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Zooplankton Production in the Presence of Different Manures in Culture System

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Feeding of fish with artemia involves a lot of financial investment and it is therefore essential to source for a cheap and yet adequate source of production of life food for fish. This research compares the effects of different organic manures on zooplankton production in culture systems. The manures used were Poultry droppings, Cow dung, Cassava peels and a Control (without manure) and were added into the culture systems at the rate of 57 mg dm-3 of water. The research was carried out for a period of twelve weeks after then identification and counting of species of zooplankton was done by taking 1ml/day from culture systems and water quality parameters in each culture system was also determined once daily. Zooplankton observed were Filinia sp. and Brachionus sp. belonging to Rotifera, Moina sp. and Daphnia sp. belonging to Cladocera and Cyclopods belonging to Copepoda. Moina sp. accounted for 11751 out of the total abundance of zooplankton irrespective of culture system while Daphnia sp. accounted for 11683, Cyclopods 7332, Filinia sp. 5594 and the least was Brachionus sp. accounting for 5230 total zooplankton. Poultry droppings stimulated the highest production having a total of 18908 zooplankton, followed by Cow dung (11845), Cassava peels (9505) and the least was from the Control (1332). The mean

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values for temperature were 27.4°C for poultry droppings, 27.1°C for Cow dung, 27°C for Cassava peels and 27.3°C for the Control. pH recorded 7.5 for Poultry droppings, 7.0 for Cow dung, Cassava peels 6.9 and 7.1 for the Control. Dissolved oxygen was 5.0 mg dm-3 throughout the culture systems. Ammonia recorded 0.9 mg dm-3 for Poultry droppings, 0.4 mg dm-3 for Cow dung, 0.0 mg dm-3 was recorded for Cassava peels and Control. Nitrite was 3.5 mg dm-3 for Poultry droppings, 0.25 mg dm-3 in Cow dung, 0.5 mg dm-3 in Cassava peels and 0.1 mg dm-3 in Control. Nitrate was 80 mg dm-3 for Poultry droppings, Cow dung was 22.5 mg dm-3, 25.0 mg dm-3 was Cassava peels while 12.5 mg dm-3 was the Control. ANOVA results showed significant relationship ($P<0.05$) between the number of zooplankton produced in relation to the various types of Manures applied. In conclusion, Poultry droppings gave the best result and Cassava peels can also serve as an option in areas where poultry droppings are in short supply. The Control gave the poorest result and this clearly indicates that fertilization is essential in culture systems.

Keywords: Organic manures; zooplankton production; fertilization; culture systems.

1. INTRODUCTION

Zooplankton are microscopic aquatic animals suspended with phytoplankton and are mostly transported on water by ambient water currents, many have locomotion used to avoid predators or to increase prey encounter rate [1]. As a natural diet, zooplankton serves an important role in the food chains of culture pond ecosystem by transferring energy from phytoplankton to the culture species and plays a key role in the pelagic food web by controlling phytoplankton production and shaping the pelagic ecosystems. Its production is directly related to the quality of water and mineral nutrients. Because of their critical role as food source for larval and juvenile fish, the dynamics of zooplankton populations have a significant influence on recruitment to fish stocks. Young fish, especially fry and fingerlings and adults have shown to exhibit better growth and survival when fed with natural food [2]. Zooplankton contains high (50-75%) moisture free or dry weight protein than other live food like phytoplankton (30%) [3].

Organic aquaculture is the culture of fish and other aquatic organisms by the use of naturally produced materials from plants and animals which must be decomposed to release their minerals and nutrients [4]. These materials are called manures or fertilizers and termed organic because they are from living matter [5]. Organic manures are most preferable for pond fertilization because it contain all the nutrients needed for biological processes and it releases nutrients into the water thereby producing plankton which is a natural food for organisms in water. Plankton production can be enhanced by application of fertilizer whether organic or inorganic to facilitate their growth in water medium [6,7].

