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ARTICLE

Growth Performance and Blood Chemistry of African Catfish, *Clarias Gariepinus* Fed Boiled Layer Chickens on a Poultry-fishery Integrated Farm, Kano State, Nigeria

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SUMMARY

Growth performance and blood chemistry of African catfish, *Clarias gariepinus* post juveniles (154.60 ± 0.55 g mean weight) fed boiled layer chickens that are unfit for human consumption was investigated over a 28-weeks period. Control fish were fed commercial fish feed alone while the test fish were fed equal mixture of the commercial fish feed and boiled layer chickens. Final mean body weights of both the control and the test fish were 538.70 ± 15.82 g and 503.30 ± 16.70 g, which were significantly ($p<0.05$) higher than their initial mean body weights but their final body weights and weight gains were insignificantly ($p>0.05$) lower in the test fish compared to the control fish. The crude protein, oil and Ash contents of the test fish (43.24 ± 0.81 %, 22.32 ± 0.26 % and 10.54 ± 1.08 %) were insignificantly ($p>0.05$) lower than those of the control fish (43.33 ± 0.80 %, 23.12 ± 0.39 % and 11.17 ± 1.88 %). Serum total glucose, total protein and total triglyceride concentrations were insignificantly ($p>0.05$) higher in the test fish (4.30 ± 0.75 $mmoL^{-1}$, 45.07 ± 2.27 gL^{-1} and 3.80 ± 0.49 $mgdL^{-1}$) compared to the control fish (2.61 ± 0.37 $mmoL^{-1}$, 42.40 ± 1.46 gL^{-1} and 3.55 ± 0.55 $mgdL^{-1}$). However, aspartate aminotransferase and alkaline phosphatase activities were significantly ($p<0.05$) lower in the test fish (202.70 ± 38.96 iuL^{-1} and 30.60 ± 2.89 iuL^{-1}) compared to the control fish (352.50 ± 33.73 iuL^{-1} and 41.87 ± 1.66 iuL^{-1}). The cost of producing a unit of the control fish was =N= 228.96 as against =N= 114.53 for a unit of the test fish. This was further reinforced by a production benefit-cost ratio of 1.76 for the test fish as against 0.94 for the control fish. The feeding of fish with boiled layer chickens that are unfit for human consumption along with commercial fish feed, which caused slight stress in the fish but greatly reduced their cost of production without obviously affecting their growth and nutritive values, is highly recommended on Poultry-Fishery integrated farms where chicken mortalities that are unfit for human consumption are readily available at negligible processing cost.

KEY WORDS: Body composition, boiled layer chickens, *Clarias gariepinus*, cost of production, growth, stress

INTRODUCTION

Aquaculture is the fastest growing agricultural production sub-sector worldwide (Kureshy *et al.*, 2000; FAO, 2004). This is because fish has become one of the most valuable and readily available cheap sources of high grade and safe animal protein to man (Slang, 1973; Sadiku and Oladimeji, 1991; Jabeen and Chaudhry, 2011). However, fish farming is faced with numerous problems such as shortages of fingerlings (Taiwo and Odunaiya, 2004) and poor water quality (Spaulding and Blasco, 1997). This is in addition to those of inadequate supply of and rising cost of fish feed (Assiah, 1977;

Omitoyin, 2005), especially as fish feed accounts for over 60 % of the total cost of aquaculture production (Eyo. 1994; Gabriel *et al*., 2007). These may have led to the increasing attempts at developing practical diets for farmed fish (Fagbenro and Adeparusi, 2003), which include the use of poultry by-products (Prinsloo and Schoonbee, 1987; Little *et al*., 1994) from broiler or meat producing processing units and also from daily mortalities on commercial layer or egg producing poultry farms. This is because of the huge additional farm cost incurred in the prompt and hygienic disposal of these wastes, which can equally be a nuisance in terms of odour, aesthetics, disease and surface and groundwater pollution menace if not properly disposed off and on time too (Carey and Thornberry, 1998). Therefore, the effective utilization of fresh chicken mortalities that are unfit for human consumption to feed fish will not only help poultry farms to recoup their losses, the practice may also help to reduce aquaculture production cost in a "waste-to-wealth" approach. However, the feeding of *Clarias gariepinus* in an earthen pond (which has natural food web and bio-filtration process) with processed chicken offal produced what was termed "a satisfactory yield under the circumstances" by Prinsloo and Schoonbee (1987). Similarly, Kamil (2006) reported that up to 50 % of fish meal in the diet of Red tilapia could be replaced with processed chicken intestinal waste beyond and above which obvious fish growth retardation occurred. This may be why Henzé *et al*. (2011) recommended a 2 – 25 % range with a mean use of 5 – 10 % inclusion levels for poultry by-products meal for fish. These notwithstanding, whether the direct feeding of fish with boiled layer chickens will be stressful and/or affects the eventual growth, body composition and the cost of producing a unit fish needs to be investigated, especially in omnivorous *C. gariepinus* and for farms where fresh chicken mortalities that are unfit for human consumption are readily available at negligible processing cost.

