

EVALUATION OF THE GROWTH OF TILAPIA AND AFRICAN CATFISH IN PONDS FERTILIZED WITH POULTRY MANURE AND COW DUNG

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ABSTRACT

A thirteen-week growth evaluation study was carried out to evaluate the effect of pond fertilization with poultry manure and cow dung on the growth of *Clarias gariepinus* and *Oreochromis niloticus* fingerlings. This study, therefore, evaluates the use of poultry manure and cow dung in the fertilization of ponds for the culture of *Oreochromis niloticus* and *Clarias gariepinus* fingerlings. A control experiment with no manure was set-up with both fish fed twice a day on normal 35.4% crude protein feed. Fish raised in ponds with fertilized poultry manure (Tank A and Tank B) had the best growth performance in terms of weight gain and specific growth rate compared with fish fed on cow dung (Tank C and Tank D) and the control experiment (Tank E and Tank F). There was a significant difference ($p < 0.05$) in the total weight gain and the specific growth rate of the fish in all the treatments. *Clarias gariepinus* performed better than *Oreochromis niloticus* in both treatments. Considering the growth performance of total weight gain, mean weight gain and specific growth rate in the treatment tanks, Tank A and Tank B, poultry manure was found most profitable and cheapest to use for pond fertilization.

Keywords: *Clarias gariepinus*, Cow dung, Growth, *Oreochromis niloticus*, Poultry manure.

INTRODUCTION

Aquaculture is presently the fastest growing animal production sector worldwide, increasing at an annual rate of about 10.3% since 2010 (FAO, 2016). Throughout the world, aquaculture is seen as a panacea for meeting the increasing demand for fish, as catches from open waters are declining due to over-exploitation and degradation of fish habitats. FAO, (2016) reported that the world per capita fish supply has reached a new record high of 20kg in 2014 due to the rapid growth in aquaculture, which provides half of all fish for human consumption. Fish farming, therefore, appears to hold the key to improve global fish production. The production of fish can be increased by feeding and pond fertilization. Feed is a single most expensive factor in any aquaculture production and consume about 50–70% of the capital cost in fish culture (Hasan, et al., 2007) while dietary protein sources is the most expensive feed ingredients (Abdel-Tawwab, et al., 2010; FAO, 2012). The proportion of dietary protein source in fish diets is also higher than other cultured animals and this makes fish feed expensive and sometimes the cost is beyond the reach of poor fish farmers. FDF (2012) reported that a large percentage of high-quality fish feeds are being imported, with about 45,000 metric tons imported in 2010. This resulted in some major challenges facing poor fish farmers. Firstly, the feed ingredient notable fishmeal is mostly imported and very expensive (Akinwande, et al., 2002) resulting in the draining of foreign exchange and secondly, there is a scarcity of fishmeal (Eyo, 2003) coupled with the consumption of fish by man and competition from other livestock industries leading to high cost of fish meal (Mistra, et al., 2003). Reducing the amount spent on feed is a means of lowering operational costs without reducing production. Thus, there is a need for

sourcing for local alternatives to reduce the dependency on scarce and expensive fishmeal for fish feed formulation.

According to Bhaktal, et al., (2004), the commonest method of providing food for culture fish in ponds and reservoirs is to enrich such ponds by application of organic manure and inorganic fertilizers to enhance the biological productivity of the ponds and reservoirs. The application of organic and inorganic fertilizers in fish ponds results in higher fish production than from unfertilized system (Green, 1992). Stickney (2000) reported that the usage of commercially available inorganic fertilizers pollutes the environment and degraded the soil quality. Inorganic fertilizers are also expensive and their use by small-holder farmers may be limited (Swift, 1993). Greater attention is being focused on the use of organic fertilizers such as animal wastes as documented by Das et al., (2005). The use of organic waste may provide not only an alternative source of cheap quality fish feed but also eliminates the problems associated with indiscriminate dumping of organic waste in the environment. Proper utilization of organic waste can contribute significantly to reduce feed cost and turn waste into flesh, protect the environment and climate by reduction of harmful gas emissions (Akankali and Nwafili, 2015). Organic fertilizers comprise a variety of plant-derived materials that range from fresh or dried plant material to animal manures and litters to agricultural by-products (Kumar et al., 2004). Large quantities of organic waste in the form of agricultural and agro-industrial by-products are being produced in Nigeria (Oladeji, 2011) which could serve as alternatives sources of conventional feeds. Ogwueleka (2009) reported that about 60% of wastes collected in Nigeria are organic waste. Animal manures have a long history of use as a

