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Performance and survival of *Clarias garienpinus* from locally processed corn and soya bean meal as a replacement for fish meal

Solomon, R. J.* and Alasa, M. B.

Department of Biological Sciences, Faculty of Science, University of Abuja, Abuja, Nigeria.

*Corresponding author. Email: johnsol2004@yahoo.com

ABSTRACT: An experiment to evaluate the effect of replacing fish feed was conducted to evaluate the growth performance of *Heteroclarias* in circular tanks each having a capacity of fifty litres of water. Fishes were divided into three groups in triplicates, with 10 fishes per tank. The fingerlings stocked were of the same size and length. Fishes in tank A were fed with laboratory prepared Soya bean and corn meal feed, while B had already manufactured feed (Coppens) and C already manufactured feed (Aquamass) was used. The fingerlings were fed 4% of their body weight twice daily, from 6.00 to 8.00am and from 6.00 to 8.00pm. Growth performances were monitored weekly for eight weeks. The results showed that treatment A (laboratory prepared feed) had the best growth performance with a mean weight (23.3±0.02 g) and length (20.00 mm) gain which exceeds that of treatment B which had a mean of 10.5±0.01 g and length of (19.3 mm). There was a significant difference (p>0.05) between growth rate and different feeds.

Key words: *Clarias garienpinus*, growth performance, corn, soya bean meal.

INTRODUCTION

Most fish farmers and ornamental fish hobbyists buy the bulk of their feed from commercial manufacturers. However, small quantities of specialized feeds are often needed for experimental purposes, feeding difficult-to-maintain pond fishes, larval or small juvenile fishes, brood fish conditioning, or administering medication to sick fish. In particular, small fish farms with a small amount of fish require small amounts of various diets with particular ingredients. It is not cost effective for commercial manufacturers to produce very small quantities of specialized feeds (De Koven et al., 1992). Most feed mills will only produce custom formulations in quantities of more than one ton, and medicated feeds are usually sold in 50-kilogram bags (De Silva and Anderson, 1995). Small fish farmers, hobbyists, and laboratory technicians are, therefore, left with the option of buying large quantities of expensive feed, which often goes to waste. Small quantities of fish feed can be made quite easily in the laboratory, classroom, or at home, with common ingredients and simple kitchen or laboratory equipment. Fish feed consist of natural food and artificial feeds. When fish have balanced diet to eat, they grow fast and stay healthy, in most fish farms natural feeds are not used owing to the fact that they are not earthen and zooplankton and phytoplankton are not readily available. Most fish farmers now depend on formulated feed that are more expensive and are not seen to be cost effective in the running of small fish farms. Most of the constituent of these artificial feed may not even be nutritionally complete, and may not support fish growth adequately (Juli-Anne and Frank, 2015). However artificial feeds have in recent times become well-compounded mixtures of feed stuff and can be either in mesh or pelleted form and are largely employed in the practice of fish farming. The mash feed are suitable for fries and pelleted feed (0.8-1mm) for fingerlings, Juveniles (2-3 mm) and adults (4.5 mm) depending on the pellet sizes. It is an established fact that artificial feed are expensive.
Studies have shown over time that in fish farming the major factors traceable to the success or failure of the farm are: stocking rate, stocking density, the water temperature, quantity and quality of feed which is the highest contributing factor, and the feeding method and frequency (National Research Council NRC, 1993). There have been overtime recommended dietary crude protein requirements for fast and healthy growth of fishes of different species. This research study would be geared towards a comparative study to evaluate the effect of commercially available feed and that manufactured in the laboratory in other to ascertain the more viable of the two feeds, considering the time rate and growth rate in terms of weight gained and length. This study aim to develop an improved variety of fish feed that would be cheaper and more readily available to fish farmers in the running of their farms.

**The concept of alternative/ artificial fish feed**

Good nutrition in animal feed enhances a production system that will produce economically healthy, high quality products. In the running of fish farms, nutrition is a key factor as it accounts for 40-50% of the cost of production (Steven, 2009). With rising demand of fishery produce and the increase in technological knowhow, there has been a tremendous advancement in the commercially available fish diet, promoting optimal fish growth and health. Development of new species- specific diet formulations supports the aquaculture industry as it expands to satisfy increasing demand for affordable, safe and quality fish and sea food products (Louis and Steven, 2009).

Prepared or artificial diets may be either complete or supplemental. Complete diets supply all the ingredients (protein, carbohydrates, fats, vitamins, and minerals) necessary for the optimal growth and health of the fish. Most fish farmers use complete diets, those containing all the required protein (18-50%), lipid (10-25%), carbohydrate (15-20%), ash (< 8.5%), phosphorus (< 1.5%), water (< 10%), and trace amounts of vitamins, and minerals (Louis and Steven, 2009). When fish are reared in high density indoor systems or confined in cages and cannot forage freely on natural feeds, they must be provided a complete diet. In contrast, supplemental (incomplete, partial) diets are intended only to help support the natural food (insects, algae, small fish) normally available to fish in ponds or outdoor raceways. Supplemental diets do not contain a full complement of vitamins or minerals, but are used to help fortify the naturally available diet with extra protein, carbohydrate and/or lipid (Bolorunduro, 1995). Fish, especially when reared in high densities, require a high-quality, nutritionally complete, balanced diet to grow rapidly and remain healthy (www.ext.vt.edu, 2011).

**MATERIALS AND METHODS**

**Fish feed formulation and preparation**

The supplementary fish feed is formulated by combining and obtaining the necessary protein requirement for juvenile stage of fishes by using the pearson’s method of formulation of fish feed (NAERLS, 2002). The protein requirements for *Clarias gariepinus* at this stage of development is put at 35-40% crude protein. This is arrived at by considering the percentage of crude protein in the choice of feed i.e. maize white (10.8%) crude protein and 40.7% for raw soya bean (NAERLS, 2002). The respective constituent of the meal are properly blend using an electric blender and mixed thoroughly upon the determined quantity using the pearson’s method of estimation, other feed constituent are added in the following measures and in no particular order; fat 10%, carbohydrate 20%, minerals and vitamins 1.5% (multimineral premix), vitamins is applied generously, binding agent (agar) 2%, preservatives (antimicrobial and antioxidant) sourced from vitamin E 0.005% the dry weight of the entire feed, in the absence of glycine cray fish is added as an attractant to stimulate a strong feeding behaviour of the fishes (Hardy and Barrows, 2002). The feed is formulated dry with a final moist content of 7% and turned into pellet forms of 2 mm and 3 mm using a rotary grinder (Hardy and Barrows, 2002). 10 kg of feed is prepared using the Pearson’s method of formulation to get 40% crude protein from Maize yellow and Soya bean combination.

To get 40% crude protein feed the formulation is as follows;

Maize yellow = 10.8% crude protein
Soya bean = 40.7% crude protein
Maize yellow = 10.8
Soya bean = 40.7
Total= 29.9
Maize white = 0.7×100 = 29.9 = 2.34
Soya bean=29.2×100 = 29.9 = 97.66

The contributions from the feeds are then as follows;

Contribution from maize =
2.34 × 10.8 ÷ 100 = 0.25
Contribution from soya bean =97.66 × 40.7 ÷ 100 = 39.75

Therefore 0.25% + 39.75% = 40% crude protein that is to produce 10 kg meal containing 40% crude protein from soya bean and maize white would require 39.75% of soya bean accounting for 3.975 kg by mass and 0.25% of maize yellow accounting for 25 g by mass of the entire fish feed.

**Feed preparation**

There is no specific method for preparation of a formu-
ted fish feed, however the preparation procedure that was employed involves the formation of dough-like mixture of the aforementioned feed constituent. The dough is started with blends of the dry ingredients, which is finely grounded and sieved to remove chaff. The dough is kneaded and water is added to produce the needed consistency for the fishes. After this heat is applied at a temperature of between 85-90°C to produce dry feed and sustain the vitamin content since they deteriorate at temperatures above 92°C. The heating is done to reduce moisture content and is done with the aid of a regulated hot plate upon drying extra oil is added to the dough to allow for easy floating. The prepared pellet is then stored in bags (cellophane) for onward usage (Hardy and Barrows, 2002).

Purchase of feed and fishes

The species of fish employed in this research is the Clarias gariepinus (Cat fish) and was purchased from the Agricultural Development Project (ADP) office/ farm in Gwagwalada Abuja. Fifty (50) of these fishes are purchased and in batches of tens in five (5) separate bowls that serve as the improvised pond. The already processed commercially available feed (Coppins and Aquamass) is purchased from the same institute and a proper comparative study to determine the more suitable of both feed is done and result taken for analysis.

Method of feeding the fishes

The fishes are fed by broadcast method for eight weeks twice a day (Morning and Evening) that is between 6 and 8 a.m. and between 6 and 8 p.m. with one quarter the mass of the fish weight. The feed is poured on the surface of the water and the fishes are allowed to come up and collect food, feeding is stopped when the fishes are seen to stop collecting the feed indicating their satisfaction. This style of feeding is employed in other to study the growth rate and development of the fishes. The bowls (improvised ponds) are divided into three pairs containing the same number of fishes and are fed at the same period of time. The fishes on purchase and transportation are first fed with commercially available feed (Coppins) for the first six weeks after which the feed is substituted with the laboratory prepared feed and a comparative study is done over the next eight weeks.

Statistical analysis

The statistical analyses employed are:

(a) Student T-test to determine if there is a mean difference in the weight and length of the fishes in comparison to the feed given and used in the study.

(b) Analysis of Variance (ANOVA): to determine if there is a mean difference in the weight and length of the fishes in comparison with the feeds used in the study. This analysis is done using the Statistical Programme for Social Sciences (SPSS) version 16 software.

Result analysis

Rearing facilities

The experimental device of these experiments is made out of (6) 50L bowl, in open system. The water supply was taken from the water tap located at the Senate building of University of Abuja main campus.

Feeding and measurement

Treatment C served as the control treatment using Aquamass feed (floating diet) containing 42% crude protein, 13% crude fat, 1.9% crude fibre and 8.9% ash was used as control feed for the first treatment. Treatment B also a comparative control employed Coppins meal containing 40% crude protein 13% crude fat, 1.9% crude fibre and 8.9% ash (Treatment A) maize 5 kg, soya bean 10-42%, blood meal 5-50%, fish meal 10-72%, wheat oil 20-20%, bone meal 0.1%, lysine 0.1% and methianine 0.1%. The fingerlings were fed 4% of their body weight twice daily, morning (6 to 8am) and evening (6 to 8pm). Samplings of fish for weight and length measurement were initially done using a scoop net. However due to difficulties in collecting the fish with the net, the water volume was reduced with a rubber siphon before the fishes were collected with the scoop net. Fish weight (g) was taken using a top loading balance (Model: Ohaus precision plus). The fingerlings were weighted in group once a week. The standard length of the fish was taken to the nearest mm with the aid of a measuring ruler. This was done once a week. Depleted water was replaced with fresh water to an effective depth of 20 cm after each cleaning.

Food utilization parameters

Specific growth rate (SGR)

This is calculated from data on changes of the body weight over the given time intervals according to the method of Brown, (1957) as follows:

\[ SGR \% = \frac{\ln W2 - \ln W1}{T-t} \times 100 \]

Where: W1 is the initial weight (gram at time t), W2 is the final weight (gram at time T) (Brown, 1957).

Food conversion ratio

\[ FCR = \frac{\text{Weight of food consumed per fortnight (g)}}{\text{Weight gained by fish per fortnight (g)}} \]
Table 1. Treatment A (Soya bean and White Maize Laboratory prepared) production parameters.

<table>
<thead>
<tr>
<th>Week</th>
<th>Gross total weight (g)</th>
<th>Mean weight (g)</th>
<th>Weight gained (g)</th>
<th>Total length (mm)</th>
<th>Mean length (mm)</th>
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<td>100</td>
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<td>125</td>
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<td>32</td>
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Table 2. Treatment B (Coppens fish meal) Production parameters

<table>
<thead>
<tr>
<th>Week</th>
<th>Gross total weight (g)</th>
<th>Mean weight (g)</th>
<th>Weight gain (g)</th>
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<th>Mean length (mm)</th>
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<td>192</td>
<td>12</td>
<td>10</td>
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**Weight gain (g)**

Weight gain (g) is calculated as the difference between the initial and final mean weight values of the fish in the bowl.

\[
\text{Weight gain (g)} = \text{Final weight} - \text{Initial weight}
\]

**Survival rate (SR)**

The survival rate, SR is calculated as total fish number harvested/total fish number stocked expressed in percentage.

\[
\text{Survival (\%)} = \frac{\text{Total fish number harvested}}{\text{Total fish number stocked}} \times 100
\]

**Relative weight gain**

Relative weight gain (RWG) = \( \frac{W_2 - W_1}{W_1} \times 100 \)

**Mean growth rate (MGR)**

This is computed using the standard equation;

\[
\text{MGR} = \frac{W_2 - W_1}{0.5t} \times 100
\]

Where; \( W_1 = \) Initial weight  
\( W_2 = \) Final weight  
\( t = \) Period of experiment in days,  
\( 0.5 = \) Constant  

**Percentage weight gain (%WG)**

This is expressed by the equation:

\[
\% \text{WG} = \frac{W_t - W_0}{W_0} \times 100
\]

Where; \( W_0 = \) weight  
\( W_t = \) Weight at time \( t \).

**RESULTS AND DISCUSSION**

During the experimental period, the range of temperature value was between 25-29°C, the pH value of the water employed was between 6.5-9.01 and the dissolved oxygen value did not fall below 5.0mg/l (Tables 1 to 3 and Figures 1 to 3). In order to compare the production parameters of the feed employed in the course of this research the results are studied from the average of the three treatments. Each of the treatments as seen in (Tables 1 to 3 and Figures 1to 3) respectively for the laboratory prepared meal, Coppens and Aquamass feed. The highest value that is in terms of weight gained was
Table 3. Treatment C (Aquamas fish meal) production parameters

<table>
<thead>
<tr>
<th>Week</th>
<th>Gross total weight (g)</th>
<th>Mean weight (g)</th>
<th>Weight gained (g)</th>
<th>Total length (mm)</th>
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<td>169</td>
<td>28</td>
<td>26</td>
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<td>28</td>
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</tbody>
</table>

Figure 1. Graphical representation of production parameters of treatment A.

obtained from the soya bean and corn meal laboratory prepared feed (50 g) and that of the already prepared meal corresponding to Aquamass was (30 g). However Aquamass recorded the highest mean length at 28 mm with the locally processed feed recording its highest mean length at 27 mm. The mean weight of Clarias gariepinus varied based on the treatment (feed) administered. This is in response to the varying constituent of the feed employed. The mean weight gained over the eight weeks of culturing were 23.3±0.02, 10.5± 0.01, and 27.1± 0.05 corresponding to laboratory prepared feed (Treatment A), purchased feed (Coppens) treatment B and purchased feed (Aquamass) Treatment C respectively. This is indicative of the fact that increased protein value in feed and high carbohydrate is good for fish feed production (Abu et al., 2010). The difference in growth observed between the treatments diets are indication of the variation in the feed utilization. This work is in consonance with Abu et al. (2010) who reported that supplementing manufactured feed with laboratory feed processed from cassava meal led to a good conversion rate and subsequently better production.

The ability of an organism to convert nutrients especially protein and carbohydrate will positively influence its growth performance. This is justified by the mean weight gain of 23.3±0.02 g of the soya bean and corn meal feed showing a good utilization of feed by the fish. According to De Silva and Anderson, (1995) a conversion ratio is between (1.2-1.8) for fish feed carefully prepared diets and the result from this research study falls within the range. The high survival rate recorded in this study indicates that feeding Clarias gariepinus with soya bean and maize meal does not lead to mortality of the fish. Cardoso et al., (2005) observed that natural feed (Cassava) enhances survival and healthy state of fish at all stages of their life.

Some earlier studies with rainbow trout as well as European seabass have suggested that the major
problem connected with poor growth of fish fed fish meal-free, plant-protein-based diets is caused by poor feed intake (Cordoso et al., 2005). In European sea-bass fed diets containing very high levels of single protein sources such as soy protein concentrate or corn gluten meal, there was a decrease in voluntary feed intake (VFI), which was improved by supplementation with an attractant mix (De Silva and Anderson, 1995). But other data indicate that when the same protein sources replaced about 60% of fish meal, adequately supplemented with limiting amino acids such as lysine or methionine, there was no need for an attractant mix such as squid extract (De Silva and Anderson, 1995). It is thus of interest to note that the diets used here lead to increase in fish growth rate and improved their conversion rate in comparison to the already manufactured feed.

**Conclusion**

Based on the results obtained from this study the use of
soya bean and maize in the preparation of feed used in the feeding of fishes (*Clarias garpiens*) cat fish enhanced growth and survival of the fish. Hence fish farmers can therefore take advantage of this ingredient as a replacement for more expensively available feed.

REFERENCES


APPENDIX

TO TEST THE DIFFERENCE IN MEAN OF TREATMENT A (LABORATORY PREPARED FEED) AND TREATMENT B AND C (PURCHASED FEED).

ANOVA

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
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<td>9</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Hypothesis

H₀: There is no significant difference in the effect of the meals on the growth rate of the fishes
H₁: There is significant difference in the growth of the fishes fed with the meals

Significance level:-
\[ \alpha = 0.05 \]

Critical Value and Rejection region:-

Reject H₀ if p-value \( \leq 0.05 \)
\[ F=21.31924, \ p-value=0.001716 \]

From the above analysis, it can be seen that the p-value (0.001716) < 0.05, thus we reject H₀ and conclude that There is significant difference in the effect of the meals.

DESCRIPTIVE STATISTICS

<table>
<thead>
<tr>
<th>Treatments</th>
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<th>B</th>
<th>C</th>
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<td>3.428</td>
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<tr>
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<td>Standard Error</td>
<td>0.376183</td>
</tr>
<tr>
<td>Median</td>
<td>1.03</td>
<td>Median</td>
<td>3.59</td>
</tr>
<tr>
<td>Mode</td>
<td>#N/A</td>
<td>Mode</td>
<td>#N/A</td>
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<tr>
<td>Standard Deviation</td>
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<td>Standard Deviation</td>
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<td>Range</td>
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<td>Minimum</td>
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<td>Maximum</td>
<td>4.02</td>
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<tr>
<td>Sum</td>
<td>5.91</td>
<td>Sum</td>
<td>17.14</td>
</tr>
<tr>
<td>Count</td>
<td>5</td>
<td>Count</td>
<td>5</td>
</tr>
</tbody>
</table>

From the descriptive analysis, the standard error of Treatment A and Treatment Band C are given below

Standard error of treatment A = 0.308389
Standard error of Treatment B = 0.376183

From the descriptive analysis, it can be seen that treatment A has a minimal standard Error than Treatment B and C and is therefore more effective.
Calculation of metabolic waste of *Clarias gariepinus* and *Tilapia niloticus* obtained from two commercial fish ponds in Gwagwalada

Solomon, R. J.* and Oguike, C. M.

Department of Biological Sciences, Faculty of Science, University of Abuja, Abuja, Nigeria.

*Corresponding author. E-mail: johnsol2004@yahoo.com

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**ABSTRACT:** An automated blood serum chemistry analytical system designed for human usage was employed to establish the levels of urea and creatinine parameters present in sera obtained from 60 experimental groups of catfish and tilapia from a commercial pond with length ranging from 10 to 58 cm and weight ranging from 98.2 to 900.2 grams (For the first group) and 6.8-5 cm and 28.9-90.5 g (for the second group) respectively. The present study was carried out to determine the result of Urea and Creatinine values of *Clarias gariepinus* and *Tilapia niloticus* obtained from two commercial ponds in Gwagwalada. The results observed from catfish when compared to that of tilapia, showed a slight difference of both species. Highest Creatinine value recorded for *Clarias gariepinus* was 1.53 mg/dl and the lowest was 0.00 mg/dl. While the highest Urea level recorded is 10.4 mg/dl and minimum was 0.04 mg/dl. Highest Creatinine value recorded for *Tilapia niloticus* was 1.43 mg/dl while the lowest value recorded is 0.02 mg/dl. Urea highest value recorded is 11.40 mg/dl and minimum was 0.02 mg/dl. The ratio of urea to Creatinine was very high for both species and can be concluded to be either as a result of gastrointestinal bleeding, kidney failure, high protein diet as well as pollution of pond water with substances such as ammonia, and urea which are excreted by fish. It is therefore important to regularly change water to control the effect Urea blood level.

**Key words:** Gastrointestinal bleeding, kidney failure, protein diet.

**INTRODUCTION**

Fish is important to man and is of the most readily available and valuable source of high graded relatively protein available to man. Furthermore, of all the source of protein, fish is the easiest to digest, with most of the species showing protein digestibility of between 90 and 98% (Acton and Melissa, 1999).

*Clarias gariepinus* of the family clariidae is the most common Nigerian fresh water fish species and is prominent in aquaculture practice. They are easily cultured with large economic gains because of their air-breathing and hardy nature, suitable reproductive strategy, nutritional efficiency and attainment of large size in a short time (Fagbenro et al., 1993). The sharp tooth catfish (*Clarias gariepinus*) is one of the most important individuals’ species in traditional fresh water fisheries in Africa. It is widely distributed in Africa, where it occurs in almost any freshwater habitat flood plains, large sluggish rivers, lakes and dams. The fish is omnivorous, feeding on fishes, birds, frogs, small mammals, reptiles, snails, crabs and other invertebrates. It is also capable of feeding on seeds and fruits.

*Tilapia* is the common name for nearly a hundred species of cichlid fish from the tilapiine cichlid tribe (Rahman et al., 2002). Tilapia are mainly freshwater fish inhabiting shallow streams, ponds, rivers and lakes and less commonly found living in brackish water. Historically, they have been of major importance in artisan fishing in Africa and the Middle East, and they are of increasing importance in aquaculture and aquaponics. Tilapia can become problematic invasive species in new warm-water habitats such as Australia, whether deliberately or accidentally introduced, but generally not in temperate climates due to their inability to survive in cold water. Tilapia ingest a wide variety of natural food organisms, including plankton, some aquatic macrophytes, planktonic and benthic aquatic invertebrates, larval fish, detritus and
decomposing organic matter (Lim and Webster, 2006).

Urea (Blood urea nitrogen) test measures the amount of nitrogen in the blood that comes from the waste product urea. Urea is made when protein is broken down in the body. A blood urea nitrogen (BUN) test measures the amount of nitrogen in your blood that comes from the waste product urea. A BUN test is done to see how well the kidneys are working, if the kidneys are not able to remove urea from the blood normally, the BUN level raises.

Creatinine is a breakdown of creatinine phosphate in muscle, and is usually produced at a fairly constant rate by the body (depending on muscle mass). Serum creatinine (a blood measurement) is an important indicator of renal health because it is an easily measured byproduct of muscle metabolism that is excreted unchanged by the kidneys. Creatinine itself is produced via a biological system involving creatine, phosphocreatine (also known as creatinine phosphate), and adenosine triphosphate (ATP, the body’s immediate energy supply).

Creatinine is a waste product of muscle turnover. Creatinine also increases as kidney function decreases. Few influences outside the kidney affect creatinine concentration, so it is a better marker of kidney function than BUN. Urea and creatinine are nitrogenous end products of metabolism, taken together the BUN and creatinine levels provide a very accurate estimation of how well the kidneys are working. Both tests are related and are associated with the complete metabolic profile, CMP. Either test can be run on a blood sample or urine sample. Abnormal levels indicate a kidney or liver-related disease or condition.

Any elevation in levels of blood urea nitrogen and/or serum creatinine does not necessarily indicate structural renal disease. Conversely, blood urea nitrogen or serum creatinine values, which appear to be within the range of normal, do not by themselves rule out significant reduction in glomerular filtration rate. Any interpretation of the blood levels of these two substances must be done with the awareness that a variety of extra renal factors can affect them. The blood urea nitrogen to serum creatinine ratio can be a valuable tool in the determination or renal functional and structural integrity (Aitken et al., 2003) . An increased ratio of BUN to creatinine may be due to conditions that cause a decrease in the flow of blood to the kidneys, such as congestive heart failure or dehydration. It may also be seen with high protein blood levels or from gastrointestinal bleeding (Adekunle, 2010). Abnormal levels indicate a kidney or liver related disease or condition. The study therefore aims to determine the metabolic waste of Clarias gariepinus and Tilapia niloticus from two commercial fish ponds in Gwagwalada.

