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INFLUENCE OF AFRICAN CATFISH (*Clarias gariepinus*) AS A PREDATOR CONTROL INTERACTION AND BAMBOO POLES SUBSTRATE ON GROWTH PERFORMANCE AND PRODUCTION OF THE MONO-SEX, MIXED-SEX NILE TILAPIA (*Oreochromis niloticus)* AND COMMON CARP (*Cyprinus carpio*) IN SEMI-INTENSIVE POLYCULTURE POND SYSTEM

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ABSTRACT

Experiments were conducted to assess the effects of African catfish (C. gariepinus) as a predator control interaction for unwanted tilapia offspring in a polyculture system and bamboo poles as substrate for periphyton development, on growth performance and production of the mono-sex , mixed -sex Nile tilapia (O. niloticus)and common carp (C. carpio) in semi-intensive polyculture pond system over a period of 150 days supplemented with wheat bran. Control and three treatments were tested using twelive 200 m^2 earthen ponds randomly applied as follow:
Control : ponds stocked with 400 mixed sex Nile tilapia (1:1) + 200 common carp+100 catfish (without treatment).
(T1): ponds stocked with 400 male Nile tilapia+200 common carp+100 catfish +fertilization, supplementary feed and bamboo poles.
(T2): ponds stocked with 400 mixed sex Nile tilapia (1:1)+200 common carp+ fertilization , supplementary feed and bamboo poles .
(T3):ponds stocked with 400 mixed sex Nile tilapia+200 common carp+100 catfish+ fertilization , supplementary feed and bamboo poles

Fish were fed a wheat bran diet ration of 3% of body weight per day. Statistical analyses of the three replicates of control, T1, T2 and T3 indicated that growth performance and production were significantly higher for treatment (T1) in which male tilapia and catfish were stocked. Mixed-sex Tilapia production in polyculture without African catfish was significantly lower than the culture systems with either all male tilapia or mixed sex tilapia with catfish . The mean gross fish yield (kg/200m^2) varied from 120.7 kg/pond for (control), 348.5 kg/ pond for (T1) , 208.8 kg /pond for (T2), and 301.1 kg/pond for (T3) . The study indicated that bamboo poles as substrate for periphyton , fertilization, supplementary feed and African catfish were a superior alternative to improve fish production under pond conditions. Water quality parameters variation in *mean values were within acceptable ranges for fish culture. It could be concluded that T1 was the best in term of growth performance and economic evaluation .*

Keywords: Mono-sex, mixed –sex, N. Tilapia, C. carp, A. catfish, C. gariepinus, supplementary feed, organic & inorganic fertilizers, periphyton.

INTRODUCTION

The demand for fish in Egypt is increasing in response to the health benefits of fish and increasing human population.In the last few years, increased interests in aquaculture and polyculture has been witnessed due to spurred interests of many people in fish farming, and this will continue to play an important role in meeting the demand for fish (FAO, 2007and Solomon and Boro, 2010).

From a theoretical viewpoint, the advantages conferred by adding substrate to an aquaculture system is an increase in the energy and nutrient transfer efficiencies of the system owing to the additive effects of the periphyton and phytoplankton- based components of production. Herbivorous fish generally require larger-sized food sources such as benthic algae, alga-based detritus or higher aquatic plants, which can be harvested more efficiently as well as zooplankton to supplement the intake of phytoplankton by omnivorous fish. Hard substrates such as bamboo and other tree branches, which are generally absent in traditional fish ponds are essential component of the periphyton-based aquaculture for inducing bacterial and zooplanktonic biomass associated with alga growth. This abundant natural food is exploited directly by many herbivorous and omnivorous fish as a basic source of food (Azim *et al*., 2001and Sahu, *et al*., 2007).

In the present study, a system of periphyton-based aquaculture was considered as an alternative to fish production in conventional, substrate-free, pond. The design of treatments focused primarily on improving fish yield through the use of minimal quantity of substrates, optimal level of fertilization with organic manure that will compensate for the small quantity of substrate used by inducing enough natural production, and the application of supplementary feed. Monoculture of an indigenous farmed species, catfish, was used with the principal aim of improving fish production in aquaculture systems (Amisah *et al*., 2008).

The overpopulation of tilapia in confined ponds is an obvious problem, and causes stunted growth due to the shortage of natural food, particularly in semi-intensive culture. However, the control of tilapias population by predator culture has been practiced worldwide (Abdel-Tawwab, 2005).

Culturing fish in polyculture system makes better use of land and water as it results in greater fish yields, together with higher economic returns than monoculture (Giap *et al.,* 2005), as well as polyculture system consider one of the most effective ways to overcome overpopulation of tilapia fry when tilapia polycultured (co-cultivated) with fry-consuming fish such as catfish. El Naggar (2007) concluded that introduction of catfish is at the rate of 13% of total tilapia stocked has not only eliminated 70% of total tilapia recruitment but also enhanced total pond production of marketable size.