Clarias gariepinus, which is readily available in Nigerian waters (Fagbenro, 1992), has also become the most cultured fish species in Nigeria (Ayotunde *et al*., 2011). This is because of its tasty flesh and high market value (Kori-Siapkere and Ubogu, 2008) in addition to being hardy (Ogundiran *et al*., 2009) and able to tolerate wide range of harsh environmental conditions (Bruton, 1979; Hogendoorn, 1979). The fact that *C. gariepinus* is omnivorous in nature (Zaid and Sogbesan, 2010) and cannibalises its own under certain conditions (Rahman *et al*., 1992), makes the fish ideal for this work. That is why this study aimed to investigate the growth performance and blood chemistry of African catfish *C. gariepinus* fed boiled layer chickens that are unfit for human consumption.

MATERIALS AND METHODS

Fish Collection, Authentication and Acclimatization

A total of 100 *C. gariepinus* of 154.60 ± 0.55 mean weight were purchased from a commercial catfish farm in Kano State of Nigeria. Fish were transported in a wide-mouthed plastic bowls, which were covered with fishing nets. Fish were identified and authenticated at the Fishery section, Department of Biological Sciences, Ahmadu Bello University, Zaria, Nigeria prior to acclimatization for 14 days in a concrete pond under natural day and night photo-periods. Pond water was completely changed once a week with a 20 % daily renewal thereafter. Fish were fed 4.5 mm Coppens® fish feed (Coppens International bv. 5700 AM Helmond, Holland) to satiation in two divided portions at 10 and 16 hours (hrs) daily.

Experimental Design

A total of 100 fish were divided into four groups (A, B, C and D) containing 25 fish each. Groups A and B , which were the control groups, were fed 4.5 mm Coppens® fish feed for the first 4 weeks and thereafter, with 6 mm Coppens® fish feed for the last 24 weeks of the experimental period. Fish were fed to satiation in two divided portions at 10 and 16 hrs daily. Groups C and D, which were the test groups, were fed an equal mixture of 4.5 mm Coppens® fish feed and boiled layer chickens (without the feathers, heads and legs that contained little or no flesh and internal organs that are easily prone to spoilage) that are unfit for human consumption and later with 6 mm Coppens® fish feed and boiled layer chickens as above). Dead layer chickens to be used were selected based on freshness and body colour. Dead layer chickens with complete pinkish body colouration were selected while those with other body colourations aside from and/or along with pink were not selected for the experiment. Selected layer chickens were de-feathered and eviscerated with heads and extremities removed prior to boiling with water only for 1 hr without any other ingredients. Boiled chicken mortalities were allowed to cool and then cut into chunks with loose pieces tied together to form additional chunks. These chunks were then tied unto the loose ends of cut-out binding wires, which were subsequently hung on the dividing walls between the ponds thereby suspending these chunks into test ponds at 12 hrs daily. Left-over bones and/or uneaten boiled layer chickens were collected from test ponds at 17 hrs daily. The quantity of fed boiled was adjusted daily based on the previous day's consumption per test fish pond. Pond water was changed once a week with a 20 % daily renewal thereafter throughout the 28-weeks experimental period.

Body Composition Analysis

Five randomly selected freshly dead chickens were analysed for their dry matter (DM), crude protein (CP), Nitrogen-free extract (NFE), Oil and Ash contents as described by AOAC (1999). Similarly, at the end of the 28-weeks experimental period, five control fish and five test fish were randomly selected and analysed for their body composition as above.