MATERIALS AND METHODS

Study area

This study was carried out in the University of Abuja main campus premises, located along Km 23 Airport road. Its climate is marked by a dry season starting from November and running to March and a wet season from April to October. Its temperature ranges from 20°C to 36°C with rainfall between 1400 mm and 1600 mm.

Experimental fish

Thirty specie of Clarias gariepinus with varying sexes and lengths ranging from 10.0 to 58.0 cm and weights 98.2 to 900.2 g, and thirty specie of Tilapia with varying sexes and lengths of 6.82 to 15.0 cm with weights of 28.9 to 90.5 g.They were collected from two commercial ponds (Jeremiah Useini farm and Agricultural Development Project (ADP) farm) in Gwagwalada (Abuja). They were examined individually for diseases (Cipriano, 2001).

Method of sample collection

Fish were caught using a small hand net. After the preliminary investigation were taken, they were placed belly upwards and blood samples were taken from the caudal circulation with the aid of a heparinized 2 cm³ disposable plastic syringes and a 21 gauge disposable hypodermic needle. The use of plastic syringe is a necessary precaution with fish blood because contact with glass results in decreased coagulation time. The puncture site was 3-4 cm from the genital opening and it was wiped dry with tissue paper to avoid mucus contamination. The needle was inserted perpendicularly to the vertebral column of the fish and gently aspirated during penetration. It was then pushed gently down until blood started to enter as the needle punctured a caudal blood vessel. Blood was taken under gentle aspiration until about 1cm³ has been obtained, then the needle was withdrawn and the blood gently transferred into lithium heparin anticoagulant tube and allowed to clot at room temperature for 30-40 min.

Centrifugation of blood sample

The blood in the anticoagulant tubes were collected and then centrifuged at 4000R for 10 min followed by serum separation and was stored in a refrigerator until analysis.

Determination of urea

Urea was determined via Nesslerization method, described in Pratt, (1996) and Aitken et al. (2003). Three test-tubes labeled Blank (B), Standard (S), and Sample (T) were used according to the Centromic Gmbit kit manual (Urea-indicator fluid, German). 1 mL of working reagent was transferred to B, S, and T. Exactly 10 uL of distilled water was added in each tube and incubated for 10 min at room temperature. The absorbance values of the sample...
Table 1. Urea and creatinine concentrations for female *Clarias gariepinus*.

<table>
<thead>
<tr>
<th>Weight (g)</th>
<th>Length (cm)</th>
<th>Urea (mg/dl)</th>
<th>Creatinine (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>710.7</td>
<td>51.7</td>
<td>4.49</td>
<td>0.29</td>
</tr>
<tr>
<td>627.5</td>
<td>45.3</td>
<td>10.0</td>
<td>1.42</td>
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<td>615.2</td>
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<td>0.00</td>
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<td>587.1</td>
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<td>502.7</td>
<td>55.6</td>
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<td>0.19</td>
</tr>
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<td>500.3</td>
<td>52.4</td>
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<td>0.18</td>
</tr>
<tr>
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<td>32.3</td>
<td>2.26</td>
<td>0.48</td>
</tr>
<tr>
<td>400.1</td>
<td>24.6</td>
<td>1.90</td>
<td>1.41</td>
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<td>295.7</td>
<td>16.5</td>
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<td>0.26</td>
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<td>157.5</td>
<td>12.4</td>
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<td>0.12</td>
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<td>154.5</td>
<td>11.0</td>
<td>0.04</td>
<td>0.19</td>
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<tr>
<td>142.5</td>
<td>12.2</td>
<td>1.34</td>
<td>1.04</td>
</tr>
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</table>

Table 2. Mean and variance of all the Parameters for female *C. gariepinus*.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Count</th>
<th>Sum</th>
<th>Average</th>
<th>Variance</th>
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<td>6094</td>
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<td>36194.35</td>
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<td>Length (cm)</td>
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<td>Urea (mg/dl)</td>
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<td>46.38</td>
<td>3.312</td>
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<tr>
<td>Creatinine (mg/dl)</td>
<td>14</td>
<td>8.99</td>
<td>0.642</td>
<td>0.306</td>
</tr>
</tbody>
</table>

Table 3. Urea and creatinine concentrations of male *Clarias gariepinus*.

<table>
<thead>
<tr>
<th>Weight (g)</th>
<th>Length (cm)</th>
<th>Urea (mg/dl)</th>
<th>Creatinine (mg/dl)</th>
</tr>
</thead>
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<td>1.49</td>
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<tr>
<td>807.8</td>
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<td>1.53</td>
</tr>
<tr>
<td>775.0</td>
<td>53.0</td>
<td>5.05</td>
<td>1.35</td>
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<tr>
<td>720.3</td>
<td>53.0</td>
<td>4.59</td>
<td>0.39</td>
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<td>650.8</td>
<td>53.6</td>
<td>2.08</td>
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<td>513.0</td>
<td>33.0</td>
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<td>0.45</td>
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<td>434.0</td>
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<td>0.73</td>
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<td>0.95</td>
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<tr>
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<td>1.41</td>
</tr>
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<td>1.04</td>
<td>0.35</td>
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<td>0.30</td>
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<td>0.14</td>
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<td>1.30</td>
</tr>
<tr>
<td>100.8</td>
<td>10.0</td>
<td>0.84</td>
<td>0.30</td>
</tr>
<tr>
<td>98.2</td>
<td>10.1</td>
<td>1.21</td>
<td>1.03</td>
</tr>
</tbody>
</table>

and standard were read against the reagent blank. Plasma urea was expressed in mg dL-1 and measured at a wavelength of 340 nm.

**Determination of creatinine**

Creatinine was determined by Jaffe spectrophotometric method described in Pratt, (1996) and Aitken, *et al.*, (2003). The working reagent, samples and standard were prepared at room temperature. Two test-tubes labeled S for standard and T for sample, and 1 ml of the working reagent was into both followed by the introduction of 100 uL of standard into S and 100 uL sample into T. The content of each tube was gently mixed, distilled water was used to zero the automatic chemical analyzer and the absorbance values of the standard and sample were recorded at 500 nm after 30 and 90 seconds. All the reagents are used as directed by the manufacturer's manual using Sodium (1+1) fluid (Centromic Gmbit, German). Distilled water was used for blank test; serum creatinine was expressed in mg dL-1 and measured at a wavelength of 340 nm.

**Statistical analysis**

The obtained data were subjected to statistical analysis using one-way analysis of variance (ANOVA) to test for level of significance between urea and Creatinine of the three fish species. The descriptive statistics mean and standard deviation were also analyzed. All analyses were performed using the SPSS (Statistical Package for Social Sciences) software program.

**RESULTS**

Table 1 shows that maximum weight recorded is 710.7 g, while the minimum weight recorded is 142.5 g. The maximum length recorded is 55.6 cm, and the minimum is 10.0 cm. The maximum level of urea recorded is 10.0 mg/dl while the minimum level recorded is 0.04 mg/dl. The highest level of creatinine recorded is 1.42 mg/dl while the minimum level recorded is 0.00 mg/dl.

From the Table 2, the mean weight is 435.28; mean length is 34.1, mean Urea is 3.312 and mean Creatinine is 0.642 (Figures 1 and 2). Appendix (Table 1) shows that there is a significant difference between the Length and Weight, Urea, Creatinine for female *Clarias gariepinus*. Therefore, we reject H0 of no significant difference.

From the Table 3, maximum weight recorded is 900.2 g, while the minimum weight recorded is 98.2 g. The maximum length recorded is 55.6 cm, and the minimum is 10.0 cm. The maximum level of urea recorded is 10.0 mg/dl while the minimum level recorded is 0.04 mg/dl. The highest level of creatinine recorded is 1.53 mg/dl while the
minimum level recorded is 0.14 mg/dl (Figures 3 and 4). From the (Table 4), the mean weight is 57.47, mean length is 11.21, mean of urea is 5.56 and mean of creatinine is 0.81. Appendix (Table 2) shows that there is a significant difference between the Weight and Length, Urea and Creatinine of Clarias gariepinus (Male). Therefore, we reject $H_0$ of no significant difference.

From the (Table 5), maximum weight recorded is 86.9 g, while the minimum weight recorded is 28.9 g. The maximum length recorded is 15.0 cm, and the minimum is 6.82 cm. The maximum level of urea recorded is 10.51 mg/dl while the minimum level recorded is 0.21 mg/dl. The highest level of creatinine recorded is 1.43 mg/dl while the minimum level recorded is 0.02 mg/dl (Figures 5 and 6). From (Table 6), the mean weight is 57.47, mean length is 11.21, mean of urea is 5.56 and mean of creatinine is 0.81. Appendix (Table 3) shows that there is a significant difference between the Weight and Length, Urea and Creatinine, of Tilapia niloticus (Male). Therefore, we reject $H_0$ of no significant difference.

From (Table 7), maximum weight recorded is 90.5 g, while the minimum weight recorded is 37.8 g. The maximum
Figure 3. A chart showing the concentration in mg/dl of urea and creatinine for male *Clarias gariepinus*.

Figure 4. Shows the physical parameters, Urea and Creatinine concentrations for male *Clarias gariepinus*.

The length recorded is 15.0 cm, and the minimum is 9.00 cm. The maximum level of urea recorded is 11.40 mg/dl while the minimum level recorded is 0.25 mg/dl. From the (Table 8), the mean weight is 55.75, mean length is 11.25, mean of urea is 6.04 and mean of creatinine is 0.84. The highest level of creatinine recorded is 1.30 mg/dl while the
Table 4. Calculation for mean and variance of male *C. gariepinus*

<table>
<thead>
<tr>
<th>Groups</th>
<th>Count</th>
<th>Sum</th>
<th>Average</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (g)</td>
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<td>804.7</td>
<td>57.47</td>
<td>295.38</td>
</tr>
<tr>
<td>Length (cm)</td>
<td>14</td>
<td>157</td>
<td>11.21</td>
<td>4.06</td>
</tr>
<tr>
<td>Urea (mg/dl)</td>
<td>14</td>
<td>77.95</td>
<td>5.56</td>
<td>12.46</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>14</td>
<td>11.35</td>
<td>0.81</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Table 5. Urea and Creatinine Concentrations of Male *Tilapia niloticus*

<table>
<thead>
<tr>
<th>Weight (g)</th>
<th>Length (cm)</th>
<th>Urea (mg/dl)</th>
<th>Creatinine (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>86.9</td>
<td>15.0</td>
<td>8.54</td>
<td>0.65</td>
</tr>
<tr>
<td>84.2</td>
<td>14.8</td>
<td>7.51</td>
<td>1.33</td>
</tr>
<tr>
<td>76.4</td>
<td>13.2</td>
<td>9.03</td>
<td>1.25</td>
</tr>
<tr>
<td>70.3</td>
<td>11.6</td>
<td>10.51</td>
<td>0.95</td>
</tr>
<tr>
<td>61.0</td>
<td>12.0</td>
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<td>1.37</td>
</tr>
<tr>
<td>60.2</td>
<td>10.5</td>
<td>0.47</td>
<td>0.02</td>
</tr>
<tr>
<td>57.3</td>
<td>10.6</td>
<td>4.31</td>
<td>0.23</td>
</tr>
<tr>
<td>54.3</td>
<td>11.3</td>
<td>4.32</td>
<td>1.21</td>
</tr>
<tr>
<td>52.3</td>
<td>11.3</td>
<td>3.65</td>
<td>0.40</td>
</tr>
<tr>
<td>48.5</td>
<td>10.2</td>
<td>7.51</td>
<td>1.10</td>
</tr>
<tr>
<td>44.2</td>
<td>9.8</td>
<td>0.21</td>
<td>0.10</td>
</tr>
<tr>
<td>43.7</td>
<td>8.9</td>
<td>9.03</td>
<td>1.01</td>
</tr>
<tr>
<td>34.5</td>
<td>8.20</td>
<td>0.22</td>
<td>0.30</td>
</tr>
<tr>
<td>30.9</td>
<td>9.60</td>
<td>4.59</td>
<td>1.43</td>
</tr>
<tr>
<td>28.9</td>
<td>6.82</td>
<td>0.33</td>
<td>1.01</td>
</tr>
</tbody>
</table>

Figure 5. A chart showing the concentration in mg/dl of Urea and Creatinine in male *Tilapia niloticus*.

Minimum level recorded is 0.08 mg/dl (Figures 7 and 8). In Appendix (Table 4), there is a significant difference between the Weight and Length, Urea and Creatinine of *Tilapia niloticus* (Female). Therefore, the Ho of no significant difference was rejected.

**DISCUSSION**

Blood biochemical values are not commonly used as a diagnostic tool in fish medicine. This is due to lack of reference intervals for various fish species, as well as
changes in blood analysis associated with specific diseases and metabolic disorders that are not well characterized.

Creatinine levels observed in this work agrees with the value reported by (Adekunle, 2010). The level of Urea observed in *Clarias gariepinus* and *Tilapia niloticus* was
Table 8. Shows calculation for mean and variance of female *T. niloticus*.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Count</th>
<th>Sum</th>
<th>Average</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
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<td>S/N</td>
<td>14</td>
<td>105</td>
<td>7.5</td>
<td>17.5</td>
</tr>
<tr>
<td>Weight (g)</td>
<td>14</td>
<td>780.6</td>
<td>55.75</td>
<td>221.43</td>
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<tr>
<td>Length (cm)</td>
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<td>157.6</td>
<td>11.25</td>
<td>3.182</td>
</tr>
<tr>
<td>Urea (mg/dl)</td>
<td>14</td>
<td>84.6</td>
<td>6.04</td>
<td>13.59</td>
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<tr>
<td>Creatinine (mg/dl)</td>
<td>14</td>
<td>11.84</td>
<td>0.84</td>
<td>0.080</td>
</tr>
</tbody>
</table>

Figure 7. A pie chart showing the concentration in mg/dl of Urea and Creatinine in female *Tilapia niloticus*.

Figure 8. A bar chart showing the physical parameters, urea and creatinine concentrations of Female *Tilapia niloticus*. 
two times higher than those reported by (Agbede et al., 1999; Ogamba et al., 2010).

Creatinine values observed in this work is slightly higher than the values reported by (Das and Mukherjee, 2000). There was an increase in Urea levels for both species and a slight increase in creatinine level for female C. gariepinus compared to male C. gariepinus. Creatinine levels are the most commonly ordered tests to show the kidney’s ability to excrete metabolic wastes (Tresseles, 1988). The result of this study showed significant increase in the levels of Urea than creatinine for both fish species. Urea level raised out of proportion to creatinine may indicate a pre-renal problem such as volume depletion (Spencer, 1986), (National Kidney Foundation, 2012). Urea levels can also be raised due to consumption of rich protein diet.

The mean Urea and Creatinine levels of Clarias and Tilapia obtained in this study is not in conformity with that of other workers. The differences may be due to difference in climatic and environmental factors in the places from where the species were obtained as suggested by (Barnhart, 1969). Creatinine level greater than 1.5mgdl or lower than 0.8mgdl is considered high or low meaning it's abnormal, while Urea level less than 7.1mgdl or higher than 20 mgdl is abnormal. Abnormal creatinine levels may be due to any of the following conditions that affect the kidneys or muscle, while abnormal urea level may indicate congestive heart failure, gastrointestinal bleeding, kidney failure or disease also diet that contains much of protein.

Conclusion

This study has provided valuable data on urea and creatinine values for Clarias gariepinus and Tilapia niloticus obtained from two commercial ponds (Jeremiah Useni farm and Agricultural Development Project (ADP) farm ) in Gwagwalada. These values can be used for future studies, also for monitoring the health status of fishes.

The high values of urea observed in both species could be majorly as a result of their water been polluted with urea which they excrete and others such as kidney failure, gastrointestinal bleeding and high protein diet.

REFERENCES


APPENDIX

Appendix Table 1. Analysis of Variance (one way ANOVA) showing the significant difference between the Length and Weight, Urea, Creatinine for female *Clarias gariepinus*.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>P-value</th>
<th>F crit</th>
</tr>
</thead>
<tbody>
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<td>2022476</td>
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<td>505618.9</td>
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<td>9.8</td>
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<tr>
<td>Within Groups</td>
<td>474346.4</td>
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<td>7297.63</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
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<td>69</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendix Table 2. Analysis of Variance (One of ANOVA) showing the significant difference between the Weight and Length, Urea and Creatinine of *Clarias gariepinus* (Male).

<table>
<thead>
<tr>
<th>Source of Variation</th>
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<th>df</th>
<th>MS</th>
<th>F</th>
<th>P-value</th>
<th>F crit</th>
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<tbody>
<tr>
<td>Between Groups</td>
<td>30153.8</td>
<td>4</td>
<td>7538.46</td>
<td>114.33</td>
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<td>2.51</td>
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<tr>
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<td>4285.80</td>
<td>65</td>
<td>65.93</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Total</td>
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<td>69</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendix Table 3. Analysis of Variance (One way ANOVA) showing the significant difference between the Weight and Length, Urea and Creatinine of *Tilapia niloticus* (Male).

<table>
<thead>
<tr>
<th>Source of Variation</th>
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<th>df</th>
<th>MS</th>
<th>F</th>
<th>P-value</th>
<th>F crit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>30153.8</td>
<td>4</td>
<td>7538.46</td>
<td>114.33</td>
<td>1.14</td>
<td>2.51</td>
</tr>
<tr>
<td>Within Groups</td>
<td>4285.80</td>
<td>65</td>
<td>65.93</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>34439.66</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendix Table 4. Analysis of Variance (one way ANOVA) showing the significant difference between the Weight and Length, Urea and Creatinine of *Tilapia niloticus* (Female).

<table>
<thead>
<tr>
<th>Source of Variation</th>
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<th>df</th>
<th>MS</th>
<th>F</th>
<th>P-value</th>
<th>F crit</th>
</tr>
</thead>
<tbody>
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<td>137.08</td>
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</tr>
<tr>
<td>Within Groups</td>
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<td>51.157</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>31378.17</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hematological analysis of *Clarias gariepinus* and *Oreochromis niloticus* from Gwagwalada Market, Abuja, Nigeria

Oluwatobi, O. T. and Solomon, R. J.*

Department of Biological Science, Faculty of Science, University of Abuja, Abuja, Nigeria.

*Corresponding author. Email: johnsol2004@yahoo.com

ABSTRACT: *Tilapia* (*Oreochromis niloticus*) and Catfish (*Clarias gariepinus*) are very common fish but little is known about their physiology. This study was carried out to determine the complete hematological profile of catfish (*Clarias gariepinus*) and *Tilapia* (*Oreochromis niloticus*) both of which were obtained from a local fish vendor in Gwagwalada market. They were anaesthetized and analysed and the values of the haematological parameters are as follows: for *Clarias gariepinus*, 124.19 (white blood cell count), 2.35 (Red blood cell count), 131.94fl (Mean corpuscular volume), 32.05% (Packed cell volume), 10.68g/dl (Haemoglobin), and 32.60g/dl (Mean corpuscular haemoglobin) and 24.16 (Mean corpuscular haemoglobin concentration) were calculated. For *Oreochromis niloticus*, 121.65 (White blood cell count), 2.24 (Red blood cell count), 132.21fl (Mean corpuscular volume), 30.07% (Packed cell volume), 10.23g/dl (Haemoglobin), 35.98g/dl (Mean corpuscular haemoglobin) and 30.48 (Mean corpuscular haemoglobin concentration) were calculated. Slight differences were observed in the values of both species with Mean corpuscular volume (*MCV*) and white blood cell count (*WBC*) having the highest mean values while red blood cell count and hemoglobin having the lowest value among both species.

Key words: Haematological parameters, Mean corpuscular haemoglobin concentration, haemoglobin, Red blood cell count.

INTRODUCTION

Fish is of great importance to man and it is one of the most readily available and value source of rich and high graded protein available to man (Heming et al., 2004). Of all source of protein fish is the easiest to digest, with the most of the specie showing protein digestibility of between 90 and 98% (Acton 1999). The prominence of fish as a source of food has been growing, with a rapid expansion in the food industry as a result of increasing population awareness and the demand for it. Currently, about 4.3 billion fingerlings of desirable fish species are required annually for stocking.

Fish live in very intimate contact with their environment and are therefore very susceptible to physical and chemical changes which may be reflected in their blood components (Zinkyl, 2002). In fish, exposure to chemical compounds can either increases or decrease in haematological levels (Arowowora et al., 2003). Blood tissues truly reflect physical and chemical changes occurring in organisms. Therefore, detailed information can be obtained on general metabolism and physiological status of fish indifferent groups of age and habitat. The study of physiological and haematological characteristics of cultured fish species is an important tool in the development of aquaculture system, particularly in regard to its use in detection of healthy from diseased or stressed fish (Olaosebikan et al., 2000). Early diagnosis is also possible, when evaluating haematological data, particularly blood parameters (Stoskopf, 1999). The health of fish has often been reported in terms of the relationship between the weight and length increase.
However, there is a need to understand the physiological concept of fish health in relation to blood and the quality of dietary protein fed. Any changes in the constituent component of blood sample, when compared to the normal values could be used to interpret the metabolic state of animal and state of health. Low haematological indices are indications of anaemic conditions.

**Tilapia fish (Oreochromis niloticus)**

Tilapia is the common name for nearly a hundred species of cichlid fish from the tilapiine cichlid tribe (Sayed, 2006). It has three different genera: Oreochromis, Sarotherodon and Tilapia (Olaosebikan et al., 2000). The members of the other two genera used to belong to the genus tilapia but have since split off into their own genera. However particular species within are still commonly called tilapia regardless of the change in their actual taxonomic nomenclature. Tilapia are mainly fresh water fishes inhabiting shallow streams, ponds, rivers, lakes, and less commonly found living in brackish water. Historically, they have been of major importance in the artisan fishing in Africa and are of increasing importance in aquaculture and aquaponics. Tilapia can become problematic invasive species in new warm water habitat (Baker, 2002) whether deliberately or accidentally introduced but generally not in temperate climate due to their inability to survive in water cooler than about 21°C (70°F).

*Tilapia* typically have laterally compressed deep bodies, their lower pharyngeal bines are fused into a single tooth bearing structure. A complex set of muscles allow the upper and lower pharyngeal bones to be used as second jaw for processing food (Moray 2000), allowing a division of labour between the true jaws (mandibles) and the pharyngeal jaw. This means they are efficient feeders that can capture and process a wide variety of food items. Typically, *Tilapia* have a long dorsal fin and a lateral line which often break towards the end if the dorsal fin and start again two or three rows of scale below. Other than their temperature sensitivity, *Tilapia* exists in or can adapt to a wide range of conditions.

*Tilapia* has been used as biological control for certain aquatic plant problems. It has a preference for a floating plant, but also consumes some filamentous algae. In Kenya, *tilapia* were introduced to control mosquito which was causing malaria, because they feed on mosquito larva, consequently reducing the number of adult female, the vector of the disease. But these benefits are however frequently outweighed by the negative aspect of *tilapia* as an invasive species (Hussein 1996).

**Catfish (Clarias gariepinus)**

The African cat fish *Clarias gariepinus* is a species of catfish family Claridae, the air breathing catfishes. African sharp tooth catfish was introduced all over the world in the early 1980s for aquaculture purposes, so is found in countries far outside its natural habitat, such as Brazil, Vietnam, Indonesia, and India. Description Jumping upstream in a branch of the Sabie River in Indonesia. Young African catfish caught in the sewers of Rishon Lezion in Israel. The African sharp tooth catfish is a large, eel-like fish, usually of dark grey or black coloration on the back, fading to a white belly. In Africa, this catfish has been reported as being second in size only to the vundu of the Zambesian waters. Although, Fish Base suggests the African sharptooth catfish surpasses that species in both maximum length and weight. *Clarias gariepinus* has an average adult length of 1 to 1.5 m. It reaches a maximum length of 1.7 m and can weigh up to 60 kg (130 lb). These fish have slender bodies, flat bony heads, notably flatter than in the genus *Silurus*, and broad, terminal mouths with four pairs of barbells. They also have large accessory breathing organs composed of modified gill arches. Also, only their pectoral fins have spines.

**Haematology**

Haematology is the science of studying the anatomical, physiological, and pathological aspects of blood. Blood is a fluid tissue contained within the cardiovascular system. The fluid element of blood is plasma and the formed elements of blood are the erythrocytes, leukocytes and thrombocytes. The primary functions of blood are: Oxygenation of tissues, nutrition of tissues, maintenance of acid-base balance; and removal of metabolic waste products from tissues. Thus, any dysfunctions of blood can have severe effects on the physiological activities of the entire body. Also, certain physiological dysfunctions in the body are reflected as alterations in blood constituents, which can be used as diagnostic indicators.