Periphyton-based aquaculture can be practised wherever fish farming is possible (Azim *et. al.*, 2001). It is considered the best practice of fish farming since it requires only cheap and readily available inputs, yet highly efficient. It is a flexible technique that originated from indigenous knowledge of brush park fisheries where bushy tree branches installed in water bodies served as a device for attracting fish for harvesting (Sahu, *et al.;*2007**).**

MATERIALS AND METHODS

Pond Preparation and Stocking : The experiment was to be conducted in twelive earthen ponds (each 200 m^2 surface area) located at Serow Fish Farm,National Institute of Oceanography And Fisheries, Dukhlia Governorate ,Egypt. These ponds were firstly drained and cleaned, then supplied with drainage freshwater from El-Serow drainage canal to a depth of 0.8-0.90 m. The experimental period lasted for 5 months(150 days, initiated on first June till first November).Experimental ponds were sun and air dried for three weeks, and planted with bamboo poles with mean diameters of 10.0cm and mean lengths of 100.0cm. Bamboo poles were driven vertically into the pond bottom at 1 metre intervals at the density of 4 poles per m2. Three replicates were performed as follow :

Control : Ponds stocked with 400 mixed sex Nile tilapia (1:1) + 200 common carp+100 catfish (without any treatment).

Treatment 1 (T1): Ponds stocked with 400 male Nile tilapia+200 common carp+100 catfish + Fertilization , supplementary feed and bamboo poles**.**

Treatment 2 (T2): Ponds stocked with 400 mixed sex Nile tilapia (1:1) + 200 common carp+Fertilization , supplementary feed and bamboo poles **.**

Treatment 3 (T3): Ponds stocked with 400 mixed sex Nile tilapia+200 common carp+100 catfish +Fertilization, supplementary feed and bamboo poles.

Details of the stocking for each treatment are presented in Table 1.

Table 1. Fish species compositions in each treatment, numbers and mean (±SE) of initial total weight and length under varying conditions.

Treatments	No. fish / pond	Initial total wt. (g)	Initial total length (cm)
Control :			
Mixed sex *Tilapia*	400	19.8 ± 0.69^a	10.8 ± 0.74^a
Common carp	200	20.4 ± 0.66^a	11.5 ± 0.57^a
Catfish	100	27.6 ± 0.08^a	12.3 ± 0.11^a
T1 :			
Male Nile *Tilapia*	400	20.6 ± 0.87^a	11.9 ± 0.75^a
Common carp	200	20.2 ± 0.35^a	10.6 ± 0.83^a
Catfish	100	26.8 ± 0.14^a	11.9 ± 0.04^a
T2 :			
Mixed sex *Tilapia*	400	19.1 ± 0.97^a	10.9 ± 0.75^a
Common carp	200	19.2 ± 0.37^a	11.6 ± 0.88^a
T3 :			
Mixed sex *Tilapia*	400	20.9 ± 1.59^a	10.7 ± 0.24^a
Common carp	200	20.7 ± 0.49^a	11.2 ± 0.49^a
Catfish	100	26.2 ± 0.14^a	11.6 ± 0.04^a

Fortnightly, the amount of fertilization using chicken manures supplemented with industrial grade urea and tripelsuper phosphate, was applied to maintain a nutrient level of 1 ppm N:0.5 ppm P (Tacon, 2003 and Kumar and Burgess, 2005). Available nitrogen (N) and phosphorus (P) from chicken manures were measured based on Gopakumar *et.al*. (2000) and Kumar and Burgess (2005).

The amount of supplementary feed was calculated on N-P equivalence of 0.2 g N and 0.01 P/100 g wet body weight of fish daily (Hassan *et al*., 2000, Islam, 2002 and Milstein *et. al*., 2003), the sources of which were different. Inorganic fertilizers(Urea with 46.5% N and TSP 46% P) were used at a rate of 0.345 kg P/feddan (100 g TSP/pond) and 2.5kg N/feddan (0.5 kg urea / pond) every two weeks , respectively . After stocking in water in plastic barrels and were broadcasting this mixture over the pond water surface (Hussein,1995 and 2002).Chicken manure was broadcast over the ponds surface at a rate of 15 kg/pond biweekly .Ponds were fertilized for 2 weeks before stocking fish to allow natural food to develop and thereafter on each fortnight ,respectively, as recommended by Hussein and Abdl-Hakim(2003). In this experiment, all the experimental ponds(without control ponds) received the same quantity of N and P,but the sources were different as given in Table 2.

The organic fertilizers(chicken manure) and inorganic fertilizers were added to the pond at biweekly interval ,while supplementary feed (wheat bran)

Table 2: Approximate chemical composition , inorganic (Urea and TSP) , organic (chicken manure) fertilizers and supplementary feed (wheat bran) and nutrient applications rates as kg/pond during the experimental period (% Dry matter basis, Mean ± SE) .

Treatments	Chicken manure	Inorganic fertilizer (Urea+TSP)	Supplementary feed (Wheat bran)	Periphyton
Dry matter	88.66± 0.01	- -	88.7± 1.11	16.3(1) 45.6(1)
Crud protein	24.88± 0.15	- -	15.2± 0.17	7.7(1) 0.27-1.22(2)
Ether extract	11.42± 0.19	- -	3.9± 0.14	10(3) 27.3(1)
Crude fiber	9.38± 0.07	46.0 46.0	8.3± 0.16	- -
Ash	19.96± 0.12	1 146	6.1± 0.15	- -
N free extract	23.74± 0.11		54.6± 0.12	
Nitrogen (N %)	3.87± 0.03		15.14± 0.53	
Phosphorus(%P_2O_5)	1.93± 0.04		3.57± 0.04	
N:P ratio	2.01± 0.03		3.17± 0.19	
Kg/ fed/150 days	1300		3770	

1) Tang and Hwang (1967)
2) Aeronson *et al*,. (1980) , de Moor and Scott (1985)
3) Xu (1989).

was added on daily basis at a rate of 3% wet body weight of fish daily. The amount of feed was increased monthly according to the measurement of fresh fish body weight. Fish growth was measured in terms of increase in body weight by random capturing(10%) of each fish species from the ponds on each month, throughout the experimental period .After obtaining the data, the fish were released back into their respective ponds. Wheat bran supplementary feed containing 15.2 % crude protein (0.50 LE/Kg) was introduced to fish in treatments ponds starting from day 30 till the end of the experiment at starvation level with feeding frequency twice daily at 10.00 and 14.00h six days a week, total amount of feed added to each pond was used as an estimate of feed consumption.

