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Insight into the Species Composition, Diversity, Abundance and Ecology of Plankton Community I n the Plastic Tank for Aquaculture Subtitle as needed (Plankton Community in the Plastic Tank for Aquaculture)

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Abstract: *Plankton is microscopic organisms that positively contribute to oxygen production and serve as food for other aquatic organisms in the environment. Low plankton community indicates that an ecosystem's food web is threatened, affecting aquaculture yield. Plankton community composition, abundance and distribution were investigated in plastic tank aquaculture from October 2018 to September 2019 at Roone Fish Farm, Port Harcourt, Nigeria. Plankton and water sample were analyzed following the standard method APHA. Eighty-one (81) species of six (6) taxa were identified in 2018 and 2019, respectively. Chlorophyceae exhibited a significant difference (p<0.05). Phytoplankton abundance followed the order: Chlorophyceae> Bacillariophyceae > cyanophyceae > Cyanophyceae > chrysophyceae > Chrysophyceae, while zooplankton followed the order: Copepoda, while zooplankton followed the order: Copepoda > Rotifera. The most dominant phytoplankton species observed was Scenedesmus sp, and zooplankton was Calanus helgolandicus. Besides total organic carbon (TOC), phosphate and nitrate, other physico-chemical parameters such as temperature, pH, turbidity, conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO), biological oxygen demand (BOD) and depth were within the permissible limit. However, the increased phosphate level placed the plastic tank under stress as regards the permissible limit of NHDES. Phytoplankton recorded more species composition than zooplankton. Therefore, the plastic tank management is monitored and standardized to increase the targeted plankton species.*

Keywords— Phytoplankton, zooplankton, artificial environment, Physicochemical parameters, Port Harcourt.

1. INTRODUCTION

The plankton community is made of phytoplankton (primary producers) and zooplankton (secondary consumers) [1]. Plankton in any aquatic ecosystem requires a good understanding of the population dynamics of the ecosystem's micro aquatic flora and fauna communities. Photosynthetic microflora drifts on the surface and column of water depending on sunlight [2]. Planktonic organisms can be divided into two groups, photoautotrophs and heterotrophs. This classification depends on their food sources. The spread of phytoplankton composition is greatly influenced by the water bodies' chemical and physical characteristics [3].

Phytoplankton exists naturally in water bodies that receive atmospheric air on the surface, dug wells, and reservoirs, among others. It is usually introduced from cultures to serve as a food supplement in aquaculture, stimulating the growth of existing algae through fertilization [4]. Plankton is vital to fisheries due to the followings; it explains fisheries yield in the global aquatic ecosystems based on the measures of the net primary production in the first trophic level. The difference between yields in the ecosystem is better understood on the efficiency of energy transferred through the food web [5].

Plankton's role in remineralization, recycling of materials and energy within the food chain in the aquatic environment is essential. Davies *et al.* [6] reported that because plankton are the primary and secondary producers, the productivity of each water body is dictated by the amount of plankton present. European Commission [7] suggested that chlorophyll pigment secreted by microflora is a predictor to control light energy during photosynthesis in an aquatic ecosystem. Taxonomic studies of phytoplankton are also very effective in re-evaluating the uses and stability of ponds. The algal flora of water sources is commonly used to preserve, improve and control water quality [8].

Tanks were used to store water for various purposes, including drinking water, irrigated agriculture, agricultural farming (both for plants and livestock), chemical manufacture, food preparation, and various other applications [9]. The plastics tanks are unique synthetic materials with a round or rectangular shape having an inlet and outlet used in culturing aquatic organisms in laboratories, homes and farms under man's control. According to [10], the local method employed in growing aquatic organisms in an outdoors/indoor system trigger high densities of species in a confined and a "controlled" environment. Plastic material density is a function of the carrying water volume of the media for the benefit of man's use. Thus, aquatic organisms are reared in different culture units of different sizes and shapes that can retain water for an extended period, including earthen ponds, concrete, plastic, wooden, metal, glass and fibre glass tanks [11].

Physico-chemical parameters determine or assess whether the water condition is suitable for the support of aquatic migration or die. Therefore, it is essential to understand water quality trends and guide pollution management efforts [12]. All life forms have tolerated limitations of physicochemical parameters within their work ethic, according to the study by [11]. These factors also affect the distribution and reproduction of different aquatic organisms [13]. Thus, a sharp drop or increase within these limits will affect the body functions of an organism [14]. According to [15], Physico-chemical parameters such as pH, alkalinity, water hardness and macronutrients determine which species or group thrives in a pond ecosystem.