The history of applying haematological methods as diagnostic aids in episodes of non-infectious and infectious diseases in confined and free-living populations of fish is quite meagre. The major reason for the lack of utility, as compared with mammalian medicine, is the variability of data. The complete blood count is an important diagnostic tool, with laboratory protocols and reference ranges well established in both human medicine and in veterinary medicine of domestic animals. Advances in zoo medicine have included the application of comparable CBC techniques adapted for many exotic animal species, including birds and reptiles, providing the veterinarian with a valuable tool for health assessment of newly-acquired quarantine animals, routine physical examinations, and for clinically ill animals. As we continue to adapt these methods for fish species, we face challenges similar to those encountered with the early applications of CBC techniques for birds and reptiles.
Like their terrestrial non-mammalian counterparts, fish erythrocytes are nucleated, and a number of the leukocytes also show similar morphology on Romanowsky type stained blood films: thrombocytes, monocytes, lymphocytes, and basophils.

Haematopoiesis

Literature shows that interest in understanding the blood cells of fish dates back to the mid 1800s. Leydig described the lymphomyeloid structures in elasmobranchs as a source of granulocytopoiesis (organ of Leydig) in 1857. Fange (2004) further studied haematopoiesis in a wide variety of elasmobranch species and described these tissues: the organ of Leydig, a white mass located in the dorsal and ventral wall of the oesophagus (abundant granulocytes and lymphocytes); the epigonal organ, associated with the gonads (abundant granulocytes and undistinguished blast-type cells); the spleen (white pulp primarily lymphocytes and red pulp primarily erythrocytes); and the thymus (lymphoid only).

In the more primitive holoccephalans, the site of granulocytopoiesis is found in the tissues within the cranium. In teleosts, the anterior portion of the kidney, referred to as the head kidney, is a major organ of haematopoiesis, with minor sites including the spleen, liver, and thymus.

Description of Fish Blood Cell morphology

**Red blood cell (RBC) count**

Red blood cells count is an estimation of the number of red blood cells per litre of blood. The RBC carries oxygen from the lungs to the rest of the body and they also carry carbon dioxide back to the lungs to be exhaled. Very low amount of red blood cells may lead to anaemia as a result of blood loss, over-hydration and a few other factors. Abnormally high numbers of red blood cells may lead to the clumping of the red blood cells, and these blocks the capillaries and makes it hard for RBC to carry oxygen.

**Packed cell volume (PCV)**

This test is used in measuring the space or volume the red volume cells take up in the blood. The value is given as a percentage of the red blood cells in a volume of blood. The packed cell volume and haemoglobin are the two major test that show if anaemia or polycythaemia is present.

**Haemoglobin (Hb)**

Haemoglobin, also known as haematocrit, molecules fill up the red blood cells: it carries oxygen and gives the blood cell its distinctive red colour. The haemoglobin test measures the amount of haemoglobin in the blood and it’s a good measure of the blood ability to carry out oxygen through the body it also shows if anaemia or polycythaemia is present.

**Mean corpuscular haemoglobin (MCH)**

It is the average amount of haemoglobin per red blood cell, measured in pictograms. The MCH may be low in types of anaemia where the red blood cells are abnormally small, or very high in other types of anaemia where the red blood cells are enlarged.

**Mean corpuscular volume (MCV)**

It is the average volume of red cells. Its value determines the kind of anaemia that will be gotten. When MCV is above or below average, it is termed as microcytic or macrocytic respectively, and if the value is within the expected range, then the anaemia is classified as normocytic. It is measured in femtoliters.

**Mean corpuscular haemoglobin concentration (MCHC)**

This is the average concentration of haemoglobin in the cells. The MCHC value may be low in iron deficiency, blood loss and anaemia caused by chronic disease.

In the light of the above, this study was carried out to determine the complete hematological profile of catfish (Clarias gariepinus) and Tilapia (Oreochromis niloticus).

**MATERIALS AND METHODS**

**Study area**

The study was conducted at the University of Abuja main campus premises. The main campus is located in Gwagwalada area council of the Federal Capital Territory (FCT), Abuja, Nigeria. Gwagwalada is located about 55 kilometres from the Federal capital territory (FCT), Abuja. It lies between the Latitude 8° 55′ and 9° 00′ North and Longitude 7° and 3′ to 7° 05′ East. Its land mass covers a total of 65 square kilometres and located along Kaduna/Lokoja express road. Gwagwalada has two distinct seasons which are; the rainy season which begin around March and ends around October and the dry season that begins around October and ends around March. Gwagwalada has a mean temperature which ranges from 29°C to 33°C. According to Balogun (2002), Gwagwalada has its highest temperature during the dry
Table 1. Hematological analysis for *Clarias gariepinus*.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>WBC</th>
<th>RBC</th>
<th>Hb (g/dL)</th>
<th>PCV (%)</th>
<th>MCV (fL)</th>
<th>MCH (g/dL)</th>
<th>MCHC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>124.19</td>
<td>2.35</td>
<td>7.73</td>
<td>32.05</td>
<td>131.94</td>
<td>32.60</td>
<td>24.16</td>
</tr>
<tr>
<td>Std. Error of Mean</td>
<td>1.673</td>
<td>0.066</td>
<td>0.24</td>
<td>0.97</td>
<td>2.027</td>
<td>.879</td>
<td>.666</td>
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<td>Median</td>
<td>125.75</td>
<td>2.43</td>
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<td>32.50</td>
<td>133.10</td>
<td>32.50</td>
<td>23.60</td>
</tr>
<tr>
<td>Mode</td>
<td>123.40</td>
<td>2.53</td>
<td>6.30</td>
<td>31.00</td>
<td>113.50</td>
<td>32.50</td>
<td>26.20</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>7.48</td>
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<td>1.10</td>
<td>4.34</td>
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<td>5.20</td>
<td>23.00</td>
<td>113.50</td>
<td>24.30</td>
<td>20.00</td>
</tr>
<tr>
<td>Maximum</td>
<td>131.40</td>
<td>2.80</td>
<td>9.20</td>
<td>39.00</td>
<td>147.90</td>
<td>40.10</td>
<td>30.20</td>
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<td>Sum</td>
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<td>47.03</td>
<td>154.60</td>
<td>641.00</td>
<td>2638.8</td>
<td>652.10</td>
<td>483.30</td>
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</tbody>
</table>

Figure 1. Graph of Haematological Value for Catfish (*Clarias gariepinus*) fish. Obtained from the mean (Table 1).

season between the month of January and April, and it drops to its lowest during the rainy season in the month of August.

**Method of sample collection**

*Tilapia* (*Oreochromis niloticus* n=20) were obtained from Gwagwalada market and were bled at the market and samples were placed in EDTA bottles. *Clarias gariepinus* (n=20) were purchased from local fish vendor in Gwagwalada market. Their body weight and length were recorded and their blood samples were placed in EDTA bottles for hematologic purpose and refrigerated. The blood samples were analysed at the University of Abuja teaching hospital, using the Sysmex k-21N machine. This gave values of the white blood cells (WBC), red blood cells (RBC), haemoglobin (Hb), packed cell volume (PCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC).

**RESULTS AND DISCUSSION**

The mean value of the haematological parameters for catfish (*Clarias gariepinus*) was recorded. WBC had a mean value of 124, RBC had a mean value of 2.3515, HB had a mean value of 7.7300, PCV had a mean 32.0500, MCV had a mean of 131.9400, MCH 32.6050 and MCHC had a mean value of 24.1650.MCV had the highest value with a value 131.9400 while RBC has the lowest value with a value 2.3515 (Table 1 and Figure 1). Figure 1 shows the graphical representation of the mean sample of haematological treatment on Tilapia fish. The graph shows that in RBC and HB the treatment is within range of 2-5-level which means it reduces. But it rises at MCV
### Table 2. Hematological analysis for Tilapia.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>WBC</th>
<th>RBC</th>
<th>Hb (g/dL)</th>
<th>PCV (%)</th>
<th>MCV (%)</th>
<th>MCH (g/dL)</th>
<th>MCHC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>121.65</td>
<td>2.24</td>
<td>10.23</td>
<td>30.70</td>
<td>132.21</td>
<td>35.98</td>
<td>30.48</td>
</tr>
<tr>
<td>Std. Error of Mean</td>
<td>1.43</td>
<td>0.113</td>
<td>0.33</td>
<td>1.054</td>
<td>2.63</td>
<td>0.70</td>
<td>0.586</td>
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<td>Median</td>
<td>123.10</td>
<td>2.35</td>
<td>8.40</td>
<td>31.00</td>
<td>136.25</td>
<td>36.15</td>
<td>30.30</td>
</tr>
<tr>
<td>Mode</td>
<td>118.20</td>
<td>2.80</td>
<td>9.40</td>
<td>35.00</td>
<td>140.20</td>
<td>35.90</td>
<td>26.90</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>6.39</td>
<td>0.509</td>
<td>1.48</td>
<td>4.71</td>
<td>11.76</td>
<td>3.17</td>
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<tr>
<td>Minimum</td>
<td>101.80</td>
<td>1.40</td>
<td>4.70</td>
<td>20.00</td>
<td>110.10</td>
<td>30.20</td>
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</tr>
<tr>
<td>Maximum</td>
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<td>2.90</td>
<td>9.80</td>
<td>38.00</td>
<td>147.80</td>
<td>43.40</td>
<td>35.80</td>
</tr>
<tr>
<td>Sum</td>
<td>2433.0</td>
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<td>161.20</td>
<td>614.00</td>
<td>2644.3</td>
<td>719.60</td>
<td>609.60</td>
</tr>
</tbody>
</table>

Figure 2. Graph of Haematological Value for Tilapia Fish (Oreochromis niloticus). Obtained from the mean (Table 2).

and WBC and then drops at PCV, MCH and MCHC. This shows that as the treatment increases the sample also increases. It was then concluded that RBC, HB PCV, MCH and MCHC treatments were not effective but WBC and MCV treatments were effective.

The mean value of all the haematological parameter for tilapia was recorded. WBC had a mean value of 121.6500, RBC had a mean value of 2.2400, HB had a mean value of 10.23, PCV had a mean value of 30.7000, MCV had a mean value of 132.2150, MCH had a mean value of 35.9800, and MCHC had a mean value of 30.4800. MCV had the highest mean value among the parameters and RBC and HB had the same mean range (2.2400) and also had the lowest mean value among the parameters (Table 2 and Figure 2). Figure 2 shows the graphical representation of the mean sample of haematological treatment on tilapia (Oreochromis niloticus), the graph shows that in RBC and HB the treatment level was around the range of two (2) which means it reduces. But it rises in MCV, WBC and then drops in MCH, MCHC and PCV. And this shows that when the treatment is increasing the sample also increases. It was concluded that RBC, HB, MCH, MCHC, PCV treatments were not effective but WBC, MCV were effective.

When a comparison with previously reported on haematological value, the result obtained was similar for most of the analyses. Adeyemo (2007) noticed a slight difference between the packed cell volume (PCV) values of both species. The PCV value obtained for Clarias gariepinus was slightly higher (32.05) than that of Tilapia (30.70) (Tables 1 and 2). Also the value of WBC of Catfish was slightly higher than in Tilapia (mean value of catfish being 124.1900 while that of Tilapia is 121.6500).
(Tables 1 and 2). The value of MCV was higher in *Tilapia* (132.2150) than in catfish (131.9400). All the haematological values determined for both species were reported as mean.

**Conclusion**

The differences obtained from the mean haematological values of both species were slightly apart. Therefore there was no much significant differences between haematological values of *Clarias garipinus* and *Oreochromis niloticus*.

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Colibacillosis in calves: A review of literature

Bashahun, G. M.* and Amina A.

Jimma University, College of Agriculture and Veterinary Medicine. School of Veterinary Medicine, Jimma, P. O. Box 307, Ethiopia.

*Corresponding author. Email: bashahun@gmail.com. Tel: +251 917307139. Fax: +25147 1110935.

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ABSTRACT: Colibacillosis is considered as one of the most important problems faced in livestock production, causing great economic losses. Calves become exposed to pathogenic E. coli in the environment when other infected or carrier calves and cows shed the bacteria in the feces. Diagnosing of E. coli infection in calves depends on an accurate history, clinical signs, culture of internal organs for bacteria, and serotyping of the organism. This disease requires an immediate response, centered on isolation and rehydration therapy. Parental antibiotics can be useful if given early, but not without rehydration therapy. Prevalence of Colibacillosis varies from 5.4 to 100%, and it is roughly estimated that a calf mortality associated with Colibacillosis of 20% may reduce net profit to 40%. Thus, control and prevention measures should be conducted through the use of dam vaccination before calving, improve hygiene around calving and proper colostrum administration.

Key words: Colibacillosis, Calves, Escherichia coli, Economic Loss, Hygiene.

INTRODUCTION

Colibacillosis also known as: E. coli infection, enterotoxigenic E. coli (ETEC) or Septicaemic Colibacillosis. Various serotypes of enterotoxigenic E. coli can cause either diarrhoea or septicaemia in very young calves (Kang et al., 2004; Gruenberg, 2014). Septicemic colibacillosis is a major cause of early calf deaths. The condition is often fatal or leads to post-septicaemic infections that are often non-responsive to treatment. If an outbreak occurs, every effort should be made to isolate the affected calves immediately. ETEC cause diarrhoea in very young calves, less than 3 to 4 days of age (typically less than 48 hours of age). Calves are depressed, do not drink or suckle, become dehydrated, and die rapidly. Very profuse and watery diarrhoea is typical of ETEC scour.

E. coli is widely distributed in nature, being present in soil, surface water, animal and human feces. E. coli produces septemia and diarrhea in a wide range of hosts including man, avian and animals. Calves are the most vulnerable to E. coli infection. Two age groups appear to be of calves of 1 to 3 days of age and of 3 to 8 weeks of old are more susceptible. Symptoms include diarrhea, a rise in body temperature, general weakness, dehydrated and lack of appetite. These symptoms are soon followed by coma and death within a few hours (Radoskis et al., 2000).

Colibacillosis (Escherichia coli) has been implicated as a major cause of scouring in calves. Many times, this is the only organism identified following routine bacteriologic culturing. Certain E. coli can cause diarrhea. Many different serotypes of E. coli have been identified; some cause scours while others do not. E. coli is always present in the intestinal tract and is usually the agent that causes a secondary infection following viral agents or other intestinal irritants. E. coli scour is characterized by diarrhea and progressive dehydration. Death may occur in a few hours before diarrhea develops. The color and consistency of the feces are of little value in making a diagnosis of any type of diarrhea. The course varies from 2 to 4 days, and severity depends on age of the calf when scouring starts and on the particular serotype of E. coli (Hudson and White, 1982).

Diagnosis depends on an accurate history, clinical signs, and culture of internal organs for bacteria and serotyping of the organism. The location at which the culture from the intestine was taken is also important. Control of E. coli scour can be difficult in a severe herd outbreak. All calves should receive colostrum as soon as
possible after birth. This helps the calf to resist *E. coli* infection. Early isolation and treatment of scours helps to prevent new cases. There are new *E. coli* cow vaccines now on the market. These vaccines contain the K99 antigen which should give immunity against many types of *E. coli*. The vaccine is administered six weeks and three weeks prior to calving. The new *E. coli* vaccine is also available in combination with the Rota and Coronavirus vaccine. This vaccination builds high antibody levels in the colostrum, but the calf must get colostrum in the first few hours of life for the vaccine to be effective (Hudson and White, 1982).

Thus, the aim of this review is to evaluate the existing literatures and disseminate appropriate information on calf *Colibacillosis*.

**METHODOLOGY**

On the way to find literatures, an electronic internet searching was carried out via google scholars. Terminologies used to search and access the required data include *colibacillosis*, *colibacillosis* in calves, *E. coli* in calves, calf diarrhea, and prevalence of *colibacillosis* in Ethiopia. Books and book chapters, short communication reports, case reports, conference abstracts, recognized international organizations reports, country reports and articles were included in this review. In the present report, all relevant literatures related to calf *colibacillosis* were reviewed properly to prepare this manuscript.

**ETIOLOGY**

The bacterium, *Escherichia coli*, is the primary cause of diarrhea in calves one to two days old. Usually associated with inadequate intake of the mother's colostrum, unhygienic conditions and stress. It may also occur in older calves subjected to stress (HMD, 2010). *E. coli* is a natural inhabitant of the intestines. However, some types of *E. coli* bacteria are capable of causing disease. The source of infection in an otherwise uninfected herd is usually normal calves and adult cows that serve as reservoirs of infection. These carrier animals can allow the bacteria to persist in a herd by circulating through animals of all ages. The most common route of infection with these pathogenic forms of *E. coli* is ingestion. It is also possible for calves to become infected via the nasopharyngeal mucosa (i.e. inhalation), which can lead to meningitis (infection of the tissues around the brain). Calves become exposed to pathogenic *E. coli* in the environment when other infected or carrier calves and cows shed the bacteria in the feces. The calves become ill when they ingest *E. coli* from contaminated bedding and calf pails, dirty calf pens, diarrheic calves in overcrowded calving grounds, and from the skin of the perineum and udder of the dam (Arsdall, 2011).

The disease is caused by specific invasive serotypes of *E. coli* that possess virulence factors enabling them to cross mucosal surfaces, overcome the bactericidal plasma factors, and produce bacteremia and septicemia. The main determinant of the disease is deficiency of circulating immunoglobulins as the result of a failure in passive transfer of colostral immunoglobulin. *Coli septicemia* is seen during the first weeks of life, with the highest incidence in animals of 2 to 5 days old. Bacteremia and septicemia in calves and lambs are most commonly associated with *E coli* and to a lesser extent *Salmonella Spp*. Approximately 30% of diarrheic calves with severe systemic clinical signs were found to be bacteremic or septicemic, with *E. coli* the most commonly isolated pathogen from blood cultures (Gruenberg, 2014).

**TYPES OF PATHOGENIC *E. COLI***

Pathogenic *E. coli* are divided into two types: *Enteropathogenic E. coli* and *Uropathogenic E. coli*. Further pathogenic *E. coli* are grouped into *enterotoxigenic E. coli* (ETEC), *enteropathogenic E. coli* (EPEC), *enteroinvasive E. coli* (EIEC), *enteroaggregative E. coli* (EAEC) and *enterohemorrhagic E. coli* (EHEC). Calf diarrhea is being controlled primarily following the maintenance of strict hygienic and sanitary measures (Radostits et al., 2000).

*Enterotoxigenic E. coli* attaches to the wall of the small intestine where it releases toxins that cause the body to excrete fluids into the intestine. This results in severe diarrhea within the first three days of life.

*Septicemic E. coli* invades the blood stream and travels to distant sites in to body including the joints and other organs.

*Enterohemorrhagic E. coli* and verocytotoxin *E. coli* produce shiga-like toxin that destroys intestinal microvilli resulting in hemorrhagic diarrhea in calves that are 2-5 weeks old.

Among *E. coli* patho-groups, the most common cause of NCD is ETEC stains that produce the K99 (F5) adhesion antigen (E. coli K99+) and heat-stable (STa or STb) and/or heat-labile (LT1 or LT2) enterotoxins (Kaper et al., 2004). The description of a study of the *E. coli* strains isolated from the sick calves in Smith and Little (1930) study led Wramby to conclude that these strains were mucoid *E. coli* possessing A-type K antigens. This type of *E. coli* is associated with a specific form of *colibacillosis* (the enteric-toxemic form) in which tremendous numbers of *E. coli* is found in the small intestine (Gay, 1964).

Systemic *colibacillosis* occurs frequently in calves, lambs and poultry. Bacteraemic strains of *E. coli* pass through the mucosa of the alimentary or respiratory tract and enter the blood stream where they may cause either (a) a generalized infection (colisepticæmia) or (b) a localized infection such as meningitis and/or arthritis in calves and lambs (Wray and Morris, 1985). This occurs
commonly in hypogammaglobulinaemic calves, usually in colostrums deprived animals, but it may also occur in some colostrum-fed animals which have failed to absorb the immunoglobulins. If colostrum is to be effective, it must be ingested within a few hours of birth because little or no absorption occurs after 24 to 36 hours.

**EPIDEMIOLOGY OF THE DISEASE**

Epidemiological studies have shown that many of the human serotypes mentioned above are capable of spreading and actually causing epidemics of diarrhea in hospitals (Gay, 1964). If evidence of this kind were available from field outbreaks of colibacillosis, it would provide convincing evidence of the pathogenicity of certain strains of *E. coli* for calves. Although there are numerous reports of the epidemic and contagious quality of field outbreaks of colibacillosis, there are few in which these observations are confirmed by serological typing. The first studies of an epidemiological nature were conducted on the experimental calves used in the previously mentioned studies of Aschaffenburg et al. (1951). It is probable that the serotype of *E. coli* associated with the enteric form of colibacillosis will be more easily determined by epidemiological studies of outbreaks of calf diarrhea. There is some evidence to suggest that the isolation of a single serotype of *E. coli* from multiple cases of scouring within the same herd would be an indication that it is the causative agent of the diarrhea.

Varying prevalence of *E. coli* has been reported by different studies. For instance, Hemashenpagam et al. (2009) in India (75%), Joon and Kaura (1993) in India (23%), Viring et al. (1993) in Sweden (11.5%), Khan and Khan (1997) in Pakistan (54%), Steiner et al. (1997) in Germany (42%), Bendali et al. (1999) in France (20.3%), Valdivia-Andy et al. (2000) in Mexico (63.7%), Oporto et al. (2008) in Northern Spain (35.9%), and Izzo et al. (2011) in Australia (17.4%), and Pourtaghi et al. (2013) in Iran (86.7%). In addition to this other studies reported the prevalence of the disease as 80% by Awad et al. (1979), 82% by Haggag and Khaili (2002), 5.4% by Azzam et al. (2006), 35.8% by El-Shehedi et al. (2013) and 63.6% by Osman et al. (2013). The differences of the prevalence rates among different studies may be due to the ecological differences and management practice as well as hygienic measures (Cho and Yoon, 2014).

**TRANSMISSION**

It is assumed that the primary source of the infection is the feces of infected animals, including the healthy dams and neonates, and diarrheic newborn animals, which act as multipliers of the organisms. Invasion occurs primarily through the nasal and oropharyngeal mucosa but can also occur across the intestine or via the umbilicus and umbilical veins. Septicemic strains of *E. coli* produce endotoxin, which results in shock and rapid death. There is a period of subclinical bacteremia that, with virulent strains, is followed by rapid development of septicemia and death from endotoxemic shock. A more prolonged course, with localization of infection, polyarthritis, meningitis, and less commonly uveitis and nephritis, is seen with less virulent strains. Chronic disease also develops in calves that have acquired marginal levels of circulating immunoglobulin. The organism is excreted in nasal and oral secretions, urine, and feces; excretion begins during the preclinical bacteremic stage. Initial infection can be acquired from a contaminated environment. In groups of calves, transmission is by direct nose-to-nose contact, urinary and respiratory aerosols, or as the result of navel sucking or fecal-oral contact (Gruenberg, 2014).

**PATHOGENESIS**

The primary harm from scour is loss of water and electrolytes (body salts) in the diarrhea. This loss of water and salts creates dehydration and alteration of the acid-base balance of the bodily fluids. Inflammation of the intestinal lining impairs the calf’s ability to digest nutrients, creating weight loss and the potential for hypoglycemia (low blood sugar). If untreated, these changes can be severe enough to result in death. *E. coli* causes a watery diarrhea and weakness in 1 to 4 days old newborn calves. Death usually occurred within 24 hours due to severe dehydration (Cho et al., 2010). The fimbrial adhesion F5 (K99) promotes the adhesion of bacterial cells to glycoproteins on the epithelial surface of the jejunum and/or ileum, and bacterial enterotoxin also causes damage to the epithelial cells, resulting in fluid secretion and diarrhea (Acres, 1985).

Pathogenicity of *E. coli* strains are due to the presence of one or more virulence factors including invasiveness factors like invasins, heat labile, heat stable enterotoxins, verotoxins and colonization factors or adhesins (Kaper et al., 2004). In addition, the virulence reasons associated with colibacillosis include the possession of large transmissible virulence plasmids, as well as the ability to resist phagocytosis and serum killing. They also include the ability to uptake iron at low extracellular concentrations and, most importantly, the ability to attach and adhere to the host’s structures. Age of the host also plays a role in the pathogenicity of *E. coli* types. There are other risk factors that increase the likelihood of a colibacillosis infection as well. The *E. coli* strain, the strength of the host’s immune system and exposure time all play a role (Lutful, 2010).