source of soluble phosphorus, nitrogen, and carbon for algal growth and natural food production (Knud-Hansen, 1998) hence resulting in higher fish yield. To increase the fish production for better economic returns, one alternative is to fertilize the pond with cheap, easily available and accessible, less competitive and suitable organic manure. Terziyski et al., (2007) reported that the basic principle behind the fertilization of fish pond with suitable organic manure is to increase the production of beneficial phytoplankton, the primary component of the aquatic food chain which is responsible for increasing the amount of harvestable fish. In addition to acting as a food for fish, plankton also perform other important functions in ponds aquaculture: a net producer of dissolved oxygen, which is indispensable for fish growth (Teichert-Coddington and Green, 1993) and the most important sink of ammonia-nitrogen, which is excreted by fish (Jimenez-Montealegre, 2001). Barkoh et al., (2005) stated that the application of organic manure increases heterotrophic bacterial biomass which stimulates other secondary productivity and mineralizes nutrients to stimulate primary productivity.

Furthermore, through respiration, the increased bacterial population generates carbon dioxide, which increases dissolved inorganic carbon available to phytoplankton, dissolves limestone to increase pond total alkalinity and can moderate increases in pH during periods of intense photosynthesis. Wurts (2004) reported that pond fertilization can enhance the fish harvest of a given water body up to 2.8 times of an unfertilized pond. Animal manures are sources of soluble phosphorus, nitrogen and carbon for algal growth and natural food production and are well known for supplying many nutrients for fish growth, plant growth and organic matter which in-turn helps in improving soil structure, water holding capacity and provide a source of slow-release nutrients, promote the growth of earthworms and beneficial microbes (Rosen and Bierman, 2005). Poultry manure has a high percentage of calcium and phosphorus (Kumar, 1992) and is a complete fertilizer with characteristics of both organic and inorganic fertilizers while cow dung has been considered as a potential fertilizer and it contains essential macro and micronutrients for plant and fish growth and valuable feed for earthworms in the vermicomposting process (Ismail, 2005). Fish flesh contains all the essential amino acids and minerals such as phosphorus, iron, iodine, copper, potassium, vitamins A and D in desirable concentrations (Abbas et al., 2010). *Oreochromis niloticus* and *Clarias gariepinus* are good fish options for aquaculture due to their relatively low input and high return on investment to fish farmers (Omitogun and Aluko, 2002) and their fast growth rate and good survival. *Clarias gariepinus* is an important fish species

particularly in Nigeria, where it remains the most cultured fish species (Akinwale, et al., 2016) while *Oreochromis niloticus* has a strong economic impact in many countries and its global production trends in aquaculture have been expanding and exceeding 5.45 million tons in 2014 (Fitzsimmons, 2016). The semi-intensive culture of *O. niloticus* and *C. gariepinus* is particularly ideal in developing countries such as Nigeria due to certain options such as management and investment (Liti, et al., 2001). Faced with the scarcity of feed and the unaffordable price of some feed ingredients in Nigeria, research into the use of manure for fertilizing ponds is inevitable. This study, therefore, evaluates the use of poultry manure and cow dung in the fertilization of ponds for the culture of *Oreochromis niloticus* and *Clarias gariepinus* fingerlings.