The formation of plankton and the link between quality variables are significant and necessary for fish farming [16]. Excessive plankton result in some species capable of producing toxins in many reservoirs/storage facilities before transferring the water to the receiving culture plastic tank is probably the most critical factor related to water quality deterioration, danger to fish and human health. Thus, the knowledge of plankton concerning its environmental conditions is a prerequisite for fish production. However, there are few or no published works in Nigeria and other countries on the plankton community in the plastic tank for aquaculture. Unlike the natural aquatic environment, there is no documented information on the plankton assemblage of the plastic tank aquaculture. Based on the intense establishment of the local aquaculture industry in Nigeria using artificial aquatic environments, there is, therefore, a need to bridge the gap in information on the plankton community of plastic tank aquaculture in Nigeria. The study aimed to evaluate the plankton community and some physico-chemical parameters of plastic tank aquaculture. The species composition, diversity and abundance, as well as the monthly variations of the plankton and some relevant water quality, were determined.

2. MATERIALS AND METHODS

2.1 Study area

The study was carried out in Roone Fish Farm, Abuloma, Port Harcourt City Local Government Area of Rivers State, Nigeria. The region appears to experience heavy rainfall and a short dry season yearly. As a result, temperatures throughout the year are relatively constant, slightly varying from 25 °C – 30 °C. The farm is located between latitudes 4.7820 N and longitudes 7.0550 E. The research was conducted for twelve months (October 2018 to September 2019) using white plastic of 3m x 3m x 1.5 (one).

2.2 Water Quality Analysis and Plankton samples collection

Temperature (°C) was measured with a Celsius thermometer. In addition, pH, total dissolved solids, electronic conductivity and dissolved oxygen were measured in-situ using an Extech digital multiple water meter (model DO 700). In contrast, Winkler's method determined biological oxygen demand (BOD) and total organic carbon was measured by the standard method described by [17].

2.2.1 Plankton samples collection: A specified water volume of 20 litres was filtered via a plankton net with a mesh size of 55 µm, adhering to a standardized methodology for aquaculture plastic tanks.

3.0 Statistical Analysis

The statistical analyses were performed using the software Minitab (Version 16). Data were subjected to a one-way analysis of variance (ANOVA) to test for the significant difference at the 0.05 level.

4 RESULTS

4.1 Physico-chemical Parameters

The mean values and standard deviation of the Physico-chemical parameter of the plastic tank are presented in Table 1. The water was found the light green during the study period. The temperature recorded in the plastic tank was 27.22±1.50 °C. At the same time, the pH (6.79±0.83) of the water was found to be almost neutral during the study period), and water depth and turbidity recorded in the plastic tank were 1.84±0.40 m and 16.39±9.53 NTU. Electronic conductivity and total dissolved solids (TDS) recorded 234±56.55 µs/cm and 135±58.10 µs/cm. In the present study, DO, BOD and TOC values were recorded as 4.95±3.03 mg/L, 2.30±0.97 mg/L and 0.17±0.18 mg/L, respectively (Table 1).

4.2 Plankton

The plankton species identified in the plastic fish tank are shown in Table 2. The plankton species composition included seventy-one (71) genera and eighty-nine (89) species. Chlorophyceae had the highest number of genera (27) and species (44), followed by Bacillariophyceae (6) and (11), Chrysophyceae (10) and (12), Cyanophyceae (10) and (11), Copepoda (8) and Rotifera (1). Regarding species dominance of phytoplankton, *Scenedesmus sp, Crucigenia sp, Nitzschia sp, Nostoc spp* and zooplankton, *Calanus helgolandicus* and *Boeckella calanoida* were dominant in numbers. The depicted plankton in the plastic tank is presented in Fig 1. The results showed that Bacillariophyceae, Chrysophyceae, Chlorophyceae and Cyanophyceae started increasing from December to April, all dry season months and lower from May to September, all wet season months (Fig. 1A-D), except for Copepoda and Rotifer which had high occurrence at January (dry season months) and completely dropped from March to August (wet season months) (Fig. 1E-F).

