PHYTOPLANKTON DYNAMICS IN EARTHEN PONDS STOCKED WITH AFRICAN CATFISH (*CLARIAS GARIEPINUS*) FEEDING WITH DIFFERENT DIETS

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Abstract

This work aimed to evaluate the effect of protein-based diets on phytoplankton composition and dynamics stocked with African catfish fingerlings *Clarias gariepinus*. Plankton samples were collected from 12 earthen ponds 400 m^2 which stocked with 40.07 ±1.12 gm fish (4000 fingerlings each). Poultry by-product meal was used to substitute fish meal as a source of the animal protein in a 25% protein pelleted feed for *C. gariepinus*. Experimental diets (25% protein), with fish meal protein replaced by protein from poultry by-product meal at three levels 0% (D_0), 35% (D_{35}) and 70% (D_{70}) were manufactured, fed to *C. gariepinus* fingerlings and the rearing period lasted for ~12 months. All treatments were characterized by both increasing in the chlorophyll "a" content and decrease in secchi disk readings with time. The data showed that the algal composition represented by the four divisions Cyanophyta, Chlorophyta, Bacillariophyta and Dinoflagellates. The diet ponds fed on D_{70} had significantly the highest standing crop of phytoplankton compared to all other treatments ($p < 0.05$). Most of this production consisted of blue green algae approximately 64-90 % of phytoplankton standing crop. Although the diet D_0 produced a high abundance of green algae but the diet with D_{35} insignificant with D_{70} in phytoplankton communities. The great abundance of blue-green algae caused the misuse of the diatoms, green algae and dinoflagellates which also accompanied by reduction in aquaculture yields. Although, the all treatments resulted in the flourish in the production of algal density but they did not lead to any significant increase in zooplankton abundance in all treatment. This is may be due to the fact that most of algal density in all treatments consisted of inedible blue-green algae which are unacceptable to zooplankton. Generally, it can conclude that there was insignificantly between D_0 and the D_{35} in terms of algal community during in all seasons. So, we can replace the poultry by-product meal at level 35 % by fish meal for African catfish feed pellets.

Introduction

Phytoplankton communities are an essential component of most pond aquaculture systems. Primary production by phytoplankton is the base of the food chain in pond cultures that depend upon natural foods to support fish or crustacean production. Plant nutrients may be intentionally added to these ponds in form of manures or chemical fertilizers to enhances phytoplankton growth and, ultimately, increase aquaculture yield. On the other hand, phytoplankton-bases food chains may be relatively unimportant in pond cultures that rely upon manufactured feeds to promote rapid growth of the fish or crustaceans (Smith 1988, 1991). Nevertheless, phytoplankton communities are considered beneficial

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even in those systems because they are part of the pond microbial community that acts to maintain adequate environmental conditions for culture. For example, phytoplankton communities at moderate standing crops are net producers of dissolved oxygen, and they assimilate ammonia as a nitrogen source for growth, thereby reducing the accumulation of un-ionized ammonia, which can be toxic to aquatic animals at relatively low concentrations. Notwithstanding the beneficial aspects of phytoplankton in aquaculture ponds, it is commonly accepted that most water quality problems in aquaculture ponds are the result of unmanaged growth of phytoplankton communities (Smith 1988, 1991). One important result of that unmanaged growth is the tendency for phytoplankton communities in freshwater aquaculture ponds to be dominated by noxious species of cyanobacteria "blue green algae".

Algal die-offs cause serious economic losses to aquaculture (Boyd *et al.,* 1978) in both intensive and extensive aquacultural systems growing both fish and invertebrates. Catfish ponds in Alabama, U.S.A. were observed throughout the spring of three consecutive years by Boyd *et al.,* (1978), on average 30% of ponds had phytoplankton die-offs each spring. Ponds having algal densities greater than 1000 *Anabaena* filaments per ml (approximately 50 μgL^{-1} chlorophyll "a") showed 81% phytoplankton die-offs each spring. Die-offs often produce high levels of ammonia which can discourage fish feeding and growth for periods of 10-15 days (Tucker *et al.,* 1984). Since total fish production depends on the length of the growing season, each severe algal die-off can reduce fish production in a 180-day growing season by 6-8%.

Cyanobacteria are widely distributed and represent at least 22 genera, including over 90 species, that have been identified from freshwater habitats (Gibson and Smith 1982). Relatively few studies of aquaculture pond phytoplankton assemblages have been conducted, but it appears that the cyanobacterial flora is as diverse as that in other habitats. As is true of other freshwater ecosystems, most of the cyanobacterial species encountered in freshwater aquaculture ponds occur as rare or minor components of the plankton community (Hariyadi et al. 1994).

The importance of cyanobacteria in aquaculture ponds, in the most basic terms of occurrence and biomass, has been amply demonstrated in channel catfish *Ictalurus punctatus* culture ponds in Mississippi, USA (Tucker and van der Ploeg, 1993). During the summer growing season, pond water temperatures are relatively warm (25-35 ^{o}C) and nutrient loading rates are high as large amounts of manufactured feed are added to ponds to promote rapid fish growth. Over the 6-months period of warm water temperatures, cyanobacteria are present in nearly all catfish culture ponds and account for over 75% of the total phytoplankton biomass in most ponds.

Aside from the obvious importance of cyanobacteria as contributors to much of the phytoplankton biomass in freshwater aquaculture ponds, the presence of bloom-forming species assumes added significance because they are generally undesirable components of the plankton community. Bloom-forming cyanobacteria are not a readily utilized source of primary production for food chains in most aquaculture systems, they are relatively poor oxygenators of the water, they have undesirable growth habits, certain species may produce odorous metabolites that confer undesirable flavors to the cultured animal, and some species may produce compounds that are toxic to fish (Paerl and Tucker, 1995).