**CLINICAL FINDINGS**

Colibacillosis can be detected in livestock by severe diarrhea caused by enteritis, lameness, stunted growth,
inactivity, lack of appetite and water consumption, and unresponsiveness. These factors are common signs of the infections listed above, and are all possible indicators of *coli bacillosis*. It is important to note that one infected animal might not express all of these characteristics, or even most of them. If an animal possesses one or more of these factors, it does necessarily have *coli bacillosis* either. These are simply common symptoms of the disease. *Coli bacillosis* signs are nonspecific and vary widely among different hosts. Morbidity and mortality are very variable depending on which infection/infections the *E. coli* strain causes in a particular flock of animals (Ahmed et al., 2013; Nolan, 2013).

In the per-acute and acute disease, the clinical course is short (3 to 8 hours), and signs are related to development of septic shock. Fever is not prominent, and the rectal temperature may even be subnormal. Listlessness and an early loss of interest in sucking are followed by depression, poor response to external stimuli, collapse, recumbency, cold extremities, and coma. Tachycardia, a weak pulse, and prolonged capillary refill time are seen. The feces are loose and mucoid, but severe diarrhea is not seen in uncomplicated cases. Tremor, hyperesthesia, opisthotonos and convulsions are seen occasionally, but stupor and coma are more common. Mortality approaches 100%. With a more prolonged clinical course, the infection may localize. Polyarthritis, ophthalmitis, omphalophlebitis, and meningitis may occur within the first week of the initial bacteremic phase (Gruenberg, 2014).

Profuse, foul-smelling, yellow-to-white diarrhea, may infect the lungs, navel or joints with affected calves being dull and emaciated and may cause sudden death in calves under two weeks of age due to septicaemia or toxæmia (HMD, 2010). The clinical syndrome believed to be associated with *coli bacillosis* may vary considerably. Calves may be affected with diarrhea for prolonged periods of time, or they may die suddenly with an acute septicaemia. There are, however, other diseases of calves which may simulate *coli bacillosis* (i.e., acute septicaemias caused by Streptococcus, Diplococcus, Pasteurella and *Salmonella spp.*). There are also a variety of conditions, both infectious and noninfectious, which may cause diarrhea in young calves. The syndromes associated with *coli bacillosis* have been divided into three forms on clinical and bacteriological grounds and on the grounds of possible pathogenesis (Gay, 1964). First, the colisepticemic form of *coli bacillosis* usually results in the rapid death of the calf and is associated with an *E. coli* bacteremia. Although many strains of *E. coli* have been isolated from cases of colisepticemia, the isolations from the internal organs of a given case are of a single strain in pure culture. Second, the enteric-toxemic form is also associated with the collapse and rapid death of the calf, but it is associated with the proliferation of certain specific strains of *E. coli* in the small intestine. There is no bacteremia, and death is presumably due to a toxemia. This form is probably analogous to that called isocolibacillosis in some earlier publications. Finally, the enteric form is part of the syndrome of the scouring calf. Death may or may not occur depending upon the severity of the physiological derangements produced.

**DIAGNOSIS**

The family *Enterobacteriaceae* is composed of gram-negative rods which may or may not be motile, and it attacks glucose with the production of acid or acid and gas. Nitrates are usually reduced to nitrites. On the basis of further biochemical reactions, the family may be arranged into divisions and then into groups, one of which is *E. coli*. These groups are not distinct, but form dense populations within the family which have certain biochemical properties. Within the *E. coli* group, the individual strains are identified by serological methods. These serological types can be further divided or classified by biochemical characteristics, phage susceptibility and susceptibility to colicines (Parr et al., 1960; Barry et al., 1962). There are three main antigens of *E. coli* which are used in its identification: O or somatic antigens, K antigens which occur as capsules or microcapsules, and H or flagella antigens.

No single laboratory parameter is considered reliable for early diagnosis of septicaemia. A moderate but significant leukocytosis and neutrophilia are seen early, but leukopenia is more common in severe and advanced cases. A left shift of neutrophils and signs of toxicity of neutrophils as well as hypoglycemia are common findings. Because failure of transfer of passive immunity is the single most important predisposing factor, subnormal serum IgG and total protein concentrations are common. Subnormal platelet counts are the result of a consumptive coagulopathy. In cases of arthritis, the joint fluid has an increased inflammatory cell count and protein concentration. With meningitis, the CSF shows pleocytosis and an increased protein concentration; organisms may be evident on microscopic examination. Less commonly, other bacteria, including other *Enterobacteriaceae*, *Streptococcus* pp and *Pasteurellas* pp, produce septicemic disease in young calves. These organisms are more common in sporadic cases than as causes of outbreaks. They produce similar clinical disease but can be differentiated by culture. As with colisepticemia, the primary determinant of these infections is a failure of passive transfer of colostral immunoglobulins (Gruenberg, 2014).

Upon postmortem examination, lesions are nonspecific. However, the small intestine may be filled with fluid and the large intestine may contain yellowish feces. Generally, the diagnosis is based on history and clinical findings, demonstration of a severe deficiency of circulating IgG, serological test and ultimately, demonstration of the organism in blood or tissues; bio-
chemical analyses (Gruenberg, 2014).

Differential diagnosis

Salmonellosis

Calves are usually affected at six days of age or older. This age corresponds very closely to the age of the coronavirus infection. Clinical signs associated with salmonella infection include diarrhea, blood and fibrin in the feces, depression, and elevated temperature. The disease is more severe in young or debilitated calves. Finding a membrane like coating in the intestine on necropsy is strong presumptive evidence that salmonella might be involved (Hudson and White, 1982).

Rotavirus

A reo-like virus can cause scours in calves within 24 hours of birth. However, when the infection- is first introduced into the herd, it can affect calves up to 30 days of age or older. Infected calves are severely depressed. There may be a drooling of saliva and profuse watery diarrhea (Hudson and White, 1982). The feces will vary in color from yellow to green. The reo-like virus infection alone causes no diagnostic gross lesions in the intestine, but there is an increased volume of fluid in both the small and large intestine.

Bovine Virus Diarrhea

The virus of bovine virus diarrhea can cause diarrhea and death in young calves. Diarrhea begins two to three days after exposure and may persist for quite a long time. Ulcers on the tongue, lips, and in the mouth are the usual lesions that can be found in the live calf (Hudson and White, 1982).

Coronavirus

Diarrhea caused by coronavirus occurs in calves that are over five days of age. At the start of the infection in herd, calves up to six weeks of age may scour. These calves are not as depressed as those infected with rotavirus. Initially, the fecal material may have the same appearance as that caused by rotavirus. As the calf continues to scour for several hours, the fecal material may contain clear mucus that resembles the white of an egg. Diarrhea may continue for several days. Mortality from coronavirus scour ranges from 1 to 25% (Hudson and White, 1982).

Coccidiosis

Coccidiosis is caused by one-celled parasites that invade the intestinal tract of animals. There are many species of coccidia. Eimeriaazurnii and Eimeriabovis are usually associated with clinical infections in cattle. Coccidiosis has been observed in calves three weeks of age and older, usually following stress, poor sanitation, overcrowding or sudden changes of feed. It often occurs in calves of 7 to 14 days after they are moved from the calving lots onto pasture (Hudson and White, 1982). Occasionally, clinical coccidiosis will be present with bleeding and very few parasites in the fecal material. Death may occur during the acute period or later from secondary complications.

Cryptosporidium

Cryptosporidium is a protozoan parasite that is much smaller than coccidia. It has the ability to adhere to the cells that line the small intestine and to damage the microvilli. Several reports from researchers and diagnosticians have associated cryptosporidium with outbreaks of calf scours. As a rule, cryptosporidium is detected in combination with coronavirus, rotavirus, and/or E. coli. Calves infected by cryptosporidium (Figure 1) have ranged from 1 to 3 weeks in age (Hudson and White, 1982).

Nutritional cause

Nutritional in calves can be caused by anything that disrupts this normal habit. A storm, strong wind, or the mother going off hunting for new grass disrupts the normal nursing pattern. When the hungry calf does get an opportunity to nurse, the cow's udder may contain more milk than normal and the calf may overeat resulting in a nutritional scour. Erratic nursing patterns may also be conducive to enterotoxemia. Nutritional scours is usually white scours caused by undigested milk passing through the intestinal tract (Hudson and White, 1982). This type of diarrhea usually presents little problem in treatment. If the affected calves are still active and alert, no treatment is required. If the calf becomes depressed or fails to nurse, it should be treated.

TREATMENT

This disease requires an immediate response, centered on isolation and rehydration therapy. Parental antibiotics can be useful if given early, but not without rehydration therapy (Constable et al., 1992). Treatment requires aggressive antimicrobial, fluid and anti-inflammatory therapy (Figure 2). Although blood cultures are recommended to retrospectively confirm the diagnosis, antimicrobial therapy must be initiated immediately in any animal suspected of being septic. Because there is no
time for sensitivity testing, the initial choice should be a bactericidal drug that has a high probability of efficacy against gram-negative organisms. Administration IV of large volumes of balanced electrolyte solutions over several hours is essential to correct hypovolemia and assure adequate peripheral tissue perfusion; fluids should include glucose to correct hypoglycemia. The beneficial effect of NSAIDs has been attributed to their anti-inflammatory, antipyretic, and analgesic properties. Glucocorticoids have also been proposed to treat septicemia, although their benefits for treatment of sepsis are less well established (Gruenberg, 2014).
CONTROL AND PREVENTION

Calves that acquire adequate concentrations of immunoglobulin from colostrum are resistant to colisepticemia. Therefore, prevention depends primarily on management practices that ensure an adequate and early intake of colostrum. The adequacy of the farm's practice of feeding colostrum should be monitored, and corrective strategies applied as required. In North American Holstein dairy herds, natural sucking does not guarantee adequate concentrations of circulating immunoglobulins, and calves should be fed 2 to 4 L of first-milking colostrum containing a minimal total mass of 100 g of IgG, using a nipple bottle or an esophageal feeder, within 2 hrs of birth; this is followed by a second feeding at 12 hrs. A cow-side immunoassay test can assist in selection of colostrum with adequate immunoglobulin concentration. Although the circulating concentration of immunoglobulin required to protect against colisepticemia is low, high concentrations are desirable to decrease susceptibility to other neonatal infectious diseases (Gruenberg, 2014).

When natural colostrum is not available for a newborn calf, commercial colostrum substitutes containing 25 g of IgG will provide sufficient immunoglobulin for protection against colisepticemia if fed early in the absorptive period. Plasma containing at least 4 g and preferably 8 g of IgG, administered parenterally, will provide some protection for older calves that have not been fed colostrum and are unable to absorb immunoglobulins from the intestine. Small-volume hyper immune serum is of benefit only when it contains antibody specific to the particular serotype associated with an outbreak. The risk of early infection should be minimized by hygiene in the calving area and disinfection of the navel at birth. To minimize transmission, calves reared indoors should be in separate pens (without contact) or reared in calf hutches (Gruenberg, 2014).

Despite the increased availability of vaccines against ETEC and other pathogens associated with NCD and continued emphasis on optimizing colostral transfer of passive immunity, improved treatment protocols for calf diarrhea are necessary. Although, the administration of intravenous fluids and oral electrolyte solutions plays the main role in treatment, the efficacy of antimicrobial drugs in treating calf diarrhea is argumentative (Constable, 2004). Diarrheic calves are more likely to have failure or partial failure of passive transfer, and so they are more likely to be bacteraemic (Constable, 2004) and this is an additional cause that antimicrobial agents might be indicated in the treatment of calf diarrhea. The type of antibiotic drug should better be selected on the basis of its sensitivity, which could be detected by laboratory examination, and the antimicrobial treatment of diarrheic calves should therefore be focused against bacteria in the two sites of infection: the small intestine and the blood (Constable, 2004).

Ensuring a clean environment for calving minimizes exposure to potential pathogens such as E. coli (Figure 3). The passive immunity acquired from the colostrum and absorbed into the circulation from the gut is the calf's main defense mechanism against E. coli diarrhea. Inadequate amounts of antibodies in the colostrum, inadequate intake of the colostrum and inadequate absorption of antibodies from the gut render very young calves susceptible to infection (Groutides and Michell, 1990). Additionally, among calves aged 1 to 4 months old, carriage of VTEC E. coli O157 was reduced if the calf...
had suckled colostrum from the mother or if the calf had stayed more than two days with the mother after calving. For herd where a known infection is present an improvement in colostrum feeding in the first 6-9 hours of life and dam immunization against ETEC E. coli F5 (K99) adhesin (Rotavec Corona, Schering Plough Animal Health, Lactovac, Zoetis Animal Health, Trivacton 6, Merial Animal Health) are the main ways of controlling disease.

**ECONOMIC IMPORTANCE OF THE DISEASE**

The economic loss occasioned by neonatal disease in young calves has been recognized for many years. It is apparent from postmortem and bacteriological examination of such calves that there are many causes of this loss; however, *coli* infection caused by *E. coli* is by far the most common (Linton, 1960). For instance, it is roughly estimated that a calf mortality of 20% may reduce net profit to 40% (Blood and Radostitis, 1989). Mortality in neonatal calves has been mostly attributed to infectious agents, such as enteropathogenic *E. coli*, *Salmonella spp.* and other viral agents.

Neonatal calf diarrhea is one of the most common diseases in young animals, causing huge economic and productivity losses to bovine industry worldwide (Cho and Yoon, 2014). Among bacteria, *ETEC* is the most economically important pathogen (Achá et al., 2004), although other bacteria have also been identified as causes of enteric disease. Gunn (2003) reported that the losses due to an occurrence of the disease include: calf death (Figure 4) - which is effectively the loss of income from a cow for the year, cost of treatment of the calf, including the time taken, which can be significant in a paddock situation, impact on growth rate and possible lower weaning weight, culling cost of the dam (in most situations she is likely to be culled because she does not have a calf at foot at weaning/marking), loss of genetic potential from the calf and the dam and decreases capacity to improve and maintain the herd. In general, the published data shown that, diseases of the new born calf mortality are the major causes of economic losses in livestock production (Singh et al., 2009). High numbers of calves usually affected within a herd and the cost of treatment of diseased calves, long-term ill-thrift in chronically affected calves and the cost of losing potential replacement heifer calves (HMD, 2010).

**Zoonotic Importance**

Several of the agents that produce diarrhea in calves can also produce diarrheal disease in people. These organisms are commonly present as subclinical infections in the gut of calves and lambs; immune compromised
people should avoid contact with young ruminants and possibly all farm animals (Radostits et al., 1994). Cattle, including calves, are one of the reservoirs for the verotoxic E. coli serotype O157:H7 that is associated with human hemorrhagic colitis and the hemolytic uremic syndrome. Infection in people is usually acquired by consumption of contaminated food, but the infective dose is low, and the possibility of infection by direct contact exists (Smith, 2002).

Other verotoxic E. coli associated with human disease can also be isolated from the feces of healthy cattle. Human disease from infection with enteric livestock pathogens has occurred after seemingly trivial contact associated with visits to livestock fairs, petting zoos, and farm educational tours. Hand cleansing and disinfection should be a component of these visits (Carter and Changapa, 1989).

CONCLUSION

Colibacillosis is considered as one of the most important problems faced in livestock production, causing great economic losses. Prevalence of Colibacillosis varies from 5.4 to 100%, and it is roughly estimated that a calf mortality associated with Colibacillosis of 20% may reduce net profit to 40%. Thus, effective control and prevention measures should be done through the use of dam vaccination before calving, improve hygiene around calving, and proper colostrum administration.

LIMITATIONS

This review has some limitations; as there is a lack of recent published documents, the old literatures were also reviewed to show relevant information on Colibacillosis in calves.

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Assessment of heavy metals in body muscles/organisms of locally reared poultry in cocoa and non-cocoa producing areas of Cross River State, Nigeria

Williams, Mary Emmanuel¹, Igile, Godwin O.², Usoro, Ofoninyene Okon¹ and Offiong, Edem¹

¹Department of Animal Science, Akwa Ibom State University, P.M.B. 1167, Uyo, Nigeria.
²Department of Biochemistry, University of Calabar, Calabar. Nigeria.

*Corresponding author. Email: mw189742@gmail.com. Tel: +234 8034062727.

ABSTRACT: There is a growing concern about the impact of increased use of Agro-pesticide on public health and safety issues especially in farming community who pursue high agricultural productivity. Pesticide pollution is a subject of global concern and the extent of its poisoning is considered to be grossly underestimated. This study was conducted to assess the concentration of heavy metals (Cd, Pb, Hg, Cr, As, and Ni) in muscle, liver, kidney and lungs of matured locally reared chickens. Sampling was carried out in two cocoa producing areas (Ikom and Etung) and non-cocoa producing area (Odukpani) in Cross River State, Nigeria, over a period of one year (November, 2013 to October, 2014). Determination of heavy metals was carried out using Atomic Absorption Spectrophotometer (ASS). Highest levels of cadmium (0.11±0.02 µg/g) and lead (0.26±0.11 µg/g) were recorded in liver simples from Etung and Ikom. The highest levels of chromium concentration (2.95±0.05 µg/g) was observed in kidney of chickens from Etung, while nickel (1.16±0.404 µg/g) was highest in lung samples from Etung and Odukpani recorded the highest nickel concentration values (1.16±0.04 µg/g). The results show that higher levels of heavy metals can accumulate in the body tissues/organisms of chickens in cocoa producing area. These are no exception since Etung is a cocoa producing area and the metals were found highest in kidney and lungs of chicken from this area. Generally, livers and kidneys were found to have the highly significant (P<0.5) levels of the metals than the muscles and lungs the lowest. However, the concentrations of all the metals studied were within the tolerance limits with exception of chromium and nickel which were respectively higher than their 0.10 µg/g and 0.5 µg/g tolerance limit. The results obtained in this study will be useful in formulating guidelines and standards for heavy metals in chicken products in cocoa-producing and non-cocoa producing areas of Nigeria.

Key words: Bio-accumulation, local chicken, tissues, organs.

INTRODUCTION

Cocoa business includes cocoa farming, cocoa seed processing, warehousing and export. This cocoa value chain processes is sustained with the application of various pesticides right from (pre and post-harvest) inception of cocoa industry in Nigeria, including cocoa producing areas of Cross River State. Unsafe use of pesticides has been shown by various studies to be detrimental to livestock, environment and particularly the food chain including crops, man and other animals. Unregulated use of pesticides can generates persistent organic pollutants (POPS) and leaves pesticide residues in the environment (Asogwa and Dongo, 2009).

Most pesticides contain heavy metals including those of global concern such as mercury (Hg), cadmium (Cd) and chromium (Cr). Others include lead (Pb), Arsenic (As) and Iron (Fe). These heavy metals are generally known to elicit deleterious metabolic and endocrine response in man and animals and also interact adversely with mineral element to reduce their bioavailability in human nutrition (Johnson, 2004). Baykov et al. (1996) and Demirezen and Uruc (2006) indicated that contamination with heavy metals is a severe health hazard since they are toxic, bio accumulates and biomagnify in the food chain. Furthermore, the accumulation of heavy metals varies...
significantly from one tissue to another within an animal and varies also between one animal to another (John and Jeanne, 1994).

The human population in cocoa growing areas of Cross River State including Ikom and Etung Local Government Areas is in the rural, low income and food insecure areas. Family poultry production especially the indigenous chickens play a significant role in the economic and social life of these resourceful poor household. Thus, rearing local chickens contributed to cheap source of animal protein intake and family income (Magothe et al., 2012). The scavenging nature of rearing family poultry (indigenous chickens) in cocoa growing areas of Cross River State exposes not only chickens but also other livestock to some toxic chemical substances (Hg, Cd, As, Pb etc) and other persistent organic pollutants (POPs) resulting from the use of pesticides in cocoa plantations. Johnson (2004) reported that, apart from bioaccumulation and bio-magnification of heavy metals from pesticides, it also exerts acute and chronic toxic effect on non-target organism in the ecosystem.

There is paucity of information on the status of pesticides residues and bio-accumulation levels in avian species, livestock and wildlife in cocoa producing areas of Nigeria. This study was carried out to assess the accumulation levels of heavy metals in body tissue and organs of family poultry locally reared chickens in cocoa producing and non-cocoa producing areas of Cross River State.

MATERIALS AND METHODS

Collection of sample

Fresh Samples (thirty per location) of breast muscles, liver, kidney and lungs of local chickens were collected from various locations of cocoa producing areas of Ikom and Etung Areas and non-cocoa producing area of Odukpani in Cross River State between the period of November, 2013 and October, 2014. A total of two hundred and seventy (270) adult unsexed chicken were used and slaughtering process were not considered as factors in heavy metal concentration in the chicken muscles and organs. Identified volunteered households at different experimental sites were randomly selected. This was done based on the level of protection that was offered by the farmers in monitoring the birds. The birds were wing banded for easy identification, housed cages and fed commercial grower mash for two weeks to enable them adapt to their new environment. Thereafter, they were released for free range extensive poultry management.

Sample preparation and digestion

Procedure for sample preparation in this study was adopted from Belton (2006). The collected tissue and organs were cleaned and packed in polyethylene bags and transported for analyses to the Analytical laboratory, Department of Chemistry, University of Calabar, Nigeria. The collected tissues and organs were cleaned and washed with demineralized water. The wet digestion procedure was used. 5.0 g of each sample (muscle, kidney, liver and lungs) was introduced into the digestion flask. 10 ml of concentrated sulphuric acid was added to the sample and the content of digestion flask heated at 70°C for 3 hrs with occasional swirling at 3 minutes interval. After complete digestion, the digest was allowed to cool and then transferred into a 20 ml standard flask with de-ionized water. The solution were transferred into acid-leached polyethylene bottles and kept at room temperature until analysis with atomic absorption spectroscopy (AAS). Heavy metals were analyzed by using varian atomic absorption spectrophotometer model 1275 AA equipped with lamps for different elements. Standard working solutions and standard curves were prepared. The standard curve for each metal was plotted and the amounts of metal present in the study samples were calculated from the standard curve.

Statistical analysis

All data collected from chemical analysis were subjected to a two-way analysis variance using a 2 x 2 factorial format in which heavy metals and location were factors in a completely randomized designed (SPSS, 1999). Mean separation was carried out where significant differences exist using Ducan Multiple Range Test (Duncan, 1980).

RESULTS AND DISCUSSION

The concentration of heavy metals in the muscles and organs of local chickens recorded in this study are presented in Tables 1 and 2.

Cadmium (Cd)

The results show that cadmium (Cd) concentration was significantly higher in the muscles (0.10 µg/g) and livers (0.11 µg/g) of local chicken from Ikom and Etung Local Government areas than those obtained in Odukpani. The higher values of Cadmium in tissues and organs of chickens in cocoa areas could be attributed to deliberate and consistent application of pesticides for pest control in cocoa plantation. Persistent accumulation of pesticides residue in the plantation could result in Cadmium level found in tissue and organs in this study comparable to the levels reported by Akan et al. (2010) for local chickens and González-Weller et al. (2006). Mariam et al. (2004) reported higher cadmium content (0.49 µg/g) in liver and 0.31 µg/g in muscles of local chicken (lean meat). These results also agree with the report of Iwegbue et al. (2008), who recorded a higher cadmium
Table 1. Heavy metals concentrations (µg/g) in muscle, liver, kidney and lungs of local chicken in Ikom cocoa producing area of Cross River State.