However, between January and February (dry season months), a higher occurrence of plankton was observed from Bacillariophyceae, Chlorophyceae, Chrysophyceae, Copepoda and Rotifera, respectively (Fig. 1). The percentage composition

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of plankton in the plastic tank was recorded as follows; Bacillariophyceae had 11.64 %, Chlorophyceae 77.79 %, Chrysophyceae 1.38 %, Cyanophyceae 7.32%, Copepoda 1.65% and Rotifera 0.20% respectively (Fig. 2). The total number of plankton varied between families (Table 3), where Chlorophyceae had the highest mean value (98.33±73.09) with a significant difference ($p<0.05$) and the lowest mean value (0.25±0.62) from the family Rotifera Rotifera with no significant difference ($p>0.05$) (Table 3).

Table 1: Physico-chemical parameters (Mean ±SD) of the plastic tank during the study period

Parameters	Plastic tank	Standard
Temp (°C)	27.22±1.50	< 35 [18]
pH	6.79±0.83	6.5-8.5 [19]
Conductivity (µs/cm)	234±56.55	340-700 [20]
TDS (µs/cm)	135±58.10	≤500 [20]
Turbidity (NTU)	16.39±9.53	25-80 NTU [20]
DO (mg/L)	4.95±3.03	>5.0 [19]
BOD (mg/L)	2.30±0.97	≤4 [19]
Depth (m)	1.84±0.40	1.5 - 2 [21]
TOC mg/L	0.17±0.18	<7.0 mg/L [22]
Phosphate (mg/L)	0.19±0.24	>0 .5 [19]
Nitrate (mg/L)	0.50±0.71	<50 [19]

KEYS: Temp-Temperature; pH-Hydrogen ion concentration; TDS-Total dissolved solids; DO-Dissolved oxygen; BOD-Biological oxygen demand; TOC- Total organic carbon

Table 2: Plankton community distribution of the plastic tank aquaculture

PHYTOPLANKTON SPECIES	Months 2018-2019											
	O	N	D	J	F	M	A	M	J	J	A	S
BACILLARIOPHYCEAE												
Aphanocapsa elachista	++	++	++	+	-	+	-	-	-	-	-	+
Cyclotella comta	-	-	-	++	-	++	-	+	-	-	-	-
Cyclotella glomerate	-	-	+	-	-	-	-	+	-	+	-	-
Cycotella meneghiniana	-	-	-	+	-	+	+	+	+	-	-	-
Nitzschia sigma	+	++	+	+	-	+	-	-	+	-	-	+
Nitzschia paradoxa	+	++	++	++	-	+	+	+	+	+	-	+
Fragilaria spp	-	-	+	+	-	-	-	-	-	-	-	+
Fragillariopsis spp	-	-	-	+	-	-	-	-	+	-	-	-
Gomphonema angustatum	-	-	+	+	-	-	-	-	-	+	-	-
Tabellaria binalis	+	+	+	+	-	+	+	-	-	-	-	-
Tabellaria focculosa	+	-	-	+	-	-	-	+	+	+	-	+
CHLOROPHYCEAE												
Achnanthes lanceolate	+	-	+	-	+	-	-	-	+	-	+	-
Ankistrodesmus fractus	+	++	++	-	+	+	-	+	+	-	+	-
A. tractus	-	-	-	-	+	-	+	-	+	-	+	-
Chlamydomonas debaryana	+	-	+	-	-	-	-	-	-	-	-	-
Chlorella autospore	+	-	+	-	+	-	-	+	-	+	-	-
C. ellipsoidea	+	-	+	-	+	-	+	-	+	-	+	-
Chlorococcum humicola	+	-	-	-	+	+	-	+	-	+	-	-
Cladophora spp	-	-	-	-	+	-	+	-	+	-	+	-
Closterium macilenlum	++	-	++	-	+	-	+	-	+	+	+	-
C. strigosum	+	+	+	+	+	+	+	+	+	+	+	-
Coelastrum microporus	+	-	-	+	+	-	-	-	-	-	+	-
C. probosis	-	-	-	-	+	-	+	-	+	-	+	-
Crucigenia fenestrate	++	-	++	-	++	-	-	+	-	-	+	-
C. granatum	-	+	-	+	+	+	-	+	+	-	+	-
C. puadrata	++	-	++	++	-	-	-	-	-	-	-	-
C. tetrapedia	++	-	++	-	-	+	-	+	-	+	-	-
C. truncate	++	-	++	-	+	-	+	-	+	-	+	-
Dispora crucigeniodes	-	-	-	+	+	-	-	+	+	-	+	-
Eudorina elegans	-	-	-	+	-	-	-	-	-	-	-	-
Fridaea torrenticola	-	-	+	+	-	-	+	-	-	-	-	-