Manures produce nutrients for primary production and its productivity depends on the type of manure used. A wide variety of organic materials have been used to promote the growth of plankton as well as stimulate the development of invertebrates and other micro-organisms from aquatic systems [2]. The use of organic manure for fish culture serves the purpose of cleaning the environment and providing economic benefits [1]. Manures from chickens, goats, rabbit, sheep, cattle and horses are excellent fertilizers for fish ponds; digested sludge from biogas generator, molasses from sugarcane factories, composted vegetation, table scraps and waste from animal slaughter house can also be used as manures for fertilization. Duration of decay is essential in comparison of the type of manure to be used and those requiring long periods to decay should be avoided [5].

It is necessary to know the standard doses of these wastes which would keep the physico-chemical parameters of water in favourable range required for the survival and the growth of natural food and fish in general. Manures containing high concentrations of ammonia could be toxic to aquatic life if too much of such are added to a pond leading to pollution indiscriminately [7]. There is no general consensus to the quantity of manure application because of the variation in nutrient components of manures. The rate of application should depend on prevailing fertility of the culture medium to avoid excessive planktonic bloom which depletes oxygen.

This research tends to investigate on the best possible organic manure medium for production of zooplankton which can serve as a best substitute for artemia in terms of nutritional quality and requirements in feeding of fry. High production costs are incurred when fish seed are fed with artemia because is quite expensive, although it contains the necessary intake requirement for fish seed. For optimal profit, it is therefore essential to reduce cost incurred from feeding with artemia with a best substitute which is relatively free and adopt the use of alternative materials such as processed grains, hays, rice bran, cotton seed meal, alfalfa meal e.t.c. in its production because some people do not like to think about manures (from excretory products) in association with food they eat. Cassava peels was adopted which is often a waste from the processing industries and was abundant in the area and its effectiveness compared against poultry droppings and cow dung in zooplankton abundance.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in a Fisheries laboratory complex of College of Agricultural Sciences; Olabisi Onabanjo University, Nigeria for a period of twelve (12) weeks. The site lies within the semi-savannah zone of southwestern Nigeria on latitude 7°N and longitude 3.5°E. It is endowed with condusive climatic conditions for agricultural pursuits throughout the year. Mean monthly temperatures of the area ranges from 22.5-30.7°C receiving a mean annual rainfall of about 1037 mm. Relative humidity is high during the rainy season which starts in March with values between 63-96% compared to the dry season which ends in November when lower relative humidity of between 55 - 84% is recorded. The temperature of the soil ranges from 24.5-31.0°C [8]. The area is noted for fish farming alongside its richly endowed soil suitable for farming.

2.2 Materials

The materials used were plastic aquaria, Poultry droppings, Cow dung, Cassava peels, Water, Beakers, Oxygen test kit, Ammonia, nitrite, nitrate and pH test kit (made by Blagdon), Mecury-in-glass thermometer, Olympus electric binoculars, Haemacytometer and Scot pro sensitive scale 600 g (made by Ohaus).

2.3 Manure Collection, Treatment and Nutrient Analysis

Each of the manures, poultry dropping and cow dung were gotten from a livestock farm and cassava peels from cassava processing industry in the area and was left for a period of twelve weeks in open air to decay. The dried form of the manures was used and this was achieved by allowing it to dry because moisture content can affect manure quality [4]. The manures were added at recommended dosage rate 57 mg dm^{-3} into 10 litres of water [9,10]. Manures were allowed to remain in water for 2-3 days for nutrients to mineralize into the water, after which each was filtered to eliminate unwanted particle organisms and the filtrates were then added to each culture system.

2.4 Nutrient Analysis

The filtrate from the manures were analysed for nutrient composition and the following nutrients were tested for: Nitrogen, Phosphorus, Potassium, Magnesium, Calcium, Sodium, Iron, Copper, Lead, Cadmium, Cobalt, Nickel, Zinc and Chromium. And most especially Cyanide determination in cassava.

2.5 Innoculation

One liter of water with algal bloom evident by the greenish colouration was added into each aquarium to inoculate the system. The set ups were daily monitored and the water level maintained at 10 litres by replacing losses using filtered water [9].

