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SELECTIVE FEEDING OF NILE TILAPIA AND SILVER CARP ON GREEN ALGAE AND CYANOBACTERIA IN AQUACULTURE

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Abstract

An experiment was conducted to know the different species of phytoplankton that silver carp *(Hypophthalmichthys molitrix*) and Nile tilapia *(Oreochromis niloticus)* feed on. This experiment conducted in the Central Laboratory for Aquaculture Research (CLAR) Abbassa- Sharkia Governorate- Egypt using 6 concrete ponds. The experimental extended for 4 months from September to desember (2011). The ponds was fertilized by inorganic fertilizers. Fish samples were collected monthly, individual weight and length were measured. Gut content samples were taken and microscopically examined. The results showed that total alkalinity (T.Alk.) and total hardness were significantly increased in the first treatment (Nile tilapia). Nitrate concentration was significantly increased in the third treatment (Silver carp). Chlorophyll "a" concentration was significantly increased in the second treatment. The obtained results indicated that cyanobacteria representing 72.3% of O.niloticus gut content, while green algae representing 69.9% of silver carp.

INTRODUCTION

Nile tilapia is an attractive species for aquaculture because of its fast growth, large size at reproduction, low feeding trophic level and low production costs (Costa-Pierce and Rakocy, 1997). Juvenile and adult Nile, (Oreochromis *niloticus)* blue *(O. aureus*) and Mozambique *(O. mossambicu*s) tilapia are reported to filter phytoplankton (Mcdonald, 1985a; McDonald, 1985b; de Moor *et al.*, 1986 and Northcott *et al.*, 1991).

The Chinese carp or silver carp is one of the most intensively cultured fish species comprising much of the production of chine's aquaculture (Liang *et al.*, 1981; Tang, 1981). it has also been introduced into 34 countries (Li *et al.*, 1990) Primarily for aquaculture purposes and has been used as a biological control agent for algal blooms in eutrophic waters (Kajak *et al.*, 1975; Sirenko *et al.*, 1976; Smith, 1985; Smith, 1988; Starling, 1993 and Xie, 1996) because of its ability to filter fine particles (Cremer and Smitherman, 1980; smith, 1989) it is a typical pump filter feeder, feeding mainly on phytoplankton (Lazzaro, 1987).

Nile tilapia and silver carp are cultured and stocked in commercial ponds and known to be effective in managing nuisance phytoplankton blooms in both eutrophic lakes (Drenner *et al.*, 1984; Starling and Rocha, 1990; Starling, 1993 and Fukushima *et al.*, 1999) and aquaculture ponds (Dunseth, 1977; Smith, 1985; Mueller, 2001 and Brune *et al.*, in press). Both species are reported to selectively filter water based on particle size. The aerosol filtration and sieving mechanisms involved in mucus entrapment by Nile tilapia effectively retain a wide range of phytoplankton particle sizes (Beveridge *et al.*, 1991; Sanderson *et al.*, 1996; Beveridge and Baird, 2000). Silver carp feeding mechanism is not fully understood; however, gut content and laboratory feeding studies indicate that silver carp are more efficient feeding on larger phytoplankton, rarely consuming particles < 10 Am in diameter (Cremer and Smitherman, 1980; Adamek and Spittler, 1984; Smith, 1989 and Vo¨ro¨s *et al.*, 1997).

MATERIALS AND METHODS

This work was conducted in the Central Laboratory for Aquaculture Research-Abbassa Abo- Hammad-Sharkia-Egypt, using 6 equal concrete ponds (5m long **x** 2m wide **x** 1m depth)) for four months. The ponds were irrigated with fresh water from "Gaddon" canal which branches from the main canal of Ismaallia. They were divided into three treatments each in two replicates was yhe use of as follow: the 1st treatment 50 fish *O. niloticus*. The 2nd was the use of 35 fish of *O. niloticus* and 15 fish *H. molitrix*. The 3 rd was the use of 50 Fish of *H. molitrix/pond*. Nile tilapia and silver carp was stocked at a rate of 5 fish/m^2 with average initial weight of 98g and 20g/fish respectively. Ponds were fertilized by 5g urea plus 100g ammonium sulfate and 30g monosuperphosphate monthly (Allen and Nelson, 1990). Water samples from each pond were taken every two weeks to determine the physio-chemical parameters.Temperature and dissolved oxygen was measured using dissolved oxygen meter model YSI 57. pH value was measured using pH-meter (Digital Mini-pH Meter, model 55, Fisher Scientific, and USA).

Total alkalinity, total hardness, total phosphorus, ammonia, nitrite, and nitrate concentrations were measured according to APHA (1985). Chlorophyll "a" was determined photometrically according to Vollenweider (1969) using spectrophotometer (model Milton Roy 21D).

Quantitative estimation of phytoplankton was carried out by the technique described by APHA (1985) using the sedimentation method. Phytoplankton samples were preserved in lugols̉ solution at a ratio of 3 to 7 ml lugols̉ solution per one liter sample and concentrated by then it transferred to separate labeled container sedimentation of one liter volumetric measuring jars for about 2 to 7 days. The surface water was siphoned and the sediment was adjusted to 50 ml from the fixed sample,1ml was drown and placed into Sedgwick-Rafter cell, and then it was microscopically examined for counting after identification of phytoplankton organisms.The results were expressed as cell counts ml^{-1}. The phytoplankton cells were identified to four divisions as green algae (Chlorophyceae), blue-green algae (Cyanobacteria), diatoms (Bacillariophyceae), and euglena (Euglinophyceae). For identification of the algal taxa, Fritsch (1979) and Komarek and Fott (1983) were followed.

Three fish of each of the 2 investigated species were collected randomly from each pond monthly, gut contents were emptied and phytoplankton species included were counted. The fish were dissected and guts removed and stored in 10% formalin solution. It was weighed, dissected and the constituent food items were separated and enumerated under light microscope and weighed (Meschiatti and Arcifa, 2002).

Statistical analysis:

The statistical analysis was applied according to Steel and Torrie (1980) on the collected data using a SPSS program (2004). Differences among means were tested for significance according to Duncan's multiple rang test (Duncan, 1955).