Gloeotacerium loitlesbergerianum	-	-	-	-	-	-	-	-	-	-	-	-
Gomphosphaeria lacustris	+	-	+	+	-	+	-	+	-	+	-	-
Quadrigula choodati	-	-	-	-	+	+	+	+	+	+	+	-
Goniochloris sculpta	-	-	+	+	-	-	-	-	-	-	-	-
Mycanthococcus antarcticus	-	-	+	+	-	-	-	+	-	+	-	-
Palmellopsis gelatinosa	+	-	+	-	+	-	+	-	+	-	+	-
Planktosphaeria gelatina	++	-	++	-	+	+	+	+	+	+	+	-
Pseudoulvella Americana	-	-	-	-	+	+	+	+	+	+	+	-
Scenedesmus armatus	++	++	++	-	+	+	+	+	+	++	+	-
S. bijuga	++	++	++	+	++	+	+	+	+	+	+	-
S. denticulatus	++	++	++	++	+	+	+	+	+	+	+	-

KEY: ++ Excessively present, + Moderately present, - absent
O-October, N-November, D-December, J-January, F-February, M-March, A-April, M-May, J-June, J-July, A-August, S-September

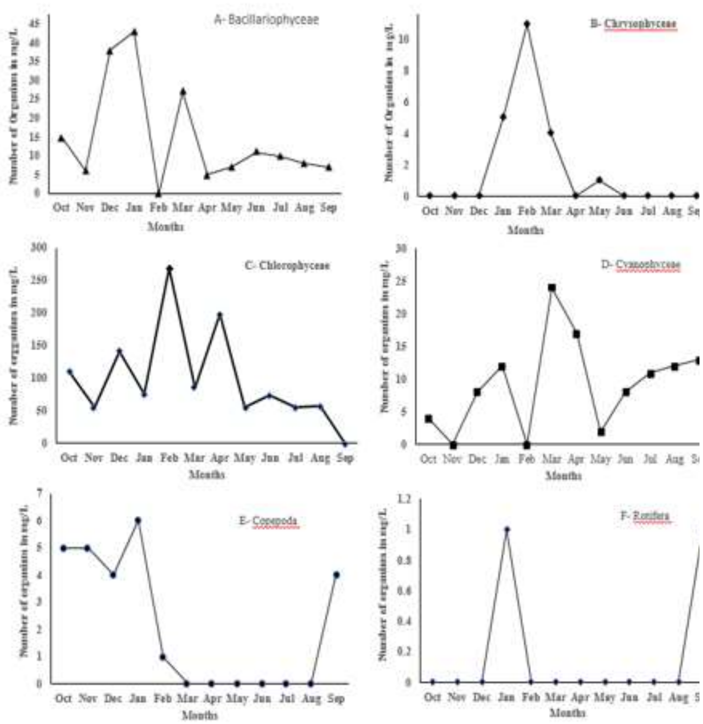

Fig 1: Monthly plankton profile of the plastic tank during the study period 2018-2019

A- Bacillariophyceae
B- Chrysophyceae
C- Chlorophyceae
D- Cyanophyceae
E- Copepoda
F- Rotifera

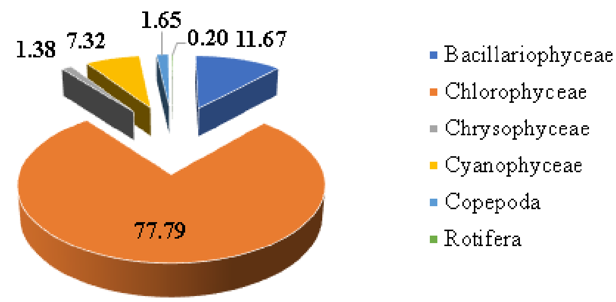

Fig 2:. Percentage distribution of plankton in plastic tank

Table 3: Plankton Families of the plastic tank (Mean ± SD)