Fish Growth Determination

At the beginning and at the end of the 28-week experimental period, 15 control fish and 15 test fish were randomly selected and weighed. Weight gain of the fish, which was calculated as the difference between the initial and final mean body weights of the fish (Zaid *et al.*, 2009), was used as a measure of fish growth. Total fish feed intake per fish by the control fish and the test fish were calculated at the end of the experiment (28-weeks or 196-days) as the total quantity of fish feed (in grammes) consumed by the control and the test fish over the total number of the control and the test fish. Daily mean feed intake per fish was then determined as the mean average of the total fish feed intake per fish of the control and the test fish for the entire 196 days or 28-weeks experimental period.

Production Benefit-cost Ratio Determination

The unit monetary cost of the commercial fish feed was determined by dividing the monetary value of a bag of the commercial fish feed with its total weight in gramme. The monetary cost of producing a unit fish was therefore, determined as a product of the unit monetary cost of the commercial fish feed and the total feed consumed per fish. Similarly, the monetary cost of producing a unit fish per weight gain was also calculated as the cost of producing a unit fish over the weight gain per fish for the control fish and the test fish. However, production benefit-cost ration was

determined by dividing the total revenue (selling price) from a unit fish by the total cost of producing that fish so as to give a ratio greater than one, equals to one and less than one indicative of production profit, break-even and loss respectively as described by Olagunju *et al.* (2007).

Blood Chemistry Analysis

Fish blood was collected through caudal venu puncture as described by Kori-Siakpere *et al.* (2005) into non-heparinised bottles from the 15 randomly selected control fish and 15 test fish. Blood samples were then centrifuged at 1,006 *g* for 3 minutes as described by Ogbu and Okechukwu (2001). Alkaline phosphatase concentrations were assayed based on enzymatic hydrolysis as described by King and Armstrong (1934). Aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activities were assayed based on the reference method of the International Federation of Clinical Chemistry as described by Schwartz *et al.* (1985) using an auto-analyzer (Bayer Express Plus, Model 15950, Germany). Serum total protein concentrations were assayed based on Biuret method as described by Henry *et al.* (1974) using the same auto-analyzer. Serum glucose concentrations were assayed based on glucose oxidase method as described by Morgan and Iwana (1997). Finally, serum total triglyceride concentrations were assayed based on enzymatic method as described by Tietz (1990) using a commercially available kit (Randox Laboratory Limited, United Kingdom).

Statistical Analysis

Data were presented as means ± SEM and also subjected to Student's *t*-test for statistical significance at $P<0.05$ using GraphPad software programme (GraphPad Prism, version 4, San Diego, CA). Differences in treatment means were determined as described by Duncan (1957) using SAS software programme (System Analysis Statistics, version 8.0, Cary, NC).

RESULTS

Analysis of the proximate composition of 4.5 mm and 6 mm Coppens® fish feed for aquaculture and selected layer chickens are as shown in Table 1. The DM and NFE contents of selected layer chickens were 36.27 ± 1.88 % and 39.51 ± 1.63 % but these were not available for the 4.5 mm and 6 mm Coppens® fish feed. Similarly, the crude fibre (CF) content of the selected layer chickens could not be determined while being 1.8 % and 3.0 % for the 4.5 mm and 6 mm Coppens® fish feed respectively. The CP content of the selected layer chickens was 43.49 ± 1.22 % while it was 42 % for both the 4.5 mm and 6 mm Coppens® fish feed. The oil content of the selected layer chickens was 14.05 ± 0.51 % while being 13 % for both the 4.5 mm and 6 mm Coppens® fish feed. However, the Ash content of the selected layer chickens was 3.15 ± 0.35 % while it was 7.40 % and 6.70 % for the 4.5 mm and 6 mm Coppens® fish feed.

Growth and production benefit-cost ratio analysis for the control and the test fish are as shown in Table 2. Final mean body weight of both the control and the test fish were 538.70 ± 15.82 g and 503.30 ± 16.70 g respectively compared to their initial mean body weight of 154.60 ± 0.55 g thereby showing a 384.10 g and 348.70 g weight gain in the control and in the test fish. Daily mean feed intake per fish was 1.78 ± 0.55 g in the test fish compared to 3.54 ± 0.11 g in the control fish. The cost of producing a unit test fish was =N=114.53 compared to =N=228.96 for a unit control fish while the cost of production per weight gain was =N= 0.33 for a unit test fish compared to =N= 0.59 for a unit control fish. Similarly, production benefit-cost ration was 1.76 for a unit test fish compared to 0.94 for a unit control fish.