The following model was used to analyze the obtained data:

$$Yij=M+Ti+eij$$

Where:

Y_{ij} =dependent variable for observation i^{th} and replicate j^{th}.
M = the overall mean.
T_i= the effect of i^{th} treatment.
e_{ij}= random error for observation i^{th} and replicat j^{th}

RESULTS

Data presented in Table (1) show that there were no significant different observed among the water temperature, dissolved oxygen (DO), pH value, Secchi disk, nitrite, total phosphorus and orthophosphate concentrations among the three treatments during the experimental period whereas the concentration of nitrate in third treatment was significantly higher than the the first and second treatment.

Total alkalinity (T.Alk.) and total hardness (TH) concentrates in the first treatment were significantly higher than the second and third treatments respectively. The mean concentration of chlorophyll "a" was in the second treatment was higher than the first and the third treatments respectively.

Phytoplankton in water:

Figers illustrate (1-4) species composition of phytoplankton in September, October, November and December. The proportion of cyanobacteria was greater than green algae in the first and second treatments while in the third treatment the proportion of green algae was greater than cyanobacteria.

Phytoplankton abundance in gut content:

Tables (2-5) revealing that cyanobacteria representing the highest percentage in *O.niloticus* feed in the 1^{st} treatment, while green algae representing the highest proportion in *Hypophthalmichthys molitrix* feed in the 3^{rd} treatment during the four experiment months. With respect to the 2^{nd} treatment, cyanobacteria dominated the feed of *Hypophthalmichthys molitrix* during September and Desember months and dominated the feed of *O.niloticus* the last two months of the experiment, while green algae dominated the feed of *O.niloticus* during the first two months and the feed of *Hypophthalmichthys molitrix* during October and November.

DISCUSSION

Chlorophyll "a" concentration which is an indication for the primary productivity (phytoplankton) was higher in the 2nd treatment than that 1st and 3rd this mean that there was appositive correlation between chl "a" content and algal density and inverse correlation with secchi disk readings in the examined ponds. This agrees with (Amany, 2012).

The present study shows that, there was decreasing in secchi disc (SD) reading in the 2nd treatment as a result of accumulation in algal density in this treatment, while high transparency at 1st and 3rd was due to their low phytoplankton. This agrees with the finding of (Amany, 2012). In the 1st treatment Nile tilapia fed on cyanobacteria with greater proportion than the green algae, which may be refer acid hydrolysis in the stomach fluids.

A prerequisite to the utilization of the cell contents is the breakdown of the algal cell wall by one of three mechanisms, i.e., acid hydrolysis, enzymatic digestion, or mechanical trituration (Bitterlich, 1985c). Tilapia are good example of species which rely on acid hydrolysis, i.e., they are particularly well adapted to disrupt cyanobacterium cell walls because pH values as low as 1.25 or even 1.0 are present in the stomach fluids during active digestion (Moriatry *et al*., 1973; caulton, 1976; payne, 1978). However, in stomachless filter-feeding fishes such as silver carp, the pH of the gut fluids is usually > 6. The lack of cellulase in the gut fluids also indicates that it is difficult to breakdown cellulose cell walls by enzymatic digestion (Ni and Chiang, 1954; Bitterlich, 1985a).

The fact that Ivlev (1961) model explained Nile tilapia filtration rate of green algae and cyanobacteria provides an important first step in modeling phytoplankton growth and population structure in the Partitioned Aquaculture System (PAS) as impacted by tilapia stocking density. Additional research needed to explain the effects of individual fish size and water temperature on Nile tilapia filtration rate. Finally, the observation that Nile tilapia effectively filters cyanobacteria provides the aquaculturists with a promising management tool for control of nuisance phytoplankton such as *Microcystis*.

In the 3rd treatment it found that silver carp fed on green algae with greater proportion than blue green which could be attributed to one of this reasons:

Feeding selectivity of silver carp which is a mechanical, passive function of its filter morphology (Spataru & Gophen, 1985 and Smith, 1989). The distances between its gill rakers which ranges from 12 to 26µ m (Hampl *et al.*, 1983) this is consistent with the current results that the lower limit for available food particles is about 10µ m (Cremer & Smitherman, 1980 and Smith, 1989). A logical consequence of the above-mentioned results is that Silver carp grazing can not control total algal biomass, but will modify the size structure of algal communities (Smith, 1989).

Xie (1996) found that the majority of the phytoplankton collected by silver carp were 8–10 µm, and were also the major components of the phytoplankton community in the studied lake water. Cremer and Smitherman (1980) reported that food particles found in the intestine of silver carp were 8–100µm when the majority of phytoplankton was17–50 µm (the fish were cultured in small ponds), and their results were agreed well with the observed distances between gill rakers. Thus, it seems that collection of food particles by the fish is largely dependent on the food availability in the environment, i.e., when most of the food items are small, they can collect food particles even smaller than the distances between their gill rakers; when most of the food items are large, they collect mainly those food particles larger than the distance between their gill rakers.

Xie (1996) showed indirectly, that the breakdown of cell walls of ingested algae by silver carp mainly takes place in the esophagus by mechanical trituration of the pharyngeal teeth, which helps to explain the different conclusions on the digestibility of algae by silver carp up to now. Nevertheless, there remain a proportion of algal cells which are intact, the proportion perhaps varying among species. On passage through the intestine, few or only a very small proportion of the intact algae are destroyed, especially those algae with cellulose cell walls such as green algae, due to the lack of cellulose in the intestine, leading to the erroneous conclusion by some authors (Ni and Chiang, 1954 and Bitterlich, 1985a,b,c) found that phytoplankton are little utilized by the stomachless fish like silver carp. Active assimilation of the broken algal cell takes place in the intestine even though the intact algal cells may change little in their proportion on passage through the intestine, explaining the effective food assimilation of silver carp on some cyanobacteria and green algae observed with isotope techniques. The presence of an intact or mobile alga in the hind gut or feces (Ni and Chiang, 1954; Spataru, 1977 and Bitterlich, 1985b) does not necessarily mean that this species is indigestible; since the present study shows that only distance between gill rakers of silver carp ca. 1/3 of the ingested *Cyclotella* remained intact in the feces. The digestibility of any food consumed by fish must be determined by the balance between energy gain from the food and the energy expending on digestion, the incomplete digestive mechanism on algae reflects a adaptive strategy for these stomachless, filter-feeding fishes which continuously feed on small suspended particles including not only plankton but also large amounts of organic detritus of low nutritional value.

Nile tilapia and silver carp should both be useful in the biological control of Microcystis and those large cyanobacteria which have been associated with off-flavor in fish flesh (Pearl and Tucker, 1995). Phytoplankton species composition and biomass management using filter-feeding organisms such as Nile tilapia has helped to provide the conditions in the PAS for increased fish carrying capacity, production and flesh quality (Brune *et al.*, in press).