Plankton Families	Mean ± SD
Bacillariophyceae	14.75 ^{b} ± 13.75
Chlorophyceae	98.33 ^{a} ± 73.09
Chrysophyceae	1.75 ^{b} ± 3.39
Cyanophyceae	9.25 ^{b} ± 7.16
Rotifera	0.25 ^{b} ± 0.62
Copepoda	2.08 ^{b} ± 2.47

Mean with a different superscript in the same column are significant (P<0.05)

5. DISCUSSION

The plastic fish tank for the aquaculture survey revealed a diverse phytoplankton community. The physico-chemical variables (temperature, pH, DO and nutrients) are essential to plankton production. Plankton is highly susceptible to environmental changes, and its dispersion fluctuates greatly depending on the season, water quality, and nutrient dynamics [23]. The number and distribution of planktonic communities are controlled by the dominant physicochemical factors [24]. The biological and chemical progressions of the biotic community in an aquatic environment are influenced by water temperature, which is a significant characteristic. Therefore, the recorded temperature in the plastic fish tank is not alarming but still within the permissible limit of 35 ˚C [18]. This result agreed with the finding by [11], that climate or weather influences the Physico-chemical parameters of the artificial culture system of the water within Port Harcourt, Nigeria. Hoff and Snell [25] opined that the optimum pH range for plankton production is between 6.5 and 9.5. pH is the trigger variable in water since many aquatic lives depend on pH for aquaculture. The observed pH was in agreement with [19], value. Thus, fish health and better growth of plankton production can be maintained when the optimum pH value is met.

The electrical conductivity of a water body is the ability of the water to produce an electric current. It depends on the water's nature and dissolved ion substances' concentrations. Yan *et al.* [26] reported that the total weight of salts in water is a conductivity function. According to [12], freshwaters have a conductivity of less than 1000 µs/cm, brackish water seems to have a conductivity of up to 1000 µs/cm, and marine water partakes a conductivity of more than 40,000 µs/cm.

Total dissolved solids (TDS) are a total load of dissolved substances in a water body. The present investigation found TDS values below the standard permissible limit of ≤ 500mg/L [12]. This finding was attributed to supplementary animal feed used by farmers, rainfall and atmospheric deposit by the wind. This report agreed with [27] findings that supplementary feed in culture water increases total dissolved solids (TDS).

Turbidity is a vital physical parameter that significantly affects the productivity of the aquatic ecosystem [28]. The obtained turbidity value was below the acceptable standard of 80 NTU [20]. This result could be attributed to significantly fewer particulate matter, debris and other microscopic organisms responsible for water turbidity. Bhatnaga and Devi [29] reported that the ability of water to transmit light penetration is a function of transparency and limit photosynthesis. The value was close to the similar finding by [11].

Dissolved oxygen (DO) constituent in water is an indicator of predominant water quality with the ability of the water body to hold up equilibrize aquatic organisms. However, the obtained mean value could be attributed to the fish stock density and fish farm fence wall preventing high atmospheric air diffusion into the tank water. Dastagir *et al.* [30] reported that no minimum concentration of DO is necessary for fish culture because the dissolved oxygen requirements depend on fish species, age and temperature. This study agreed with the finding of [11], who reported values of DO 4.34 mg/l and 6.33mg/l in similar culture systems in Port Harcourt. Thus, the recorded dissolved oxygen (DO) level was within the acceptable range for aquaculture [20].

Biological oxygen demand (BOD) increases as the bio-degradable organic matter increases in water bodies. BOD values recorded in this study were within the acceptable limit of 1 mg/L to 3 mg/L for aquatic organisms. In the present study, the BOD reflected that organisms and organic substances in the plastic tank were in equilibrium. Ekubo and Abowei [31], reported that water bodies with biological oxygen demand (BOD) level less than 1.0 and 2.0mg/L are regarded as good water, 3.0 mg/L fairly good, 5.0 mg/L doubtful and 10 mg/L heavily polluted. Therefore, the obtained result indicated that the plastic tank water was suitable for aquaculture.

The plastic tank's water depth and total organic carbon (TOC) were insignificant. The water volume maintained average, while total organic carbon was less than the permissible limit of 4 mg/L for natural water [22]. The obtained results could be attributed to trace of the element from long decomposed material in the farm site and movement of groundwater serving as the water source for culture purposes. These findings were tied with the report by [32-33], opined that reservoirs act as a sink to total organic carbon in natural and artificial fish culture systems.