2.5 Plankton Sampling

Plankton abundance were determined daily by measuring 1 ml out of the culture media using Haemacytometer after stirring thoroughly to ensure even distribution of organisms in the aquaria. Guides by Yamaguchi and Bell [11] were used for identification and counting of species in each sample was done under the Olympus electric binoculars at a power of X40. Zooplankton classified were *Filinia sp.* and *Brachionus sp.* belonging to Phylum Rotifera, *Daphnia sp.* and *Moina sp.* belonging to Cladocera and *Cyclopods* belonging to Copepoda.

2.6 Water Quality Parameters

Parameters analysed were Dissolved oxygen, Hydrogen ion concentration (pH), Temperature, Ammonia, Nitrite and Nitrate to determining the effect of each of the manures and decayed cassava peels on water quality of each of the culture media.

2.7 Statistical Analysis

SPSS 20.0 application was used for Analysis of Variance ANOVA to compare the means and state the significant differences between the manures and Microsoft Excel 2013 for graphical illustrations.

3. RESULTS AND DISCUSSION

3.1 Results

Results of water quality variables measured for each treatment and graphical illustrations are shown in Table 1 and Figures 1-3 respectively.

Table 2 shows the results obtained from nutrient analysis (dry weight) of various treatments used before the commencement of the experiment. The nutrients analysed were Nitrogen, Phosphorus, Potassium, Magnesium, Calcium, Sodium, Iron, Copper, Lead, Cadmium, Cobalt, Nickel, Zinc and Chromium and cyanide level was determined.

The number and species of zooplankton measured in the green water used to inoculate

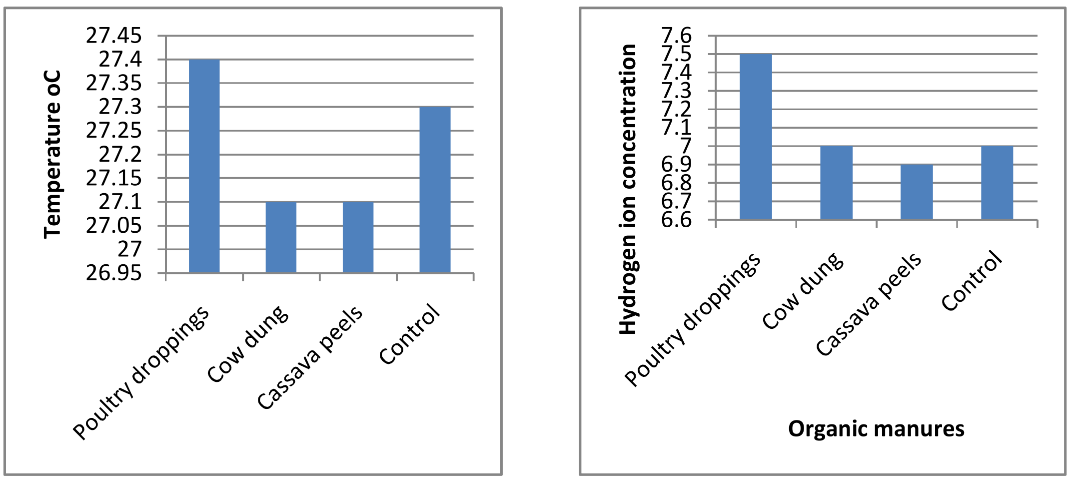

Figure 1. Mean temperature (°C) and hydrogen ion concentrations (mg dm^{-3}) from the organic manures