Table 1. Mean ± SE of some water Limnological characteristics in the experimental ponds.

Parameters	**Treatment**		
	1^{St}	**2^{nd}**	**3^{rd}**
Temp (ºC)	21.76^{a}±0.55	21.58^{a}±0.55	21.14^{a}±0.55
DO (mg/l)	7.49^{a}±0.86	7.88^{a}±0. 86	7.68^{a}±0. 86
pH	8.78^{a}±0.3	8.55^{a}±0.3	8.85^{a}±0.3
SD (cm)	16.4^{a}±2.3	15.4^{a}±2.3	16.3^{a}±2.3
NH_3-N (mg/l)	0.49^{a}±0.06	0.57^{a}±0.06	0.48^{a}±0.06
NO_2- N (mg/l)	0.06^{a}±0.005	0.06^{a}±0.005	0.05^{a}±0.005
NO_3 -N (mg/l)	0.38^{b}±0.09	0.32^{b}±0.09	0.52^{a}±0.09
T.Alk. (mg/l as $CaCO_3$)	260.4^{a}±17.1	246.9^{ab}±17.1	232.4^{b}±17.1
TH (mg/l as CaC O_3)	210.8^{a}±23	199.1^{ab}±23	194.4^{b}±23
TP (mg/l)	0.61^{a}±0.07	0.63^{a}±0.07	0.56^{a}±0.07
OP (mg/l)	0.03^{a}±0.02	0.03^{a}±0.02	0.05^{a}±0.02
Chl.a (mg/l)	111.3^{b}±17.5	125.02^{a}±17.5	103.2^{b}±17.5

Means followed by different litters at the same row are statistically different ($p<0.05$)

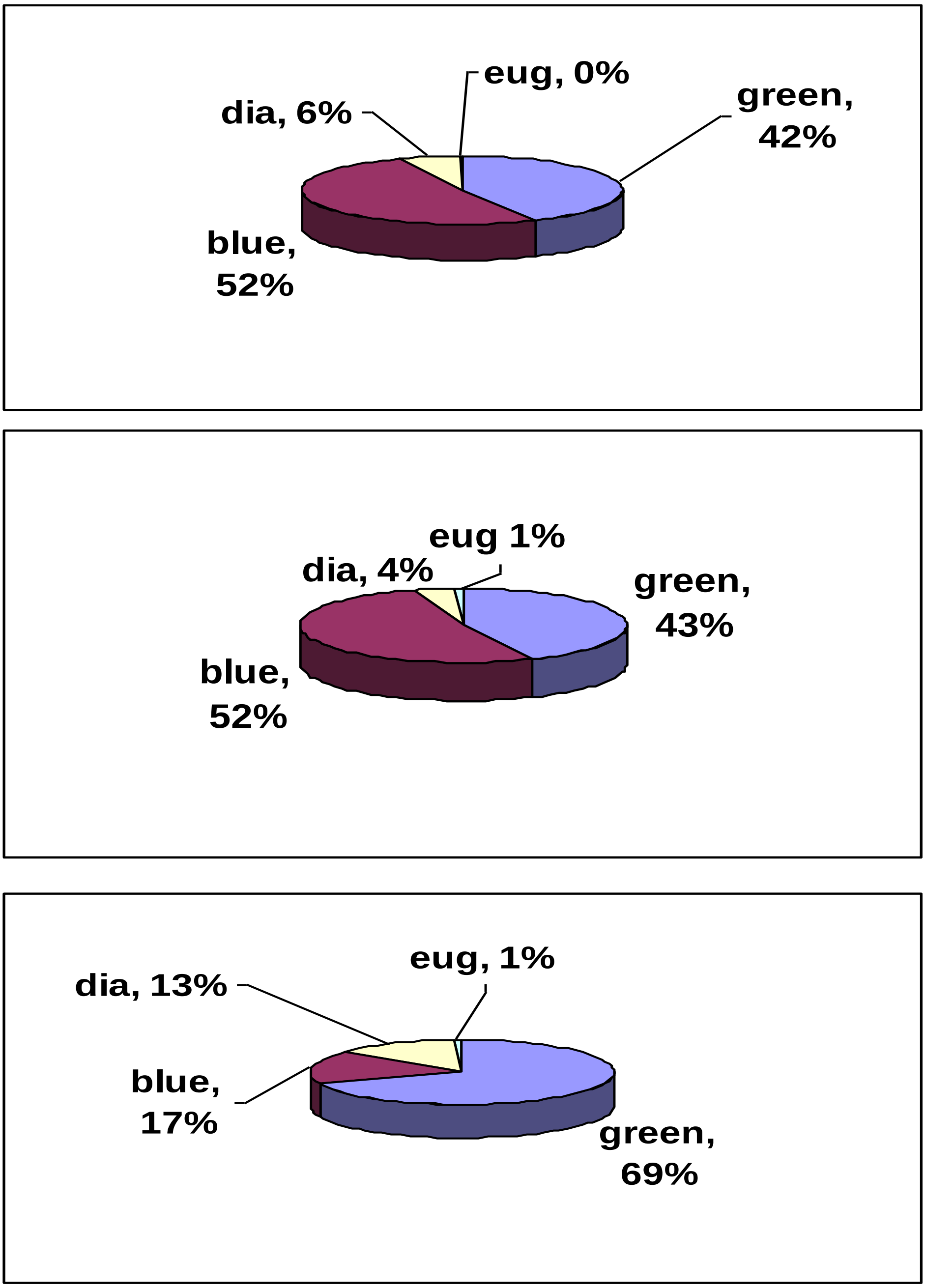


Figure 1. Phytoplankton abundance in water during September. [Chlorophyta (green), Cyanophyta (blue), Bacillarophyta (diatom), Euglenophyta (euglena)].