Materials and Methods

Experimental fish and management

The experiment which lasted thirteen weeks was conducted at the fish farm of the Department of Aquaculture and Fisheries Management, University of Ibadan. Six earthen based ponds (with concrete walls) (outdoor cement tanks with soil base) with equal dimensions of 6.5m X 3.2m X 1.4m deep marked Tank A, Tank B, Tank C, Tank D, Tank E and Tank F in triplicate were cleared of aquatic weeds, limed with calcium carbonate at the rate of 800kg/ha and allowed to dry for five days. Water was let into all the culture ponds through the borehole to a level of 0.7m and this water level was maintained throughout the experimental period. Four hundred and twenty fingerlings each of *Oreochromis niloticus* and *Clarias gariepinus* of average weight ($2.30 \pm 0.4g$) and ($2.50 \pm 0.3g$) respectively were purchased from a reputable fish farm in Ibadan. The fish were disinfected with 0.1% potassium permanganate as described by Joshi et al., (2002b) and acclimatized for 14 days in the fish farm laboratory. Tank A and Tank B were fertilized with fresh poultry manure collected from the battery system of the Teaching and Research farm, University of Ibadan at a rate of $0.5kg/m^2$ while Tank C and Tank D were fertilized with fresh cow dung collected at the animal unit of the same research farm at the same rate two weeks before stocking as starting dose for establishing satisfactory environmental conditions for optimum plankton production in the treatment tanks. Tank E and Tank F were the control treatment and were not fertilized at all. Forty fingerlings of *Oreochromis niloticus* were stocked at a rate of 2fingerlings/ m^2 and randomly distributed into each treatments Tank A, Tank D and Tank F while forty fingerlings of *Clarias gariepinus* were stocked at the same stocking density and randomly distributed into each treatments Tank B, Tank C and Tank E. The test fish in Tank A and Tank B stocked with *Oreochromis niloticus* and *Clarias gariepinus*

fingerlings respectively were fertilized with poultry manuring weekly while Tank C and Tank D stocked with *Clarias gariepinus* and *Oreochromis niloticus* fingerlings respectively were fertilized with cow dung manure weekly and the control group, Tank E and Tank F were fed twice daily with 35.4% crude protein formulated feed at 5% of body weight of fish between 0800–0900 hours and 1600–1700 hours throughout the thirteen weeks experimental period. The formulated feed was prepared using finely ground ingredients as per the following composition: Cassava meal (23%), rice bran (15%), soybean meal (30%), fish meal 25%, fish oil (4%) while dicalcium phosphate, vitamin mix, and mineral premix are 1% each.

Monitoring of water quality parameters and plankton estimation

Analysis of water quality parameters such as temperature, dissolved oxygen, pH, turbidity, nitrate, nitrite, ammonia, nitrogen, potassium, and phosphorus of the experimental set-up was done fortnightly and water samples collected from the experimental set-up was done between 0900 and 1000hours on sampling days. Water temperature was measured using a digital thermometer while pH was measured with a digital pH meter. The remaining water quality parameters were determined following standard procedures (APHA 1998). Proximate composition of poultry manure, cow dung, and formulated feed were determined using the AOAC (2016) methods. Plankton samples were collected fortnightly for quantitative analysis. Planktons were collected with a plankton net made of standard bolting silk cloth of 15µm mesh size and concentrated to 2ml and preserved in 4% formalin. Enumeration of concentrated plankton was performed under a light microscope using a Sedgewick-rafter counting chamber mounted on a microscope at x 40magnification (Brummett, 2000) and the different organisms in the sub-samples were identified using the standard identification method described by Odium (1971) and Needham and Needham (1975).

Blood sample collection and hematological evaluation

2 milliliters (ml) of blood were collected at the end of the experimental period from the caudal peduncle of both the experimental and control fish as described by Joshi et al., (2002a). The blood samples were dispensed into tubes containing lithium heparin (EDTA) anticoagulant. Haemoglobin was counted by cyanomethemoglobin method. White blood cells (WBC) and red blood cells (RBC) were estimated by Neubauer's improved haemocytometer using Turks and Hyem's solution as diluting fluid respectively. Packed cell volume (PCV), mean corpuscular haemoglobin concentration (MCHC); mean corpuscular haemoglobin (MCH), mean cell volume (MCV) and platelet were calculated using standard formula described by Dacie and Lewis (1991) and Joshi et al., (2002a) respectively. Separate syringe and needle was used for each fish.