The slow growth rate of bloom-forming cyanobacteria may affect aquaculture production in ponds where the food for fish or crustaceans originates entirely from in-pond primary production. In essence, the low biomass-specific rates of net carbon fixation by cyanobacterial communities relative to most eukaryotic phytoplankton (diatoms, green algae, and dinoflagellates) should translate into reduced aquaculture yields in which cases. The efficiency of food transfer in phytoplankton-based food chains may by further reduced when bloom-forming cyanobacteria are present because they are acknowledged to be poorly utilized as food by herbivorous crustacean zooplankton (Paerl 1988). Cyanobacterial biomass is inefficiently utilized by zooplankton herbivore populations because the colonies or filaments may be too large to be effectively processed or the biomass may be indigestible, toxic, or of poor food quality (Porter and Orcutt 1980). The transfer of carbon from primary production to herbivores in cyanobacteria-based food chains may rely heavily on detritus pathways or grazing by rotifers and protozoans to convert this biomass into food more readily utilized by herbivorous zooplankton (Paerl 1988). The additional steps in cyanobacteria-based food chains may reduce the efficiency of transfer of organic matter and nutrients from primary production to aquaculture crop.

In this study, we estimated the chlorophyll "a" , secchi disk visibility and briefly summarized the occurrence of diatoms, green algae, blue green algae and dinoflagellates in African catfish aquaculture ponds and the consequences of their presence.

Materials and Methods

This work was carried out for one year period (from Sept. 2002 to Aug. 2003). Twelve earthen ponds each of 400 m^2 area with the same average water depth (~ 1.0 m) at the WorldFish Center (Abbassa, Sharkia Governorate, Egypt) were used in this work. Before the experiment, the ponds were drained, cleaned and exposed to the sun for one week. The ponds were filled by fresh Nile water from "Gadaon" channel branched from Ismailia canal; the water was filtered through saran screen to prevent the entrance of wild fish, their eggs and larvae to the experimental ponds. Water level was maintained at 1.0 m and any water loss

due to evaporation or seepage was compensated periodically to maintain the depths of ~1.0 m.

Experimental design:

The ponds were randomly assigned to three groups with four replicates per each treatment. The first treatment served as a control receiving commercially formulated pellets with 25% protein from fish meal (D_0). In the second treatment 35% of fish meal protein was replaced with that of poultry by-product meal as source of animal protein (D_{35}). 70% of fish meal protein was replaced with that of poultry by-product meal as source of animal protein) (D_{70}) for the third treatment. All ponds were stocked with *Clarias gariepinus* fingerlings (40.07±1.12gm) obtained from the WorldFish Center stock ponds. Fish were stocked at a rate of 10 fish/m^2. The catfish were fed the control diets at a rate of 5% of fish biomass for one month before applying the tested diets as acclimatization period.

Water physicochemical analysis:

Water temperature (^oC) and dissolved oxygen (DO, mg/l) were measured using an oxygen electrode, water samples were collected to measure both the hydrogen ions (pH) by using the ACCUMET pH meter (model 25) and total ammonia (mg/l) by using HACH Comparison (1982). Total alkalinity (as $CaCO_3$ mg/l), total hardness (mg/l) and nitrate (NO_3) were determined according to Boyd and Tucker (1992). Secchi disk visibility was measured at 10-11 am for every pond biweekly as recorded by Boyd and Tucker (1992).

Chlorophyll "a" determination:

Randomized water samples were collected from the all corners and middle of the ponds at the designated time on biweekly basis to determine chlorophyll "a" concentrations (from Oct. to August) and identify and count the phytoplankton (from Jan. to August).

Chlorophyll "a" concentrations was determined photometrically by using spectrophotometer. Water sample (100 ml) was filtered through a membrane filter (0.45 µm pore size), then the membrane filter was grounded and the chlorophyll "a" contained in the phytoplankton cells was extracted in a known volume of acetone. The concentration of chlorophyll "a" can be obtained through the following equation (Vollenweider, 1969).

$$\text{Chlorophyll "a" } (\mu g/l) = [11.9\ (A665 - A750) \times V] / [L \times 1000/S]$$

Where:

A665 = the absorbance at 665 nm,

A750 = the absorbance at 750 nm,

V = the acetone extract volume in ml,

L = the length of light path in the spectrophotometer in cm and

S = the volume in ml of sample filtered.

Phytoplankton estimation:

Quantitative estimation of phytoplankton was carried out by the technique adopted by APHA (1985) using the sedimentation method. Phytoplankton samples were preserved in Lugol's solution (prepared by dissolving 100g of potassium iodine (KI) and 50g iodine crystal in 1 liter distilled water solution containing 100 ml glacial acetic acid) at a ratio of 3 to 7 ml Lugol's solution to one liter sample and concentrated by sediment one liter water sample in a volumetric for about 2 to 7 days. The surface water was siphoned and the sediment was adjusted to 100 ml. These samples can be kept in closed glass containers (preferably dark) and stored in the dark (preferably in the fridge). If the samples are stored for a long period for a long period (months), formalin should be added (1 ml of 40% formalin per 10 ml of sample). For shorter periods, addition of some extra lugol's solution every two weeks is advised, so that the color is kept dark brown. From the fixed sample, 1 ml was drown and placed into sedgwick-Rafter cell, then was microscopically examined for counting after identification of phytoplanktonic organisms. The results were then expressed as counts per ml. The phytoplankton cells were identified to four division as green algae (chlorophyceae), blue-green algae (cyanophyceae), diatom (bacillariophyceae), and euglena (euglenophyceae). For identification of the algal taxa, Fritsch (1979) and Komarek and Fott (1983) were consulted.