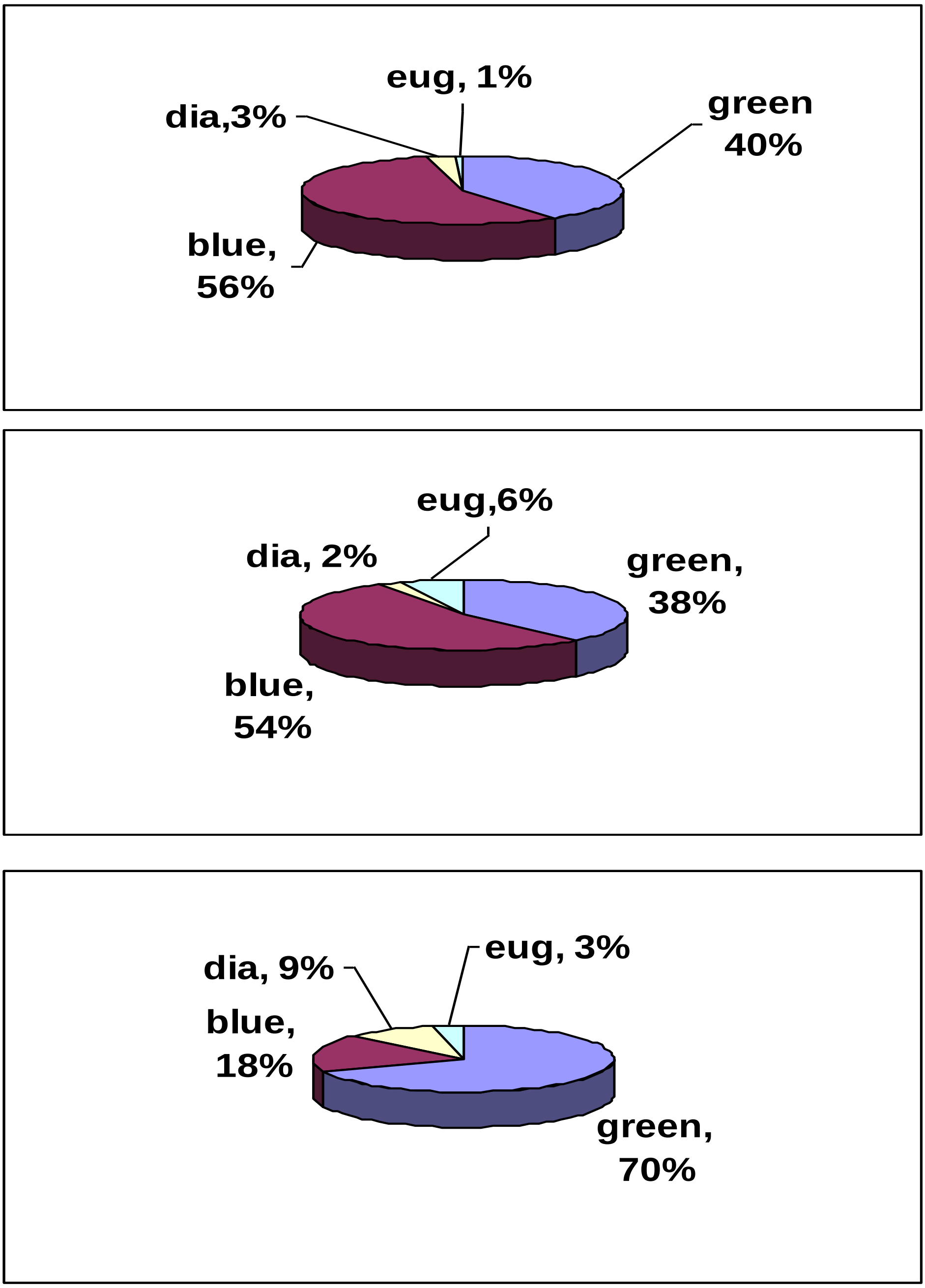


Figure 2. Phytoplankton abundance in water during October. [Chlorophyta (green), Cyanophyta (blue), Bacillarophyta (diatom), Euglenophyta (euglena)].