Fish were sampled fortnightly for evaluation of growth, survival and feed utilization following the procedure of Akinwole et al., (2014). The selected growth indices are Total weight gained (TWG), Mean weight gained (MWG), Specific growth rate (SGR), Feed conversion rate (FCR), Protein intake (PI), Protein efficiency ratio (PER) and Percentage survival.

The experiment followed a completely randomized design model. All growth data were subjected to one-way analysis of variance (ANOVA) and statistical analysis involving correlation (r) and regression as described by Steel, et al., (1997).

Results

Proximate composition of formulated diet, cow dung and poultry manure

The proximate compositions of formulated diet, cow dung, and poultry manure are presented in Table 1. Cow dung has a low crude protein value of 7.1% which was significantly lower (p<0.05) to 35.4% crude protein for the experimental feed. The highest values for ash (28.4%) and moisture content (23.7%) were recorded in poultry manure and the lowest value of ash (10.3%) was recorded in cow dung.

Table 1 Proximate composition of formulated diet, cow dung and poultry manure

Components	Formulated diet (%)	Cow dung (%)	Poultry manure (%)
Crude protein	35.4±1.3	7.1±0.2	18.6±1.5
Ether extract	6.2±0.9	3.8±0.4	3.5±0.3
Moisture content	11.3±0.6	18.2±1.8	23.7±0.1
Ash	10.7±1.0	10.3±1.3	28.4±0.7
Crude fibre	6.6±0.2	39.6±0.7	12.7±0.1
Nitrogen free extract	29.8±0.1	21.0±0.5	13.1±0.4

Monitoring of Water quality parameters

The water quality parameters of the experimental set-up are presented in Table 2. The

mean water temperature in poultry manure and cow dung treated ponds were significantly higher (p<0.05) than that of the experimental diet (control)

treatment ponds. This may be due to the occurrence of higher biological activity in fertilized ponds compared to the control treatment ponds. The mean pH values in poultry manure and cow dung treated ponds did not show any significant difference ($p < 0.05$) but significantly different from the control treatment ponds. Significantly higher values ($p < 0.05$) of dissolved oxygen were recorded from the control diet treatment than the organic wastes treatments. Significantly lowest ($p < 0.05$) turbidity values recorded in poultry manure treatment, (Tank A and Tank B). Turbidity was highest in the control diet treatment. Poultry manure treatment showed the highest ($p < 0.05$) nitrate content while the lowest

occurred in the control treatment. Poultry manure treatment (TB) recorded the highest values of water-soluble phosphate. Nitrate and phosphorus are among the essential nutrients for both plants and animals. The highest values for potassium, phosphorus, and ammonia were recorded in poultry manure treatment while the lowest of these parameters were recorded in the control diet treatment. The Physico-chemical parameters of the experimental set-up ranged within the favourable limits required for *Oreochromis niloticus* and *Clarias gariepinus* production as recommended by El-Sayed (2006).

Table 2 Water quality parameters measured in the experimental tanks fertilized with different organic manures and the formulated diet tanks stocked with *Oreochromis niloticus* and *Clarias gariepinus*

