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GROWTH RESPONSE OF NORTH AFRICAN CATFISH FRY TO ORGANIC AND INORGANIC FERTILIZERS

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Background. Fertilizer application is considered a viable low-cost method of sustainable aquaculture production. This study was carried out to investigate the growth response of north African catfish, *Clarias gariepinus* (Burchell, 1822), fry to inorganic- (NPK) and organic (cow dung and poultry dropping) fertilizers.

Materials and methods. Catfish fry (0.05–0.06 g) were transferred for six weeks into a 0.13-m deep, culture units of the surface area of 0.135 m^2. Each culture unit was treated with either cow dung +NPK (T_1), poultry dropping (T_2), cow dung + poultry dropping (T_3), control with no fertilizer (T_4), NPK + poultry dropping (T_5), cow dung (T_6), NPK + cow dung + poultry dropping (T_7), and NPK (T_8).

Results. Fertilizer type was found to influence the quality and quantity of plankton, which in turn determined the growth and well-being of catfish fry. The best weight increase was recorded in T_1 (1.37 ± 1.01 g) followed by T_2 (0.49 ± 0.31 g), and then T_7 (0.40 ± 0.23 g). The survival rate in T_1 (100%) and T_2 (60%) were the highest relative to the control (T_4)(87%). Dissolved oxygen, pH, and temperature of culture water were variously affected by the treatments.

Conclusion. The results indicate that mixture of NPK and either cow dung or poultry droppings would adequately cater for the growth needs of *C. gariepinus* fry before feeding on compounded diet.

Key words: fish, growth, *Clarias gariepinus,* fry, fertilizers, poultry droppings, NPK, cow dung

INTRODUCTION

The genus *Clarias* is widespread in Africa and south-east Asia and its utilization for fish culture has significantly increased (Bard et al. 1976). The north African catfish, *Clarias gariepinus* (Burchell, 1822) has been considered a very important food fish in Nigeria (Ayinla 1988) and the most favoured pond-cultured fish species in Africa (Bard et al. 1976). Micha (1973) observed that *C. gariepinus* is ideal for culture because of its tolerance to low dissolved oxygen, rapid growth rate and acceptability of a variety of food items. Davy and Chouinard (1980) noted that the most critical area of fish fry production and the major critical period is immediately before and during the initiation of first feeding. If food is not immediately available to fish hatchlings the fry may become weak and become predisposed to predation in natural rearing systems (Rana 1990). If the initial feeding of *C. gariepinus* fry is delayed beyond 5.4 days, more than 50% of the fish may die (Owodeinde et al. 2004). Availability of food during initial feeding is thus very essential for the survival and growth of fish. Huisman et al. (1976) considered the lack of suitable food as the main cause of mortality in most fishes at this stage, emphasizing the importance of, not only, of the quantity and quality, but also the feed size.

Live food such as *Artemia*, *Daphnia*, rotifers, and copepods are the most satisfactory "first food" for fry (Bard et al. 1976). After this transition period of two weeks the fry can detect and eat artificial food (Madu et al. 1993). Consumption of live food during the first four days of feeding ensures adequate survival of *C. gariepinus* fry (cf. Adeyemo et al. 1992). Micha (1973) analysed the stomach contents of 15-day-old *C. gariepinus* fry and reported that the entire food contents was zooplankton, and that beyond that age the contents changed to larvae of aquatic insects and eventually artificial feed.

Most hatchery operations in Nigeria rely on brine shrimp, *Artemia salina* as the fry feed. *Artemia* is imported into the country and it is very expensive. This study

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therefore attempts to overcome this problem, particularly at the subsistence level; through application of the appropriate fertilizers to boost natural productivity that could sustain the fry to stage when they can readily accept compounded diet.

MATERIALS AND METHOD

Clarias gariepinus fry were produced in the fisheries laboratory of the Lagos State University using hormonal induced spawning, artificial fertilization, and incubation techniques. The hatchlings (average weight of 0.05–0.06 g) after yolk absorption were transferred into culture unit of 0.135 m^2 with water filled to a depth of 0.13 m, and allowed to stay for six weeks. Fertilizers were earlier applied to the seven culture units as shown in Table 1 while the remaining tank had no fertilizer and served as the control. Each treatment was replicated three times and allowed to stand for five days, before transferring 15 fry into them. The quantity of fertilizer used is as recommended by FAO (Andren 1975).