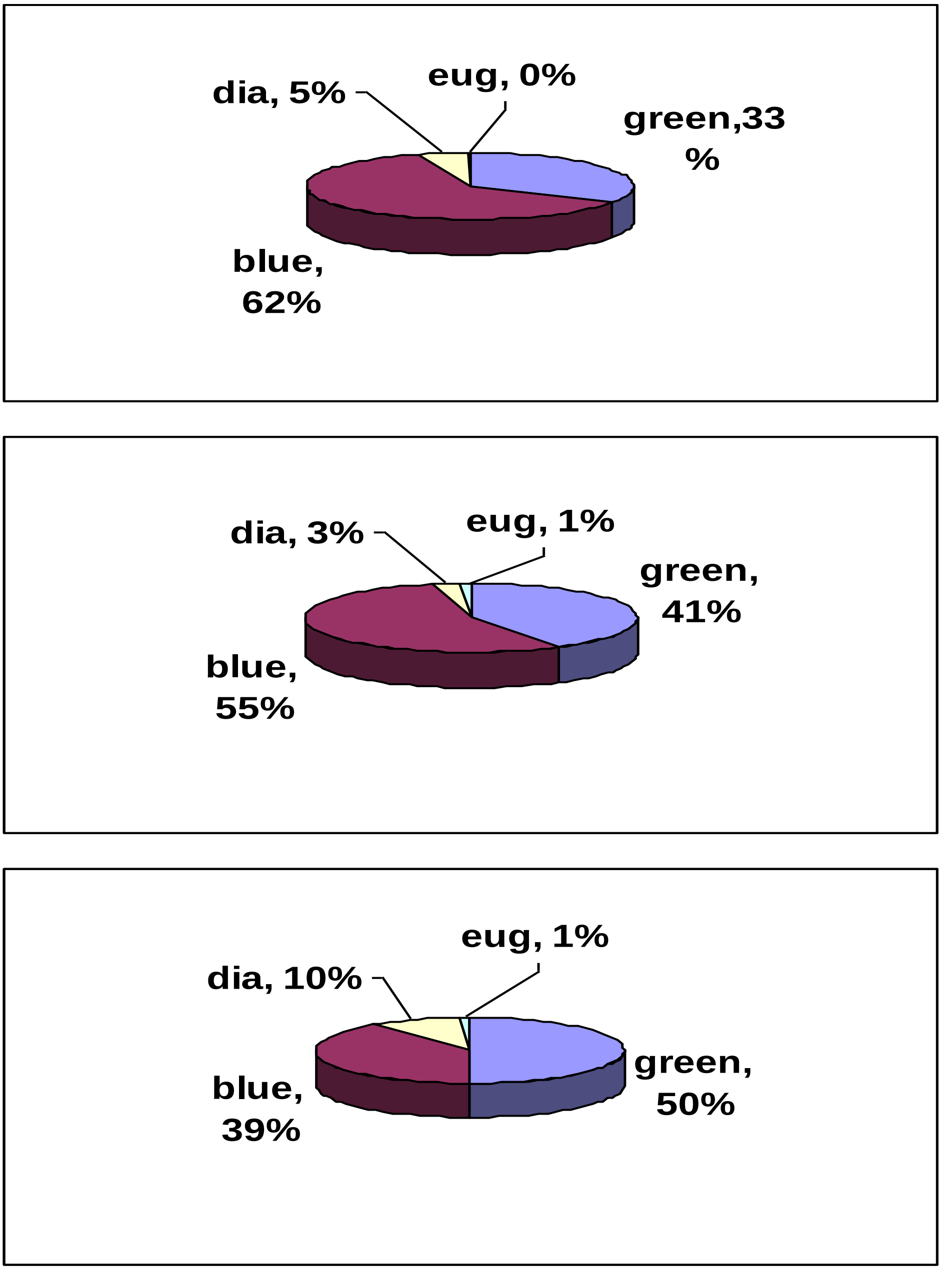
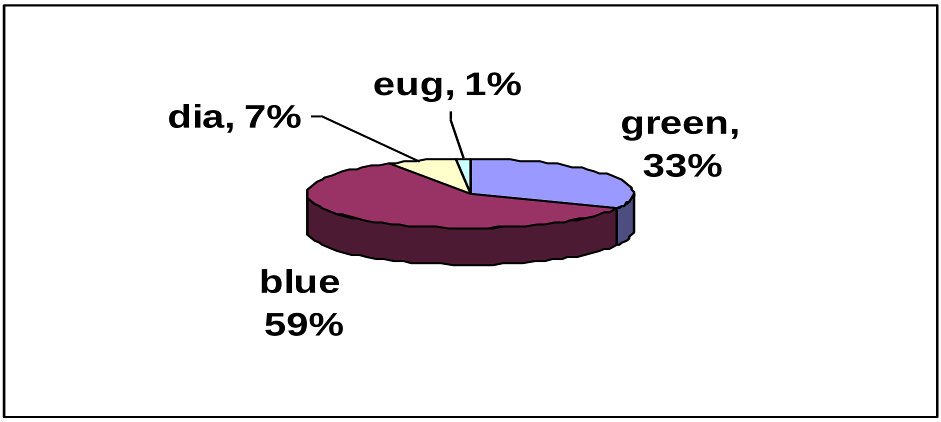
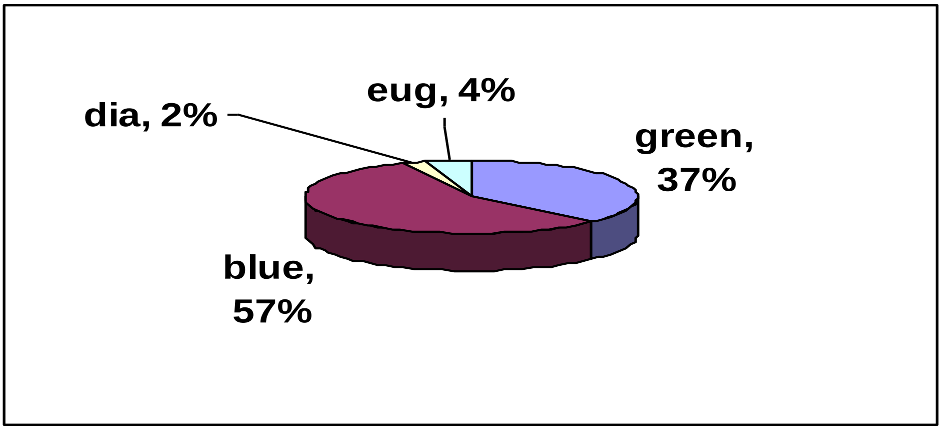


Figure 3. Phytoplankton abundance in water during November. [Chlorophyta (green), Cyanophyta (blue), Bacillarophyta (diatom), Euglenophyta (euglena)].





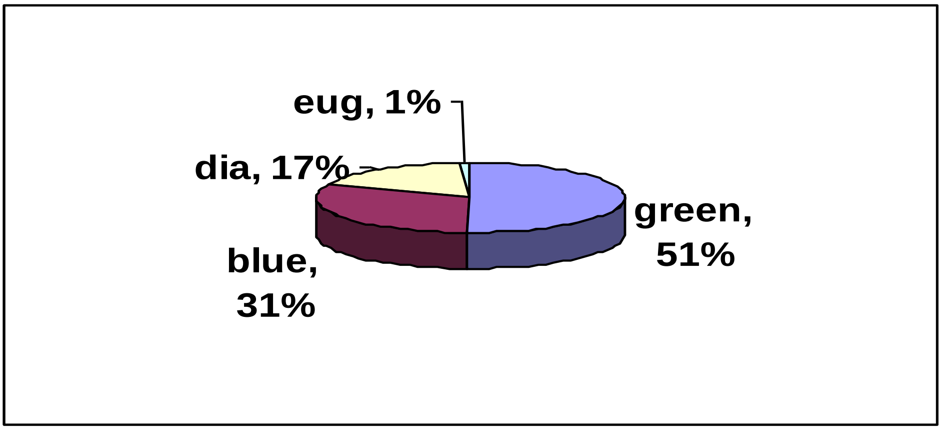


Figure 4. Phytoplankton abundance in water during December. [Chlorophyta (green), Cyanophyta (blue), Bacillarophyta (diatom), Euglenophyta (euglena)].

Table 2. Phytoplankton in stomach during September (organism/ml).