Parameters	Poultry manure		Cow dung		Formulated diet	
	Tank A	Tank B	Tank C	Tank D	Tank E	Tank F
Temperature (°C)	31.2 ± 0.4	29.3 ± 0.3	28.6 ± 0.1	29.8 ± 0.2	25.07 ± 0.1	26.4 ± 0.8
DO (mg/l)	4.7 ± 0.4	4.5 ± 0.3	5.1 ± 0.1	4.9 ± 0.2	5.9 ± 0.2	5.7 ± 0.1
pH	8.7 ± 0.2	8.5 ± 0.3	8.4 ± 0.7	8.2 ± 0.2	7.7 ± 0.1	6.9 ± 0.3
Transparency (Cm)	26.7 ± 1.8	29.3 ± 0.5	30.5 ± 0.2	28.3 ± 0.3	38.6 ± 0.5	39.7 ± 1.4
Nitrite (mg/l)	0.03 ± 0.00	0.03 ± 0.00	0.02 ± 0.00	0.02 ± 0.00	0.01 ± 0.00	0.01 ± 0.00
Ammonia (mg/l)	0.26 ± 0.02	0.27 ± 0.03	0.22 ± 0.01	0.24 ± 0.02	0.19 ± 0.02	0.18 ± 0.01
Nitrate (mg/l)	1.47 ± 0.11	1.52 ± 0.13	1.26 ± 0.05	1.34 ± 0.08	0.73 ± 0.12	0.65 ± 0.09
Potassium (mg/kg)	0.85	0.90	0.48	0.50	0.19	0.19
Nitrogen (mg/kg)	2.00	2.02	1.62	1.67	0.33	0.31
Phosphorus (mg/kg)	1.95	1.98	0.17	0.18	0.08	0.08

Plankton species diversity differed considerably between the manured treatments and control treatment (Table 3). Zooplankton and phytoplankton such as cladocerans, daphnia, moina, scenedesmus spp. were either absent or represented in the control diet treatment with a low number compared to the manured treatments. The overall plankton population was the highest under poultry manure treatment and lowest in the formulated feed (control) treatment. The density of phytoplankton

and zooplankton were significantly low in control treatment. Within the manured treatments, the abundance (No/litre) of the different species varied considerably. Poultry manure is richer in minerals because of its high percentage of ash content as shown in Table 1. This may be the reason for high plankton growth observed in Table 3 and consequently, superior growth performance of *Clarias gariepinus* and *Oreochromis niloticus* in poultry manure treated tanks (Table 5).

Table 3 Species composition and abundance of plankton in experimental and control ponds

Species	Poultry manure		Cow dung		Formulated diet	
	Tank A (No/L)	Tank B (No/L)	Tank C (No/L)	Tank D (No/L)	Tank E (No/L)	Tank F (No/L)
Cl	338.24	329.13	163.72	171.54	–	–
Co	694.81	713.59	572.47	539.66	226.94	233.86
Da	185.49	191.04	109.15	115.28	–	–
Cy	317.73	308.32	294.92	301.52	119.35	124.61
Ro	79.46	84.03	54.05	60.02	24.33	19.70
Mo	238.54	235.62	187.39	194.60	–	–
Sc	2.36	2.31	3.17	3.12	–	–
Ch	14.88	15.02	9.06	8.99	–	–
Na	116.10	114.79	85.94	89.06	39.65	41.33
Sp	13.05	13.11	12.27	11.98	4.04	4.02
Tp	126.45	121.64	78.93	84.10	21.47	18.06

Cl-Cladocera; Co-Copepoda; Da-Daphnia sp.; Cy-Cyclops sp.; Ro-Rotifera; Sc-Scenedesmus sp.; Mo-Moina sp.; Ch-Chlorella sp.; Na-Nauplii; Sp-Spirogyra sp.; Tp-Total phytoplankton.

Table 4 shows the haematological changes in experimental fish fertilized with poultry manure, cow dung, and the control treatment. *Clarias gariepinus* and *Oreochromis niloticus* fed on organic manures showed a significant decrease ($P<0.05$) in haematological parameter values compared to the *Clarias gariepinus* and *Oreochromis niloticus* fed on control treatment (formulated diet). The haematology parameters of mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were similar for all the treatments. The haematology parameters of Packed cell volume (PCV), haemoglobin (Hb), Red blood cell (RBC), White blood cell (WBC), and platelets of *Clarias gariepinus* and *Oreochromis niloticus* in different

treatments were similar ($p<0.05$) with the control diet treatment. However, the highest values of the haematology parameters were recorded in *Clarias gariepinus* and *Oreochromis niloticus* in the formulated diet treatment.