Analysis of body composition of both the

control and test fish are as shown in Table 3. The DM was 30.33 ± 1.71 % in the test fish compared to 26.92 ± 0.47 % in the control fish. However, the CP was 43.24 ± 0.81 % in the test fish compared to 43.33 ± 0.88 % in the control fish. Similarly, the oil content was 22.32 ± 0.26 % in the test fish compared to 26.92 ± 0.47 % in the control fish. Ash was 10.54 ± 1.08 % in the test fish compared to 11.17 ± 1.88 % in the control fish but the NFE was 23.90 ± 1.48 % in the test fish compared to 22.37 ± 1.79 % in control fish.

The blood chemistry of both the control and the test fish are as shown in Table 4. The AST activity was 202.70 ± 38.96 in the test fish compared to 352.50 ± 33.73 in the control fish. The ALT activity was 43.93 ± 4.93 in the test fish compared to 50.47 ± 11.51 in the control fish. Similarly, the ALP activity was 30.60 ± 2.89 in the test fish compared to 41.87 ± 1.66 in the control fish. Serum glucose concentration was 4.30 ± 0.75 in the test fish compared to 2.61 ± 0.37 in control fish and serum total protein concentration was 45.07 ± 2.27 in the test fish compared to 42.40 ± 1.46 in the control fish. Finally, serum total triglyceride concentration was 3.80 ± 0.49 in the test fish compared to 3.55 ± 0.55 in the control fish.

DISCUSSION

The insignificantly ($p>0.05$) lower final mean body weight of the test fish compared to those of the control fish suggests that the feeding of fish with boiled layer chickens that are unfit for human consumption might slightly reduce fish growth in terms of weight gain. This finding is similar to what was reported by Ayoola (2011) when *C. gariepinus* juveniles were fed poultry hatchery waste. Kamil (2006) also reported reduced weight gain in *Oreochromis* Sp. (Red tilapia) on a 50 % fishmeal replacement with chicken intestinal waste-based diet. Lower weight gain in the test fish compared to those of the control fish might have been due to reductions in the amino acids contents (histidine, methionine, cystein, lysine and phenylalanine) coupled with reduced digestibility of the connective tissue and skin contents of boiled layer chickens occasioned by their subjection to high temperature of over 100°C as reported by other workers (Opstvedt *et al.*, 1984; Tacon and Jackson, 1985; Davies *et al.*, 1989; McCallum and Higgs, 1989; Fowler, 1990; Hasan *et al.*, 1997, Nengas *et al.*, 1999; Hardy, 2000).

The insignificant ($p>0.05$) decrease in the CP, Oil and Ash as well as the insignificant ($p>0.05$) increase in the NFE and DM contents of the test fish compared to the control fish suggests that the feeding of fish with boiled layer chickens that are unfit for human consumption might have affected the body composition of the test fish without greatly changing their nutritive values. This finding is similar to what has been reported by other researchers (Nengas *et al.*, 1999; Emre *et al.*, 2003) where insignificant ($p>0.05$) changes were reported in the body compositions of *Sparus aurata* and *Cyprinus carpio* fed poultry meal and poultry by-products respectively. Reduced Coppens® fish feed consumption occasioned by the feeding of boiled chickens that are unfit for human consumption, which produced almost same level of weight gain in the test fish compared to that of the control fish without significant ($p>0.05$) changes in their body compositions, meant considerable reduction in the cost of producing a unit of test fish compared to a unit of control fish. This will positively improve the profitability status of the aquaculture (Crampton, 1985).

The insignificant ($p>0.05$) increase in serum metabolites (total glucose, protein and triglyceride concentrations) in the test fish compared to those of the control fish suggests that the feeding of fish with boiled layer chickens that are unfit for human

consumption might have been slightly stressful to the test fish. This might have been responsible for the reduced weight gain of the test fish. These findings agrees with the work of Ayoola (2011) who reported increased serum total protein and triglyceride concentrations in *C. gariepinus* on a 50 % feed supplementation with poultry hatchery waste. However, Omitoyin (2007) reported increased total protein but decreased total triglyceride concentrations in *C. gariepinus* fed poultry litter. The decreased Serum enzymes (AST, ALT and ALP) activities in the test fish suggested that feeding fish with boiled layer chickens that are unfit for human consumption caused no obvious cellular damage or dysfunction even though the fish were slightly stressed. This is because serum enzymes (AST, ALT and ALP) are non-functionally present in the serum where they exist in small amounts such that their increased serum activities are indicative of cellular damage and/or dysfunction (Wells *et al*., 1986; Salah El-Deen, 1999). The transformation of protein to glycogen might also be responsible for lower values of the enzymes of protein-carbohydrate metabolism (AST and ALT activities) in the test fish as suggested by Abou El-Naga *et al*. (2005). The findings of this work agrees with the works of Omitoyin (2007) who reported a significant ($P<0.05$) reduction in ALP activity in *C. gariepinus* fed poultry litter but disagrees with the work of Ayoola (2011) who reported elevated ALP activities in *C. gariepinus* juvenile on a 50 % feed supplementation with poultry hatchery waste.