Phytoplankton groups	T_1 (Tilapia)	T_2 (Tilapia)	T_2 (Silver)	T_3 (Silver)
Chlorophyta				
Pandorina	91031.6	-	271103.5	305344.2
Pediastrum	338840.2	466298.8	90367.8	-
Tetra chlorella	197235.2	233149.4	162662.1	
Scenedesmus	1122724	2349427.1	108441.4	29068.4
Closterium	20229.3	-	-	5036.6
Tetrastrum	136547.5	349724.1	-	35795.7
Planktosphaeria	96088.9	851891.9	108441.4	-
Microspora	45515.8	-	-	-
Volvox	15171.9	457578.4	-	-
Palmella	101146.3	-	120490.4	-
Total	2164530.7	4708069.7	861506.6	375244.9
Percentage (%)	14.9	53.9	14.3	53
Cyanophyta				
Merismopedia	525960.6	-	271103.5	-
Microcystis	11449758.3	1856227.7	3413083.1	15109.8
Gloeocapsa	-	-	1084413.8	-
Chrococcus	-	-	325324.1	-
Coccochloris	-	152443.7	54220.7	-
Total	11975718.9	2008671.4	5148145.2	15109.8
Percentage (%)	82.4	23	85.2	2.1
Bacillarophyta				
Cyclotella	242751.1	233149.4	-	1888.7
Synedra	-	-	-	8346.4
Navicula	75859.7	1067105.9	-	201607.3
Nitzschia	-	-	-	31730.7
Tabellaria	70802.4	726349.1	30122.6	73552.4
Total	389413.2	2026604.4	30122.6	317125.5
Percentage (%)	2.7	23.2	0.5	44.8
Euglenophyta	-			

Table 3. Phytoplankton in stomach during October (organism/ml).

Phytoplankton groups	T_1 (Tilapia)	T_2		T_3 (Silver)
		Tilapia	Silver	
Chlorophyta				
Pandorina	-	1895311.8	-	1562155.6
Pediastrum	162656.9	541517.7		59069.4
Tetra chlorella	6971013.6	3519864.7	-	22477.1
Tetraedron	-	-	-	22477.1
Scenedesmus	2796149.3	10559599.4	14540.2	117068.1
Closterium	-	406138.2		48716.7
Cosmarium	-	-	-	21540.5
Tetrastrum	348550.7	-	-	65558.1
Planktosphaeria	-	541517.7		39334.9
Koliella	-	21525329.3	407124.3	4682.7
Volvox	348550.7	-	43620.5	5619.3
Ankistrodesmus	-	-	-	11238.5
Palmella	232367.1	-	-	5619.3
Total	10859288.3	38899278.8	465285	1985557.3
Percentage (%)	31.4	85.5	61.5	76.5
Cyanophyta				
Anabaena	38727.7	-	-	-
Merismopedia	580917.8	-	-	-
Microcystis	19782148.6	6362835	290803.1	-
Lyngbya	-	-	-	11238.5
Coccochloris	348550.7	-	-	-
Total	20750344.8	6362835	290803.1	11238.5
Percentage (%)	60	13.9	38.5	0.4
Bacillarophyta				
Cyclotella	2648977.7	-	-	-
Synedra	193639	-	-	11238.5
Navicula	77455.5	270758.8	-	587213.2
Tabellaria	852011.3	-	-	33715.6
Total	3772083.5	270758.8	-	632167.3
Percentage (%)	8.6	0.6	-	23
Euglenophyta		**-**		

Table 4. Phytoplankton in stomach during November (organism/ml).

Phytoplankton groups	T_1 (Tilapia)	T_2		T_3 (Silver)
		Tilapia	Silver	
Chlorophyta				
Pandorina	-	75868.7	395430.9	-
Pediastrum	77902.8	-	158831.3	41214.8
Tetra chlorella	36835.7	2807142.5	9533824.1	14637
Tetraedron	-	-	39543.1	-
Scenedesmus	1482288.3	379343.6	6477148.6	168325.8
Closterium	-	-	118629.2	21955.5
Tetrastrum	52622.4	151737.4	803382.4	182962.7
Staurastrum	98666.9	-	-	-
Planktosphaeria	-	-	318980.2	-
Koliella	-	379343.6	3780311.4	-
Golenkinia	-	151737.4	-	462223
Microspora	11840	-	-	178543.1
Volvox	54047.3	75868.7	664323.4	251084.3
Total	1814203.4	4021041.9	21690404.6	1320946.2
Percentage (%)	25.4	40.8	69.4	57.3
Cyanophyta				
Merismopedia	350001.9	2351930.2	555580.4	14637
Microcystis	4889513.8	1896717.9	6795455.4	91288.8
Gloeocapsa	-	227606.2	-	-
Lyngbya	-	-	-	7318.5
Chrococcus	46044.6	910424.6	395430.9	573925.5
Coccochloris	6577.8	227606.2	785587.9	-
Total	5292138.1	5614285.1	8532054.6	687169.8
Percentage (%)	74.2	56.9	26.5	29.8
Bacillarophyta				
Diatoms	-	-	-	9244.5
Cyclotella	15896.1	227606.2	362477.7	-
Synedra	13155.6	-	-	36592.6
Navicula	-	-	405315.9	204918.4
Nitzschia	-	-	39543.1	-
Fragilaria	-	-	-	14637
Tabellaria	-	-	434973	-
Total	29051.7	227606.2	1242309.7	265392.5
Percentage (%)	0.4	2.3	3.9	11.5
Euglenophyta				
Euglena	-	-	72495.5	30429.7
Total	-	-	72495.5	30429.7

Percentage (%)	-	-	0.2	1.3

Table 5. Phytoplankton in stomach during December (organism/ml).

Phytoplankton groups	T_1 (Tilapia)	T_2		T_3 (Silver)
		Tilapia	Silver	
Chlorophyta				
Pediastrum	367669.6	252321.8	15372.8	67167.8
Tetrachlorella	6150626.8	199200.7	600649.9	17990.1
Tetraedron	919507.7	-	98388.2	-
Scenedesmus	2459040.2	1509500.1	73915.1	922295.3
Closterium	98871.7	-	-	179903
Tetrastrum	59323.06	61973.8	-	3274207.6
Planktosphaeria	218317.7	199200.7	123948.4	-
Koliella	652553.6	-	49949.3	-
Golenkinia	98871.7	-	16649.7	-
Volvox	398871.7	1328004.8	-	5218343.8
Ankistrodesmus	42372.9	247895.4	9989.8	17990.3
Palmella	59323.1	61973.8	118767.1	17990.3
Total	11524631,3	3860071.1	1107630.3	9553975.5
Percentage (%)	25	37.2	27.5	92.7
Cyanophyta				
Merismopedia	1169086.4	261174.6	-	49173.2
Microcystis	31522571.3	4231928.6	2263905.3	-
Gloeocapsa	-	-	16129.5	-
Lyngbya	-	-	15136.5	-
Chrococcus	21186.4	247895.4	90817.2	283046.2
Coccochloris	762646	199200.7	458794.1	-
Total	33475490,1	4940199..3	2844782.6	332219.4
Percentage (%)	72.7	47.6	70.7	3.1
Bacillarophyta				
Diatoms	-	66400.2	-	-
Cyclotella	310126.5	199200.7	17574.7	80356.03
Synedra	39548.7	199200.7	18499.7	31182.9
Navicula	496304.1	1057984.4	24218.1	304710.9
Nitzschia	98871.7	664000.2	-	-
Fragilaria	98871.7	-	-	35980.3
Total	1043722.7	1589186.2	60292.5	452230.1
Percentage (%)	2.3	15.3	1.5	4.2
Euglenophyta				
Euglena	-	-	9249.9	-
Total	-	-	9249.9	-
Percentage (%)	-	-	0.2	-

RECOMMENDATION

The obtained results suggest the recommendation to use Nile tilapia with silver carp to utilization from phytoplankton that found in water.