<table>
<thead>
<tr>
<th>Heavy metal (µg/g)</th>
<th>Muscle</th>
<th>Liver</th>
<th>Kidney</th>
<th>Lungs</th>
<th>Muscle</th>
<th>Liver</th>
<th>Kidney</th>
<th>Lungs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>0.10±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.11±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.07&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.06±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.02±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.04±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.05±0.01&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.03±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
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<tr>
<td>Lead</td>
<td>0.21±0.07&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.22±0.11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.25&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.21±0.05&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.18±0.06&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.20±0.06&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.21±0.02&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.14±0.05&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.05±0.02&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.04±0.03&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.06&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>0.02±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
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<tr>
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<td>2.95&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.20±0.07&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.87±0.06&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.21±0.05&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.84±0.11&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.17±0.05&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>Arsenic</td>
<td>0.05±0.01&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.02±0.02&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.05&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.01±0.00&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.05±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.02±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.04±0.02&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.01±0.00&lt;sup&gt;c&lt;/sup&gt;</td>
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<td>Nickel</td>
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<td>1.03±0.01&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.05±0.02&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>1.05±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.12±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.04±0.02&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.16±0.04&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Cadmium</td>
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<td>0.07±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.02±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
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<td>0.05±0.01&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.03±0.01&lt;sup&gt;c&lt;/sup&gt;</td>
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<tr>
<td>Lead</td>
<td>0.21±0.05&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.26±0.11&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.25±0.02&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.24±0.05&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>Mercury</td>
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<td>Chromium</td>
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<td>Arsenic</td>
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<td>0.01±0.00&lt;sup&gt;c&lt;/sup&gt;</td>
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<td>Nickel</td>
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<td>1.05±0.01&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>1.04±0.02&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.16±0.04&lt;sup&gt;a&lt;/sup&gt;</td>
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<sup>abcd</sup>Means with different superscripts along the same column are significantly different (P<0.05).

concentration level in the liver of turkey. Doganoc (1996) reported a higher level of cadmium and zinc in the liver and kidney of hens which exceeded the permissible limit of 0.5 ppm set by FAO/WHO (2000). Cadmium is known to be toxic to almost every system in the body (Lee et al., 1996). Baykov et al. (1996) reported that feed is one of the principal environmental sources of cadmium in poultry. The higher concentration of cadmium in the liver of local chicken in the cocoa producing areas could be attributed to detoxification function of the organ where toxic substances get accumulated.

Cadmium concentration in the kidney and liver over long time could interact with a number of minerals such as zinc, iron, copper and sodium due to chemical similarities and competition for bounding site (Aranha, 1994 and Stoyke et al., 1995). In addition cadmium can replace Calcium in the bone structure making the bone to lose its rigidity and become porous. A condition observed in Itai-Itai syndrome.

Roga-Franc et al. (1996) also observed cadmium levels in the livers and kidneys of cattle in Poland and found its concentration to be above the permissible limit recommended by FAO/WHO (2000). Cadmium concentrations in all the samples studied were lower than 0.5ppm limit by FAO/WHO (2000).

Lead (Pb)
The livers and kidneys of local chickens in Ikom and Etung cocoa producing areas recorded higher lead concentration levels compared to Odukpani, a non-cocoa producing area. The highest lead concentration was found in liver (0.26 µg/g) of chicken in Ikom followed by 0.25 µg/g in kidneys of chickens in Etung and the lowest level was recorded in muscles (0.12 µg/g) of chicken in rural area of Cross River State. Franc et al. (1996) also observed higher levels of lead concentration in liver of poultry (3.15 µg/g) and kidney (3.85 µg/g). A higher lead concentration was observed by...
possible bio-accumulation in animals that feed on them. All these metals may lead to toxic reaction along the food chain (Duffus 1980; Lawal et al., 2006; Okonya et al., 1988). These results revealed that Pb accumulated mostly in liver which agrees with reports of many studies (Miranda et al., 2005; Koréneková et al., 2002). High levels of Pb in poultry products possibly arise mainly from contamination of feed and water sources (Oforka et al., 2012). The major source of lead pollution is automobile exhaust gases which arise from anti-knocking agent added in gasoline resulting in soil contamination and plants (Mariam et al., 2004). Other sources are untreated waste effluents of industry, which find their way to irrigation channels and hence pollute the fodder and plants, leading to toxic reaction of plants and animals (Oforka et al., 2012). The major source of lead pollution is automobile exhaust gases which may result in absorption by plants, leading to high levels of Pb in poultry products. These results agree with reports of many studies (Miranda et al., 2005; Koréneková et al., 2002). High levels of Pb in poultry products possibly arise mainly from contamination of feed and water sources (Oforka et al., 2012). The major source of lead pollution is automobile exhaust gases which results in soil contamination and plants (Mariam et al., 2004). Other sources are untreated waste effluents of industry, which find their way to irrigation channels and hence pollute the fodder through soil. Lead is a metabolic poison and a neurotoxin that binds to essential enzymes and several other cellular components and inactivates them (Cunningham and Saigo, 1997). Toxic effects of lead are seen on haemopoietic, nervous, gastrointestinal and renal system (Baykov et al., 1996).

Mercury (Hg)

Mercury concentration as determined in tissue and organs of chicken at various locations of study are summarized in Tables 1 and 2. Highest mercury concentration was found in kidney of chicken in Ikom (0.05 µg/g) and lowest in the muscle (0.01 µg/g) tissue in chicken in Odukpani. All the study samples at different locations showed
mercury concentration within 0.01 to 0.03 µg/g and are within the permissible limit of 0.03 ppm (ANZFA, 2001). Samek et al. (1997) discovered the highest mercury quantity in skin and liver of chicks. Mariam et al. (2004) attributed a greater concentration of mercury in poultry to intake of mercury-contaminated feeds as compared to other animals. Key environmental sources of mercury include pesticide and fertilizer, contamination of stream, run-off water, rivers and lakes, industrial wastes and fungicides. The mercury escapes into the air and soil and get accumulated in fodder plant and hence in animal tissues. Mercury is toxic to central nervous system and the kidney is the organ most vulnerable to damage. The easy access to this toxicant to man is through multiple pathway - air, water, food, domestic products and even vaccines increases exposure (Harada, 2001). Children and foetus are more susceptible to mercury toxicity. According to WHO (2000) report, 0.05mg/kg mercury contaminated food should not be sold for human consumption.

Chromium (Cr)

The concentration of chromium in tissue and organs of chicken significantly (P<0.05) differ between various study locations. Liver and kidney of chickens recorded higher Cr concentration than muscles and lungs from different locations. The highest Cr concentration was found in kidney (2.11 µg/g) of chicken in Etung Local Government Area (cocoa producing area) which may be attributed to pesticides, fungicide as well as fertilizer application in cocoa plantations. The concentration levels of Cr in this study were higher than 0.65 µg/g (liver) and 0.27 µg/g (kidney) in local chicken reported by Akan et al. (2010). Iwegbue et al. (2008) reported chromium concentration in chicken meat, gizzard and turkey to range between 0.01 and 3.43mgkg⁻¹ which is above the permissible limit of 0.10 µg/g by FAO / WHO (2000). Chromium is an essential element assisting the body to utilize sugar, protein and fat, at the same time it is carcinogenic. It act as a co-factor in insulin hormone response, controlling carbohydrate metabolism in human. However, increased concentration of this metal can affect mineral and enzymes status of animal and human being. ATSDR (2004) pointed out that excessive amount of chromium may cause adverse health effects. The chromium concentration in the livers and kidneys of study samples is strikingly high and indicating chromium pollution in the environment. Chromium can be transported by surface run-off to surface water in its soluble form. Zhao et al. (2002) pointed out that soluble and unabsorbed chromium complexes can leach into soil solution which could make it more bioavailable for plant root absorption hence polluting the fodder through the soil. However, the leach ability also increases as the soil pH increases.

Arsenic (As)

The arsenic concentration was observed in the muscles and organs of chickens at different locations of study and it was found that kidney of local chicken in Etung (cocoa producing area) showed the highest concentration of 0.05 µg/g and lowest concentration of 0.01 µg/g in the lungs of chickens in all study locations (Tables 1 and 2). The permissible limit of arsenic in the livers of chickens has been reported as 2.0 ppm (ANZFA, 2001). But the results of this study showed that the arsenic concentration in all the samples studied were lower than 2.0 ppm. Higher concentration of arsenic in livers (78.96 ppm) and kidneys (63.45 ppm) of poultry have been reported by Mariam et al. (2004). The results of this study is in line with the observations of Akan et al. (2010) who reported arsenic concentration levels of 0.03 µg/g in liver and 0.11 µg/g in kidney of chickens. Higher concentration of arsenic in the livers and kidneys of cattle and goats has also been reported by Krupa and Swida (1997). Arsenic pollution in the environment may be due to copper smelting, coal combustion, burning of firewood and cow dung (Charles and Margaret, 1993). Furthermore, many arsenic compounds absorb strongly in soils and are transported only over short distances in ground water and surface water.

Nickel (Ni)

The concentration of nickel in the muscle, liver, kidney and lungs ranged between 1.00 and 1.16 µg/g in all the study locations. The highest nickel concentration of 1.16 µg/g and 1.15 µg/g were observed in the lungs of chicken in Etung (cocoa area) and Odukpani (non-cocoa area) respectively, while the lowest value of 1.00 µg/g was found in the muscles of chicken in Odukpani. These results confirm the findings of Akan et al. (2010) who observed higher value of nickel in liver (1.09 µg/g) than that of kidney (0.24 µg/g) in chicken. Present results obtained for nickel in liver were in the line with that of Ghita et al. (2009) who also observed a higher concentrations of chromium, iron, zinc and nickel in liver and intestine than in muscles .Oforka et al. (2012) reported mean values of 0.08 mgkg⁻¹, 0.167 mgkg⁻¹ and 0.74 mgkg⁻¹ nickel in gizzard, liver and muscles respectively. Concentration levels of nickel observed in this study were higher than the values stated above, but are similar to the results of similar study by Surtipanti et al. (2005) in Indonesia. The permissible limit of nickel in food according to WHO (1996) is 0.5 mgkg⁻¹. The results of the current study indicated higher nickel concentration in tissue and organs at different locations which exceeded the stipulated tolerance limit. This indicated nickel pollution/contamination in the study locations. This may be attributed to results from geological weathering, herbicides, and pesticides application and leaching of
rocks as well as discharge of domestic wastes in these areas. Table 2 shows the interactive effect of locations and heavy metal concentration on tissues and organs of local chicken. There was no significant (P>0.05) interaction effects on mercury, arsenic and nickel concentrations in tissues and organs of chicken. Although, cocoa producing areas (Ikom and Etung) exhibited higher concentration values of these metals than non-cocoa producing area. However, significant interaction (P<0.05) of location and heavy metals (lead, cadmium, chromium) concentration was observed in the tissues and organs of chicken in both cocoa and non-cocoa producing areas.

Conclusion

This study was set out to evaluate the concentration and possible accumulation of heavy metals (Cd, Pb, Hg, As and Ni) in tissue/organisms of family poultry (local chicken) in cocoa producing and non-producing areas of Cross River State. General results show that heavy metals accumulations were mostly higher in liver and kidney and lower in muscle and lungs and have concentrations below the permissible limits of FAO/WHO (2000) while the concentration of Cr and Ni in all study area were higher. The concentration level of metal studied in cocoa areas were below the permissible levels (FAO/WHO, 2000), thus chickens may be considered safe for human consumption from these areas. However, efforts should be made to reduce the presence of Chromium (Cr) and Nickel (Ni) in the environment to avoid its bio-accumulation and consequently its toxic effect. The information provided from this study may form or serve as guidelines and standards for chicken meat products in cocoa producing and non-producing areas of Nigeria.

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Effect of cassava peel meal on morphometric characteristics of reproductive organs and visceral organ weights of Cockerels

Christian O. Ezihe

Department of Veterinary Physiology, Pharmacology and Biochemistry, University of Agriculture, Makurdi, Nigeria.
Email: chrisezihe@yahoo.com. Tel: +2348034439824.

ABSTRACT: This study was designed to evaluate the effect of cassava peel meal on the morphometric characteristics of reproductive organs and visceral organ weights of cockerels. Four treatment diets were formulated to contain 0% (1), 10% (2), 20% (3) and 30% (4) cassava peel meals (CPM) respectively. Forty cockerels, 24 weeks of age, were randomly assigned to the four treatment diets with two replicates of five birds per treatment group. Data were collected on morphometric characteristics of the reproductive organs as well as the visceral organ weights. Data were subjected to analysis of variance (ANOVA) and significant means were separated using Duncan’s multiple range test. The results of this study showed non-significant differences (P>0.05) in right and left testicular weights, paired testicular weights, right and left epididymal weights, paired epididymal weights, right and left ductus deferens, and paired ductus deferens. There were also non-significant differences (P>0.05) in the average heart weights, gizzard weights, abdominal fat weight and percentage, average spleen weights, liver weights, lungs and kidney weights. It could be concluded from this study that dietary inclusion of sun-dried cassava peel meal up to a level of 30% has no adverse effect on the morphometric characteristics of the reproductive organs as well as the visceral organ weights of cockerels.

Key words: Analysis, Bovans, diets, poultry, processed.

INTRODUCTION

Africa is currently plagued with a food crisis, partly due to the unprecedented rise in human population and the alarming drop in per capita food production particularly in the last decade. Low intake of protein has repercussions and adverse effects on the economy of a country not only in terms of pronounced malnutrition and in terms of diseases resulting in reduced human productivity, but also in the incidence of infant mortality. In Nigeria, limited supplies of protein and energy carriers (soya beans, groundnut cake fishmeal, maize, etc.) and consequent importation usually results in significant increases in the cost of domestic livestock production (Cantner, 1987). The shortage of protein in Nigeria and the rapidly increasing demand of livestock products could be alleviated through the production of poultry meat and eggs.

Livestock production plays a very important role in the national economy and its estimated contribution to the national Gross Domestic Products (GDP) is placed at between 5 to 6%, which accounts for nearly 15 to 20% of the agricultural GDP (Ahmed, 2004). The poultry industry has a great potential in realizing the poultry demand of the country due to its fast growth rate, high creation of employment opportunities, high turnover rate of animal protein as well as provision of high quality meat and eggs for human consumption.

Feed makes up at least 60% of the cost of production for all animal species and sometimes as much as 85% (Gill, 2003). It holds a vital position in bridging the animal supply and demand gap in developing countries like Nigeria. Conventional feed ingredients such as maize have become insufficient for livestock feeding due to increasing demand for human consumption as well as livestock feeding. In order to reduce the cost of poultry
production, the nutritional potential of unconventional feed sources mainly energy and protein, which are cheap and locally available need to be investigated. One of such feed sources is cassava (*Manihot spp*), which forms the main starchy food for many people living in Sub-Saharan Africa (Parr et al., 1988). Cassava peels are the main by-products of cassava-based industries and are available in large quantities in the country. Since cassava peels are not directly consumed by humans, they can serve as alternative or non-conventional feed ingredient for livestock and poultry. Many reports (Osei and Duodu, 1988; Ogbonna, 1991; Ogbonna and Adebowale, 1993) have shown that cassava peels can replace maize in poultry rations without marked adverse effects on the performance of birds. Incorporation of processed cassava peels into cockerel ration reduced the cost of production without adverse effect on the carcass quality and economy of feed conversion of birds (Aina, 1990). Dairo and Egbeyemi (2012) reported that mixture of cassava peel and caged layer manure can be included in weaner rabbit diets up to 25% without adverse effect on their growth performance. Adeyemo et al. (2013) reported that maize can be replaced with up to 50% hydrolyzed cassava peels in chicken feed without deleterious effects. Oladunjoye et al. (2014) reported that 15% cassava peel meal can be included in broiler chicken diets using 0.2% methionine but the use of 20% CPM requires supplementation with 0.4% methionine. Cassava peel meal can be made a better feed stuff by improving the nutritional factor by supplementing with enzyme (Midau et al., 2011). Abu et al. (2015) reported that 20% inclusion of cassava leaf meal and 20% cassava peel meal as replacement for soya bean meal and maize respectively could be used in both broiler starter and finisher diets without any deleterious effect on growth and carcass yield of broiler chickens. There is need to investigate the effect of cassava peel meal on reproductive parameters of chickens. Therefore, this research was conducted to evaluate the effect of cassava peel meal on the morphometric characteristics of reproductive organs and visceral organ weights of cockerels.

**MATERIALS AND METHODS**

**Experimental location**

The experiment was conducted at the Poultry Unit, Livestock Teaching and Research Farm, University Of Agriculture, Makurdi, Benue state, Nigeria. Benue State is a state in the mid-belt region of Nigeria with a population of about 4,253,641 in 2006 census. Its geographic coordinates are Longitude 7° 47’ and 10° 0’ East and Latitude 6° 25’ and 8° 8’ North. The annual rainfall ranges from 100 to 200 mm and Temperature fluctuates between 21 to 37°C (https://en.wikipedia.org/wiki/Benue_State).

**Formulation of experimental diets**

Fresh cassava peels were collected from Garri processing centers in North Bank area of Makurdi in Benue State, Nigeria. The cassava peels were thoroughly washed to remove sand particles and subsequently sun-dried for a period of 5 to 7 days and hammer milled for use. Four experimental diets were formulated to contain 0% (1), 10% (2), 20% (3) and 30% (4) cassava peel meal respectively (Table 1).

**Experimental birds and management**

Forty, twenty-four weeks old, Bovans cockerels of between 1.83 to 2.07 kg were used for this study. The birds were hatched at The Evangelical Church of West Africa (ECWA) rural Development Farm, Jos, in the Middle Belt of Nigeria. The birds were given water and corresponding diets ad-libitum for eight weeks.

**Experimental design and data collection**

The birds were randomly assigned to four treatment diets. The birds in each treatment group were further divided into two replicates of five birds each in a completely randomized design (CRD). The reproductive organs were dissected free of fats and adhering tissues before evaluation of their weights. The visceral and reproductive organs weights were measured using a digital balance. Relative values of the visceral and reproductive organs were determined by dividing the organ weights by the live weights of the respective cockerels.

**Statistical analysis**

Data collected from this study were subjected to analysis of variance (ANOVA) and the means where significant, were separated using Duncan’s Multiple Range Test (Steel and Torrie, 1980).

**RESULTS AND DISCUSSION**

The effects of cassava peel meal on morphometric characteristics of reproductive organs of cockerels are shown in Table 2 while the effects of cassava peel meal on the visceral organ weights of cockerels are presented in Table 3. There were non-significant differences (P>0.05) in right and left testicular weights, paired testicular weights, right and left epididymal weights, paired epididymal weights, right and left ductus deferens, and paired ductus deferens of cockerels in the different dietary groups. There were also non-significant differences (P>0.05) in the average heart weights, gizzard weights, abdominal fat weight and percentage, average spleen weights, liver weights, lungs and kidney
Table 1. Percentage Composition of Diets.

<table>
<thead>
<tr>
<th>Feedstuff</th>
<th>1 (0%)</th>
<th>2 (10%)</th>
<th>3 (20%)</th>
<th>4 (30%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava Peel Meal</td>
<td>0</td>
<td>10.00</td>
<td>20.00</td>
<td>30.00</td>
</tr>
<tr>
<td>Groundnut Cake</td>
<td>25.00</td>
<td>25.00</td>
<td>25.00</td>
<td>25.50</td>
</tr>
<tr>
<td>Maize</td>
<td>55.00</td>
<td>50.00</td>
<td>46.00</td>
<td>39.41</td>
</tr>
<tr>
<td>Rice Offal</td>
<td>16.23</td>
<td>11.15</td>
<td>5.01</td>
<td>-</td>
</tr>
<tr>
<td>Palm Oil</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.00</td>
</tr>
<tr>
<td>Bone Meal</td>
<td>3.00</td>
<td>3.00</td>
<td>3.10</td>
<td>3.18</td>
</tr>
<tr>
<td>Premix (Grower)</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.10</td>
<td>0.15</td>
<td>0.16</td>
<td>0.17</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.17</td>
<td>0.20</td>
<td>0.23</td>
<td>0.24</td>
</tr>
<tr>
<td>Salt</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Calculated Analysis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>1 (0%)</th>
<th>2 (10%)</th>
<th>3 (20%)</th>
<th>4 (30%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Protein %</td>
<td>17.00</td>
<td>17.00</td>
<td>16.84</td>
<td>16.74</td>
</tr>
<tr>
<td>Energy (Kcal/ kg ME)</td>
<td>2707</td>
<td>2674</td>
<td>2656</td>
<td>2657</td>
</tr>
<tr>
<td>Calcium %</td>
<td>1.08</td>
<td>1.08</td>
<td>1.11</td>
<td>1.18</td>
</tr>
<tr>
<td>Total Phosphorus %</td>
<td>0.80</td>
<td>0.79</td>
<td>0.80</td>
<td>0.81</td>
</tr>
<tr>
<td>Available Phosphorus %</td>
<td>0.60</td>
<td>0.60</td>
<td>0.62</td>
<td>0.63</td>
</tr>
<tr>
<td>Methionine + Cystine %</td>
<td>0.60</td>
<td>0.60</td>
<td>0.61</td>
<td>0.60</td>
</tr>
<tr>
<td>Lysine %</td>
<td>0.70</td>
<td>0.70</td>
<td>0.70</td>
<td>0.70</td>
</tr>
<tr>
<td>Crude Fat %</td>
<td>3.70</td>
<td>3.60</td>
<td>3.43</td>
<td>3.34</td>
</tr>
<tr>
<td>Crude Fiber %</td>
<td>8.54</td>
<td>8.44</td>
<td>8.25</td>
<td>8.36</td>
</tr>
<tr>
<td>Hydrogen Cyanide(g/kg)</td>
<td>0</td>
<td>1.00</td>
<td>2.00</td>
<td>3.00</td>
</tr>
</tbody>
</table>

Pfizer Grower Premix at the rate of inclusion provides the following additional nutrients per kg of diet: Vitamin A 3.200 i.u. Vitamin D 3.640 i.u., Vitamin E 2 i.u., Vitamin K 0.8 mgr, Thiamine, B₁ 0.6 mgr, Riboflavin, B₂ 1.6 mgr, Pyridoxine, B₆ 0.6 mgr, Niacin 6 mgr, vitamin B₁₂ 0.004 mgr, Panthothenic Acid 2mgr, Folic Acid 0.2 mgr, biotin 0.008mgr, Choline Chloride 0.08gr, Antioxidant 0.05gr, manganese 0.032gr, Zinc 0.02gr, Iron, 0.008gr, Copper 0.002gr, Iodine 0.00048gr, Selenium 0.08mgr and Cobalt 0.08mgr.

Table 2. Effect of Cassava peel meal on the morphometric characteristics of reproductive organs of Cockerels (Mean ± SEM).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>1 (0%)</th>
<th>2 (10%)</th>
<th>3 (20%)</th>
<th>4 (30%)</th>
<th>LS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Testicular Weight (g)</td>
<td>11.35± 1.09</td>
<td>11.97±1.41</td>
<td>13.03±1.17</td>
<td>10.62±0.09</td>
<td>ns</td>
</tr>
<tr>
<td>Right Testicular Weight (g)</td>
<td>10.92± 1.01</td>
<td>11.80±1.24</td>
<td>12.73±1.37</td>
<td>10.73±1.21</td>
<td>ns</td>
</tr>
<tr>
<td>Paired Testicular Weight (g)</td>
<td>11.13±1.03</td>
<td>11.88±1.31</td>
<td>12.88±1.55</td>
<td>10.68±0.90</td>
<td>ns</td>
</tr>
<tr>
<td>Left Epididymal Weight (g)</td>
<td>5.00± 0.32</td>
<td>5.52±0.39</td>
<td>5.18±0.52</td>
<td>5.68±0.43</td>
<td>ns</td>
</tr>
<tr>
<td>Right Epididymal Weight (g)</td>
<td>5.50± 0.53</td>
<td>5.15±0.43</td>
<td>4.52±0.49</td>
<td>4.95±0.46</td>
<td>ns</td>
</tr>
<tr>
<td>Paired Epididymal Weights (g)</td>
<td>5.25± 0.27</td>
<td>5.33±0.36</td>
<td>4.85±0.37</td>
<td>5.32±0.31</td>
<td>ns</td>
</tr>
<tr>
<td>Left Ductus Deferens (g)</td>
<td>0.72± 0.09</td>
<td>0.78±0.11</td>
<td>0.83±0.10</td>
<td>0.62±0.13</td>
<td>ns</td>
</tr>
<tr>
<td>Right Ductus Deferens (g)</td>
<td>0.83± 0.05</td>
<td>0.90±0.13</td>
<td>0.88±0.11</td>
<td>0.63±0.12</td>
<td>ns</td>
</tr>
<tr>
<td>Paired Ductus Deferens (g)</td>
<td>0.78± 0.06</td>
<td>0.84±0.11</td>
<td>0.86±0.09</td>
<td>0.63±0.13</td>
<td>ns</td>
</tr>
</tbody>
</table>

LS, level of significance; ns= not significant. SEM, Standard error of the means.

Weights of cockerels in the different dietary groups. Although, cockerels on diets containing CPM had numerically higher gizzard weight than those on control diet, there was no pattern of change in gizzard weight with increasing levels of CPM in the diets. Thus, these suggest that inclusion of sun-dried cassava peels up to a level of 30% in the diets of cockerels did not have any deleterious effect on cockerel production. Pido et al. (1979) in a related study, supplemented maize with a maximum of 50% Fermented Cassava Meal (FCM) and
obtained comparable heart weight values.