Fertilizers were dissolved in water and then spread over the pond surface. One week prior to stocking, the sex was visually determined and male and female fish were manually sorted into separate hapas. Tilapia were stocked at a density of 3 fish/m2 (600 fish/pond) in all three treatments. The sex ratios of tilapia in treatment T2 was maintained at approximately a 1:1 ratio. African catfish were stocked at a density of 0.5 fish/m2 (100 fish/pond) in treatments T1 and T3 .

Fifteen days after the ponds had been filled with water, experimental fish were released into the ponds at a rate of 600 fingerlings / pond . The experimental fish used for the present study were collected from fishponds located at the Serow Fish Farm . Fish of all species were randomly assigned to treatments .

The following measurements were taken during stocking of each pond To monitor growth parameters, tilapia sp. , common carp and African catfish were : individual lengths and weights of 40 male tilapia (T1), 40 mixed sex tilapia (control ,T2 and T3), 10 African catfish (T2 and T3), and total weight of the fish remaining to be stocked. African catfish were introduced into the culture system two weeks after stocking of the tilapia to ensure that tilapia species fingerlings were abundant in the culture system at the time of the African catfish introduction. Samples of cultured fish species were captured randomly by using drag net from each experimental treatment and released back into their respective ponds after recording the data for wet body weight (WBW). At the end of the experiment all substrates were removed,ponds drained, and all fish harvested.

Data were collected on Gross production; *i.e.*:

1) **Total bulk weight** by species harvested per pond.
2) **Net wet body weight gain (NWG) (g)** = Mean final fish Wt. (g) - Mean initial fish Wt.(g).
3) **Specific growth rate** was determined by the formula as:
   SGR = [In (Final wet body weight)– In (Initial wet body weight)] /Culture period(days) x100
4) **Condition Factor(K):**The condition factor(k)was calculated From the relationship :

$$K = 100w/ L^{b} .$$

Where:*W* = The weight of the fish in grams, *L* = The total length of the fish in centimeters and *b* = 3 (Tudorancea *et al*., 1988).

Water Quality Analysis and samples: Water quality samples were collected monthly from each pond manually from the middle of water column by putting a closed sample bottle and opened in the desired depth, this procedure was done in different five spots in each pond then samples were mixed in a plastic bucket and 1 litter sample was taken as a representative water sample of each pond. These samples were taken 1 week after fertilizer application. At the time of sampling, water temperature, dissolved oxygen visibility was measured in addition to their measurements two times weekly. Water temperature and dissolved oxygen were measured daily at 900 h using dissolved oxygen and temperature meter (model

Orion 835 A), pH was measured daily by (Acumen 25 meter), total alkalinity, nitrate (No_3), total ammonia nitrogen (TAN;$NH_{3/4}$) were measured according to Boyd (1990) and APHA (2000). Phytoplankton, zooplankton and chlorophyll-A were calculated using Vollenweider (1969) equation. Plankton concentrations in the various treatments were related to fish production. Gross and net primary productivity were measured fortnightly using the light and dark bottle method according to the following equations (Cole 1983)**:**

Gross productivity ($mgO_2/ m^3/h$) = (LB – DB) x 1000 / PQXt

Net productivity ($mgO_2/ m^3/h$) = (LB – IB) x 1000 / PQXt

Where: LB is the concentration of oxygen in the light bottle (mg/L), DB is the concentration of oxygen in the dark bottle(mg/L), IB is the concentration of oxygen in the initial bottle(mg/L), PQ is the photosynthetic quotient(assumed to be 1.2), and t is hours of incubation.

Fish samples: Samples of each fish species from each pond were collected monthly, and then fish was weighed and immediately returned to the water of the same pond. At the end of the experiment, all fish were harvested and weighted.

Statistical analysis: The variation in parameters and significance and their interaction among the different treatments for these parameters were tested by using SAS Program Ver. 9.1 (SAS, 2005). Significant results were compared using Duncan's Multiple Range Tests (1955) with repeated sampling to observe the comparison of mean values among the treatments . Standard error (± SE) of treatment means was calculated from the residual means square in the ANOVA.

RESULTS AND DISCUSSION

Fish growth performance and production :

The data on the growth performance, *i.e.*, average initial weight (g /fish), average final weight (g/fish), average initial length(cm/fish), average final length (cm / fish) ,average net weight gain(g /fish), SGR, condition factor (K) and total fish production (Kg / pond) for all experimental fish as effected by the experimental treatments (organic , chemical fertilizers, supplementary feed and African catfish (*C. gariepinus*) as a predator control interaction in polyculture pond system) are presented in Table 3.