Zooplankton estimation:

Zooplankton samples for quantitative analysis were taken biweekly. Ten liters of the pond water were filtered through zooplankton net of 55 µm mesh diameter. Samples were preserved immediately after collection in 4% neutral formalin. Total zooplanktons were determined in each replicate following Ludwig (1993).

Statistical analysis:

One-way ANOVA was used to evaluate the significant difference of the concentration of different items studied with respect to treatment and months. A probability at level of 0.05 or less was considered significant. Means and standard errors were also estimated. All statistics were run on the computer, using the SAS program (SAS, 1999).

Results and Discussion

Phytoplankton density in pond water could be considered as an index to the photosynthetic activity. In this research, chlorophyll "a" content was considered as an index to algal density. Phytoplankton density in the D_{70} treatment was the highest during the whole experiment compared to D_0 or D_{35}.

The chlorophyll concentration which is considered as an index for algal density, in the D_0 treatment increased from January (269.55 µg L^{-1}) and reached a concentration of 583.84 µg L^{-1} in June. This was accompanied with an increase in

pH and a decrease in the total alkalinity as shown in Table (1). There was insignificantly between D_{35} and D_{70} in the chlorophyll "a" concentration ($P<0.05$). All treatments were characterized by both increasing in the chlorophyll "a" content and decrease in secchi disk readings with time (Table, 2).

Table (1): Some water quality parameters of earthen ponds (400 m^2) stocked with *C. gariepinus* reared in a mono-culture system at a rate of 10 fingerlings/m^3 and fed with three diets with different source of animal protein for 12 months

Item	Treatment		
	D0 (T1)	D35 (T2)	D70 (T3)
Temperature (°C)	20.35^{A}±0.5	20.36^{A} ± 0.50	20.48^{A} ± 0.50
Dissolved oxygen (mg/Ll)	2.04^{A}±0.13	1.91^{A}± 0.13	2.13^{A} ± 0.14
pH	7.61^{A} ±0.02	7.57^{A} ± 0.02	7.60^{A} ± 0.02
Ammonia (mg/L)	0.02^{A} ± 0.001	0.02^{A} ± 0.001	0.02^{A} ± 0.001
Ammonium (mg/L)	0.92^{B} ± 0.03	1.05^{A} ± 0.04	0.89^{B} ± 0.03
NO_3-N (mg/L)	0.52^{A} 0.03	0.46^{A} ± 0.03	0.48^{A} ± 0.02
NO_3 (mg/L)	2.31^{A} ± 0.12	2.19^{A} ± 0.11	2.14^{A} ± 0.11
NO_2 (mg/L)	0.03^{A} ± 0.004	0.03^{A} ± 0.003	0.03^{A} ± 0.004
T. alkalinity (mg/L)	389.5^{A} ± 5.12	373.13^{A} ± 6.06	379.71^{A} ± 6.18
T. hardness (mg/L)	243.51^{A} ± 7.07	229.08^{A} ± 5.41	228.90^{AB} ± 0.25
Salinity (ppt)	0.8^{A} ± 0.15	0.62^{A} ± 0.10	0.61^{A} ± 0.11
E C (µmhos/cm)	981.19^{A} ± 23.24	862^{B} ± 22.25	863.31^{B} ± 23.89
Total zooplankton (org./L)	2662^{A} ± 242	2702^{A} ± 242	2763^{A} ± 242
Initial body weightg (g/fish)	47.84^{A} ± 11.13	38.13^{A} ± 1.47	42.32^{A} ± 1.36
Final body weight (g/fish)	224.02^{A} ± 10.09	237.61^{A} ± 7.41	236.35^{A} ± 2.95
Total harvest (kg/pond)	580.7^{B} ± 18.87	697.93^{A} ± 28.33	666.95^{AB} ± 33.16

Note: D0 (T1) = diet with zero% replacement of poultry by-product by fish meal,
D35 (T2) = diet with 35% replacement of poultry by-product by fish meal and
D70 (T3) = diet with 70% replacement of poultry by-product by fish meal.
A, B, C, D. Values-having different script at the same row are significantly ($P<0.05$) different.

Table (2): Mean concentration of chlorophyll "a" (µgL-1) and secchi disk (cm) of earthen ponds (400 m^2) stocked with *C. gariepinus* reared in a mono-culture system at a rate of 10 fingerlings/m^3 and fed with three diets with different source of animal protein during the experimental period.