Plankton are an essential feature of colour water bodies as they are greatly influenced by the composition of nutrients, physical and chemical parameters and organic matter in the environment. According to [34], high temperature enhances photosynthesis in the dry season months of water bodies. In this study, the high density of phytoplankton in the dry season (October to March) assisted in high photosynthesis. Chlorophyceae had the highest percentage abundance in this study and could be attributed to nutrient status (nitrogen-nitrate and phosphate), high temperature and low depth in the plastic media. These plastic fish tanks receive tremendous quantities of supplementary fish feed that increases the nutrient status of the water. The findings supported the report by [35] that Chlorophyceae is the most abundant plankton group in Nigeria's fresh water for fish culture.

Bacillariophyceae was the second abundant family and might be due to an average temperature and low nutrient concentration during the dry season (December to January). A lower nutrient concentration coincided with high temperatures maintained during the dry season. This nutrient might be attributed to hot weather conditions, flying dust particles, less mixing of nutrients in the water column and less rainfall. Thus, this finding was in line with the view by [36] that the distribution of Bacillariophyceae reflects the average ecological conditions of this aquatic environment.

Furthermore, the community structure of Chrysophyceae and Cyanophyceae in plastic fish tanks indicated an unpolluted culture system. Cyanophyceae had higher dominance than Chrysophyceae. The Cyanophyceae group recorded an abundance higher from February to May. The prevalent Cyanophyceae group was characteristic of a eutrophic environment with a high concentration of nitrate and phosphate [37]. These could result from trace nutrients (nitrate and phosphate) and left-over feed in the plastic fish culture tank. Therefore, the finding agreed with the report by [38], stating that the relative abundance of Cyanophyceae species is a function of nitrate and phosphate in water bodies. Sen *et al.* [39] reported that natural unpolluted environments are characterized by balanced biological conditions and contain a great diversity of plants and animals' lives with no one species dominating. However, phytoplankton tends to gain abundance and biomass when required favourable conditions such as nutrient concentration and light intensity are met in water bodies. This observation centered on anthropogenic activities regarding the ecological factor of any water bodies body. This work disagrees with the finding of [40]. They reported that the high growth of phytoplankton is a function of the favourable Physico-chemical variable during the dry season than wet season months.

Jouenne *et al.* [41] stated that phytoplankton composition varies with season, which imputes variation in nutrient access, light and temperature. Furthermore, a lesser plankton community structure was observed during the wet season because low temperature enhances low photosynthesis. This finding could be attributed to calm weather conditions in the biota resulting in the death of some species, and decomposition invariably becomes a nutrient. According to [42], phytoplankton has been known to have a higher abundance than zooplankton. This present work on zooplankton having lower biomass than phytoplankton followed other studies of an open water system.

Copepoda group had high abundance during the dry season period from October to March, and Rotifera members were associated with total lack or very low in the wet season period. However, this could be attributed to low water depth following a similar observed result by [43] in Minichinda Stream, Rivers State. The results of the present study stressed the effects of management and environmental factor on plankton in the plastic fish tank concerning fish farming aquaculture.

6. CONCLUSION

The present study provides an insight into the species composition, diversity, abundance and ecology of plankton in the plastic tank for aquaculture. From the results, phytoplankton recorded more species composition, diversity and abundance than zooplankton in the plastic fish tank for fish culture. The factor responsible for this could be light as the prevailing environmental condition for phytoplankton, artificial fish feed and long-term wash of the overhead water tank, which enhances phytoplankton assemblage. At the same time, the lack of zooplankton stresses the density of fish species in the plastic tank. Therefore, it is recommended that the management be standardized to increase targeted species, thus phytoplankton production.

7. SIGNIFICANCE STATEMENT

This study discovers that increased nutrients in the plastic tank directly by food supply aided by temperatur e can be beneficial to herbivorous fish species for aquaculture. Thus, this study reveals that plankton abundance is a function of sunlight and nutrients composition of available feed in the environment. This study will help the researcher to unveil critical coactive effect of nutrients from source water supply and to explore other micronutrients that will aid prolific blowout of plankton in plastic tank culture environment.

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