Bitto et al. (1999) fed graded levels of CPM to 10 weeks old cockerels and obtained similar testis, epididymal and ductus deferens weights. The non-significant effect of dietary inclusion of CPM on paired ductus deferens weights suggests stability on sperm storage and rate of passage in birds raised on CPM. Udedibie et al. (1988) obtained higher visceral weights in broilers confirming the influence of feed ingredients, class of poultry, age and breed on visceral organ weights. Results of abdominal fat weight recorded in this study agree with the observations of Le Clercq (1985) who reported that male birds are homozygous for leanness, and thus have abdominal fat making up about 0.7% of body weight. Cockerel ration increases in energy from 13 weeks and this result in declining abdominal fat. Sonaiya (1986) observed that abdominal fat variables steadily increased from the 8th to the 13th week (1.16%), declines up to the 15th week (0.73%), before increasing again at the 16th week. Rather than fat deposition, the energy demand is apparently required for non-carcass use such as the development of sexual organs and sexual activity. The record of enlarged testes weight supports the above claim. Panigraphi et al. (1992) obtained slightly lower liver values with the incorporation of 250 g/kg fast dried, 500 g/kg fast dried, 250g/kg slowly dried and 500g/kg slow dried cassava root into broiler starter ration. The average liver weights in birds fed the controlled diets was generally higher than the weight of birds fed the treated diets, which means that CPM did not enlarge the liver weights. Atuahue et al. (1986) obtained slightly lower liver weight values with a maximum of 10.0% cottonseed meal inclusion in broiler starter rations. Pido et al. (1979) replaced maize with a maximum of 50.0% Fermented Cassava Meal (FCM) and obtained 2.20% liver weights. Udedibie (1988) also obtained 1.90% liver weight values with 20.0% replacement of protein with Poultry Offal Meal (POM) in broiler finisher rations. Different liver values obtained in the above researches could be because of age, breed, and class of poultry, methods of drying and nutritional composition of the various diets.

CONCLUSION

The inclusion of sun-dried cassava peel meal up to a level of 30% has no adverse effect on the morphometric characteristics of the reproductive organs as well as the visceral organ weights of cockerels.

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Effects of over stocking on the growth rate of *Clarias gariepinus*

Ojonugwa, E. B. and Solomon, R. J.*

Department of Biological Sciences, Faculty of Science, University of Abuja, Abuja- Nigeria.

*Corresponding author. Email: johnsol2004@yahoo.com

ABSTRACT: The African catfish (*Clarias gariepinus*) were reared at four different stocking densities in a circular plastic bowls to evaluate the effects of over stocking on the growth rate of *Clarias gariepinus*. 140 fish were stocked at 10, 20, 30 and 40 with a mean of 8.5, 8.66, 9.2 and 9.15 respectively. The growth trial lasted for 92 days (June to August). The final mean weight of fish stocked at densities 10, 20, 30 and 40 were 153.1, 121.5, 96.6 and 68.6 (g) fish were with 10% body weight between the hour of 8.00 to 9.00am and 5.00pm to 6.00pm. Feed not consumed are siphoned out to avoid contamination of water which will be toxic to the fish. The corresponding mean values of specific growth rate were 3.05, 2.80, 2.62, and 2.26. The feed conversion ratio (FCR) was 5.91, 5.45, 5.14 and 4.76 and cumulative survival rates were 99.86, 99.65, 96.66 and 92.5%. The temperature range from 26.5 to 30.5°C. The pH range from 6.9 to ± 0.36 to 7.25 ± 0.22. The Dissolved oxygen (DO) was 2.65mg/l to 5.41 mg/l. The result revealed that over stocking had a significant effect on the growth rates of *Clarias gariepinus*. Fish held at the highest stocking density of 40 exhibited the lowest growth and survival rate.

Key words: African catfish, over stocking, growth rate.

INTRODUCTION

Aquaculture practices are still in the extensive and semi intensive in Nigeria (Adikwu, 1999) and recently intensive re-circulatory systems (Bolorunduro, 2006). Data on domestic fish production in Nigeria has shown a downward decline over the years, 1982 (920, 484), 1990 (315,000) and 1996 (200, 171) metric tons as reported by (FDF, 1990; FOS, 1997). In order to sustain the current average domestic production of 615,507 metric tons per annum, an effective delivery system has to be put in place (FDF, 2007). Nigeria is amongst the largest consumer of fish in Africa (FAO, 1999); its total available land for aquaculture development according to fisheries statistics of Nigeria is about 1.7 million hectares and existing pond area under cultivation is about 60,000 hectares with a domestic production of merely 0.62 million metric tons while it has an aquaculture potential of producing about 2.5 million tons. Nigeria’s current domestic fish production from aquaculture is only about 85, 087 tones and consumption was estimated to be over one million metric tons, in order to reduce importation of fish in Nigeria, there is need to develop local domestic fish production.

*Clarias gariepinus* is a highly appreciated fish in Nigeria due to its favorable food conversion ratio, resistance to disease, low technology farming system, excellent food meat quality, possibility for high stocking density and can tolerate wide ranges of environmental conditions (Fagbenro et al., 2003) and also they can grow to a large size of over 10kg (Reed et al., 1967; Olaosebikan and Raji, 1999) which are attractive to consumers. Thus, *Clarias gariepinus* was chosen for this study because of its ready availability, economic and ecological advantages.

Environmental stress is an important factor responsible for limiting fish performance under aquaculture conditions. When fish are subjected to adverse environmental conditions, some endocrine and physiological alteration occur, often resulting in changes in ability of the fish to survive, grow and reproduce (Barton and Iwama,
over stocking is a common chronic stressor in aquaculture that can induce a prolonged elevation of Cortisol levels which may cause damaging consequences, and suppressed growth (Rowland et al., 2006). This effect has been attributed to factors such as decreased food consumption. The high stocking density (over stocking) also imposes increased energy demands that require changes of gluconeogenic and glucolytic activities under such conditions, food consumption is reduced. The extra expenditure energy has to be met by the reserve, resulting in reduced growth (Rowland et al., 2006). Over stocking is a common aquaculture practice used to manage water usage or increase fish stocking density (Baras and Lagardere, 1995). However, the use of high stocking density as a technique to maximize water usage and thus increase stock production has also been shown to have adverse effect on growth. In many cultured fish species, growth has indirect relationship to stocking density and this observation is mainly attributed to social interaction (Holm et al., 1990; Haylor 1991; Ma et.al., 2006). Social interactions as a result of competition for food and/or space can negatively affect fish growth. On the other hand, the fish price is influenced by the market requirements such as size and production, which depends on their growth.

According to Brummet, (2000) when the amount of fish stocks exceeds the carrying capacity of the water supply, and the condition of the fish deteriorates then mortality will increase due to rapid growth of protozoa and bacterial diseases and parasites. Therefore by establishing the relationship between dietary protein level and over stocking, stress monitoring of fish stocks and prediction on their growth rate need will be possible and enhanced. With global population expansion, the demand for fish is steadily increasing and natural fish population have declined during the last decade due to environmental degradation and overfishing. This has resulted in an increasing effort in the technology for more domestic production. A lot of people have gone into the fish farming at both subsistence and commercial level in north-central Nigeria; however, there has been low capacity production due to problems of knowing the right size of fish to stock, stocking at too high density (over stocking) and under-stocking of fish (Edward and Demaine, 1988). A lot of farmers have been discouraged by incidence of high mortality in the present day practice in north-central Nigeria. Plastic container used in culturing fish is not new in Nigeria, the problem is that the practice has remained at experimental level for over two decades (Okorie,2003). There have been different researches concerning different species of catfish, all over the world for aquaculture because of its high potentiality and preference. Stocking at best density in order to avoid over stocking still attract attention of researchers because factors are aimed at yielding a higher profit for the farmers and getting good quality fish at a reasonably short period of time.

The growth of *Clarias* species depends upon stocking density, dietary, protein quality, energy content of feed, physiological status (age, sex) environmental variables, farming conditions and food availability are some of the main factors that affects fish growth (Lovell, 1989). In terms of the fish production in plastic containers, over stocking (high stocking density) which is related to the volume of water or surface area per fish is an important factor. Increase in stocking density (over stocking) results in increasing stress, which leads to higher energy requirements, causing a reduction in growth rate and food utilization. Contrarily, in case of low stocking densities fish may not form shoals and feel comfortable. Consequently, identifying the optimum stocking density for a species is a critical factor not only for designing an efficient culture system (Leatherland and Cho, 1985), but also for optimum husbandry practices. Controlling the fish size and production are the two importance task to meet the market demands as price of fish is determined by the market demand of supply (Size and production) and that in turn depends on their growth rate. Over stocking (High stocking density) to produce more fish which increase fish intensification may not be the problem of space shortage.

**Biology of Clarias gariepinus**

*Clarias gariepinus* is a member of the family clariidae. They occur naturally in south East Asia and in Africa and are sometimes called Africa catfish or mudfish. *Clarias gariepinus* is well appreciated in many Africa countries (De gram et al., 1996). The clarids exhibits many qualities which makes them suitable for culturing. They have a high fecundity, faster growth rate, disease resistance can withstand handling stress as well as been highly palatable (Eroudu et al., 1993; Nwandukwe, 1993). They are very adaptive to extreme environmental conditions and can withstand low oxygen level in the range of 6.5 to 8.0 (Huiissman and Ritcher, 1987; Fabgenro and Sydenham, 1988). They are able to live in turbid water and tolerate temperature of 8°-35°C. The optimal temperature for growth is 28°-30°C (Teugel, 1986) *Clarias gariepinus* has long based rayed dorsal fin (reed et al., 1967) without an adipose tissue, two pairs of nasal and maxillary barbles on its dorsal ventrally flattened head, elongated body with fairly long dorsal and anal fins and also smallish eyes. This species can attain length of up to 1.7m including the tail and can weigh 59kg when fully grow their color ranges from dark grey to black dorsally and cream coloured ventrally (Skelton, 1993). It comprises of species such as *Clarias anguillaris, Clarias gariepinus, Clarias lazera* and *Clarias mossambicus* (Teugels, 1982). The Africa catfish are omnivores (Reed et al., 1967) feeding on a large variety of plant and
animals like weed, planktons, small insects, small fish, crustaceans, worms etc. (Bakare, 1968) but they have high tendency towards been a carnivores as adult. Catfish are therefore said to be an opportunistic feeder, feeding on virtually everything that come their way.

**Stocking density and culture**

Over stocking (high stocking density) is one of the main factors determining the growth rate of fish (Engle and Valderama, 2001; Rahman et al., 2005) and the final biomass harvesters (Boujard et al., 2002). Environmental variables, farming conditions and food availability are other factors that can affect fish growth. In terms of the fish production in plastic container, over stocking (stocking density) which is related to the volume of water or surface area per fish is an important factor. Increase in stocking density that is over stocking result in increasing stress, which leads to higher energy requirements causing a reduction in the growth rate and food utilization (Aksungur et al., 2007).

Contrarily, in case of low stocking densities fish may not form shoals or group together and feel comfortable. Consequently, identifying the optimum stocking density for a species is a critical factor not only for designing an efficient culture system (Leatherland and Cho, 1985) but also for optimum husbandry practices. Controlling the fish size and production are two important tasks to meet the market demands. Increase in stocking density (over stocking) to produce more fish which increase fish intensification may not be the best way of dealing with problem of space shortage (Aksungur et al., 2007). In many cultured fish species, growth is inversely related to stocking density and this is mainly attributed to social interactions and fool (Huang and Chiu, 1997; Haylor, 1991; Bjorensson, 1994; Irwin et al., 1999; Ma et al., 2006). Social interaction through competition for food or space can negatively affects fish growth while the price of fish is determined by market demand of supply (size and production) which in turn depends on their growth.

Paspt et al. (1992) suggested that in intensive aquaculture the stocking density is an important indicator that determines the economic viability of the production system. In intensive larvae and fry culture, several factors influence survival welfare, growth and production for example feeding (Kerdchwen, 1992; El-sayed, 2002), stocking density (Rahman et al., 2005; Schram et al., 2004).

The effects of over stocking on the growth rate and survival have been studied on some African catfishes such as *Clarias gariepinus* (Haylor, 1992) and *Heterocranu longifilis* (Ewa-oboho and Enyenih, 1999; Coulibaly et al., 2007). The effects of over stocking on tilapia production as reported by Otubusin and Opeloye, (1985) in floating bamboo-net cages in Kigera III reservoir New Bussa, Nigeria shows that fish growth generally decreased with an increase in stocking density. The slow growth rate of the fish observed in the study may be attributed to low productivity of the Kigera III reservoir.

Muthukumarana et al. (1985) carried out an experiment using *sarotherodon niloticus* in cages (at three stocking densities; 400, 600 and 800m²) fed varying crude protein levels for a period of four months; it was observed from his result that there was no weight gains and feed conversion ratio between stocking densities for a particular dietary crude protein level. (Osotero et al., 2007) revealed that over stocking has an inverse relationship with level of protein intake which affects weight and growth of fish (*Clarias gariepinus*). Growth is the manifestation of the net outcome of energy gains and losses within a framework of abiotic and biotic conditions. In fact, under crowded conditions at higher stocking densities, fish suffer stress as a result of aggressive feeding interaction and eat less, resulting in growth retardation (Bjorensson, 1994) space is a factor which can be used to determine the fish growth rate in aquaculture (Otubusi, 2000).

**Nutritional requirements**

**Protein requirement**

Dietary protein requirement of Africa catfish have been reported by several authors; Fagbenro et al. (1992) reported 42.5% dietary protein requirement for *H. longifilis*. In *Clarias gariepinus*, the protein requirement of fingerling, juveniles and adult fish varies. For instance, juveniles and fingerlings require more protein compared to the adult (Halver, 1978) reported that the gross protein requirements are highest in initial feeding and that it decrease as fish increase in size. Machiels and Haenke, (1986), Ayinla, (1988) and Degani et al. (1989) concluded that *Clarias gariepinus* brood stock requires about 40% crude protein for *Clarias anguicularia* and (Fagbenro et al., 1992) recommended 40-42.5% for *Heterancus bidorsalis*. The quality of protein in any feed stuff is principal influenced by its amino acid composition (Ayinla, 1991) and this is turn induces its digestibility in the diet. Digestibility of some amino acids varies amongst ingredients. Fish utilizes both plant and animal proteins although the latter is more nutritionally better. The more closely the dietary protein meets. The qualitative requirement of indispensable amino acid by the fish, the greater its utilization, for cultured fish try to grow at a maximum rate, it must have a diet in which have its digestible feed ingredient consist of balanced protein (indispensable amino acid). Ayinla (1991), stated that deficiency in any of these ten essential amino acids will cause reduced appetite, reduced growth rate, disease or even death in fish. The ten indispensable amino acid
needed for growth are Arginine, Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Valine, Threonine and tryptophan (NRC, 1993). Fagbenro et al. (2000) reported that the estimated essential amino acid requirements in (g/kg protein) for Clarias gariepinus as argentine (445), Histidine (21.5), Isoleucine (30.6) Leucine (52.2), Lysine (57.6), Methionone (18.3), Phenylalalmonne (27.3), Threonine (31.6) and Valine (29.0).

**Carbohydrate requirement**

The carbohydrate-based feed stuffs are usually the cheapest source of energy for cultured fish due to their relative abundance. Buhler and Halver, (1961) reported that relatively high levels of carbohydrates are tolerable by carnivores' fish and that dietary carbohydrate levels of around 20% may be optimal. Fiber has no nutritional value in feed (Sado, 1989) apart from aiding the passage of food into the gut of fish. A dietary excess or deficiency of useful energy can reduce growth rate because energy needs for maintenance and voluntary activity must be satisfied before energy is available for growth. Energy is a nutritional requirement for the culture of animals. Failure to include adequate quantity in diet may result in reduced growth while excessive quantities of energy results in undesirable fat deposition or reduced feed consumption (NRC, 1993).

**Fats requirements**

Lipids include free fatty acids, triglycerides, phospholipids, oils, waxes and sterol. All these lipids provide dietary energy which is about twice as much as the energy produced by carbohydrates and protein Sado (1989) and Catacutan (1999) revealed that homoeothermic animals have dietary lipids are an important source of energy and the only source of essential fatty acids (EFA) in fish, only differs in species and from age and size (Shepherd and Bromage, 1992) determining requirements for fatty acid is difficult for fish because the metabolic requirement is very small and fatty acids stored in the body or even carried over from egg yolk can influence performance of the experimental fish according to Lovell, (1987).

**Vitamins and minerals**

Vitamins are organic compounds required by fish in very small amounts for growth, metabolism of tissue nutrients and diseases resistant. Vitamin are either fat or water soluble; water soluble are easy leached from polluted feeds when they come in contact with water and they include thiamine, riboflavin, pyridoxine, Pantothenic acid, Nicotinic acid, Biotin Insitol, Choline, Folic acid, B-12 and Ascorbic acid (Ayinla, 1991). In highly stocked plastic containers, it is important to feed with complete diets since it is doubtful if the nutrient supply of natural food organisms in water body will be adequate to meet the vitamin requirements of the fish. Mineral requirements of fish is similar to those of terrestrial animals, fish requires minerals in trace amount for tissue formation and other metabolic activities. Most important minerals are calcium (Ca) and phosphorus (P) which must be supplied in sufficient quantities (Lall, 1991) although fish absorbs some of these minerals in water and reduce their requirement, nevertheless, it is safer to supply adequate amount of calcium in feeds to forestall possible deficiency symptom in fish. Comparably, P is lower than Ca in natural water so it does not occur in reasonable amounts. The most reliable source of phosphorous (P) for fish is through its diet Sado, (1989) reported that blood meal, bone meal and limestone inclusion into feeds can effectively take care of the deficiency.

**Water quality parameters**

Fish and other aquatic organisms such as shrimps and crayfish are known to be very rich in protein and need to cultivate these in clean water in the locality is highly needed. The need for clean water to raise this protein rich and needed aquatic commodity cannot be over emphasized. The productivity of a given body of water is determined by its physical, chemical and biological properties. These environmental properties of water need to be conducive for fish to grow well; therefore, an ideal water conditions is a necessity for the growth and survival of fish. The population density of organism of any water system such as in land fresh water and lakes always vary according to the physico-chemical factors such as hydrogen-ion concentration (PH), dissolved oxygen (DO) conductivity, nutrient and temperature (Abolude, 2007).

**Temperature**

Water temperature is one of the major environmental factors that affects and controls food utilization at all levels and stages of fish growth. The suggested temperature ranges from 20 to 30°C while the lethal levels are from 2 to 42°C. Fish are poikilothermic and water plays an important role in their feeding as it affects their metabolic activities, feeding potential, growth, survival, reproduction in all species of fishes (Dupree and Hunner, 1994). Temperature has a pronounced effect on the rate of chemical and biological processes in water; for instance, fish require twice as much oxygen at 30°C than 20°C (Adeniji and Ovie, 1990). It is recommended that
fish in the tropics be kept in water whose temperature range is between 25 - 30°C (Auta, 1993). Sudden increase in temperature will stress or even kill fish and this has formed the basis for the acclimatization of fish (Adeniji and Ovie, 1990). Temperature has been found to affect the dominance and distribution of phytoplankton in water as it influences the growth rates and mortality of planktons and other organism (Orchutt and Porter, 1983). Temperature is known to influence organisms to varying degrees, depending on their sensitive thus fish survival in plastic container depends on temperature and dissolved oxygen (Countotant, 1987).

Dissolved oxygen

Dissolved oxygen in water is very essential to life in the aquatic environments as it affects the physiology and distribution of the aquatic organism. Nearly all aquatic organisms with the exception of some bacteria must have oxygen to survive and most of these organism mushes extract their oxygen from liquid water. The two main sources of oxygen into the aquatic environment are the atmosphere and photosynthetic activities of aquatic planks. The ideal range of dissolved oxygen in the water must be at least 5mg/l is required to sustain fish and other aquatic life in water bodies (Adakole, 2000). Insufficient dissolved oxygen (D.O) in a water system tend to cause anaerobic decomposition of organic materials in water thereby leading to the production of obnoxious (annoying) gases such as carbon dioxide, hydrogen sulphides and methane which bubble to the surface. The physiology of aquatic organism is such that they can tolerate only narrow ranges of temperatures, outside which they cannot function normally (Willoughby, 1976). Kutty, (1968) and Kutty and Sanders, (1973) reported that Atlantic salmon stopped swimming when dissolved oxygen concentration remained below 5ppm but goldfish, tilapia and carps swims at oxygen level of 1 to 2 ppm. Inadequate dissolved oxygen has many effects of fish like reduced feeding; impaired growth and leading to fish becoming stressed thereby becoming susceptible to diseases. Cold water fish require large amounts of dissolved oxygen with temperature range of 5 to 15°C while warm water fish with a temperature range of 20 to 40°C are able to survive with low oxygen content.

Hydrogen-ion concentration

The hydrogen ion concentration (pH) of any water is the measurement of acidity or alkalinity of that water body. It is usually measured on a scale of 0-14 with 7 being neutral. The effect of pH on the chemical, biological and physical properties of a water system makes its study very crucial to the lives of the organisms in the medium.

Fresh waters with a pH ranging from 6.5 to 9.0 have been known to be productive and recommended as suitable for fish culture (Adeniji 1986; Auta, 1993). Increase in acidity and alkannity of any water body may increase or decrease the toxicity of poison in the water; solar radiation and temperature accelerates photosynthesis, which in turn increase carbon dioxide absorption altering the bicarbonate equilibrium and producing OH- thus raising the pH (Branco and Senna, 1996).

Hynes, (1974) observed that PH values below 5 or above 9 are harmful to most animals within the normal range, according to Wuhramann and worker (1982) and Krenkel (1974) pH has more influence on some poison. Chronic pH levels may reduce fish reproduction and are associated with fish die-offs (Stone and Thomfore, 2006) (Adeniji and Ovie, 1990) reported that acid and alkaline death point is approximately at pH 4 and 11 respectively.

In view of the above, the aim of the research is to determine the effect of overstocking on the growth rate of Clarias gariepinus

MATERIALS AND METHODS

Experimental fish

One hundred and forty fingerlings of clarias gariepinus were obtained from a reputable farm: Efugo’s Farm in Kuje – Abuja, Nigeria. The fish were transported to the Department of Biological Sciences University of Abuja in 50 litres plastic which was half filled with fresh water at the early hour in the morning to avoid mortality due to high temperature, and were acclimatized for one week. The mean initial weight for the fish was 8.9±0.4 g and the length was 0 to 10 cm. During the period of acclimatization the fish were fed with coppens at 20% body weight (10% in the morning 8:00 to 9:00 am and 10% in the evening 5:00 to 6:00 pm.

Feeding and measurement

At the end of the acclimatization period the fish were randomly selected and stocked into four (4) circular plastic bowls at different stocking densities of 10, 20, 30 and 40 for treatment 1, 2, 3 and 4 respectively. The bowl with the lowest stocking densities (10) served as the control. The positioning of the bowls allowed a natural photoperiod of 12 h sunlight and 12 h darkness throughout the experiment and the other forty are stocked for replicates. The fish were feed with coppens (an artificial pelletted floating feed containing 42% crude protein) with 10% body weight (5% in the morning and 5% in the evening between the hours of 8:00 to 9:00am.
Plate 1: Images showing how fishes are been stocked in different circular plastic bowls.

and 5:00 to 6:00pm respectively. The feed for each treatment and its replicate were weighed in separate nylon for onward feeding. The feed particle size increased periodically as the fish grow. The fish were weighed using a weighing scale at the commencement of the experiment and on a weekly basis during the experiment and a calibrated measuring ruler (cm) was used to take the length of the fish at the commencement of the experiment and weekly basis for 12 weeks.

Circular bowls and water management

The circular bowls of the same size with 80 litres capacity per each were bought from Gwagwalada market. The bowls were washed and filled with tap water to 40 liters capacity (the fish were given equal room). The bowls were covered with mosquito nets to prevent the fingerlings jumping out and also intrusion of insect and other foreign bodies (birds). The water in the bowls was changed after three days interval to avoid accumulation of toxic waste which will be harmful to the fish (Plate 1).

Growth response

To determine the growth response of the fish the following parameters were calculated:

**Mean weight gain (g)**

\[ MWG = Wt_2 - Wt_1 \]

Where, \( Wt_1 \) = initial mean weight of the fish at time \( T_1 \) and \( Wt_2 \) = final mean weight of fish at time \( T_2 \)

**Specific growth rate (SGR)**

\[ SGR = 100 \frac{(\log e W_f - \log e W_i)}{\text{Time (days)}} \]

\( W_f \) = final average weight at the end of the experiment, \( W_i \) = initial average weight at the beginning of the experiment, \( \log e \) = natural logarithm reading and Time = number of days for the experiment.