The water quality parameters in the tank were monitored three times daily. The temperature was recorded using mercury-in-glass thermometer; pH was determined using Griffin pH meter model 40, and the dissolved oxygen measured using Winkler's method.

Qualitative and quantitative plankton analyses were carried out by filtering one litter of water sample taken from each of the tanks using plankton net. The concentrate was then fixed in a reagent bottle using formalin solution.

A light microscope was used to identify the plankton, according to a taxonomic key (Prescott 1984). The estimated count of different plankton items present was obtained by using Sedgewick rafter (approximately 500 × 20 × 1 mm). The bottom area was divided into 1000 squares. The fish were sampled weekly using a scoop net and then weights and lengths measured. The same procedure was adopted for every tank.

Length and weight of the fry were used to determine the growth condition (condition factor, K) (Le Cren 1951). of fish using the relationship:

$$K = \frac{100 \times W}{L^3}$$

where:
W, fresh weight [g];
L, standard length [cm]

Analysis of variance was performed to establish significant differences arising from treatment effects. Least significant difference (LSD) was used to identify differences in means of temperature, dissolved oxygen, pH, plankton abundance, increase in fish length, and increase in fresh weight respectively following Sokal and Rohlf (1995).

RESULTS

Mean increase in length and weight, temperature, dissolved oxygen, pH and plankton abundance are shown in Table 2. The mean temperature in all the tanks ranged from 24.9 ± 1.3°C to 25.6 ± 1.1°C. The mean pH showed minimal variation (from 7.2 ± 0.81 to 7.8 ± 0.89). Dissolved oxygen content showed significant variation in all the treatments (3.7 ± 0.6 mg · l^{-1} to 9.1 ± 2.8 mg · l^{-1}) while the values were low in T_3 (3.7 ± 0.6 mg · l^{-1}) and T_7 (3.9 ± 0. 4 mg · l^{-1}) while the highest value was recorded in T_5 (9.1 ± 2.8 mg · l^{-1}). T_4 (7.5 ± 1.3 mg · l^{-1}), T_1 (6.5 ± 0.8 mg · l^{-1}), T_2 (6.5 ± 0.8mg · l^{-1}), and T_6 (4.8 ± 0.7 mg · l^{-1}) have values of the best range for fish culture.

Plankton abundance in all the treatments is presented in Table 3. T_8 had highest plankton abundance (12.38 × 10^3) followed by T_1 (10.55 × 10^3), T_7 (9.86 × 10^3) then T_3 (9.76 × 10^3). T_6 (7.14 × 10^3), and T_4 (5.96 × 10^3) had the lowest plankton abundance.

The growth condition of *C. gariepinus* fry in different fertilizer treatments are summarized in Table 2. T_1 gave

Table 1

Fertilizer treatments in individual tanks

Treatment	Fertilizer type	Quantity per 0.1353 m^2	Quantity per 1 ha
T_1	cow dung + NPK	225 g + 0. 34 g	15 000 kg + 25 kg
T_2	poultry dropping	270 g	20 000 kg
T_3	cow dung + poultry dropping	225 g + 135 g	15 000 kg + 10 000 kg
T_4	control	—	—
T_5	NPK + poultry dropping	0.34 g + 135 g	25 kg + 10 000 kg
T_6	cow dung	450 g	30 000 kg
T_7	NPK + cow dung + poultry dropping	0.225 g + 150 g + 90 g	16.6 kg + 10 000 kg + 6666 kg
T_8	NPK	0.675 g	50 kg

NPK contains nitrogen, phosphate, and potassium in ratio 15 : 15 : 15

Table 2

Mean length increase, weight increase, pH, dissolved oxygen, temperature, and plankton abundance in treatment tanks and condition factor of Clarias fry ($\bar{x} \pm s$)