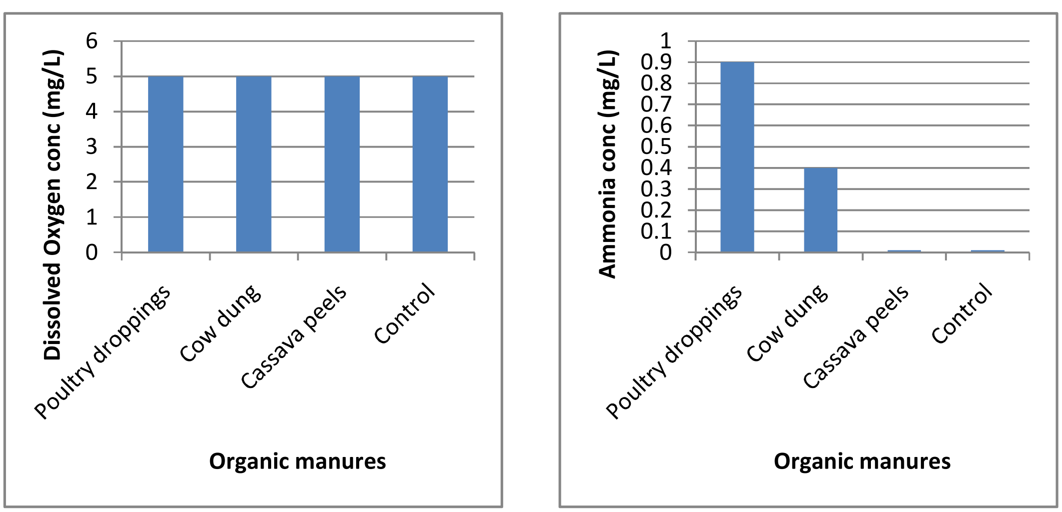

Figure 2. Mean dissolved oxygen and ammonia concentrations (mg dm^{-3}) from the organic manures

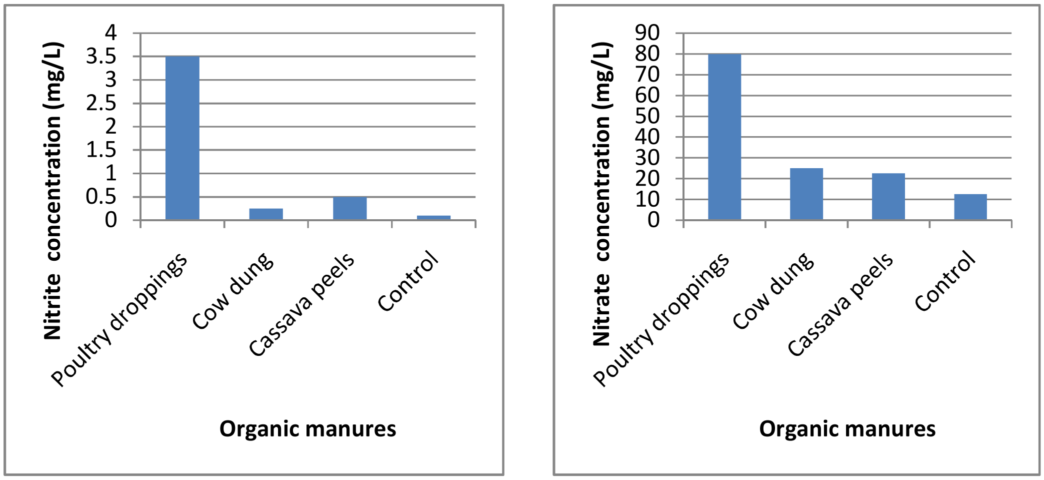

Figure 3. Mean nitrite and nitrate concentrations (mg dm-^{3}) from the organic manures

Table 1. Mean values for physico-chemical parameters measured for various treatments

Parameters	Treatments			
	Poultry droppings	Cow dung	Cassava peels	Control
Temperature (°C)	27.4	27.1	27.1	27.3
Hydrogen ion concentration	7.5	7.0	6.9	7.0
Dissolved oxygen (mg dm-^{3})	5.0	5.0	5.0	5.0
Ammonia (mg dm-^{3})	0.9	0.4	0.0	0.0
Nitrite (mg dm-^{3})	3.5	0.25	0.5	0.1
Nitrate (mg dm-^{3})	80	25.0	22.5	12.5

the system is presented in Table 3. The species of zooplankton include *Moina sp.* and *Daphnia sp.* belonging to Order Cladocera, *Brachionus sp.* and *Filinia sp.* belonging to the Phylum Rotifera and *Cyclopods* belongs to Subclass Copepoda. A total number of 67 species of zooplankton were inoculated, *Filinia sp.* accounted for 10, *Brachionus sp.* 13, *Moina sp.* 16, *Daphnia sp.* 17 and *Cyclopods* accounted for 11 in number.