On the basis of comparison of mean values of average body weight in different treatments, the growth performance of Nile *Tilapia* (*O. niloticus),* Common carp (*C.carpio*) and African catfish (*C. gariepinus*) for all treatments of fertilizations, bamboo substrate and supplementary feed during the experimental period (in 150 days) were better with T1 and T3,while the other treatments were lower than this treatment (Table 3).The group of fish in T1 had a significant (P>0.05) highest body weight , average daily weight gain , SGR and condition factor than the rest of experimental groups .As evident from

comparison of means of average body weight, T1 and T3were the best treatment as compared to other treatments.

As presented in Table (3), DWG and TFP of the fish species populations were significantly($p<0.05$) higher for treatments (T1) (stocked with male tilapia species) than treatments T2 and T3. However, there were a significant differences between fish species populations for DWG and TFP in T2 and T3. The well established fact that male tilapia species in a monosex population grow faster than individuals in a mixed-sex population may account for this finding. There were no significant differences in growth performance of catfish among all treatments ($P>0.05$).

As presented in Table (3), the group of fish in T1 had asignificant ($p<0.05$) highest total production (348.5 Kg / pond), followed by T3 (301.1 Kg/pond) ,T2 (208.8Kg/pond) then control (120.7 Kg/pond) , respectively. Average final wet weight ,net weight gain ,SGR and condition factor(K) followed the same manner of production parameters, however SGR has the highest value was achieved by T1. These are in agreement with results of Hussein and Abdel-Hakim (2003) and Eid *et al*.(2010).

The carnivorous catfish (*Clarias gariepinus*) not only functions as a biological control, but also increases economic gain due to its high market value. However, population control of tilapias by culture with predators has been practiced worldwide. Various predatory fish species have been used with varying success in combination with different tilapia species depending on their availability. However, the difficulty in breeding or obtaining predators of the correct size often resulted in limited application of this population control method (Penman and McAndrew, 2000).The proper use of predatory fish is considered as a safe biological method for covering tilapia overpopulation in ponds without affecting the big size prey. Moreover, Clarias species are widely cultivated under various systems (Haylor, 1989)

Semi-intensive culture of Nile Tilapia *Oreochromis niloticus* commonly utilizes organic and inorganic (chemical) fertilizers to increase primary production and ultimately fish yield. This system could be useful and applicable in fish farms or fish culture stations where water supplies are readily available and water loss through evaporation or by seepage is replaced regularly (El Naggar *et al* , 2008). Fertilization research have been essentially trial and error studies evaluated primarily by yield comparisons, rather than focusing on a actual dynamic process which rarely determine the effectiveness of particular fertilization strategy (Abbas *et. al.;* 2010). Using of chemical fertilizer sources of N and P (rather than organic fertilizers) also helps maintain high water quality, i.e., high dissolved oxygen (DO) and moderate pH (Ibrahim and Nagdi, 2006).

Water Quality parameters During the Experimental period :

Average of water quality data variation for different water quality parameters of different treatments over the study period are presented (Table 4). Water quality parameters were within acceptable ranges for fish culture. There were significant ($P>0.05$) differences in water quality parameters between the different treatment ponds.

As shown in Table (4) all of water quality parameters were affected by treatments, except for water tempreture, DO and pH.The Use of inorganic , organic fertilizers and supplementary feed improved water quality through stimulation of natural food, mainly phytoplankton and zooplankton, suitable for the filter feeding tilapia and carp species. Organic fertilizers acts as an energy source for bacterial growth , but the aerobic decomposition of organic matter by bacteria is an important drain of oxygen supplies in ponds (Boyd, 1982). Both phytoplankton and zooplankton biomass were significantly higher in ponds with improved fertilization compared to ponds with poor nutrition (Table 4). Total ammonia nitrogen fluctuated throughout experiment but remained below 1 mg/ L and at the pH levels observed; NO2, NO3 and total alkalinity (mgCaCo$_3$/l) probably did not adversely affect fish performance. Major water quality parameters measured during the study remained in the favorable range for fish culture (Boyd, 1990), suggesting that cultured fish growth performance was not limited by any of the water quality parameters. Comparable results were obtained by Lawson (1995). All ponds were within acceptable range of water quality parameters during the study.

As shown in Table (4), no significant differences($P\leq0.05$) were observed in water temperatures among treatments.However, the higher value of water temperature in T2 (28.9±0.91) received organic , inorganic and feed may be attributed to the increase in organic matter contents of this pond that may lead to temperature increase . This range was beneficial to fish culture and these are in agreement with results of Hussein and Abdel-Hakim (2003).The concentration of dissolved oxygen (DO) were not significantly ($P\leq0.05$) influenced by the experimental treatments. Oxygen levels in all treatment ranged between (6.5 -7.2mg/ L) throughout the experiment, and were within the optimum range and higher than 5 mg/ L which reported by Boyd (1990) as the minimum desirable DO level in fish ponds. These are in agreement with results of Hussein and Abdel-Hakim (2003).