Treatment	Temperature [°C]	Dissolved oxygen [mg · l^{-1}]	pH	Plankton abundance ($\times 10^3$)	Increase in length [cm]	Increase in weight [g]	Initial length [cm]	Initial weight [g]	Condition factor (K)
Cow dung + NPK (T_1)	25.5 ± 1.0^{a}	6.5 ± 0.8^{a}	7.2 ± 0.81^{a}	10.6 ± 1.0^{a}	0.58 ± 0.18^{a}	1.87 ± 1.01^{a}	1.96	0.062	11.79
Poultry dropping (T_2)	25.5 ± 1.2^{a}	6.5 ± 0.8^{a}	7.9 ± 0.87^{b}	8.56 ± 0.6^{b}	0.37 ± 0.34^{b}	0.49 ± 0.31^{b}	1.98	0.062	4.42
Cow dung + Poultry dropping (T_3)	25.6 ± 1.1^{a}	3.7 ± 0.6^{b}	7.7 ± 0.79^{c}	9.76 ± 1.6^{c}	0.23 ± 0.20^{c}	0.36 ± 0.23^{c}	1.98	0.060	3.89
Control (T_4)	24.9 ± 1.3^{b}	7.5 ± 1.3^{c}	7.5 ± 0.78^{d}	5.96 ± 0.7^{d}	0.27 ± 0.16^{d}	0.33 ± 0.48^{c}	1.98	0.062	3.44
NPK + Poultry dropping (T_5)	$25.1 \pm 1.4^{b, c}$	9.1 ± 2.8^{d}	7.4 ± 0.85^{d}	8.9 ± 0.9^{e}	0.17 ± 0.15^{e}	0.05 ± 0.25^{d}	1.98	0.055	1.06
Cow dung (T_6)	$25.3 \pm 1.3^{a, b, c}$	4.8 ± 0.7^{e}	7.5 ± 0.87^{d}	7.14 ± 0.5^{f}	0.31 ± 0.23^{f}	0.36 ± 0.20^{c}	1.91	0.049	3.74
NPK + Cow dung + Poultry dropping (T_7)	$25.1 \pm 1.1^{b, c}$	3.9 ± 0.4^{f}	$7.8 \pm 0.89^{b, c}$	9.86 ± 1.6^{c}	0.86 ± 0.37^{g}	0.40 ± 0.23^{c}	1.79	0.060	2.47
NPK (T_8)	$25.1 \pm 1.2^{b, c}$	7.1 ± 1.6^{g}	7.2 ± 0.90^{a}	12.38 ± 2.0^{g}	0.12 ± 2.03^{h}	0.03 ± 0.57^{d}	1.76	0.060	1.35

Differences between column means, bearing the same superscripts, are not statistically significant by least significant difference (LSD) statistic ($P > 0.05$)

Table 3

Plankton composition and abundance in individual treatment tanks ($\bar{x} \pm s$)