Highest PCV value of $26.58\pm 2.00\%$ was recorded in *Oreochromis niloticus* in the control diet treatment while the lowest value of $22.71\pm 1.95\%$ was recorded in *Oreochromis niloticus* fed cow-dung treatment. Highest Hb value of $9.61\pm 1.25\text{g}/100\text{ml}$ was recorded in *Oreochromis niloticus* in the control diet treatment while the lowest value of $7.13\pm 0.20\text{g}/100\text{ml}$ was in those *Oreochromis niloticus* fed on cow dung treatment. Other haematological parameters followed the same trend for *Clarias gariepinus*.

Table 4 Haematological parameters of *Oreochromis niloticus* and *Clarias gariepinus* reared in fertilized ponds of poultry manure, cow dung and the experimental (control) feed

Parameters	Poultry manure		Cow dung		Formulated diet	
	Tank A	Tank B	Tank C	Tank D	Tank E	Tank F
PCV (%)	23.62±2.04	24.32±1.10	23.86±2.13	22.71±1.95	25.19±0.11	26.58±2.00
Hb (g/100ml)	7.55±1.31	8.24±0.49	7.99±1.07	7.13±0.20	9.12±1.60	9.61±1.25
RBC ($\times 10^6/\mu\text{l}$)	2.49±0.06	3.21±0.15	3.04±0.22	2.29±0.08	3.95±1.19	4.06±1.27
MCV (fl)	73.60±0.02	75.63±1.54	75.31±1.13	72.99±1.03	77.28±1.15	78.04±0.41
MCH (pg)	25.14±0.01	26.18±0.22	26.09±0.16	24.80±1.44	28.30±1.03	28.85±0.00
MCHC (g/dL)	32.51±0.14	33.70±0.27	33.57±0.14	33.16±0.32	35.07±0.26	35.93±1.35
WBC ($\times 10^3/\mu\text{l}$)	12700±43	12900±16	12800±25	12700±19	14100±20	14400±42
Platelet (fL)	300000±32	310000±24	310000±16	310000±15	330000±23	333000±39

PCV–Packed cell volume; Hb–Hemoglobin; RBC–Red blood cell; MCV–Mean corpuscular volume; MCH–Mean corpuscular haemoglobin; MCHC–Mean corpuscular haemoglobin concentration; WBC–White blood cell.

Fish growth, survival, and production

The total weight gained, mean weight gained, specific growth rate, percentage survival, feed conversion ratio and protein efficiency ratio of *Carias gariepinus* and *Oreochromis niloticus* in the experimental set-up are presented in Table 5. The total weight gained, mean weight gain and percentage survival of *Clarias gariepinus* and *Oreochromis niloticus* were significantly different among treatments ($p<0.05$). Fish cultured in poultry manured culture ponds showed highest growth performance, specific growth rate and percentage survival than the control treatment and cow dung treatment for both *Clarias gariepinus* and *Oreochromis niloticus*. The highest total weight gained of fish was observed in poultry manure treatment, followed by formulated diet treatment and least in cow dung treatment. The growth of fish in poultry manure was significantly ($p<0.05$)

different from the formulated diet treatment and the cow dung treatment. Fish production was significantly ($p<0.05$) higher in the poultry manuring treatments than the cow dung treatment. Poultry manure had significantly highest ($p<0.05$) ash contents than those of control diet and cow dung (Table 1). This may be the reason for higher growth and specific growth rate of *Clarias gariepinus* and *Oreochromis niloticus* fingerlings recorded from poultry manure treatment. The overall percentage survival of *Clarias gariepinus* ranged from 84.7% in formulated diet treatment to 93.2% in poultry manure treatment while that of *Oreochromis niloticus* ranged from 84.1% in formulated diet treatment to 94.6% in poultry manure treatment. However, the difference in percentage survival of fish among the treatments and the control diet treatment was not significant ($p<0.05$) in this experiment.