Month	Treatment					
	D_0		D_{35}		D_{70}	
	Chl. "a"	S.D.	Chl. "a"	S.D.	Chl. "a"	S.D.
January	269.55 Ab± 26.93	11.00 Aa ± 0.58	219.60 Ac ± 23.26	10.00 Aa ± 1.08	268.33 Ac±21.47	10.75 Aa ± 0.48
February	315.90 Ab± 30.46	11.00 Aa ± 0.78	280.89 Abc ± 36.56	8.31 Bab± 0.65	373.05 Abc± 26.81	8.00 Bb ±0.53
March	249.42 Bb ± 20.45	8.88 Ab ± 0.83	233.49 Bc ± 23.83	7.75 Abc± 0.53	485.78 Aab ±86.72	7.88 Ab ± 0.88
April	268.42 Bb ± 19.99	5.50 Acd ± 0.50	271.93 Bbc ± 25.76	6.00 Acde± 1.08	377.07 Abc± 47.61	5.88 Acd ± 0.83
May	566.18 Aa ± 36.17	4.75 Ad ± 0.41	390.75 Bb ± 21.81	4.88 Ae ± 0.30	418.24 Babc± 35.53	5.50 Ac ± 0.16
June	583.84 Aa ± 111.47	5.25 Acd ± 0.25	529.93 Aa ± 65.30	5.50 Ade 0.50	535.63 Aa ± 33.04	5.50 Ac ± 0.29
July	348.80 Ab ± 14.34	6.38 Acd ± 0.26	338.40 Abc ± 30.77	6.13 Acde± 0.52	372.88 Abc ± 22.55	6.75 Abc ± 0.53
August	264.18 Bb ± 22.40	7.00 Abc ± 1.00	295.55 ABbc± 33.82	7.50 Abcd± 0.87	355.33 Abc ± 9.87	7.75 Ab ± 0.85

Note: D_0 = diet with zero% replacement of poultry by-product by fish meal, D_{35} = diet with 35% replacement of poultry by-product by fish meal and D_{70} = diet with 70% replacement of poultry by-product by fish meal.
A, B, C, D. Values-having different script at the same row are significantly (P<0.05) different.

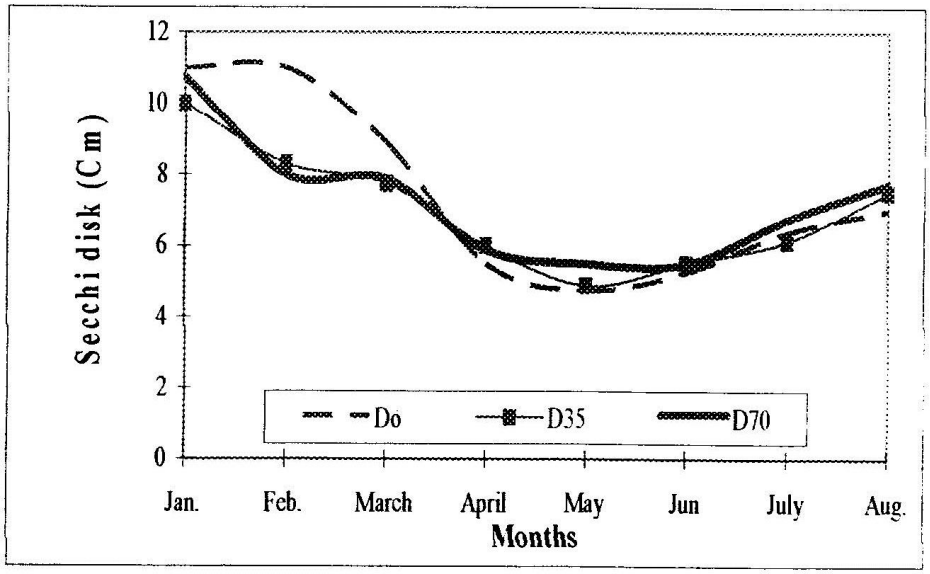

Figure (1): Fluctuations of Secchi disk visibility (Cm) of earthen ponds stocked with *C. gariepinus* fed with different diets during culture period.

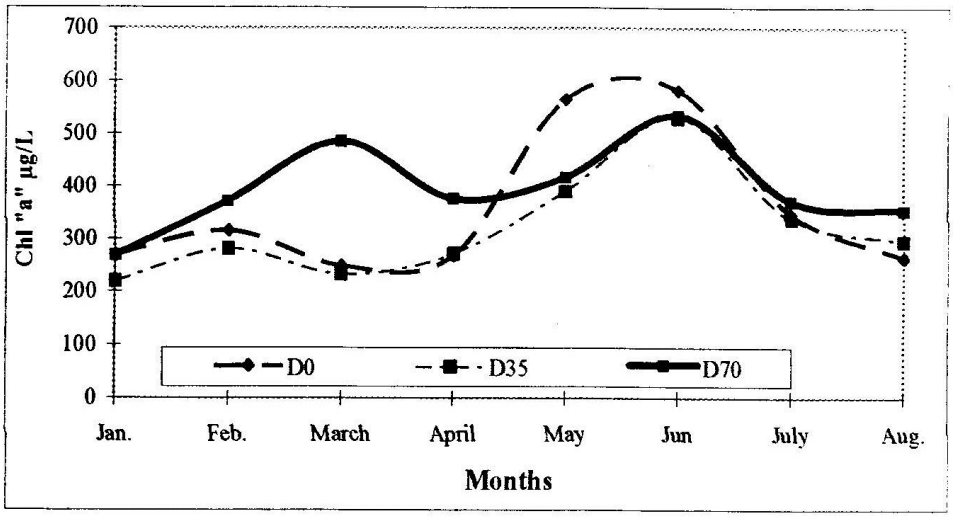

Figure (2): Fluctuations of chlorophyll "a" concentrations (µg/L) of earthen ponds stocked with *C. gariepinus* fed with different diets during culture period.