Plankton component	Affiliation	Cow dung + NPK ($\times 10^3$) (T_1)	Poultry ($\times 10^3$) (T_2)	Cow dung + poultry dropping ($\times 10^3$) (T_3)	Control ($\times 10^3$) (T_4)	NPK + poultry dropping ($\times 10^3$) (T_5)	Cow dung ($\times 10^3$) (T_6)	NPK + Cow dung + poultry dropping ($\times 10^3$) (T_7)	NPK ($\times 10^3$) (T_8)
Microsystis	P	3.49 ± 0.47	2.30 ± 0.20	3.27 ± 0.60	2.23 ± 0.28	1.38 ± 0.03	3.02 ± 0.05	3.45 ± 0.06	3.37 ± 0.35
Cossinodiscus	P	0.201 ± 0.01	0.16 ± 0.06	1.72 ± 0.07	0.19 ± 0.05	0.22 ± 0.05	1.14 ± 0.14	1.0. ±0.01	2.10 ± 0.09
Scenedesmus	P	1.79 ± 0.11	1.22 ± 0.32	0.21 ± 0.01	0.17 ± 0.03	0.57 ± 0.05	0.55 ± 0.05	1.0 ± 0.02	1.04 ± 0.05
Pinularia	P	—	0.52 ± 0.10	0.23 ± 0.03	—	—	0.23 ± 0.04	—	—
Navicula	P	0.204 ± 0	0.56 ± 0.14	0.86 ± 0.02	1.17 ± 0.18	—	0.13 ± 0.04	0.88 ± 0.03	1.02 ± 0.06
Lemanea	P	—	—	0.17 ± 0	0.29 ± 0.02	—	0.15 ± 0.04	—	—
Oscillatoria	P	0.204 ± 0.01	1.12 ± 0.31	1.47 ± 0.01	—	1.04 ± 0.01	0.79 ± 0.18	1.0 ± 0.01	1.0 ± 0.30
Euglena	P	—	—	—	1.10 ± 0.09	—	—	—	0.21 ± 0.04
Cyclotella	P	0.22 ± 0.04	1.02 ± 0.29	—	—	0.12 ± 0.01	—	0.48 ± 0.04	—
Closterium	P	0.213 ± 0.01	—	0.13 ± 0.01	—	—	—	0.14 ± 0.02	—
Asterocystis	P	0.211 ± 0.03	0.11 ± 0.05	—	—	—	—	—	—
Nitzschia	P	—	—	—	—	—	—	—	—
Cladocera	Z	0.630 ± 0.04	—	0.09 ± 0	—	0.16 ± 0.03	—	0.18 ± 0.01	—
Stigeoclcnium	P	0.212 ± 0.01	—	—	—	—	—	0.15 ± 0.04	—
Cosmanium	P	—	—	—	—	0.17 ± 0.01	—	0.19 ± 0.01	—
Coelosphaerium	P	0.210 ± 0.02	0.14 ± 0.08	—	—	3.72 ± 0.28	—	0.14 ± 0.03	3.23 ± 0.22
Sarcodina	Z	0.518 ± 0.01	—	0.09 ± 0.01	—	0.21 ± 0.03	—	0.14 ± 0.02	—
Chlorella	P	0.213 ± 0.01	—	—	—	0.20 ± 0.12	—	0.20 ± 0.01	—
Stephanodiscus	P	0.210 ± 0.04	—	—	—	0.23 ± 0	—	0.13 ± 0	—
Ankistrodesmus	P	0.114 ± 0.01	—	—	0.24 ± 0.04	—	—	—	—
Microsphora	P	—	0.15 ± 0.09	—	—	—	—	—	—
Asterioneila	P	—	0.12 ± 0.05	—	—	—	—	0.16 ± 0.02	—
Coelastrum	P	0.115 ± 0	—	—	—	0.27 ± 0.01	0.66 ± 0.20	—	—
Rotifer	Z	0.661 ± 0.11	0.72 ± 0.22	0.72 ± 0.02	—	0.23 ± 0.01	—	0.27 ± 0.05	0.23 ± 0.03
Daphnia	Z	0.618 ± 0.12	0.13 ± 0.07	0.39 ± 0.04	—	0.17 ± 0.03	—	0.20 ± 0.05	—
Mosquito larvae	Z	0.518 ± 0.03	0.15 ± 0.10	0.27 ± 0.01	0.57 ± 0.16	0.21 ± 0	0.47 ± 0.11	0.15 ± 0.14	0.18 ± 0.05
Chironomus larvae	Z	—	0.14 ± 0.05	0.14 ± 0	—	—	—	—	—
Plankton, total		10.55 ± 1.0	8.56 ± 0.60	9.76 ± 1.60	5.96 ± 0.70	8.9 ± 0.90	7.14 ± 0.50	9.86 ± 1.60	12.38 ± 2.0