The total number of zooplankton produced from the five (5) species at the end of the 12 weeks experimental period was 41590 (Table 4). From the table, treatment A which is poultry droppings, the five species stimulated a total number of 18908 zooplankton. Treatment B which is cow dung, the five species stimulated a total of 11845 zooplankton while Treatment C and D which were cassava peels and the control, the five species stimulated a total number of 9505 and 1332 zooplankton respectively. Moina sp. accounted for 11751 zooplankton, Daphnia sp. accounted for 11683, Brachionus sp. was 5230 and Filinia sp. was 5594 while Cyclopods was 7332.

Analysis of Variance showed significant differences ($P<0.05$) between the production of zooplankton by treatments A (poultry droppings), B (cow Dung), C (cassava peels) and the control. There are significant differences in the number of Cyclopods produced by poultry droppings ($P<0.05$) ($F=8.436$), cow dung ($P<0.05$) ($F=5.905$), cassava peels ($P<0.05$) ($F=6.636$) in comparism with the control. *Brachionus sp.* produced by poultry droppings ($P<0.05$) ($F=3.954$), cow dung ($P<0.05$) ($F=4.533$), cassava peels ($P<0.05$) ($F=5.221$) in comparison with the control. *Daphnia sp.* produced by poultry droppings ($P<0.05$) ($F=4.545$), cow dung ($P<0.05$) ($F=5.133$) cassava peels ($P<0.05$) ($F=4.465$) in comparism with the control. *Moina sp.* produced by poultry droppings ($P<0.05$) ($F=0.770$), cow dung ($P<0.05$) ($F=7.301$) cassava peels ($P<0.05$) ($F=1.960$) in comparism with the control. *Filinia sp.* produced by poultry droppings ($P<0.05$) ($F=0.932$), cowdung ($P<0.05$) ($F=1.921$) cassava peels ($P<0.05$) ($F=1.764$) in comparism with the control. This analysis reveals that the amount of zooplankton stimulated by the manures are relatively different in abundance, this can be attributed to the nutrient composition of the manures used.

Table 2. Nutrient analysis from various treatments used before the experiment (dry weight)

Nutrients	A	B	C	D
% N	2.34	0.57	0.28	0.1
% P	0.24	0.04	0.01	0.0
% K	0.03	0.03	0.03	0.0
% Ca	0.10	0.10	0.11	0.1
% Mg	0.04	0.03	0.04	0.0
Na (mg kg-1)	64.91	57.20	63.68	2.0
Fe (mg kg-1)	15.63	13.91	15.03	0.00
Cu (mg kg-1)	4.11	3.47	3.61	0.00
Pb (mg kg-1)	0.14	0.09	0.12	0.00
Cd (mg kg-1)	0.04	0.03	0.04	0.00
Co (mg kg-1)	0.06	0.05	0.06	0.00
Ni (mg kg-1)	0.14	0.09	0.13	0.01
Zn (mg kg-1)	11.33	9.72	10.71	0.00
Cr (mg kg-1)	0.012	0.009	0.011	0.000
Cyanide (mg dm^{-3})	00.00	00.00	13.44	00.00

Legend: A – Poultry droppings; B – Cow dung; C – Cassava peels; D – Control (water)