PH remained fairly alkaline throughout the study period. pH ranged between 7.8 and 8.5 and not significantly($P\leq0.05$) influenced by the experimental treatments and this is in agreement with Boyd (1998) and Hussein and Abdel-Hakim (2003). Boyd (1990) reported that application of ammonium and urea-based fertilizers can cause acidification of pond water because of nitrification,

which produces two hydrogen ions from each ammonium ion. The ammonia concentrations (NH_4-mgN/l) were significantly ($P \leq 0.05$) influenced by the experimental treatments and they ranged between 0.19-0.39 mg/l. These results show a slight increase in ammonia concentration with the increase of the pH, which is in agreement with Hussein and Abdel-Hakim (2003). They reported an ammonia concentration of (0.181-0.297 mg/ L) in ponds fertilized with chicken manure and inorganic fertilizers. These low concentrations of ammonia may be attributed to ammonia utilization by phytoplankton (Boyd, 1998) or oxidation of ammonia nitrite especially in high dissolved oxygen level conditions (Boyd, 2000). Total ammonia nitrogen fluctuated throughout experiment but remained below 1 mg / L and at the pH levels observed; unionized ammonia probably did not adversely affect fish performance. Major water quality parameters measured during the study remained in the favorable range for fish culture (Boyd, 1990), suggesting that fish growth performance was not limited by any of the water quality parameters. Comparable results were obtained by Hussein (2002 and 2004).Alkalinity (as mg$CaCo_3$/ l) values ranged from 108 mg/l to 262 mg/l and were significantly ($P \leq 0.05$) influenced by the experimental treatments. Diana *et al.,(*1994) reported that fertilization alone led to low alkalinity. Even though the values of physic-chemical characteristics of water ponds during the experimental period were within the acceptable limits for tilapia ,carps and mullet as indicated byMiranda-filho *et al.* (1996).

The use of inorganic fertilizer improved water quality through stimulation of natural food, mainly phytoplankton and zooplankton .Both phytoplankton and zooplankton biomass were significantly ($P \leq 0.05$) higher in ponds with improved fertilization compared to ponds with poor nutrition (Table 4).

Chlorophyll-a (mg/l) ,number of phytoplankton and zooplankton per liter in water , net productivity and gross productivity($gO_2/m^2/h$)of different treated ponds are presented in Table 4. There were significantly ($P \leq 0.05$) influenced by the experimental treatments .Net primary productivity values indicated greater autotrophic concentration to fish growth with the chemical fertilizer treatment. Net primary productivity in organically fertilized ponds in Hondoras was significantly greater than in inorganically fertilized ponds (Green *et al.*, 1989 and 1990).

The effects of bamboo substrate on fish production in the three treatments, which were fertilized (organic + inorganic) and substrate with supplementary feeding application provided considerable growth differences among the treatments. Provision of bamboo substrates and supplementary feeding resulted a greater fish production than in the ponds with substrate-free system . The results obtained in this study corroborate similar findings in which fish yields for substrate treatment than in ponds without substrate treatments system have been documented (Azim *et al*., 2002a &b and 2003, and Amisah *et al*., 2008) yield recorded for the substrate system over the 90- day culture period was 10 kg, which was more than fish yield in ponds substrate–free system and this result also agrees with those found by Wahab *et. al*.,(1999) for Labeo calbasu in periphyton-based culture. Greater percentage of the 10 kg net yield was contributed by the significant growth performance of catfish. The high yield from catfish may be partly attributed to the high survival percentage in the culture systems.

The study has demonstrated that fish production in the periphyton-based systems was higher than in the ponds substrate–free system. This could be accounted for by the additional feed provided by the periphyton surfaces (Azim *et al*., 2002 a & b, and Amisah *et al*., 2008). Periphyton is the total assemblage of attached aquatic flora and fauna that are more easily consumed by fish. In traditional fish ponds, as in the case of the substrate–free control, the pond bottom presents the only substrate for benthic algae to grow (Azim *et al.,* 2003 and 2004, and Amisah *et al*., 2008). Apparently this produces less food to meet the requirements of most culture species. However, tree branches as additional substrates, provide more algae along with zooplankton which provides natural food to increase fish yield. From an ecological viewpoint, periphyton-based culture represent appropriate natural source of food for fish production (Amisah *et al*., 2008 and Eid *et al*., 2010) and performs better than the traditional substrate–free systems. Periphyton-based systems offer the potential for increasing natural food as well as nutrient efficiency for higher fish output in enclosed culture systems.

Conclusions:

1. The reliability of manually sexing tilapia is low and results in serious contamination of all male treatments with female fish. Reproduction undermined the all male treatment experiment.
2. Production of large adult tilapia is significantly lower in ponds with mixed sexes; however, the total biomass including reproduction does not differ gready.
3. Tilapia production in polyculture with African catfish is significantly lower than the culture systems with either all male tilapia or mixed sex tilapia.
4. African catfish predation of tilapia fry is sufficiently effective to serve as population control for tilapia. The active predation, however, occurred only in semi-intensive culture systems where fish are fed their natural diet.
5. Further research should be focused on the following areas: 1) the assessment of the effects of increased variation in tilapia and catfish stocking ratios, and 2) the bioeconomics of the polyculture versus the monoculture of catfish and tilapia.

The present study advice that fingerlings of catfish /Tilapia species of the same size/length should not be stocked at the same time, if to be stocked together, fingerlings of Tilapia are to be stocked for the two to three month before catfish, are stocked this is to enhance the feeding of catfish on tilapia larvae and water quality should be checked.

REFERENCES

Abbas, S. ; I. Ahmed, M.Salim and K.Rehman (2010). Comparative effects of fertilization and supplementary feed on growth performance of three fish species. *Int. J.Agric.Biol*.,**12**:276-280.