Table 5: Nutrient utilization and growth performance of *Clarias gariepinus* and *Oreochromis niloticus* reared on poultry manure, cow dung, and experimental feed

Parameters	Poultry manure		Cow dung		Formulated diet	
	TA	TB	TC	TD	TE	TF
Initial mean wt (g)	2.50	2.30	2.30	2.50	2.30	2.50
Final mean wt (g)	91.13	109.56	58.55	52.91	80.62	68.02
Total wt gain (g)	88.63	107.26	56.25	50.41	78.32	65.52
Mean wt gain/day (g)	0.985	1.192	0.625	0.560	0.870	0.728
SGR (%/day)	3.996	4.293	3.597	3.391	3.952	3.671
Survival (%)	94.6	93.2	87.4	89.3	84.7	84.1
FCR	1.827	1.437	4.946	5.719	2.132	2.574
Protein intake	30.119	28.668	84.582	87.643	42.856	39.974
PER	2.943	3.741	0.665	0.575	1.828	1.639

SGR–Specific growth rate; FCR–feed conversion ratio; PER–Protein efficiency ratio.

Discussion

Proximate composition of formulated diet, cow dung and poultry manure

The results of these analyses were presented in Table 1. Proximate analysis conducted on poultry manure, cow dung and formulated diet revealed that formulated diet has the most superior crude protein (35.4%) and ether extract (6.2%) than those of the poultry manure and cow dung. However, formulated diet was directly consumed by the fish in the control treatment tanks while manures were left in the tanks for plankton growth (Schroeder, 1980). Poultry manure is richer in ash content (minerals) than in either cow dung or formulated diet. This may be the reason for high plankton growth and consequently superior performance of *Clarias gariepinus* and *Oreochromis niloticus* in poultry manure treatment tanks.

Monitoring of Water quality parameters

The average values of water temperature and pH in the different treatments were similar during the experimental period and varied within a narrow range. The water pH in the treatments were in alkaline range throughout the experimental period, indicating favourable conditions for biological production and higher photosynthetic activity in organic manure treatments tanks than the control treatment tanks, hence pH variations in the manured tanks can also be correlated with photosynthetic activity. Dissolved oxygen levels improve in manure tanks due to photosynthesis while ammonia levels are reduced through assimilation by phytoplankton (Boyd, 1990). The values of ammonia recorded in this experiment were low. Generally, *Clarias gariepinus* and *Oreochromis niloticus* are capable of tolerating low dissolved oxygen levels of 3mg/l (Boyd, 1990).

Nitrogen, phosphorus, and potassium were significantly higher where organic fertilization was applied to ponds in comparison with the control (Kumar, et al., 2005) (Table 2). The poultry manure treatment showed the highest ($p < 0.05$) nitrogen, phosphorus and nitrate contents which were lowest

in the control treatment tanks. The higher phosphorus values in the manured tanks may be associated with the increase in phosphorus produced during the decomposition of organic manures. Both soluble organic phosphorus and orthophosphate are released during the process of organic fertilizer decomposition under aerobic conditions (Wudtisin and Boyd, 2005). The Physico-chemical parameters of formulated diet, poultry manure and cow dung for both *C. gariepinus* and *O. niloticus* in this study ranged within the optimum limits recommended for the culture of *C. gariepinus* and *O. niloticus* (El-sayed, 2006).

Plankton abundance

Plankton numbers in the treatment tanks were expressed in No/l (Table 3). There was significantly higher ($p < 0.05$) mean values of plankton production in poultry manure treatment than the cow dung or the formulated diet. Examination of plankton showed that species diversity differed considerably between the organic manured treatments and the formulated diet treatment (control). Cladocerans formed a substantial proportion of the total plankton composition in the poultry manure and cow dung treatments but were absent from the control treatment. Other zooplankton and phytoplankton such as daphnia, moina, scenedesmus species e. t. c. were either absent or represented in a low number in the control treatment compared to the manured treatments. Within the manured treatments, the abundance (No/l) of the different species varied considerably. Higher nitrate, phosphate, and potassium in organic manure treatments favour the multiplication of plankton production (Padmavathi and Veeraiyah, 2009). The relationship between the provision of organic manure and plankton biomass observed in the experiment can be related to nutrients input. Poultry manuring improved the growth of fish significantly ($p < 0.05$) in the treatment tanks (Table 3) and the highest total weight gained was recorded in poultry manure treatment tanks. This result agreed with Boyd (1990) which reported a strong positive correlation between fish growth

and primary productivity in fertilized ponds without supplementary feeding.