3.2 Discussion

The Mean values of temperature, hydrogen ion concentration and dissolved oxygen recorded (Table 1) were condusive for the culture of fresh water organisms as discussed by Abu et al. [6], Bocek and Gray [4], Dagg and Shin-ichi [2], Ipinmoroti and Iyiola, [9], Wurtz [7], that the optimum temperature for fresh water organisms is between 25–32°C; recommended pH range is between 6.5–9.0 and recommended range for oxygen in freshwater culture system must not be less than 5.0 mg dm^{-3}. The permissible ammonia level in freshwater ponds is 0.1 mg dm^{-3}, if higher than this fish will suffer chronic lethal ammonia poisoning and requires immediate remedial action [1]. Ammonia results from natural by products of decomposition of dead plants, uneaten food and fish faeces and is very dangerous therefore its levels in culture systems must be reduced to 0 mg dm^{-3} at all times by increased aeration and addition of freshwater. Ammonia level was highest in treatment A (poultry droppings) than B, C and D and reduced during the experiment by constant addition of freshwater [4,9]. Nitrite level recorded (Table 1) during the was a little high and ideal water condition is 0.0 mg dm^{-3} and levels above 4.0 mg dm^{-3} is very toxic [9]. During the experiment, nitrite levels were high and reduced by addition of freshwater. Nitrate is a major macro nutrient used by plants to grow stimulating the production of zooplankton and levels above 100 mg dm^{-3} will encourage the growth of dangerous algae which affects pond plants. Nitrate level recorded for poultry droppings was high (Table 1), therefore producing high population of zooplankton (Table 4), followed by cow dung, cassava peels and control. This shows that poultry droppings are best for zooplankton production.

Table 3. Mean population of zooplankton estimated in the innoculant

Zooplankton	Mean (No dm^{-3})
Filinia sp.	10
Brachionus sp.	13
Moina sp.	16
Daphnia sp.	17
Cyclopods	11
Total	67

Treatment A which is poultry droppings accounted for the highest zooplankton population (18908) (Table 4). This was largely due to the high nutrient content of poultry droppings as shown in Table 2. This agrees with the research findings of Ipinmoroti and Iyiola, [9] and Wurtz, [7] that poultry droppings is the best for culture of fresh water zooplankton due to its high nutrient composition promoting pond production in relation to other forms of manures.

Table 4. Total number of species of zooplankton produced from the treatments (No dm^{-3})

	A	B	C	D	Total
Filinia sp.	2844	1454	1078	218	5594
Brachionus sp.	2816	1102	1165	147	5230
Daphnia sp.	4914	3493	2927	349	11683
Moina sp.	5026	3654	2645	426	11751
Cyclopods	3308	2142	1690	192	7332
Total	18908	11845	9505	1332	41590

Legend: A – Poultry droppings; B – Cow dung; C – Cassava peels and D – Control (water)

Adeniji and Ovie [12] explained that the two important components of algal nutrients are Phosphates and Nitrates and both have a linear relationship with the amount of zooplankton produced. From the results in Table 2, analysis of treatment A which is poultry droppings showed adequate concentration of Phosphate and Nitrates in the extract and Treatment D which is the control experiment had the lowest concentration of Phosphate and Nitrate as compared to other manures. This confirmed the result in Table 4 that Poultry droppings produced the highest amount of zooplankton during the experiment, followed by cow dung, cassava peels and the control accounted for low zooplankton production resulting from low algal concentration. This emphasizes that culture systems must be fertilized whether with organic or inorganic fertilizers for optimal production.

4. CONCLUSION

It still remains a fact that poultry droppings are the best to stimulate zooplankton production with care on ammonia concentration and from this research it was evident that the Nitrate and Phosphate concentration has a direct relationship on plankton production, the higher the concentration of nitrates and phosphates, the higher the production of plankton and based on this relationship, poultry droppings stimulated the highest production of zooplankton; others produced appreciable quantities of zooplankton and the poorest was water (without manure) which stimulated very little production. This emphasizes the importance of fertilization for optimal stimulation of zooplankton. Cassava peels which are common wastes in sub-saharan Africa produced quite a substantial amount of zooplankton and can serve as a substitute for excretory products although there is need to address the issue of cyanide concentration by allowing it to decay so the cyanide concentration can be detoxified and allow the essential nutrients to mineralize.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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