The D_{70} had the highest abundance of phytoplankton compared to all treatments with significant different ($P< 0.05$). The mean number of organisms was arranged between (10.02 to 19.36 x 10^4 org. ml^{-1}). Most of this production was unused to fish and consisted of the unacceptable inedible blue green algae (7.96– 17.08 x 10^4 org. ml^{-1}), approximately 64.55 to 88.08 % of total number of phytoplankton. Although the diet with zero replacement of poultry by-product by fish meal (D_0) produced a high abundance of green algae (1.03 –4.06 x 10^4 org. ml^{-1}). The diet with 35% replacement of poultry by-product by fish meal (D_{35}) caused less flourish of phytoplankton 8.68-17.49 x 10^4 org. ml^{-1} (9-30 % green algae, 61-89 % blue green algae, 0.1-1.93 % diatoms and 1.2-7.69 % dinoflagellates (Table 3). The great abundance of blue-green algae caused the misuse of the diatoms, green algae and dinoflagellates which should translate into reduced aquaculture yields (Paerl 1988).

It is known that blue-green algae release toxins (Westhuizen *et al.,* 1986) which cause fish death when present in high concentration. Blue-green algae blooms have long been known to be involved in animal deaths and even human illness in many countries (Schwimmer & Schwimmer, 1968). Blue green algae synthesize compounds with an earthy-musty flavor and odor, which are excreted into the water and absorbed by fish, giving them an off-flavor (Lovell and Sackey, 1973). The occurrence of toxic algal blooms is to a large extent unpredictable and even the potency of blooms can vary within relatively short periods. This renders them potentially dangerous and suspect at all times. It is known that amongst other factors environmental conditions and heterogeneity of toxic species and strains play an important role in the variability of toxic blooms (Scott *et al.*, 1981).

D_0 treatment caused a decrease in blue-green abundance (86.53 % in March to (43.3%) in July of total abundance of phytoplankton, this helped fish to consume the green algae, diatoms, and dinoflagellates.

Densities of phytoplankton fluctuated during the growing season. Possible causes of these fluctuations include changes in pH, temperature, light intensity, and nutrient concentrations (Boyd, 1990).

The blue green algae (Cyanobacteria) in months (Jan., Feb., Mar., and Apr.) represented the high abundance in all treatments due to the low temperature (water temperature 15-25ºC). Species of *Microcystis* and *Anabaena*, two bloom-forming cyanobacterial genera common to freshwater aquaculture ponds, are dominant in all treatments. The blue green algae have high nutrient uptake capabilities as they can accumulate inorganic phosphorus and nitrogen and store them as polyphosphate and cyanophycin, respectively when the water temperature was approximately 20 to 25ºC (Persson, 1988).

Table (3): Phytoplankton dynamics and overall mean (x 103 L-1) of earthen ponds (400 m^2) stocked with *C. gariepinus* reared in a mono-culture system at a rate of 10 fingerlings/m^3 and fed with three diets with different source of animal protein during the experimental period.