Abdel-Tawwab,M. (2005). Predation Efficiency of Nile Catfish, Clarias gariepinus (Burchell,1822) on Fry Nile Tilapia, Oreochromis niloticus (Linnaeus, 1758): Effect of Prey Density, Predator Size, Feed Supplementation and Submerged Vegetation. *Turk. J. Fish. Aquat. Sci*. **5**: 69-74 .

Aeronson ,S. ;Berner,T. and Dubinsky, Z. (1980). Microalgae as a source of chemicals and natural products ,In algae Biomass.Production and use (Shelef, G and Soeder,C.J.eds)pp,575-602.Amsterdam:Elsevier.

Amisah, S.; ADJEI-Boateng, D., Aflanu, D. D. (2008). Effects of bamboo substrate and supplementary feed on growth and production of the African catfish,Clarias gariepinus. *J. Appl. Sci. Environ. Manage. June*, **12**(2) 25 - 28

APHA. (2000). Standard Methods for Examination of Water and Waste Water. *21th edn.American Public Health Association*, Washington, DC,USA,1268 pp.

Azim, M.E., Milstein, A., Wahab, M.A., Verdegem, M.C. J., (2003). Periphyton water quality relationship in fertilized fish ponds with artificial substrates. *Aquaculture Res*., **228** (2003) 169-187.

Azim, M.E.; Rahama, MM; Wahab, MA; Asaeda, T; Little, DC; Verdegem, MCJ (2004). Periphyton based pond polyculture system; bioeconomic comparison of on farm and on station trials. *Aquacult. Res.*, **222** (2004); 237-243.

Azim, ME; Verdegem, MCJ; Khaton, H; Wahab, M.A; Van Dam AA; Beveridge, MCM (2002a). A comparison of fertilization, feeding and three periphyton substrate for increasing fish production in freshwater pond aquaculture in Bangladesh. *Aquacult. Res*. , **212:** 227- 243.

Azim, ME; Wahab, MA., Van Dam, AA; Van Rooij, JM; Beveridge, MCM., Verdegem, MCS (2002b). The effects of artificial substrate on freshwater pond productivity and water quality and the implications for periphyton based aquaculture. *Aquat. Living Resour.* , **15** (4), 231- 241.

Azim, ME; Wahab, MA; Van Dam, AA; Beveridge, MCM; Verdegem, MCJ. (2001). Optimization of fertilization rate for maximizing periphyton production on artificial substrate and the implication for periphyton based aquaculture. *Aquat. Res.* , **32**:749-760.

Boyd, C. E. (1982). *Water Quality Management For Pond Fish Culture*. Elsevier Scientific Publishing Company, New York, NY, 318 pp.

Boyd, C. E. (1990). *Water Quality In Ponds For Aquaculture*. Alabama Agriculture Experiment Station Auburn Univ., Alabama, 482 pp.

Boyd, C. E. (1998). *Water Quality For Pond Aquaculture*. Research and development series No 43. pp37. International Center for Aquaculture and Aquatic Environments. Alabama Agriculture Experiment Station. Auburn Univ.

Boyd, C. E. (2000). *Water Quality- An Introduction*. Kluwer Academic published Bosto, Massachusetts.

Cole, G. A. (1983). *Textbook of Limnology*. The C.V. Mosby Company.St.Louis, MO.401 pp.

de Moor, F.C., and Scott,W.E. (1985). Digestion of Microcystis aeruginosa by Tilapia *(Oreochromis mossambicus).* J.of the Limnol.Soc.of Southern Africa,**11**: 14-19.

Diana, J.S., C.K. Lin and K. Jaiyen (1994). Supplemental feeding of tilapia in fertilized ponds. *J. World Aquacult. Soc.*, **25**: 497–506

Duncan, D.B.(1955). Multiple-range and multiple F tests. *Biometrics*, **11**:1-42.

EID, A. S., Ibrahim, M. A-R.; Hammouda, Y. F. Tahoun, AL-Azab M. and Abo-State, Hanan ALi.(2010). Effect of fertilization and feeding regimen on growth performance of mono-sex and mixed-sex nile tilapia reared in earthen ponds. *Am. J.of Agr.and Bil.Sc.*, **5** (2):135-142

El-Naggar, G. O. (2007). Efficiency of African catfish *Clarias gariepinus* in controlling unwanted reproduction of Nile tilapia *Oreochromis niloticus* in low input production system. *Egypt. J. Aquat. Biol. & Fish.*, **11** (3) 105-113.

EL- Naggar, G. O.; Ibrahim N. A. and Abou- Zead, M. Y. (2008). Influence of fertilizers types and stocking density on water quality, growth performance and economic returns of nile tilapia - african catfish polyculture system. *International symposium on tilapia in aquaculture*.

FAO (2007). *Food and Agriculture Organization of the United Nations*. Fishstat Plus. FAO, Rome.

Giap, D.H., Yi, Y. and Lin, C. K. (2005). Effects of different fertilization and feeding regimes on the production of integrated farming of rice and prawn *Macrobrachium rosenbergii* (De Man). *Aquaculture Research*, **36**: 292-299.

Gopakumar, K., S. Ayyappan, and J.K. Jena. (2000). Present status of integrated fish farming in India and wastewater treatment through aquaculture. *Proceedings of the National Workshop on Wastewater Treatment and Integrated Aquaculture*. South Australian Research and DevelopmentInstitute, Adelaide, Australia.