It was concluded that though the feeding of fish with boiled layer chickens that are unfit for human consumptions might have insignificantly ($p>0.05$) reduced the growth of the test fish while causing negligible stress, the practice considerably reduced the cost of producing the test fish without obviously affecting their nutritive values. We therefore, recommend the feeding of catfish with boiled layer chickens that are unfit for human consumption on Poultry-Fishery integrated farms where such layer chicken mortalities are readily available and at negligible processing cost.

TABLE I: Proximate composition of 4.5 mm and 6 mm commercial fish feed and selected layer chickens that are unfit for human consumption

Proximate parameters	4.5 mm Coppens® fish feed (%)	6 mm Coppens® fish feed (%)	Boiled layer chicken (%)
Dry matter	-	-	36.27 ± 1.88
Crude protein	42.00	42.00	43.49 ± 1.22
Oil	13.00	13.00	14.05 ± 0.51
Ash	7.40	6.70	3.15 ± 0.35
Nitrogen-free extract	-	-	39.51 ± 1.63
Crude fibre	1.8	3.00	-

TABLE II: Growth and production cost analysis for the control fish on commercial fish feed alone and the test fish on equal mixture of the commercial fish feed and boiled layer chickens that are unfit for human consumption

Performance parameters	Control fish	Test fish	p-value
Initial mean body weight (g)	154.60 ± 0.55^{a}	154.60 ± 0.55^{a}	-
Final mean body weight (g)	538.70 ± 15.82^{b}	503.30 ± 16.70^{b}	0.14
Weight gain/fish (g)	384.10	348.70	-
Total feed intake/fish (g)	693.84	348.88	-
Experimental period (days)	196	196	-
Daily mean feed intake/fish (g)	3.54 ± 0.11	1.78 ± 0.55	<0.001*
Cost of fish feed/bag (=N=)	5000	5000	-
Total weight of fish feed/bag (g)	15000	15000	-
Cost/g of feed (=N=)	0.33	0.33	-
Cost of production/fish (=N=)	228.96	114.53	-
Cost of production/weight gain (=N=)	0.59	0.33	-
Market price of fish/kg (=N=)	400	400	-
Selling price of the fish/kg (=N=)	215.48	201.32	-
Production benefit-cost ratio	0.94	1.76	-

Values with different alphabet within the same column are statistically significant at p<0.05
Values with asterisks within the same row are statistically significant at p<0.05

TABLE III: Body composition of the control fish on commercial fish feed alone and the test fish on equal mixture of the commercial fish feed and boiled layer chickens that are unfit for human consumption

Proximate Parameters	Control fish	Test fish	p-value
Dry matter	26.92 ± 0.47	30.33 ± 1.71	0.10
Crude protein	43.33 ± 0.80	43.24 ± 0.81	0.94
Oil	23.12 ± 0.39	22.32 ± 0.26	0.13
Ash	11.17 ± 1.88	10.54 ± 1.08	0.78
Nitrogen-free extract	22.37 ± 1.79	23.90 ± 1.48	0.52

TABLE IV: Blood chemistry of the control fish on commercial fish feed alone and the test fish on equal mixture of the commercial fish feed and boiled layer chickens that are unfit for human consumption

Blood chemistry parameters	Control fish	Test fish	p-value
AST (iuL^{-1})	352.50 ± 33.73	202.70 ± 38.96	<0.007*
ALT (iuL^{-1})	50.47 ± 11.51	43.93 ± 4.93	0.61
ALP (iuL^{-1})	41.87 ± 1.66	30.60 ± 2.89	<0.002*
Glucose ($mmoL^{-1}$)	2.61 ± 0.37	4.30 ± 0.75	0.05
Total protein (gL^{-1})	42.40 ± 1.46	45.07 ± 2.27	0.33
Total triglyceride ($mgdL^{-1}$)	3.55 ± 0.55	3.80 ± 0.49	0.73

Values with asterisks are statistically significant at p<0.05

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