Z, zooplankter P, phytoplankter

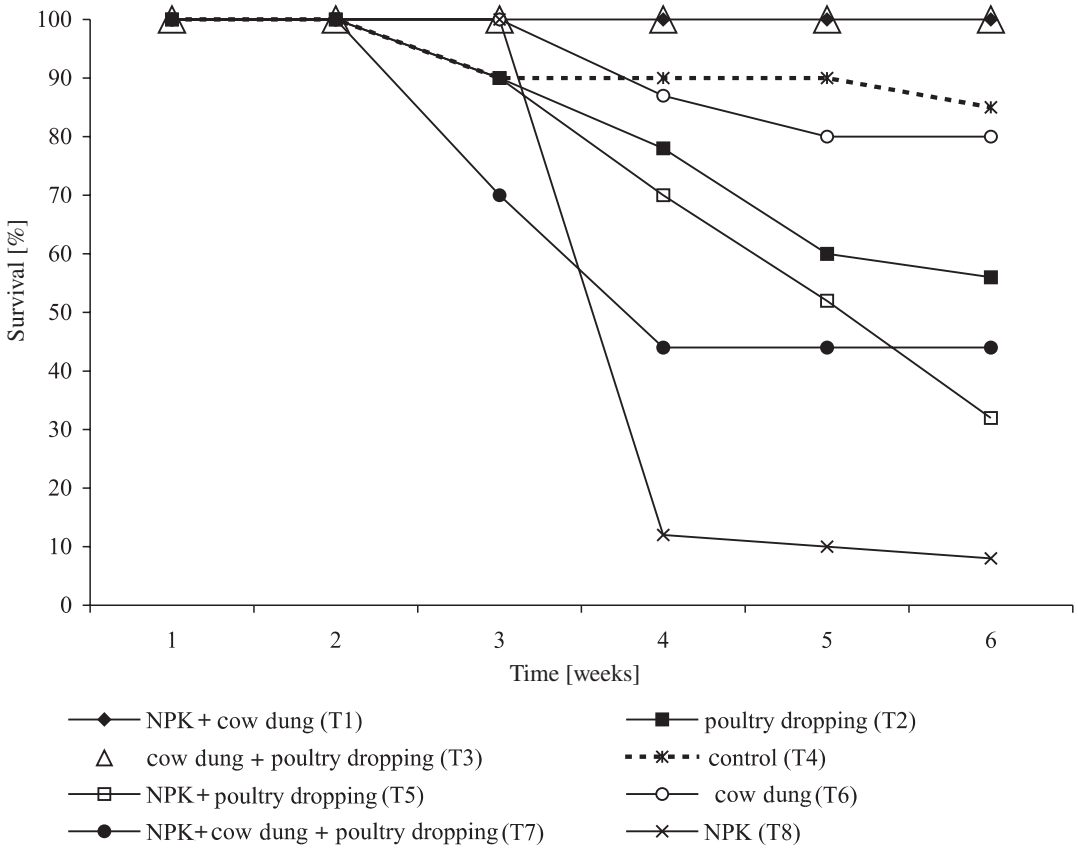

Fig. 1. Survival of *Clarias gariepinus* fry in various fertilizer treatments

the best weight increase of 1.87 ± 1.01 g with condition factor (K) of 11.79 and a corresponding 100% fish survival (Fig. 1). This was followed by T_2 with weight increase of 0.49 g and *K* of 4.42. Fry in T_5, T_7, and T_8 had *K* values lesser than the control, T_4 (3.44). T_5 yielded the smallest *K* value (1.06).

DISCUSSION

Fertilizer treatments used in the presently-reported study increased plankton abundance. This agrees with the findings of Tidwell et al. (2000), Azim et al. (2001), Keshavanath et al. (2001), and Dharmaraj et al. (2002). The best growth performance in terms of well-being, growth rate, and survival rate was recorded in treatment with T_1. This may partly result from the superiority of plankton in terms of quantity and quality generated by the nutrients. It may also be due to high production of rotifers (0.661×10^3) and *Daphnia* spp. (0.61×10^3) as shown in Table 3. These zooplankters are among the most preferred food for fry (Micha 1973, Bard 1976).

The dissolved oxygen was most optimal on T_1 for feeding and growth as reflected in highest condition factor (K) of 11.79 and 100% survival rate. Poultry dropping (T_2), which has the second best growth also showed a similar pattern of plankton composition with T_1. The zooplankton abundance (1.14×10^3), in this treatment was however lower than the value obtained from T_3 (1.70×10^3) with fry weight increase of 0.36 ± 0.23 g.

The reason for the low growth value could be attributed to a low level of dissolved oxygen (3.7 mg $\cdot$ l^{-1}) in the T_3 treatment. The poor dissolved oxygen in this treatment could result from the phosphorus content of poultry dropping which in turn enhances eutrophication and consequently, depletes dissolved oxygen content (Blais et al. 2000). Also cow dung is a known source of nutrients and so is responsible for eutrophication in water bodies (Chale 2003). Both cow dung and poultry dropping may therefore have contributed, respectively, to oxygen depletion of the treated water due to plankton growth.

In T_5 and T_8 there was poor growth in of fish (0.05 and 0.03 g, respectively). T_8, though highest in plankton abundance (1.24×10^4) compared with all other treatments, had very low species diversity (2 zooplankters and 7 phytoplankters). The zooplankton count (4.1×10^2) was equally low. These two treatments T_5 and T_8 were the only treatments that produced *Coelosphaerium* (3.72×10^3 and 3.23×10^3 respectively). These blue-green algae could inhibit growth. Total lack of *Scenedesmus* in these two treatments could also create a vacuum in the food chain of *C. gariepinus*. The survival of fry in the two tanks was very low, 33 and 8%, respectively.

The mean temperature range of 24.9 ± 1.3°C to 25.6 ± 1.1°C falls within the range (24 to 32°C) reported by Boyd (1979) as the best temperature tropical fishes eat and grow fastest and so could not have directly influenced the growth disparity in the experiment. This is also true for pH, which was within the range of 6.5–9 recorded by Boyd (1979).

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