* Gross energy in the body of *O. niloticus,* which was higher than that of *C. carpio* in pond 4 is less than that for the same species in other ponds. This may be attributed to the increase of stocking rate of *C. carpio* in pond 4 and also to the relatively low productivity of this pond. However in case of *O. niloticus* in the same pond (with a low stocking rate 0.5 fish/m), there was no marked effect on the gross energy.

It can be seen from the present results that the main changes occurred incarbohydrate content. lipid content and gross energy. These changes are somewhat related to the stocking rates and productivity of water especially in case of *C. carpio.* however the main changes in *O.niloticus* was mainly in carbohydrate. On the other and *O. niloticus* has attained higher gross energy htan *C. carpio.* This indicates that, as a general, the physiological conditions of the species *(O. niloticus)* are better than of c. carpio. This agrees with the findings of Cui Wootton (1988), who reported that body composition and energy content are good indicators of the physiological conditions of a fish.

It may be finally concluded from the present study that, these informations may be useful for management and development of fresh-water fish culture in ponds depending to a great extent on the natural food and a good water quality for reducig as possible the increased coast of artificial feeds.

It is also important to indicate that in determining rates of stocking for various levels of management, different ranges of stocking must be tested to enable selection of the maximum rates to produce desirable size fish in a maximum period of time.

It is also worth to state that, the water quality and stocking rates affects the growth and biochemical composition of both species. This study showed that more work has to be done on the biochemical composition of most fresh-water fishes to clarify the picture of the physiological conditions of these fishes in the rearing ponds.

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