Green, B.W., Alvarenga, H.R., Phelps,R.P. and Espinoza, J. (1989). Honduras Cycle III of the CRSP Global Experiment, pond Dynamics / *Aquaculture CRSP Data Reports* ,Oregon state University, Corvallis .

Green, B.W., Alvarenga, H.R., Phelps,R.P., and Espinoza, J. (1990). Honduras Cycle I of the CRSP Global Experiment, pond Dynamics / Aquaculture CRSP Data Reports, Oregon state University, Corvallis.

Hassan, M., M. Javed and G. Mahmood (2000). Response of different levels of nitrogen from broiler droppings towards planktonic biota of major carps rearing ponds. *Pakistan J. Biol. Sci*., **3**(10): 1712-1715.

Haylor, G. S. (1989). The case for the African catfish Clarias gariepinus (Burchell, 1822), Clariidaw: comparison of relative merits of Tilapine fishes especially Oreochromis niloticus (L.) and C. gariepinus of African culture. *Aquaculture and Fisheries Management*, **20**: 279-285.

Hussein, M. S. (1995). Semi-intensive fish culture in some Egyptian fish farms. PH.D.Thesis, Faculty of Agri. , Suez Canal Univ., 256pp

Hussein,M.S. (2002). Evaluation the effect of installing scraps bamboo as a substrate for periphyton on growth performance and production of fish cultured in earthen ponds. *An. of Agri.Sc.,Moshtohor*,**40**(4):2045-2061.

Hussein, M. S. and Abdel-Hakim N. F. (2003). Comparative study on efficiency of chemical fertilizers,manures and artificial feed as fish food in polyculture ponds. *An. of Agri.Sc*.,Moshtohor, **41**(1):179-193

Hussein,M.S. (2004). Effect of chicken manure and overwintering culture, performance of mixed Nile tilapia (Oreochromis niloticus) and common carp (Cyprinus carpio) in earthen ponds. *J. of Productivety and Devel*.(Agr.Res.). **9**(1): 17-24.

Ibrahim, N.A. and Nagdi, Z.A. (2006). Effect of nitrogen fertilizer source on water quality and performance of two tilapia species. *Egypt. J. of Appl. Sci*., **21** (6).

Islam, M. S. (2002). Evaluation of supplementary feed for semi-intensive pond culture mahseer, *Tor putitora* (Hamilton). *Aquaculture Res***.,** **212**: 263–276.

Khallaf, E.A. and Gaber, N. (1991). Analyses of stomach contents and intraspecific interaction over diet of Clarias lazera (Cuv. & Val.) in Bahr-Shebeen canal. *Bulletin of Faculty of Science Zagazig University*, **13** (2): 481-499.

Kumar,M.S.,and S.N.Burgess.2005. Evaluation of optimal species ratio to maximize fish polyculture production. *Journal of Applied Aquaculture*,**17**(1)

Lawson, T. B. (1995). *Fundamentals Of Aquaculture Engineering*. Chapman & Hall. An International Thomson Publishing Company. New York. USA.

Miranda-Filho,K.C., Wasielesky,W.Jr. and Macada A.P. (1996). The effect of ammonia and nitrite on the growth of mullet, Mugil platanus (pisces, Mugilidae). *Rev. Bras. Biol*., **55**:45-50

Milstein, A., A. Alkon, Y. Avnimelech, M. Kochba, G. Hulata and G.Schroeder (2003). Effect of manuring rate on ecology and fish performance in polyculture ponds. *Aquaculture*, **96**: 119–13

Penman, D.J. and McAndrew, B.J.(2000). *Genetics For The Management And Improvement Of Cultured Tilapias*. In: M.C.M. Beveridge and B.J. McAndrew (Eds.), Tilapia: Biology and Exploitation. Kluwer Academic Publishers, the Netherlands: 27-38.

Sahu, P.K., J.K. Jena, P.C. Das, S. Mondal and R. Das (2007). Production performance of *Labeo calbasu* (Hamilton) in polyculture with three Indian major carps *Catla catla* (Hamilton), *Labeo rohita*(Hamilton) and *Cirrhinus mrigala* (Hamilton) with provisions of fertilizers, feed and periphytic substrate as varied inputs. *Aquaculture Res.*, **262**: 333–339 Statistical Analyses Systems(SAS)2005.SAS Program ver.9.1,SAS Institute Incorporation,Cary, NC27513 USA

SAS (2005). *Statistical Analyses Systems* .SAS Program ver.9.1,SAS institute incorporation, Cary, NC27513 USA.

Solomon, J.R And Boro, S.G. (2010). Survival Rate In Poly Culture Of Catfish H*eteroclarias* /Tilapia *(Oreochromis niloticus)*, Fed 2% Body Weight. New York, *Science Journal*, **3**(9)

Tacon, A.G. J. (2003). *Aquaculture Production Trends Analysis*. In: Review of the State of World Aquaculture .FAO Fisheries Circular No. 886, Revision 2,FAO, Rome, pp.5-29.

Tang, Y. A. and Hwang,T. L. (1967). Evaluation of the relative of milk fish in brachiwater ponds. *FAO Fish . Rep***.,** **44**(3):365-372.

Tudorancea, C., C. H. Fernando and J. C. Paggi. (1988). Food and feeding of *Oreochromis niloticus* (Linnaeus,1758)juveniles in Lake Awassa (Ethiopia). *Arch. Hydrobiol. Suppl*., **79:** 267-289.