REFERANCES

Adamek, Z. and P. Spittler, 1984. Particle size selection in the food of silver carp, Hypophthalmichthys molitrix. Folio Zool., 33: 363–370.

Allen, E.J and E.W. Nelson, 1990. On the artificial culture of marine plankton organisms. J.Mar. Biol. Assoc.,8: 421.

Amany, A.M., 2012. Inhibition of the development of microalgae by extracts of fresh water algae. Benha University.

American Public Health Association (APHA), 1985. Standard Methods for Examination of Water and WasteWater, 16th edition. American Public Health Association,Washington, D.C.

Beveridge, M.C.M. and D.J. Baird, 2000. Diet, feeding and digestive physiology. In: Beveridge, M.C.M., McAndrew, B.J. (Eds.), Tilapias: Biology and Exploitation. Fish Fish. Ser., vol. 25. Kluwer Academic Publishing, Dordrecht, Netherlands, pp. 59–87.

Beveridge, M.C.M; P.K. Sidar; G.N. Frerichs and S. Millar, 1991. The ingestion of bacteria in suspension by the tilapia Oreochromis niloticus. Aquaculture, 81: 373– 378.

Bitterlich, G., 1985a. Digestive enzyme pattern of two stomachless filter feeders, silver carp, *Hypophthalmichthys molitrix* Val., and bighead carp, *Aristichthys nobilis* Rich. J. Fish Biol., 27: 102–112.

Bitterlich, G., 1985b. The nutrition of stomachless phytoplanktivorous fish in comparison with tilapia.Hydrobiologia, 121: 173–179.

Bitterlich, G., 1985c. Digestive process in silver carp _*Hypophthalmichthys molitrix*. studied in vitro. Aquaculture, 50: 123–131.

Brune, D.E.; G. Schwartz; J.A. Collier; T.E. Schwedler and A.G. Eversole, in press. Partitioned Aquaculture System. In: Tucker, C.S., Hargreaves, J.A. (Eds.). Catfish Culture. Elsevier, Amsterdam, Netherlands.

Caulton, M.S., 1976. The importance of pre-digestive food preparation to *Tilapia rendalli* Boulanger when feeding on aquatic macrophytes. Trans. Rhod. Sci. Assoc., 57: 22–28.

Costa-Pierce, B.A. and J.E. Rakocy, 1997. Tilapia Aquaculture in the Americas, vol. 1.World Aquaculture Society, Baton Rouge, LA, USA, 258 pp.

Cremer, M. and R.O. Smitherman, 1980. Food habits and growth of silver and bighead carp in cages and ponds. Aquaculture, 20: 57–64.

De Moor, F.; R.C. Wilkinson and H.M. Herbest, 1986. Food and feeding habits of *Oreochromis mossambicus* in hypertropic Hartbeespoort Dam S. Afr. J. Zool., 21: 170–175.

Drenner, R.W.; S.B. Taylor; X. Lazzaro and D. Kettle, 1984. Particle grazing and plankton community impact of omnivorous cichlid. Trans. Am. Fish. Soc., 113: 397– 402.

Duncan, D.B., 1955. Multiple range and multiple F-tests. Biomet., 11:1-15.

Dunseth, D.V., 1977. Polyculture of channel catfish, Ictalurus punctatus, silver carp, Hypophthalmichthys molitrix,and three all-male tilapias, Sarotherodon spp. PhD dissertation. Auburn University, Auburn, AL, USA.

Fritsch, F.E., 1979. The structure and reproduction of the algae.Vikas Publ. House, New Delhi, 791pp.

Fukushima, M.; N. Takamura; L. Sun; M. Nakagawa; K. Matsushige and P. Xies, 1999. Changes in the planktoncommunity following introduction of filter-feeding planktivorous fish. Freshw. Biol., 42: 719 –735.

Hampl, A.; J. Jirasek and D. Sirotek, 1983. Growth morphology of the filtering apparatus of silver carp (*Hypophthalmichthys molitrix* Val.) II. microscopic anatomy. Aquaculture, 31: 153–158.

Ivlev, V.S., 1961. Experimental Ecology of the Feeding of Fishes. Yale Univ. Press, New Haven, CT, USA, 19– 40.

Kajak, Z.; J.I. Rybak; I. Spodniewska and W.A. Gadlewska-Lipowa, 1975. Influence of the planktivorous fish, *Hypophthalmichthys molitrix*, on the plankton and benthos of the eutrophic lake. P. Arch. Hydrobiol., 22: 301–310.

Komarek, J. and B. Fott, 1983. Das phytoplankton des Susswassers 7 telie, 1. Halfte, Pub. E. Schweizerbartsche verlagbuchhandlung (Nagele U. Obermiiler).

Lazzaro, X., 1987. A review of planktivorous fishes: their evolution, feeding behaviours, selectivities, and impacts. Hydrobiologia, 146: 97–167.

Li, S.; L. Wu; J. Wang; Q. Chou and Y. Chen, 1990. Comprehensive Genetic Study of Chinese Carps. Shanghai Scientific and Technical Publishers, Shanghai.

Liang, Y.; J.M. Melack and J. Wang, 1981. Primary production and fish yields in Chinese ponds and lakes Trans. Am. Fish. Soc., 110: 346–350.

McDonald, M.E., 1985a. Carbon budgets for a phytoplanktivorous fish fed three different unialgal populations Oecologia, 66: 246–249.

McDonald, M.E., 1985b. Growth of a grazing phytoplanktivorous fish and growth enhancement of grazed alga Oecologia, 67: 132–136.

Meschiatti, A.J. and M.S. Arcifa, 2002. Early life stages of fish and the relationships with zooplankton in a tropical Brazilian reservoir: Lake Monte Allegro. Brazilian Journal of Biology, 62: 41-50.