Month	Green algae		Blue green algae		Diatoms		Dinoflagellates		Total standing crops
	Count	%	Count	%	Count	%	Count	%	
D_0									
January	$6860^{Be} \pm 123$	$15.33^{Ae} \pm 0.33$	$37487^{Ccd} \pm 1519$	$83.53^{Ca} \pm 0.40$	$61^{Ce} \pm 2$	$0.10^{Ade} \pm 0.0$	$462^{Bf} \pm 25$	$1.03^{Bg} \pm 0.09$	$44870^{Cd} \pm 1625$
February	$9863^{Bd} \pm 141$	$14.70^{Ae} \pm 0.83$	$57733^{Cb} \pm 3536$	$84.18^{Ba} \pm 0.85$	$61^{Be} \pm 2$	$0.10^{Ade} \pm 0.0$	$692^{Cf} \pm 38$	$1.00^{Cg} \pm 0.03$	$68349^{Cc} \pm 3519$
March	$10302^{Bd} \pm 154$	$10.66^{Af} \pm 0.18$	$83529^{Ca} \pm 1561$	$86.53^{Ca} \pm 0.19$	$57^{Ce} \pm 3$	$0.09^{Ae} \pm 0.01$	$2628^{Be} \pm 38$	$2.71^{Af} \pm 0.04$	$96516^{Ca} 1636$
April	$12157^{Bd} \pm 669$	$11.99^{Aef} \pm 0.55$	$85719^{Ca} \pm 2166$	$83.94^{Ba} \pm 0.74$	$82^{Ae} \pm 6$	$0.10^{Ade} \pm 0.0$	$4029^{Bd} \pm 164$	$3.96^{Ae} \pm 0.20$	$101987^{Ca} \pm 1725$
May	$17868^{Ac} \pm 1181$	$22.66^{Ad} \pm 1.73$	$55766^{Cb} \pm 2104$	$70.06^{Bb} \pm 1.57$	$131^{Ad} \pm 8$	$0.16^{Ad} \pm 0.02$	$5673^{Cb} \pm 223$	$7.14^{Ab} \pm 0.21$	$79437^{Cb} \pm 1459$
June	$23296^{Ab} \pm 992$	$33.43^{Ac} \pm 1.04$	$39843^{Cc} \pm 474$	$57.36^{Bc} \pm 0.98$	$291^{Bc} \pm 18$	$0.43^{Ac} \pm 0.03$	$6113^{Ca} \pm 94$	$8.81^{Aa} \pm 0.19$	$69543^{Cc} \pm 918$
July	$38111^{Aa} \pm 1400$	$49.94^{Ab} \pm 1.69$	$33027^{Cde} \pm 1079$	$4303^{Bd} \pm 1.51$	$543^{Cb} \pm 20$	$0.71^{Bb} \pm 0.03$	$4593^{Cc} \pm 153$	$6.01^{Bc} \pm 0.23$	$76274^{Cb} \pm 487$
August	$40635^{Aa} \pm 357$	$53.60^{Aa} \pm 0.42$	$30487^{Ce} \pm 307$	$40.23^{Cd} \pm 0.39$	$800^{Ba} \pm 16$	$1.05^{Ca} \pm 0.03$	$3878^{Cd} \pm 132$	$5.13^{Bd} \pm 0.15$	$75799^{Cb} \pm 402$
D_{35}									
January	$11017^{Af} \pm 486$	$12.70^{Bd} \pm 0.21$	$74033^{Be} \pm 2155$	$85.33^{Bb} \pm 0.19$	$114^{Ade} \pm 2$	$0.10^{Ad} \pm 0.0$	$1615^{Ae} \pm 16$	$1.85^{Af} \pm 0.03$	$86779^{Be} \pm 2628$
February	$10424^{ABf} \pm 390$	$9.06^{Bf} \pm 0.26$	$103615^{Bc} \pm 4552$	$89.69^{Aa} \pm 0.31$	$57^{Be} \pm 2$	$0.04^{Bd} \pm 0.02$	$1372^{Be} \pm 36$	$1.20^{Bg} \pm 0.07$	$115467^{Bd} \pm 4521$
March	$14023^{Ae} \pm 116$	$9.31^{Bef} \pm 0.10$	$133833^{Bb} \pm 1154$	$88.93^{Ba} \pm 0.09$	$77^{Bde} \pm 3$	$0.06^{Ad} \pm 0.02$	$2563^{Bd} \pm 105$	$1.69^{Bfg} \pm 0.06$	$150496^{Bb} \pm 1245$
April	$15284^{Aed} \pm 219$	$8.76^{Bf} \pm 0.16$	$155000^{Ba} \pm 3777$	$88.59^{Aa} \pm 0.52$	$89^{Ade} \pm 6$	$0.05^{Bd} \pm 0.02$	$4519^{Bc} \pm 313$	$2.60^{Cd} \pm 0.21$	$174891^{Ba} \pm 3607$
May	$16103^{Ad} \pm 280$	$10.74^{Be} \pm 0.31$	$127449^{Bb} \pm 2532$	$84.71^{Ab} \pm 0.52$	$137^{Ad} \pm 6$	$0.10^{Bd} \pm 0.0$	$6651^{Bb} \pm 244$	$4.46^{Cd} \pm 0.21$	$150340^{Bb} \pm 2163$
June.	$21620^{ABc} \pm 457$	$17.39^{Bc} \pm 0.47$	$93845^{Bd} \pm 2067$	$75.34^{Ac} \pm 0.68$	$368^{Ac} \pm 25$	$0.30^{Bc} \pm 0.03$	$8686^{Ba} \pm 153$	$6.99^{Bb} \pm 0.18$	$124518^{Bc} \pm 1879$
July	$28383^{Bb} \pm 1039$	$25.03^{Bb} \pm 1.11$	$75017^{Be} \pm 2085$	$65.84^{Ad} \pm 1.12$	$1649^{Bb} \pm 30$	$1.48^{Ab} \pm 0.05$	$8753^{Ba} \pm 192$	$7.69^{Aa} \pm 0.15$	$113802^{Bd} \pm 1455$
August	$32505^{Ba} \pm 940$	$30.03^{Ba} \pm 0.46$	$66615^{Be} \pm 604$	$61.58^{Be} \pm 0.30$	$2068^{Aa} \pm 54$	$1.93^{Aa} \pm 0.08$	$7005^{Bb} \pm 43$	$6.48^{Ac} \pm 0.09$	$108193^{Bd} \pm 1492$
D_{70}									
January	$10195^{Ag} \pm 451$	$10.18^{Cd} \pm 0.39$	$88223^{Ae} \pm 993$	$88.08^{Ab} \pm 0.39$	$99^{Bde} \pm 1$	$0.10^{Ad} \pm 0.0$	$1691^{Af} \pm 31$	$1.70^{Af} \pm 0.04$	$100207^{Af} \pm 1216$
February.	$10838^{Ag} \pm 205$	$8.0^{Be} \pm 0.15$	$122540^{Ac} \pm 3130$	$90.30^{Aa} \pm 0.17$	$69^{Ae} \pm 2$	$0.05^{Bd} \pm 0.02$	$2224^{Af} \pm 91$	$1.64^{Af} \pm 0.06$	$135671^{Ad} \pm 3313$
March	$14038^{Af} \pm 131$	$7.86^{Ce} \pm 0.12$	$160386^{Aa} \pm 2617$	$89.59^{Aab} \pm 0.06$	$107^{Ade} \pm 3$	$0.10^{Ad} \pm 0.0$	$4515^{Ae} \pm 212$	$2.53^{Ae} \pm 0.09$	$179045^{Ab} \pm 2856$
April	$15954^{Ae} \pm 226$	$8.29^{Be} \pm 0.23$	$170760^{Aa} \pm 6675$	$88.08^{Ab} \pm 0.47$	$92^{Ade} \pm 9$	$0.05^{Bd} \pm 0.02$	$6813^{Ad} \pm 299$	$3.59^{Ad} \pm 0.26$	$193618^{Aa} \pm 6539$
May	$17479^{Ad} \pm 206$	$10.80^{Bd} \pm 0.25$	$136053^{Ab} \pm 2270$	$83.88^{Ac} \pm 0.39$	$149^{Ad} \pm 6$	$0.10^{Bd} \pm 0.0$	$8490^{Ac} \pm 157$	$5.25^{Bc} \pm 0.16$	$162170^{Ac} \pm 1956$
June	$20653^{Bc} \pm 294$	$15.21^{C} \pm 0.37$	$104773^{Ad} \pm 1939$	$76.95^{Ad} \pm 0.51$	$418^{Ac} \pm 9$	$0.31^{Bc} \pm 0.01$	$10198^{Aa} \pm 154$	$7.53^{Ba} \pm 0.18$	$136042^{Ad} \pm 1623$
July	$27714^{Bb} \pm 917$	$22.13^{Bb} \pm 0.83$	$86343^{Ae} \pm 1533$	$68.79^{Ae} \pm 0.81$	$1740^{Ab} \pm 32$	$1.38^{Ab} \pm 0.3$	$9629^{Ab} \pm 144$	$7.68^{Aa} \pm 0.09$	$125426^{Ade} \pm 935$
August	$33505^{Ba} \pm 671$	$27.15^{Ca} \pm 0.49$	$79634^{Ae} \pm 1358$	$64.55^{Af} \pm 0.52$	$2171^{Aa} \pm 78.7$	$1.75^{Ba} \pm 0.05$	$8057^{Ac} \pm 68$	$6.55^{Ab} \pm 0.1$	$123367^{Ae} \pm 1555$