**Survival rate (%)**

Survival rate (%) = number of fish that survived \times 100/ total number of the stocked fish

**Feed conversion ratio (g)**

\[ FCR = \text{weight of feed given/fish weight gain}. \]
Mean length gain (cm)

MLG = Lt2 - Lt1

Physiochemical parameter

Temperature

Surface water temperature was read twice daily to the nearest °C with the aid of mercury in glass thermometer and data observed were recorded.

pH

The pH of the water body was also carried out twice daily with the use of water test quality apparatus containing micro-pipette, a test-tube and an indicator. Water was taken from the fish pond (treatments) with the use of micro-pipette, and then released into a calibrated test-tube, at the level of 10 ml, and then four drops of indicator was added, to observe the acidity and alkalinity of the water.

Dissolve oxygen

The alkaline Azide modification of winkers method was adopted for determination of DO in water. 100 ml of the fish water sample was transferred into a 250 ml conical flask and 2 ml of manganese sulphate solution was added, followed by 2 ml of sodium iodide azide reagent, with a dropping pipette below the surface of the water. The conical flask was stopped to exclude air bubbles and the solution mixed thoroughly by inverting several times, until a clear solution is obtained. More also, 2 ml of concentrated sulphuric acid was added by allowing the acid run down the neck of the flask and the flask re-stopped and the solution mixed by gentle inversion until dissolution is complete. The solution was titrated with 0.0125 m sodium thiosulphate (Na2S2O3·5H2O) solution to a pale straw colour. 1 ml of starch solution was added and the titration was continued by adding the thiosulphate solution drop-wise until the disappearance of the blue colour.

Calculation:

\[
\frac{Mg_{DO}}{L} = \frac{16000 \times M \times V}{V2/V1(V1 - 2)}
\]

Where: M = molarity of thiosulphate solution, V = volume of the thiosulphate used for titration, V1 = volume of the bottle (250ml) with stopped in place and V2 = volume of aliquot taken for titration.

Data analysis

Data were analyzed by analysis of variance (ANOVA) (Snedecor and Cochran, 1982) and the differences between means were examined using least significant difference test.

RESULTS

Mean weight gain

The initial weight in all the treatment was 8.9±0.4 (9): range was between 8.5 to 9.15 g while the mean final weight in all the treatment was 109.9±35.9 g the range was from 68.6 to 153.1 g. The daily weight gain shows an inverse relationship; as stocking density increase, the control pond (10) had the highest final mean weight of 153.1 g followed pond A (20) with 121.5 g and B (30) with 96.6 g while the least was recorded in pond C (40) having mean final weight of 68.6 g. This result shows that there was significant difference (P<0.05) between the mean final weight gain in all the treatments which shows that as the stocking density increases the weight gain decreases.

Feed conversion ratio

The analysis of the feed conversion ratio, which expresses the efficiency of fish in converting food to flesh was best in the control pond (10) having FCR of 4.76 followed by pond A with 5.14, pond B 5.45, and the least was in pond C with 5.91. There was a significant difference (P< 0.05) in the FCR in all the treatments.

Specific growth rate

The specific growth rate in this study shows that as the stocking density increases growth rate decreases (Figure 1). The control pond had the best SGR of 3.05, pond A 2.80, pond B 2.62 and the least was in pond C having 2.26. One can also conclude that there was no significant difference (P<0.05) in the SGR between ponds A, B and C.

Survival rate

The mean survival rate ranged between 92.5 to 99.86%. Control pond, pond A and pond B had the highest survival rate while the least was in pond C.

Physiochemical parameters

The water temperature in all treatments (ponds) ranged between 26.51±1.54 to 27.4±1.39°C. The temperature of
the water in pond B and C was highest due to over stocking (Table 1).

**Hydrogen ion concentration**

The hydrogen ion concentration ranged from 6.92±0.36 to 7.25±0.22 and the pH 7.25 was highest in pond B.

**Dissolved oxygen**

The dissolved oxygen (DO) during the culture period was highest in the control pond 5.41±2.18 (Table 1).

**DISCUSSIONS**

The survival of *clarias gariepinus* ranged between 92.5 to 99.8% which is compared to a similar work done by Otubusin, (2000) and Osofero et al. (2007) with a range of 98.5 to 99.5%. The high survival rate recorded in all the treatments could be attributed partially to the physiochemical parameters and the good health condition of the fish. This result also indicates an inverse relationship between survival rate and stocking density. It was observed that as stocking density increases survival decreases (Figure 1). This is due to stress experienced as a result of aggressive feeding behavior where energy meant for growth is used up in frenzy feeding activities.

The growth and mortality of *Clarias gariepinus* cultured at various stocking density were not initially affected by density but the overall harvest in terms of final weight and size were directly related to stocking density (Table 2 and Figure 2). As the stocking density increases the weight gain decreases. This depicts an inverse relationship as was observed in similar works by Otubusin (2000). Growth is a manifestation of the net outcome of energy gains or losses within an environment. Weight gain is one of the important indices for measuring growth which was obvious among different ponds (treatments).

The water temperature range in this study falls within the idea temperature required for catfish culture in fresh water. The temperature range of 26.2 to 27.8 also agrees with work of Adeogun et al. (2004) on the culture of *Clarias gariepinus* in pond water.

The water pH range of 6.9 to 7.25 in this study falls within tolerable range of which catfish cultivation which agreed with the pH ranges observed by Thomas and Michael (1999) and Khattab et al. (2000).

The dissolved oxygen of 5.4 recorded in this study also agrees with similar work reported by Otubusin and Olaitan (2001).

The feed conversion ratio in this study showed that the
Table 2. Growth performance of *Clarias gariepinus* in a circular plastic bowl at different stocking densities.

<table>
<thead>
<tr>
<th>Pond</th>
<th>(SD)</th>
<th>IWT (g)</th>
<th>FWT (g)</th>
<th>MWG</th>
<th>SGR</th>
<th>FCR</th>
<th>SUR%</th>
<th>MLG</th>
<th>DWG</th>
<th>DLG</th>
<th>ILT</th>
<th>FLT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>10</td>
<td>8.5</td>
<td>153.1</td>
<td>144.6</td>
<td>3.05</td>
<td>4.76</td>
<td>99.86</td>
<td>16.62</td>
<td>1.56</td>
<td>0.18</td>
<td>8.71</td>
<td>25.33</td>
</tr>
<tr>
<td>A</td>
<td>20</td>
<td>8.66</td>
<td>121.13</td>
<td>112.98</td>
<td>2.80</td>
<td>5.14</td>
<td>99.65</td>
<td>14.43</td>
<td>1.21</td>
<td>0.15</td>
<td>8.76</td>
<td>23.19</td>
</tr>
<tr>
<td>B</td>
<td>30</td>
<td>9.2</td>
<td>96.6</td>
<td>87.4</td>
<td>2.62</td>
<td>5.45</td>
<td>96.66</td>
<td>13.16</td>
<td>0.95</td>
<td>0.14</td>
<td>8.85</td>
<td>22.01</td>
</tr>
<tr>
<td>C</td>
<td>40</td>
<td>9.15</td>
<td>68.6</td>
<td>59.45</td>
<td>2.66</td>
<td>5.91</td>
<td>92.5</td>
<td>12.99</td>
<td>0.65</td>
<td>0.14</td>
<td>8.03</td>
<td>21.02</td>
</tr>
</tbody>
</table>

SD, stocking density; SGR, specific growth rate; IWT, initial weight; FCR, feed conversion ratio; FWT, final weight; SUR, survival rate; MWG, mean weight gain; MLG, mean length gain; DWG, daily weight gain; DLG, daily length gain; ILT, initial length; FLT, final length.

Figure 2. Mean length fish stocked at different stocking densities.

Control pond had the best conversion ratio of 4.76 while pond C had the lowest of 5.91. The ability of *Clarias gariepinus* to utilize feed nutrient at maximum biochemical efficiency allows for higher feed conversion ratio. This study shows that at higher stocking density (over stocking) fish expend more energy due to aggressive feeding than converting it to flesh. The overall weight gain at stocking density of 40 fishes in a circular plastic bowl was low and may be attributed to high energy being expended during feeding (aggressive feeding) whereas at lower stocking density of 10 fish higher conversion to flesh and weight was obvious. The value of feed conversion in this research shows that stocking density has an effect on the ability of fish to convert it feed into flesh and may also be attributed to feeding techniques, quality of feed and temperature variation.

Specific growth rate decrease with increase in stocking density. The growth rate of 3.05 g observed in this study was lower than 4.2 g reported for *Clarias gariepinus* by Otubusin (2000).

Growth according to Bowen (1982) was determined through the combined effects of quantity and food quality. The quality and quantity of a given food or feed is directly proportional to its ability to support growth.

Conclusion and recommendation

Over stocking is one of the major problems that affect the growth rate of fish. Increase in stocking density result in an increasing stress, which leads to higher energy requirement and also causes a reduction in growth rate and food utilization. Consequently, identifying the optimum stocking density for specie is a critical factor not only for designing an efficient culture system but also for optimum husbandry practices. Controlling the fish size and production are two important tasks to meet the market demands. However, the stocking density of 10 to 20 fishes in a circular plastic bowl of 80 litres with a water
volume of 40 litre performed better than 30 to 40 fingerlings. That is, over stocking has a significant effect on the growth rate of *Clarias gariepinus*. Therefore, it is recommended that for optimum productivity, density of fish stocked in a circular plastic bowl of 80 litres should not exceed 25 fish. However, further research can be carried out using different species of fish and different container to determine the effect of over stocking on the growth rate of *Clarias gariepinus*.

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Prevalence of gastrointestinal parasites in one humped camels (*Camelus dromedarius*) slaughtered at the Maiduguri metropolitan abattoir, Borno State, Nigeria

Yakaka Wakil¹, Jallailudeen Rabana Lawal¹*, Yagana Ahmed Gazali², Amina Mohammed Bello¹, Esther Solomon Mshelia¹ and Awokoya Moses Ayomikun¹

¹Department of Veterinary Medicine, Faculty of Veterinary Medicine, University of Maiduguri, P. M. B. 1069, Maiduguri, Borno State, Nigeria.
²Department of Veterinary Anatomy, Faculty of Veterinary Medicine, University of Maiduguri, P. M. B. 1069, Maiduguri, Borno State, Nigeria.

*Corresponding author. Email: rabanajallailudeen@yahoo.com. Tel: +234 8032886428.

ABSTRACT: This study was conducted to elucidate the prevalence of gastrointestinal parasites in one humped camels (*Camelus dromedarius*) slaughtered at the Maiduguri Metropolitan abattoir. Borno State, between the months of January to June 2015. Out of the 202 fecal samples collected from camels of both sexes and analyzed for the prevalence of segments, worms or oocysts of gastrointestinal parasites of camels. The overall prevalence of 69.3% was recorded, *Strongyloides* eggs 83 (41.1%) was the most dominant, followed by *Strongyloides* species 19 (9.5%), *Coccidia* 15 (7.4%), *Trichuris* species 9 (4.5 %), *Ciliates* 7 (3.5%), *Fasciola* species 2 (0.9%), *Monezia* species 2 (0.9%), *Balantidium* species 1 (0.5%), *Amphistomes* species 1 (0.5%) and *Ascaris* 1 (0.5%) respectively. Prevalent rate was higher in female 81 (40.10%) compared to the male camels 59 (29.21%). Prevalence was also found to be higher in adult 96 (47.50%) compared to young camels 44 (21.78%). The occurrence of gastrointestinal parasites are more frequent in camels in slim body condition score 82 (40.49%) compared to camels in good body condition 58 (28.71%). It was concluded that gastrointestinal parasites of various species are still common amongst trade camels in the study area. This may constitute a major health and economic problem in the camel production in the arid and semi-arid northeastern Nigeria.

Key words: Prevalence, Gastrointestinal Parasites, one humped camels (*Camelus dromedarius*), Maiduguri, Northeastern Nigeria.

INTRODUCTION

The camel is an important part of the culture and agriculture of many countries and has existed as far back as the history of human civilization (Allen et al., 1992). It is an important multipurpose animal which is found in the arid and semiarid zones of the world (Al Haj and Al Kanhal, 2010). They have a unique anatomical and physiological adaptive characteristic of the harsh climatic condition of the desert areas (Rabana et al., 2011). Camels are Saharan and Sub-Saharan animals, they are also important to the people of Sahel savannah for economic and agricultural purposes (Oryan et al., 2008; Sazmand et al., 2011). Until the advent of motorized transport systems and the development of certain nomadic economics, it was referred to as the ship of the desert (Pwaveno and Arunsi, 2011). Camel meat and milk has been reported to be a source of high quality animal protein especially in areas where other animals slaughtered for meat find it difficult to thrive (FAO, 2008; Kadim et al., 2008).

The Nigerian camel population is mainly found around
Camels are almost the domestic animal best adapted to the harsh environments and fluctuating nutritional conditions of the arid and extremely arid zones (Rabana et al., 2011). They are known to tolerate a lot of parasitic infections of economic importance with minimal economic losses compared to many other livestock (Radfar and Gowhari, 2013). However, camels can be infected with various gastrointestinal parasites which include nematodes cestodes, trematodes and protozoans. These are generally known to contribute to a great loss in most of animal production (Duguma et al., 2014). The major clinical signs of parasitic gastroenteritis due to internal parasitism which include; severe diarrhea, stomach pain, weight loss, reduce production rate, decrease feed intake and subsequent death in more severe cases. The zoonotic aspects of these parasites are of public health significance (Allen et al., 1992). Some of these helminth parasites also have zoonotic implication for those who work closely with camels (McCarthy and Moore, 2000; Razavi et al., 2009). This present study therefore aimed to determine the current status of the prevalence of gastrointestinal parasites in the one humped camels (Camelus dromedarius) slaughtered at Maiduguri Abattoir and to evaluate the risk factors such as age, body condition score and sex of the camels as its affects their health status and economic importance.

MATERIALS AND METHOD

Study area

This study was conducted in Maiduguri, Borno State which lies within the semi-arid zone of the Northeastern part of Nigeria, with an area of 69,436 sq.km. Maiduguri lies between Latitude 11°N and Longitude 13°E. It has a mean day temperature of 38°C.

Sample population

The camels used for this study were trade camels brought in from the neighboring countries of Chad and Niger republic and presented for slaughter at the metropolitan abattoir of which the one humped camels (Camelus dromedarius) are the most predominant, while a few two humped camels (Camelus bacterianus) are also slaughtered at the abattoir.

Study design and samples size determination

A stratified random sampling technique was adopted to determine the prevalence of gastrointestinal parasites in camels slaughtered in Maiduguri abattoir. Fecal samples were collected from the Maiduguri abattoir.

Estimation of ages, body condition scoring and sexes

Ante-mortem examination and tagging of the camels before slaughter was conducted to evaluate their ages, body condition scoring and sex. The age of the sampled camels was determined based on dentition by dental eruption according to Payne and Wilson (1999), Bello et al. (2013) and substantiated by information from Khan et al. (2003). The body condition score (BCS) of each sampled camel was evaluated by visual observation and manual palpation according to the guideline described by Faye et al. (2001). Scores of 1 to 5 (1 = very lean, 2 = below average, 3 = average or ideal, 4 = above average and 5 = very fat) have been adopted to assess BCS in camels (Gaden, 2005). Notations of the fat status of spinoous and transverse processes of vertebra, hollow of flank, and ribs described by Faye et al. (2001); and measurements of hump height and chest depth according to Gaden (2005) were used to score body condition. The qualitative notations described by Faye et al. (2001) were used with slight modification. For ribs, the scales were 1 = individually visible, 2 = slightly visible, 3 = intermediate, 4 = not very visible, and 5 = not visible; for spinoous and transverse processes of vertebrae, 1 = very prominent, 2 = prominent, 3 = intermediate, 4 = slightly prominent, and 5 = not visible; and for hallow of flank, 1 = very visible, 2 = visible, 3 = intermediate, 4 = slightly visible, and 5 = not visible. For convenience, the camels were categorized into two condition groups as “poor” (BCS of 1 to 3) and “good” (BCS of 4 to 5) according to Robinson (2010). Since this work was carried in the abattoir, less number of animals was found with poor BCS whereas others were within good body condition score.

Sample size estimation

The sample size was estimated based on the formula described by Thrusfield (2005) and previous prevalence of 92.4% as reported by (Pwaveno et al., 2011). But in order to increase the precision of the sampling in the study about 202 camels were considered.

Fecal sample collection

Fresh fecal samples were collected per rectum from each labeled camel using disposable hand gloves. Fecal samples were transferred into polythene bags identified, labeled and immediately transported to the University of Maiduguri, Department of Veterinary Medicine Research Laboratory for coprological analysis. Each sample was
processed using the standard floatation and sedimentation technique to identify and classify the different gastrointestinal parasites or oocyst as previously described by Hansen and Perry (1994). All parasitic eggs were identified morphologically as described by Soulsby (1992), Urquhart et al. (1996) and Brar et al. (2011).

Data analysis

The data collected were entered into Graph Pad InStat version 3.05. Descriptive statistic was used to determine the prevalence (p) of the parasites and the risk factors associated with the disease (age, sex, body condition score and apparent health status). Chi-square (χ²) test for their significant difference by using confidence level at 95% and P < 0.05 was considered significant.

RESULTS

Microscopic coprology revealed that some samples were positive for single and mixed infection of gastrointestinal parasite ova/oocystes. Ten (10) species of gastrointestinal parasites were recovered from the samples examined. The species include 4 species of nematodes, 1 species of cestodes, 2 species of trematodes and 3 species of protozoans. Overall prevalence rate of gastrointestinal parasites was found to be 140 (69.3%). The various prevalent rates of gastrointestinal parasites from the infected camels revealed that Strongylids eggs 83 (41.1%) were the most dominant followed by Strongyloides species 19 (9.5%), Coccidia species 15 (7.4%), Trichuris species 9 (4.5%), Ciliates 7 (3.5%), Monezia species 2 (0.9%), Fasciola species 2 (0.9%), Balantidium species 1 (0.5%), Amphistomes species 1 (0.5%) and Ascaris 1 (0.5%) in descending order of occurrence in infected camels (Table 1). Amongst the infected camels, females 81 (40.10%) were more infected than the male 59 (29.21%) camels. There was no significant difference (P-value = 0.9528 at 95% CI) between infection and sex of camels. Prevalent rate of gastrointestinal parasites were observed to be higher in adult camels 96 (47.52%) compared to the young 44 (21.78%). There was no significant difference (P-value=0.9774 at 95% CI) between infection and ages of camels. The prevalence of gastrointestinal parasites was found to be higher in camels with poor body condition score 82 (40.59%) compared to camels with good body condition score 58 (28.71%). There was significant difference (P-value = 0.0300 at 95% CI) between infection and body condition score of camels (Table 2).

<table>
<thead>
<tr>
<th>Gastrointestinal parasites encountered</th>
<th>Species of Parasites encountered</th>
<th>Number of camel affected (N = 202)</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nematodes spp.</td>
<td>Strongyles</td>
<td>83</td>
<td>41.10</td>
</tr>
<tr>
<td></td>
<td>Strongyloides</td>
<td>19</td>
<td>9.50</td>
</tr>
<tr>
<td></td>
<td>Trichuris</td>
<td>9</td>
<td>4.50</td>
</tr>
<tr>
<td></td>
<td>Ascaris</td>
<td>1</td>
<td>0.50</td>
</tr>
<tr>
<td>Cestodes spp.</td>
<td>Monezia</td>
<td>2</td>
<td>0.90</td>
</tr>
<tr>
<td>Trematodes spp.</td>
<td>Amphistome</td>
<td>1</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>Fasciola</td>
<td>2</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>Coccidia</td>
<td>15</td>
<td>7.40</td>
</tr>
<tr>
<td>Protozoan spp.</td>
<td>Ciliates</td>
<td>7</td>
<td>3.50</td>
</tr>
<tr>
<td></td>
<td>Balantidium</td>
<td>1</td>
<td>0.50</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>140</td>
<td>69.30</td>
</tr>
</tbody>
</table>

DISCUSSION

The present study revealed that trade camels brought for slaughter in the study area harbors different genera of gastrointestinal parasites which include nematodes, trematodes, cestodes and protozoans which are of economic importance to the production of camels (Kamani et al., 2008). This finding is consistent with those of Bamaiyi and Kalu (2011) and Mahmuda et al. (2014) who reported the same genera of gastrointestinal parasites in camels from Maiduguri and Sokoto, Nigeria respectively. Nematodes species were the most prevalent gastrointestinal parasites in camels followed by protozoans species, followed by trematodes species and cestodes species from the study area which also agrees with the report of Mahmuda et al. (2014) and Duguma et al. (2014). The present study revealed an overall prevalent rate of 69.30% gastrointestinal parasites in the affected camels. This finding is lower than 92.4%
reported in the same study area by Bamaiyi and Kalu (2011) whose study was conducted during the rainy season while the present study was carried out during the dry season. The variation in the prevalence rates may therefore be associated with the season of sample collection which is known to affect the worm burdens, abundance of parasites and its activities which are usually high during the rainy season. Considering reports from other parts of Nigeria, reports from the present finding was also lower than those reported in Sokoto with 78.0% (Mahmuda et al., 2014) and 78.5% in Kano (Al Haj and Al Kanhai, 2010). Our finding was also lower than the 81.3% reported in Iran (Anvari-Tafti et al., 2013), 84.80% in Pakistan (Musadiq et al., 2013), 62.7% in Tanzania (Swai et al., 2011) and 41.1% in Egypt (Mahmoud et al., 2008). However, our finding is higher than 68.9% reported by Kamani et al. (2008) and 37.33% by Azhar et al. (2013). The various differences from the reported prevalence rate of gastrointestinal parasites in camel from various researches may probably be associated to the different geographical locations of the study areas, time or periods of sample collection and variation in the techniques used for sample analysis or may be due to the husbandry system being employed by the camel pastoralist.

The result of the present study also concurred with the findings of 80.56%, 9.26%, 6.48% and 3.71% for nematodes, protozoans, trematodes and cestodes respectively reported by Mahmuda et al. (2014). The result of the present study revealed that *Strongyle* spp. eggs were found more prevalently. The high prevalence rate for *strongyle* spp.is consistent with previous findings of other researchers (Bamaiyi and Kalu, 2011; Mahmuda et al., 2015). This study supports previous findings that nematodes are the commonest helminths in camels (Swai et al., 2011; Duguma et al., 2014; Ibrahim et al., 2016).

The finding of the present study revealed high prevalent rate of gastrointestinal parasite infection in female camels compared to the male ones. This finding agrees with those of Bamaiyi and Kalu (2011). Demelash et al. (2014) also reported higher gastrointestinal parasite burden in female camels compared to the male ones. This could be associated with the fact that female camels’ physiological peculiarities which usually constitute stress factors may be immune-suppressing which may make them to succumb to infections by the parasites than males even where both sexes share equal chances of exposure to the parasite infections (Swai et al., 2011). However, Mahmuda et al. (2014) reported a high prevalence rate of gastrointestinal parasites in male camels compared to the female ones. But the present study revealed that there was no significant difference ($P>0.05$) in the prevalence of gastrointestinal parasite between the male and female camels.

The result of the present study also revealed high prevalent rate of gastrointestinal parasites in adult camels compared to the young ones. This finding may be associated with several exposures of adult camels to the parasites during grazing compared to the young ones. Though, there was no significant association ($P>0.05$) between the age and occurrence of gastrointestinal parasites in the infected camels. This finding is consistent with those of Duguma et al. (2014) who reported none significant association between the prevalence of gastrointestinal parasites and the age of camels.

The present study revealed that body condition score of the camel shows significant association ($P<0.05$) with the prevalence of gastrointestinal parasites. The presence of the association between body condition and gastrointestinal parasites agrees with previous report of Swai et al. (2011), however contrast the finding of Duguma et al. (2014) who reported the absence of association between the prevalence of gastrointestinal parasites and body condition score of camels in a similar study. This variation could probably be associated with the fact that loss of body condition in the camels could be due to other factors such as seasonal changes and the presence of other concurrent disease conditions which may suppress the immune system and make the camel

<table>
<thead>
<tr>
<th>Table 2. Risk factors associated with gastrointestinal parasites in trade camels in Maiduguri.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk factors</strong></td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>BCS</strong></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

*p<0.05, BCS*, Body condition score, N, Total number of camels examined, LL – UL, Lower limit – Upper limit, CI, Confident interval at 95%.