Haematological parameters

Blood is a good indicator to determine the health of an organism (Joshi, et al., 2002a) and also acts as a pathological reflector of the whole body and hence haematological parameters are important in diagnosing the functional status of the exposed animal to toxicants (Joshi et al., 2002a). *Clarias gariepinus* and *Oreochromis niloticus* fed on organic manures showed no significant difference ($P < 0.05$) in haematological parameter values compared to the *Clarias gariepinus* and *Oreochromis niloticus* fed on control treatment (formulated diet). The haematological parameters (haemoglobin, red blood cell count, packed cell volume e. t. c.) values observed in *Oreochromis niloticus* and *Clarias gariepinus* fed on organic manuring of poultry manure and cow dung are similar with that of the formulated diet treatment. The values of haematological parameters of both *Clarias gariepinus* and *Oreochromis niloticus* fed on organic manures of poultry manure and cow dung are lower than those reported for African catfish by Agbede et al., (1999). There was no significant difference among the haematological values in all the treatments and the control treatment. The haematological values recorded in all the treatments were within the ranges recommended for normal and healthy catfish (Omoniyi, et al., 2002).

Fish growth, survival, and production

The survival and final weight of treatment fish in this experiment were presented in Table 5. The highest final weight of *Clarias gariepinus* and *Oreochromis niloticus* were observed in poultry manure treatment and least in cow dung treatment. Fish growth in poultry manure was significantly ($p < 0.05$) different from the control and cow dung treatments. Fish growth was poor in the cow dung treatment for both *Clarias gariepinus* and *Oreochromis niloticus*. Specific growth rate (SGR) values followed the trend of fish growth at the termination of the experiment. Boyd (1990) reported a strong positive correlation between fish growth and primary productivity in fertilized ponds without supplementary feeding. De Silva and Anderson, (1995) reported that natural food produced from fertilization of ponds with organic manure is nutritive and contains 51.1% crude protein, 27.3% carbohydrate and 7.7% fat, while the calorific value ranges from 6.7 to 23.8KJ/g. In the tanks receiving poultry manuring, fish growth obtained is entirely attributable to the natural food. In the poultry manuring treatment, the growth of *Clarias gariepinus* and *Oreochromis niloticus* double those in the cow dung treatment, reflecting the ability of both *Clarias gariepinus* and *Oreochromis niloticus* to extensively feed on the available natural food and

convert it into flesh. The difference in percentage survival of fish in the control diet and treatment tanks was not significant ($p < 0.05$) in the experiment, whereas, the control diet treatment recorded lowest percentage survival ($p < 0.05$). This could be due to the natural mortality of fish in tanks since water quality parameters were similar in all treatments, but higher nitrogen, phosphorus and potassium levels in the organic manure treatments. Gross fish production was influenced both by fish weight and percentage survival. Fish production was highest in the poultry manure treatment and least in the cow dung treatment.

Conclusion

The results obtained in the study showed the importance of natural food in culturing *Clarias gariepinus* and *Oreochromis niloticus*. Fish growth in the poultry manure was significantly better than the formulated diet (control) and the cow dung treatment. Findings in this study revealed that poultry manure enhances higher natural fish foods/plankton production than cow dung and formulated diet due to its superior nutrients contents, high survival and growth rates of fish. *Clarias gariepinus* showed tendencies of performing better than *Oreochromis niloticus* in organically fertilized ponds while *O. niloticus* performed better than *Clarias gariepinus* in the formulated diet (control) treatment. The recycling of animal wastes for aquaculture leads to high fish yields, cleaning of the environment, protection of the environment and climate by reduction of harmful gas emissions and also provide additional economic benefits.

Further research work should be done on the improvement of the growth of *Clarias gariepinus* and *Oreochromis niloticus* by cow dung by combining it with other organic wastes or a rich source of nutrients.

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