Note: D_0 = diet with zero% replacement of poultry by-product by fish meal , D35 = diet with 35% replacement of poultry by-product by fish meal and D70 = diet with 70% replacement of poultry by-product by fish meal. Values-having different capital script (A, B, C, .,.,.) means that there are significant ($P<0.05$) different among treatments.Values-having different small script (a, b, c,., .,…)means that there are significant ($P<0.05$) different among months.

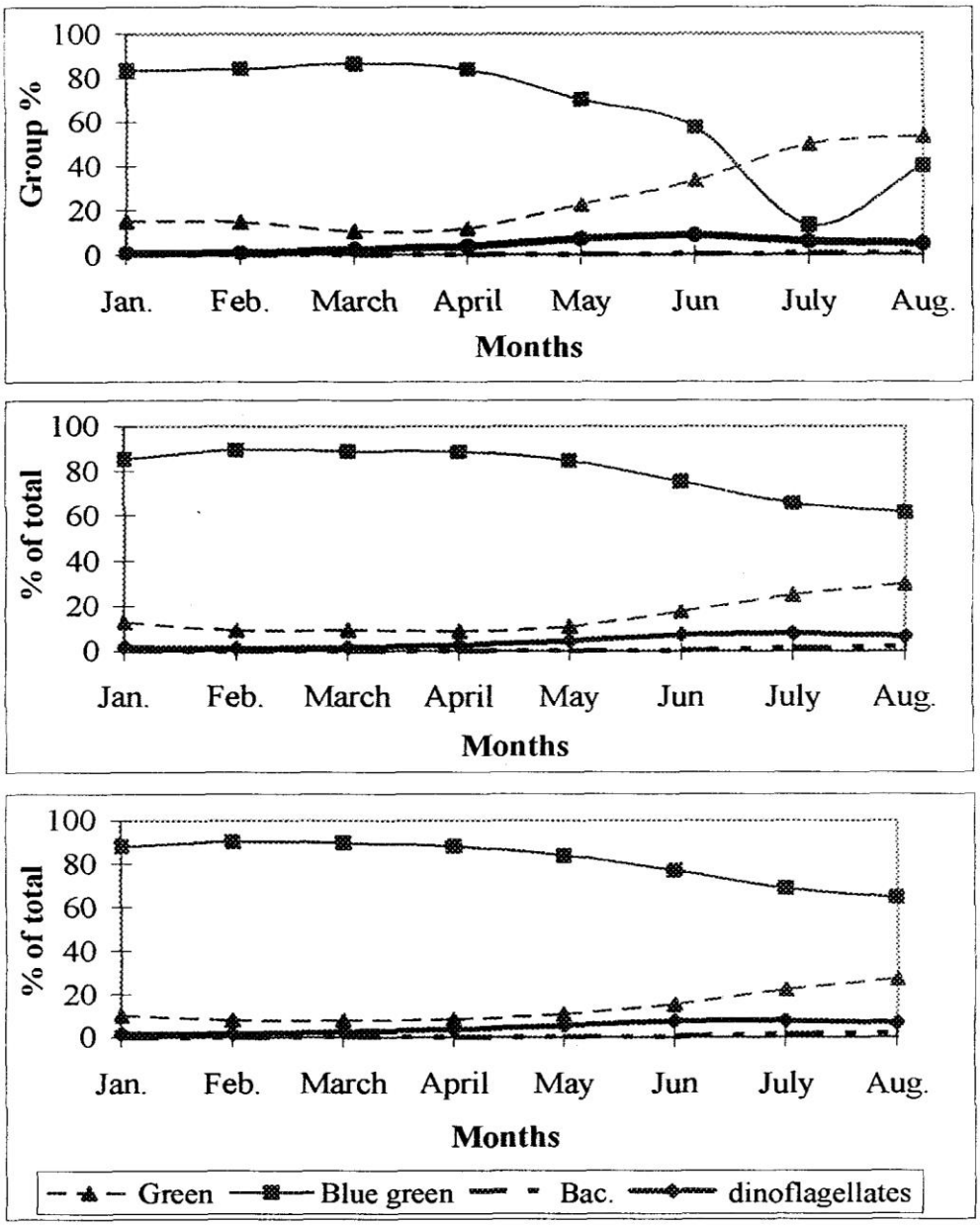

Figure (3): Fluctuations of green algae, blue green algae, diatoms and dinoflagellates % of total for earthen ponds stocked with *C. gariepinus* fed with different diets (A, D_0; B, D_{35}; and C, D_{70}) during culture period.