Moriarty, D.J.W.; J.P.E.C. Darlington; I.G. Dunn; C.M. Moriarty and M.P. Tevlin, 1973. Quantitative estimationof the daily ingestion of phytoplankton by *Tilapia nilotica* and *Haplochromis nigripinnis* in Lake George, Uganda. Proc. R. Soc. London B, 184: 299–319.

Mueller, R.C., 2001. Effect of filter feeders on the phytoplankton community of the Partitioned Aquaculture System. MSc thesis. Clemson University, Clemson, SC, USA.

Ni, D. and S. Chiang, 1954. On food of silver carp and bighead carp. Acta Zool. Sin., 6: 59–71.

Northcott, M.E.; M.C.M. Beveridge and L.G. Ross, 1991. A laboratory investigation of the filtration and ingestion rates of the tilapia, *Oreochromis niloticus*, feeding on two species of blue-green algae. Environ. Biol. Fishes, 31: 75–85.

Payne, A.I., 1978. Gut pH and digestive strategies in estuarine grey mullet _Mugilidae. and tilapia _Cichlidae..J. Fish. Res. Board Can., 13: 627–629.

Pearl, H.W. and C.S. Tucker, 1995. Ecology of blue-green algae in aquaculture ponds. J. World Aquacult. Soc., 26:109–131.

Popma, T.J., 1982. Digestibility of selected feed stuffs and naturally occurring algae by tilapia. PhD dissertation.Auburn University, AL, USA.

Sanderson, L.L.; M.C. Stebar; K.L. Ackermann; S.H. Jones; Batjakas, I.E. and L. Kaufman, 1996. Mucus entrapmentof particles by suspension-feeding tilapia (Pisces: Cichlidae). J. Exp. Biol., 199: 1743– 1756.

Sirenko, L.A.; P.S. Vovk; A.Y. Malyarevskaya and T.I. Birger, 1976. Control of eutrophication of the Dnieper Reservoir by algae removal and hervivorous fishes introduction. Limnologica, 10: 603–606.

Smith, D.W., 1985. Biological control of excessive phytoplankton growth and the enhancement of aquaculturalproduction. Can. J. Fish. Aquat. Sci., 42: 1940–1945.

Smith, D.W., 1988. Phytoplankton and catfish culture: a review. Aquaculture, 74: 167–189.

Smith, D.W., 1989. The feeding selectivity of silver carp, *Hypothalmichthys molitrix* Val. J. Fish Biol., 34: 819–828.

Spataru, P. and M. Gophen, 1985. Feeding behaviour of silver carp *Hypophthalmichthys molitrix* (Val.) and its impact on the food web in Lake Kinneret, Israel. Hydrobiologia, 120: 53–61.

Spataru, P., 1977. Gut contents of silver carp - *Hypophthalmichthys molitrix* (Val) and some trophicrelations to other fish species in a polyculture system. Aquaculture, 11: 137–146.

SPSS, 2004. Statistical package for the Social Sciences. Release: 13. SPSS INC, Chicago, USA.

Starling, F.L.R.M. 1993. Control of eutrophication by silver carp *Hypophthalmichthys molitrix*. in thetropical Paranoa Reservoir Brasilia, Brazil.: a mesocosm experiment. Hydrobiologia, 257: 143–152.

Starling, F.L.R.M. and A.J.A. Rocha, 1990. Experimental study of the impacts of planktivorous fishes on plankton community and eutrophication of a tropical Brazilian reservoir. Hydrobiologia, 200– 201: 581–591.

Steel, R.G.D. and J.A. Torrie, 1980. Principles and procedures of statistics. 2nd ed., USA McGraw Hill, 183 – 193.

Tang, Y., 1981. Evaluation of balance between fishes and available fish foods in multispecies fish culture ponds in Taiwan. Trans. Am. Fish. Soc., 99: 708–717.

Vo¨ro¨s, L.; I. Oldal; M. Presing and V.-K. Balogh, 1997. Size-selection and taxon-specific digestion of plankton algae by silver carp, (Hypophthalmichthys molitrix Val.). Hydrobiologia, 342–343: 223– 228.

Vollenweider, R.A., 1969. A manual on methods for measuring primary production in aquatic environments. IBP Handb. No. 12 Blackwell Scientific Publication Oxford., 213pp.

Xie, P. and N. Takamura, 1996. Impact of filter-feeding silver and bighead carps on the long-term changes in the community structure of Cladocera in Lake Donghu. Acta Hydrobiol. Sin., 20: 47–59.

Xie, P., 1996. Experimental studies on the role of planktivorous fishes in the elimination of *Microcystis* bloom from Donghu Lake using enclosure method. Chin. J. Oceanol. Limnol., 14: 193–204.

إنتقاء البلطى النيلى والمبروك الفضى للطحالب الخضراء والسيانوبكتيريا فى الاستزراع السمكى

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الملخص العربي

تهدف الدراسة لمعرفة الانواع المختلفة من الفيتوبلانكتون التى يتغذى عليها كلا من أسماك البلطى النيلى والمبروك الفضى. اجريت هذه التجربه بالمعمل المركزى لبحوث الثروة السمكية بالعباسة ابوحماد شرقية. تم أستخدام ستة أحواض أسمنتية متساوية مساحة الحوض (١٠م٢). وزعت فيها ثلاث معاملات مثلت كل معاملة فى مكررتين على النحو التالى المعاملة الاولى أستخدمت أسماك البلطى النيلى بمفردها، المعاملة الثانية استخدمت أسماك البلطى النيلى مع أسماك المبروك الفضى، أما المعاملة الثالثة تم وضع أسماك التحاليل الفيزيائية والكيمائية والبيولوجية. لقياس الرقم الهيدروجيني، تركيز الأكسجين الذائب، الأمونيا،اليبتريت النترات، الأورثوفوسفات كما تم قياس شفافية المياه، الكلوروفيل أ. أظهرت النتائج أن البلطى النيلى فى المعاملة الأولى تغذى على٧٢.٣% من السيانوباكتريا أما المبروك الفضى فى المعاملة الثالثة تغذى على٦٩.٩% من الطحالب الخضراء بينما فى المعاملة الثانية أظهرت النتائج أن البلطى النيلى تغذى على ٥٤.٣% من الطحالب الخضراءبنسبة أكبرمن السيانوباكتريا أما المبروك الفضى فتغذى على ٥٥.٢% من السيانوباكتريا.