Vollenweider, R. A. 1969. *A Manual On Methods Of Measuring Primary Production In Aquatic Environments*. IBP Handb. No. 12 Blackwell Scientific Publications, Oxford, 213 pp.

Wahab, M.A., Azim, M.E.; Ali, M.H.; Beveridge, M.C.M.; Khan, S. (1999). The potential of periphyton based culture of a native major carp, Labeo calbusa. *Aquaculture. Res*., **30**: 409-420.

Xu, H. (1989). *A comparison of Tilapia (Oreochromis niloticus) production in pond, cage and pen culture*, AIT Thesis AE,41-89.Asian Inst.of Tech.,Bangkok, Tailand.

تأثير تداخل القراميط الأفريقى كا مفترس مسيطرةِ وركائز البامبوعلى أداءِ النمو والإنتاجِ للبلطى النيلى وحيد الجنسِ و المُخْتَلَطِ والمبروك العادى، في نظامِ الأستزراع المختلط .

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أجريت التجارب لتَقييم تأثيراتِ التسميد والغذاء الأضافى وركائز البامبو و تداخل القرموطِ الأفريقي كا مفترس للسيطرة على النسلِ غير المرغوب لسمك البلطى على أداء النمو وإنتاج السمكِ الكلّيِّ على هذه الأسماكِ التجريبيةِ فى نظام الأستزراع المختلط الشبه مكثف على مدى ١٥٠ يوم . تم تغذية الأسماك بنخالة القمح كغذاء أضافى بمعدل ٣% مِنْ وزنِ الجسمِ مرّتين في اليوم.وكمية الغذاء المقدم للسمك يعدّلَ شهرياً مستنداً على الكتلة العضوية المشتركة لانواعِ السمك المستزرع ، و خصائص المياة تم قياسها شهرياً.

تم أجراء ثلاثة معاملات مكررة مرتين فى نظام الأستزراع المختلط على البلطى النيلى وحيد الجنس والمختلط، والمبروك العادى و القرموط الأفريقى ، وتم أستزراعها فى ٨ أحوض أرضية مساحة كل حوض ٢٠٠ متر مربع ، وبشكل عشوائى . وتم تخزين الأحواض كما يلى :

الكنترول : تم تخزين الأحواض بمعدل ٤٠٠ سمكة بلطى مختلط الجنس+ ٢٠٠سمكة مبروك +١٠٠سمكة قراميط ، وبدون أضافة أى معاملة .

معاملة (١) : تم تخزين الأحواض بمعدل ٤٠٠ سمكة بلطى نيلى وحيد الجنس ذكور + ٢٠٠ سمكة مبروك عادى + ١٠٠ سمكة قراميط .

معاملـة (٢) : تـم تخـزين الأحـواض بمعـدل ٤٠٠ سـمكة بلطـى نيلـى مخـتلط الجـنس (بنسـبة ١ ذكر : ١أنثى) + ٢٠٠ سمكة مبروك عادى .

معاملة (٣) : تم تخزين الأحواض بمعدل ٤٠٠ سمكة بلطى نيلى مختلط الجنس (بنسبة ١ ذكر : ١أنثى) + ٢٠٠ سمكة مبروك عادى + ١٠٠ سمكة قراميط .

معدل إنتاج الأسماك اليومى والأنتاج الكلى للأسماك كان معنوياَ مرتفعاَ فى المعاملة ١ . والتحليل الأحصائى للمكررات يدل على أن أنتاج السمك فى المعاملة ١ أكبر من أنتاج الأسماك فى المعاملة ٢ والمعاملة ٣ . أنتاج البلطى فى المعاملة بدون أضافة القراميط كان معنوياَ أقل من المعاملات الأخرى . وكان متوسط أنتاج السمك يتراوح بين ٣٢١.٠ كج / حوض فى المعاملة ١ ، و٢٠٨.٨ كج للمعاملة ٢ ، و٢٩٦.١ كج للمعاملة ٣ ، بينما كانت ١٢٠.٧ كج للكنترول . وأفتراس القرموط الأفريقي لصغارِ سمك البلطى كَانَ فعّال بما فيه الكفاية للعَمَل على الحدّ من الزيادة السكانية لسمك البلطى ؛ على أية حال، عملية الأفتراس كانت نشيطة فقط في أنظمةِ الزراعة نصف الكثيفةَ. وأشارَت الدراسةُ إلى أن أقطابِ البامبو كركائز لتنمية البيريفيتون periphyton كَانتْ كابديل جيد لتَحسين إنتاجِ السمكِ تحت ظروف الحوض . إختلافات خصائص المياه كانت ممتازِ في القِيَمِ المتوسطةِ وكَانتْ ضمن المجاميعِ المقبولةِ لأستزراع السمكِ. ولاتوجد هناك إختلافاتَ هامّةَ في خصائص المياه وكانت ممتازةِ بين أحواض المعاملات المختلفةِ .

التوصية :ويتضح من هذة الدراسة أن أفضل معاملة هى الأولى (تخزين الأحواض بمعدل ٤٠٠ سمكة بلطى نيلى وحيد الجنس ذكور + ٢٠٠ سمكة مبروك عادى + ١٠٠ سمكة قراميط) من حيث مقاييس النمو والأنتاجية.