Nevertheless, blue green algae declined in summer season (May, Jun., Jul., and Aug.) because of the temperature was high which the green algae enhanced growth. The increase in chlorophyll "a" content with time in fish pond (Table, 2 and Fig, 2) was due to the accumulation of incomplete cropping of the algae by fish where the blue-green algae which ranged between 60 to 90% in all treatments. The decomposition of this heavy load of algae and the release of ammonia as a by-product (Tucker *et al.*, 1984).

Zooplankton consume phytoplankton, but they consume primarily small phytoplankton less than 25 µm in diameter (Gliwicz, 1969, 1977; McCauley and Downing, 1985) and are apparently unable to control algal biomass in fish ponds (Vyhnalek, 1983).

The effect of feeding source on the relative abundance of zooplankton was insignificant ($P< 0.05$) and was not related to the absolute abundance of algal organisms but to the quality of algal production. Although, all treatments resulted in the flourish in the production of algal density but, they did not lead to any significant increase in zooplankton abundance in all treatment. This is may be due to the fact that most of algal density in all treatments consisted of inedible blue-green algae which are unacceptable to zooplankton of fish (Table,1).

Generally, it can conclude that there was significant between D_0 and the D_{35} and D_{70} but the D_0 the best in terms of algal quality during all months. So, it is better using artificial feed than other poultry by product feed in terms of quality of phytoplankton community and conducts the blue green algae problems. But, Table (1) showed that the D_{35} gave the highest production (697.93 kg/pond) of African catfish with a significant difference ($P< 0.05$) when compared with the other treatments, So, it can replace the poultry by-product meal at level 35 % by fish meal of African catfish feed pellets.

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ديناميكية الهائمات النباتية في علائق مختلفة للقرموط الإفريقي المرباة في الأحواض الترابية

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تم جمع عينات مياه كل أسبوعين لتقدير الكلوروفيل (أ) وعد وتصنيف الهائمات النباتية من 12 حوض ترابي (400 م^2) حملت بإصبعيات سمكة القرموط الأفريقي (40.07 جم ±1.12) بمعدل 10 إصبعيات للمتر المربع الواحد. ويهدف هذا العمل إلى تقييم تأثير الإحلال الجزئي لبروتين مسحوق الأسماك بنظيره في مسحوق مخلفات الدواجن في علائق القرموط الأفريقي على تركيز الكلوروفيل (أ) وديناميكية الهائمات النباتية, حيث أستخدم مسحوق مخلفات الدواجن كمصدر للبروتين الحيواني ليحل محل مسحوق السمك في علائق هذه الأسماك. ولقد تم تصنيع ثلاث علائق (حبيبات علف طافي يحتوى على 25% بروتين). المعاملة الأولى صفر% إحلال من بروتين العليقه (مصدر البروتين الحيواني هو مسحوق السمك)، أما المعاملة الثانية فكانت 35% إحلال من بروتين العليقه وكانت المعاملة الثالثة 70% إحلال من بروتين العليقه بواقع 4 أحواض لكل مستوى إحلال (معاملة). وتم تغذية الأسماك لمدة عام تقريباً على هذه العلائق.

وأظهرت النتائج تميز كل المعاملات بالتناسب العكسي بين كلاً من قرص الشفافية وتركيز الكلوروفيل مع مرور الوقت حيث أظهرت النتائج زيادة تركيز الكلوروفيل بزيادة درجة الحرارة (تدريجياً من الشتاء إلى الصيف).

كانت عشائر الطحالب الكلية تنتمي إلى أربع أقسام و هي الخضراء المزرقة و الخضراء و الدياتومات و الدينوفلاجيلات. و تميزت جميع المعاملات بازدهار للهائمات النباتية. و كان معظم الإنتاج غير مستخدم أو مفيد للسمك و كون كميات من الطحالب الخضراء المزرقة غير مأكولة أو مستساغة حوالي 64-90% من المحصول الكلى للهائمات النباتية. وأنتجت عليقه نسبة إحلال صفر كميات كبيرة من الطحالب الخضراء. ولكن الإحلال 35% غير معنوية مع عليقه إحلال 70% في عشائر الهائمات النباتية.

تسبب الازدهار الضخم للطحالب الخضراء المزرقة فقد للطحالب الخضراء والدياتومات والدينوفلاجلات والتي تؤدى إلي اختزال الإنتاج السمكي. على الرغم من أن جميع المعاملات أنتجت ازدهارا في كثافة الطحالب ولكنها لم تؤدى إلى زيادة معنوية في كثافة الهائمات الحيوانية حيث أن معظم الكثافة الطحلبية في جميع المعاملات تتكون من الطحالب الخضراء المزرقة الغير مقبولة للهائمات الحيوانية ومن ثم السمك.

وعامة، حيث أنه لا يوجد فرق معنوي بين المعاملة الأولى (صفر% إحلال) والمعاملة الثانية (35% إحلال) في جودة الطحالب (النوع والتركيب) خلال موسم الاستزراع. لذلك نستطيع الإحلال الجزئي لبروتين مسحوق الأسماك ببروتين مسحوق مخلفات الدواجن عند مستوى 35% في علائق القرموط الأفريقي المرباة في الأحواض الترابية.