*The result of the present study also revealed high prevalent rate of gastrointestinal parasites in adult camels compared to the young ones. This finding may be associated with several exposures of adult camels to the parasites during grazing compared to the young ones. Though, there was no significant association ($P>0.05$) between the age and occurrence of gastrointestinal parasites in the infected camels. This finding is consistent with those of Duguma et al. (2014) who reported none significant association between the prevalence of gastrointestinal parasites and the age of camels. This study supports previous findings that nematodes are the commonest helminths in camels (Swai et al., 2011; Duguma et al., 2014; Ibrahim et al., 2016). The finding of the present study revealed high prevalent rate of gastrointestinal parasite infection in female camels compared to the male ones. This finding agrees with those of Bamaiyi and Kalu (2011). Demelash et al. (2014) also reported higher gastrointestinal parasite burden in female camels compared to the male ones. This could be associated with the fact that female camels’ physiological peculiarities which usually constitute stress factors may be immune-suppressing which may make them to succumb to infections by the parasites than males even where both sexes share equal chances of exposure to the parasite infections (Swai et al., 2011). However, Mahmuda et al. (2014) reported a high prevalence rate of gastrointestinal parasites in male camels compared to the female ones. But the present study revealed that there was no significant difference ($P>0.05$) in the prevalence of gastrointestinal parasite between the male and female camels. The result of the present study also revealed high prevalent rate of gastrointestinal parasites in adult camels compared to the young ones. This finding may be associated with several exposures of adult camels to the parasites during grazing compared to the young ones. Though, there was no significant association ($P>0.05$) between the age and occurrence of gastrointestinal parasites in the infected camels. This finding is consistent with those of Duguma et al. (2014) who reported none significant association between the prevalence of gastrointestinal parasites and the age of camels. The present study revealed that body condition score of the camel shows significant association ($P<0.05$) with the prevalence of gastrointestinal parasites. The presence of the association between body condition and gastrointestinal parasites agrees with previous report of Swai et al. (2011), however contrast the finding of Duguma et al. (2014) who reported the absence of association between the prevalence of gastrointestinal parasites and body condition score of camels in a similar study. This variation could probably be associated with the fact that loss of body condition in the camels could be due to other factors such as seasonal changes and the presence of other concurrent disease conditions which may suppress the immune system and make the camel.
vulnerable to parasitic diseases.

Conclusion

In conclusion, gastrointestinal parasites of various species are prevalent amongst one humped camel in Maiduguri, the occurrence was found to be more in female and adult camels. Therefore, there is need for strategic deworming of camel using broad spectrum anthelmintic, coupled with good management practice for enhancing the productivity of camels as well as other livestock reared in close proximity.

CONFLICT OF INTEREST

The authors have not declared any conflict of interest.

ACKNOWLEDGEMENT

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Comparative morphometric traits differentiation and phenotypic correlations between *Achatina achatina* (Linne, 1758) and *Achatina fulica* (Bowdich, 1822) snails with four and five whors

Okon, B.*, Ibom, L. A, Halilu A. and Onwuka, P. O.

Department of Animal Science, University of Calabar, Calabar, Nigeria.

*Corresponding author. Email: profbasseyokon@gmail.com. Tel: +234(0)803 418 3263.

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**ABSTRACT:** Four hundred (400) adult black-skinned snails, two hundred (200) each of the *Achatina achatina* and *Achatina fulica* with 4 and 5 whors were used respectively for the study. Identification and sorting of the snails sourced from a reputable snail vendor in Ibadan into breeds was done using the appropriate profile and template. The body weights of *Achatina achatina* and *Achatina fulica* snails with 4 whors ranged from 83.00 to 180.50 g (average 156.90 g) and from 30.60 to 85.20 g (average 49.70 g) respectively. That for *Achatina achatina* and *Achatina fulica* snails with 5 whors ranged from 132.70 to 272.80 g (average 138.95 g) and from 50.60 to 119.30 g (average 59.58 g) respectively. Results obtained from the study showed that *Achatina achatina* snails with 4 and 5 whors were genetically heavier and larger than *Achatina fulica* with 4 and 5 whors. Results of phenotypic correlation coefficient among morphometric traits of the two breeds indicated negative, weak, low significant (P<0.05) and mostly non-significant (P>0.05) differences between body weight and most body components (morphometric traits) studied. The only positive, low non-significant (P>0.05) phenotypic correlation coefficient (r<sub>p</sub>) obtained was r = 0.420 between body weight and aperture width for *Achatina fulica* snails with 4 whors. Whereas, for *Achatina achatina* snails with 5 whors, positive, low significant (P<0.05) phenotypic correlation coefficients obtained was r = 0.529 between body weight and aperture width and r = 0.660 between spiral width and aperture width respectively. *Achatina fulica* snails recorded the only positive highly significant (P<0.01) phenotypic correlation coefficient of r = 0.602 between aperture width and shell width for the snails with 5 whors. Breed type, age and size differences of snails used, body weight ranges, as well as number of whors on snail shell have high effects of morphometric traits differentiation and phenotypic correlation coefficient estimates. Thus, the morphometric traits of the two breeds (*Achatina achatina* and *Achatina fulica*) of snails studied could be chosen to differentiate as well as characterize snails.

**Key words:** Black-skinned snails, *Achatina achatina*, *Achatina fulica*, morphometric traits, phenotypic correlations.

**INTRODUCTION**

Snail farming is an interesting and profitable venture if large, mature breeding stocks of snails with high reproductive potentials are used and properly managed. Nigeria is richly endowed with many breeds of snails (*Archahatina marginata*, *Achatina achatina*, *Achatina fulica*) which has recently attracted the attention of consumers, producers/sellers and researchers (Okon and Ibom, 2012; Nwankwo and Onwarah, 2015).

Among these, *Achatina achatina* and *Achatina fulica* are snails with tremendous unexploited nutritional, health, economic and genetical potentials. According to Okon et al. (2012), *Achatina achatina* is the largest gastropod among the giant African land snails recorded in the Guinness Book of records, with a maximum of recorded shell length of 27cm; while *Achatina fulica* is the smallest (CAB, 2003, Venette and Larson, 2004). But in Nigeria,
Achatina achatina is the second most popular breed of snail after Archachatina marginata kept and reared (Okon et al., 2012).

Achatina achatina (Plate 1) also called giant Ghana snail or giant tiger land snail is found in Nigeria, Ghana, Cameroon, Guinea, Togo, Cote d’Ivore, Liberia, Benin Republic and Sierre Leone (Venette and Lason, 2004; Okon and Ibom, 2012). It is often sought after because of its large size, distinct markings and nutritive value. It has a pattern of black wavy streaks on a yellowish background and can grow up to 30 cm in shell length and 25 cm in shell width (Cobbinah et al., 2008). The shells are conical in shape and fairly pointed than other snail species. In captivity under intensive management, it attains sexual maturity between 10 and 12 months and can lay between 30 and 300 eggs/clutch with diameter from 4 to 10 cm per egg (King, 2008). It is the most prized snail after Archachatina marginata for eating as it may weigh up to 500 g at maturity.

Achatina fulica (Plate 2), also called giant East African snail found in Africa, specifically in South of the Sahara in East Africa (Kenya and Tanzania), Liberia and Cote d’Ivore (Venette and Larson, 2004; Okon and Ibom, 2012). A. fulica is one of the smallest among the giant land snails of the world, growing with a long and greatly swollen body whorl (Jummai and Okoli, 2013). It has a narrow, conical shell being about twice as long as its width and contains 7 to 9 whorls when fully grown. The shell is generally reddish brown in colour with weak yellowish vertical markings but colouration varies with environmental conditions and diet. The adult A. fulica snail shell is about 7 cm in length and 20 cm or more in width. It produces large eggs that are 4.5 to 5.5 cm in diameter and only hatch at temperature of about 15°C.

According to Okon and Ibom (2011), the quantitative measure of animal conformation is important as this will enable reliable parameters for a given trait to be estimated and therefore allow its inclusion in breeding programmes. While, Ibom (2009) opined that body weight and body parameters such as shell length, shell width, shell thickness, shell ‘mouth’ length and shell ‘mouth’ width are quantitative (morphometric) traits mostly used to measure snail growth and growth rate. In addition, Okon and Ibom (2011) recommended morphometric (phenotypic) traits as good prediction tools of hatching weights in juvenile and F1 crossbred of A. marginata snails. Besides, these authors opined that genetic improvement of any breed of snail in order to increase their contribution to the much needed animal protein in Nigeria is inevitable and could be achieved by estimate of genetic correlations among performance traits in the breeding objective and development of selection program for effective planning. There is dearth of information on comparative morphometric (phenotypic) traits differentiation and phenotypic correlations between these two breeds of snails with 4 and 5 whorls.

MATERIALS AND METHODS

Experimental site

The research was carried out in Department of Animal Science, University of Calabar, Calabar, Nigeria.
Experimental Animals

Four hundred (400) adult mature black-skinned snails, two hundred (200) each of Achatina achatina (Aa) and Achatina fulica (Af) were sourced from a reputable snail farmer in Ibadan. The sorting was done using keys prescribed by Segun (1975) and Hodasi (1984). Identification of the snails into breeds (Achatina achatina and Achatina fulica) was done using the profile and template of Nisbert (1974) and Rushton (2012) respectively.

Achatina achatina and Achatina fulica snails with four (4) whorls on the shell had body weight ranges from 83.00 to 180.50 g (average 156.90 g) and from 30.60 to 85.20 g (average 49.70 g) respectively. While Aa and Af snails with five (5) whorls on the shell had body weight ranges from 132.70 to 272.80 g (average 139.95 g) and from 50.60 to 119.30 g (average 59.58 g) respectively.

Data collection

Data measured on morphometric (phenotypic) traits from both breeds were body weight (BDW), shell length (SHL), shell width (SHW), Aperture length (APL), Aperture width (APW), Spiral length (SPL), Spiral width (SPW), diagonal length (DAL) and length between the aperture and first spiral (LAS).

The morphometric (phenotypic) dimensional shell parameters were measured in millimeters (mm) using Venier caliper, while the body weights (BDW) were measured in grammes (g) using Scout Pro® electronic scale with a sensitivity of 0.01 g. The dimensional shell parameters were taken as described by Ibom (2009) and El. Zaffir et al. (2011).

Statistical analysis

The data obtained were analysed using GENSTAT (2011) software package for simple statistics (mean and standard error), t-test and phenotypic correlations, between body weights and other morphometric traits.

RESULTS AND DISCUSSION

The results of the description of sampled population were expressed as Mean ± standard error of mean and paired sampled test for each morphometric measurement (Table 1). Achatina achatina snails with 4 and 5 whorls had higher values for all measured morphometric traits than Achatina fulica snails. There were large disparities which were significantly different (p<0.001) between the mean body weights with number of whorls of these two breeds; 156.90 g for A. achatina, 49.70 g for A. fulica with 4 whorls while 138.95 g for A. achatina, 59.58 g for A. fulica with 5 whorls (Table 1). Similarly, all other measured morphometric traits of A. achatina snails 4 and 5 whorls were bigger and longer than those of A. fulica with 4 and 5 whorls. The results indicated that A. achatina with 4 and 5 whorls are genetically heavier and larger than A. fulica with 4 and 5 whorls, as this was confirmed by the test of significance of the difference (t-test) between the two breeds with 4 and 5 whorls (Table 1). The results agreed with the views of CAB (2003) and Venette and Larson (2004) that A. achatina is the largest snail among the giant African land snails and A. fulicathe smallest. Besides, the results also agreed with Okon et al. (2012) and Etukudo (2013) that snails with higher number of whorls weigh more and are heavier and larger than those with lower number of whorls.

On the other hand, the results of mean body weights (Table 1) in this study did not agree with the higher mean body weight (BDW) value of 138.60 g for A. fulica snails with 4 whorls by Okon et al. (2012). The BDW results were higher than the 127.20 g and 48.85 g for mean body weights for A. achatina and A. fulica snails with 4 whorls respectively reported recently by Etim (2017). The mean BDW of 182.00 g and 65.05 g for A. achatina and A. fulica snails with 5 whorls also reported by Etim (2017) were higher and heavier than the 138.95 g and 59.58 g for A. achatina and A. fulica snails with 5 whorls obtained in this study. Whereas, Etta et al. (2015) reported a higher mean BDW of 137.50 g for A. fulica snails with 4 whorls compared to very low mean BDW of 49.90 g for A. fulica snails with 4 whorls in this study. While, Ibom et al. (2014) had earlier reported higher mean body weights of 93.70 g, 109.70 g and 73.00 g for A. fulica snails from central agro-ecological zone, northern agro-ecological zone and southern agro-ecological zone of Delta state respectively. But, further recorded low mean body weights of 120.90 g, 107.50 g and 72.00 g for A. achatina snails from central agro-ecological zone, northern agro-ecological zone and southern agro-ecological zone of Delta state compared to the higher and heavier results obtained for A. achatina snails here (Table 1). The difference in BDW here could be attributed to the age and size differences of snails used; body weight ranges as well as number of whorls on the shell of the snails. Ibom et al. (2014) used snails that were not classified into their different number of whorls, thus the variations in the mean BDW results.

On the other hand, morphometric traits measured as expressed large disparities which were significantly (p<0.001) different between the mean shell parameters with number of whorls in these two breeds of snails (Table 1). The results obtained were higher and longer than the 10.440 mm, 5.087 mm, 5.291 mm, 2.990 mm for SHL, SHW, APL and APW for A. fulica with 4 whorls respectively reported by Etta et al. (2015).

The results of phenotypic correlations among morphometric traits of the two breeds evaluated (Tables 2a and 2b) indicated negative, weak, low and non-significant (p>0.05) correlation coefficients (r) between
Table 1. Mean ± SE and Paired Sampled Test of Morphometric Traits between Achatina achatina (Aa) and Achatina fulica (Af) snails with 4 and 5 whorls.

<table>
<thead>
<tr>
<th>Morphometric Traits</th>
<th>No. of whorls</th>
<th>AA X±SE</th>
<th>AF X±SE</th>
<th>Paired morphometric traits</th>
<th>t-values</th>
<th>Significant level</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDW (g)</td>
<td>4</td>
<td>156.90 ± 6.280</td>
<td>49.70 ± 3.430</td>
<td>AA-BDW/AF-BDW</td>
<td>14.98</td>
<td>0.00/***</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>138.95 ± 10.550</td>
<td>59.58 ± 2.330</td>
<td>AA-APL/AF-APL</td>
<td>7.33</td>
<td>0.00/***</td>
</tr>
<tr>
<td>APL (cm)</td>
<td>4</td>
<td>5.078 ± 0.070</td>
<td>2.781 ± 0.148</td>
<td>AA-APL/AF-APL</td>
<td>16.22</td>
<td>0.00/***</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>4.763 ± 0.139</td>
<td>3.243 ± 0.083</td>
<td>AA-APL/AF-APL</td>
<td>9.74</td>
<td>0.00/***</td>
</tr>
<tr>
<td>APW (cm)</td>
<td>4</td>
<td>1.820 ± 0.050</td>
<td>0.881 ± 0.067</td>
<td>AA-APW/AF-APW</td>
<td>10.40</td>
<td>0.00/***</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1.732 ± 0.088</td>
<td>1.061 ± 0.044</td>
<td>AA-APW/AF-APW</td>
<td>7.63</td>
<td>0.00/***</td>
</tr>
<tr>
<td>SHL (cm)</td>
<td>4</td>
<td>10.122 ± 0.158</td>
<td>5.844 ± 0.228</td>
<td>AA-SHL/AF-SHL</td>
<td>14.75</td>
<td>0.00/***</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>9.258 ± 0.259</td>
<td>6.786 ± 0.129</td>
<td>AA-SHL/AF-SHL</td>
<td>9.52</td>
<td>0.00/***</td>
</tr>
<tr>
<td>SHW (cm)</td>
<td>4</td>
<td>4.332 ± 0.076</td>
<td>2.544 ± 0.102</td>
<td>AA-SHW/AF-SHW</td>
<td>12.98</td>
<td>0.00/***</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>4.063 ± 0.130</td>
<td>2.661 ± 0.052</td>
<td>AA-SHW/AF-SHW</td>
<td>10.09</td>
<td>0.00/***</td>
</tr>
<tr>
<td>SPL (cm)</td>
<td>4</td>
<td>2.244 ± 0.96</td>
<td>0.775 ± 0.054</td>
<td>AA-SPL/AF-SPL</td>
<td>13.35</td>
<td>0.00/***</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1.979 ± 0.073</td>
<td>1.118 ± 0.045</td>
<td>AA-SPL/AF-SPL</td>
<td>10.28</td>
<td>0.00/***</td>
</tr>
<tr>
<td>SPW (cm)</td>
<td>4</td>
<td>1.046 ± 0.070</td>
<td>0.150 ± 0.022</td>
<td>AA-SPW/AF-SPW</td>
<td>12.15</td>
<td>0.00/***</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>0.705 ± 0.052</td>
<td>0.261 ± 0.037</td>
<td>AA-SPW/AF-SPW</td>
<td>6.74</td>
<td>0.00/***</td>
</tr>
<tr>
<td>DAL (cm)</td>
<td>4</td>
<td>3.159 ± 0.063</td>
<td>1.594 ± 0.093</td>
<td>AA-DAL/AF-DAL</td>
<td>13.50</td>
<td>0.00/***</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>2.947 ± 0.110</td>
<td>1.802 ± 0.043</td>
<td>AA-DAL/AF-DAL</td>
<td>9.71</td>
<td>0.00/***</td>
</tr>
<tr>
<td>LAS (cm)</td>
<td>4</td>
<td>7.173 ± 0.123</td>
<td>4.363 ± 0.121</td>
<td>AA-LAS/AF-LAS</td>
<td>16.34</td>
<td>0.00/***</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>6.574 ± 0.206</td>
<td>4.702 ± 0.089</td>
<td>AA-LAS/AF-LAS</td>
<td>9.52</td>
<td>0.00/***</td>
</tr>
</tbody>
</table>

AA = Achatina achatina, AF = Achatina fulica, BDW = Body weight, APL = Aperture length, APW = Aperture width, SHL = Shell length, SHW = Shell width, SPL = Spiral length, SPW = Spiral width, DAL = Diagonal length and LAS = Length between the aperture and first spiral. *** P<0.001 (Highly Significant).

Table 2a. Phenotypic coefficient of correlation (r_p) of morphometric traits between Achatina achatina and Achatina fulica snails with 4 whorls.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>BDW</th>
<th>SHL</th>
<th>SHW</th>
<th>APL</th>
<th>APW</th>
<th>SPL</th>
<th>SPW</th>
<th>DAL</th>
<th>LAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDW</td>
<td>1.00</td>
<td>-0.362**</td>
<td>-0.041**</td>
<td>-0.434*</td>
<td>0.259NS</td>
<td>0.156NS</td>
<td>0.226NS</td>
<td>0.026NS</td>
<td>0.223NS</td>
</tr>
<tr>
<td>SHL</td>
<td>-0.581*</td>
<td>1.00</td>
<td>-0.124**</td>
<td>0.011NS</td>
<td>0.094NS</td>
<td>-0.030NS</td>
<td>-0.350NS</td>
<td>-0.152NS</td>
<td>-0.658**</td>
</tr>
<tr>
<td>SHW</td>
<td>-0.621**</td>
<td>0.273NS</td>
<td>1.00</td>
<td>-0.356NS</td>
<td>-0.479NS</td>
<td>-0.068NS</td>
<td>0.254NS</td>
<td>-0.227NS</td>
<td>0.090NS</td>
</tr>
<tr>
<td>APL</td>
<td>-0.060NS</td>
<td>-0.639**</td>
<td>0.163**</td>
<td>1.00</td>
<td>0.210NS</td>
<td>0.125NS</td>
<td>-0.013NS</td>
<td>-0.034NS</td>
<td>-0.480NS</td>
</tr>
<tr>
<td>APW</td>
<td>0.420NS</td>
<td>-0.091NS</td>
<td>-0.657**</td>
<td>-0.190NS</td>
<td>1.00</td>
<td>0.338NS</td>
<td>-0.001</td>
<td>0.012NS</td>
<td>-0.430NS</td>
</tr>
<tr>
<td>SPL</td>
<td>0.187**</td>
<td>-0.192NS</td>
<td>-0.141**</td>
<td>-0.024NS</td>
<td>0.191NS</td>
<td>1.00</td>
<td>-0.303NS</td>
<td>-0.205NS</td>
<td>-0.222NS</td>
</tr>
<tr>
<td>SPW</td>
<td>0.239NS</td>
<td>-0.284NS</td>
<td>0.183NS</td>
<td>-0.002NS</td>
<td>0.370NS</td>
<td>-0.368NS</td>
<td>1.000</td>
<td>0.066NS</td>
<td>0.063NS</td>
</tr>
<tr>
<td>DAL</td>
<td>0.339NS</td>
<td>0.013NS</td>
<td>-0.578**</td>
<td>-0.090NS</td>
<td>0.193NS</td>
<td>-0.213NS</td>
<td>-0.220NS</td>
<td>1.000</td>
<td>-0.020NS</td>
</tr>
<tr>
<td>LAS</td>
<td>-0.547*</td>
<td>0.084NS</td>
<td>0.020NS</td>
<td>0.016NS</td>
<td>-0.169NS</td>
<td>-0.165NS</td>
<td>0.000NS</td>
<td>-0.370NS</td>
<td>1.000</td>
</tr>
</tbody>
</table>

BDW = Body weight, SHL = Shell length, SHW = Shell width, APL = Aperture length, APW = Aperture width, SPL = Spiral length, SPW = Spiral width, DAL = Diagonal length and LAS = Length between the aperture and first spiral. ** P<0.01 (High significant level), * P<0.05 (Lower significant level).

Body weights and most shell components studied for A. achatina and A. fulica snails with 4 and 5 whorls. There was only one negative, highly significant (p<0.01) phenotypic correlation coefficient (r_p = -0.658) between SHL and LAS for A. achatina snail with 4 whorls in this study (Table 2a). Also, there were very few negative, highly significant (p<0.01) phenotypic correlation coefficients (r_p) between BDW and SHW (r = -0.621), APL and SHL (r = -0.639), APW and SHW (r = -0.657) for A. fulica snails with 4 whorls. Most of the non-significant (p>0.05) phenotypic correlation coefficients obtained in this study (Table 2a and 2b) denoted that these pairs of traits have no direct relationship and are likely not controlled by the same genes in the same direction. The only positive, but low, non-significant (p>0.05) phenotypic correlation coefficient obtained for Achatina fulica snails with 4 whorls was between BDW and APW (r = 0.420), whereas that for A. achatina with 5 whorls was between BDW and APW (r = 0.529), and between SPW and APW (r = 0.550) respectively. The
only highly positive, significant phenotypic correlation coefficient of \( r = 0.602 \) was obtained between APW and SHW for the snails with 5 whorls. This, according to Ibom (2009) and Okon et al. (2011) signifies that the pairs of morphometric trait used have direct relationship or at least they are controlled by the same gene in the same direction, thus selection for one trait will lead to improvement of the others. The results corroborated Ehiobu and Kyado (2000) and Ibom (2009) views that correlations between morphometric traits could be high or low, positive or negative. On the other hand, these results of negative, low, non-significant phenotypic correlations between the body weights and most of the shell parameters studied disagreed with Okon et al. (2010a, b) and Okon et al. (2011) earlier views of high correlated responses of these morphometric traits for selection and cross breeding for genetic improvement. The differences in correlation coefficients could be attributed to breed effect, age and size differences of snails used, body weight ranges as well as number of whorls. In other words, breed type and number of whorls on shell of the snails used have high effects on phenotypic correlation coefficient of \( r \). The correlation coefficient of \( r = 0.96 \) between hatchlings body weight (BDW) and shell length (SHL) for the purebred white-skinned (Albino) and F1, crossbred snails of \( A. \ marginata \). Similarly, Sam et al. (2016) recently reported strong, positive and highly significant correlation coefficient of \( r = 0.711 \) between BDW and SHW for black-skinned \( A. \ marginata \) and \( r = 0.827 \) between BDW and SHW for white-skinned \( A. \ marginata \). Whereas, Etta et al. (2015) noticed strong, positive, medium phenotypic correlation coefficients of \( r = 0.717 \) between BDW and BSL, \( r = 0.674 \) between BDW and BSW, \( r = 0.618 \) between BSL and SML for \( Achatina fulica \) snails. The differences in correlation coefficients could be attributed to earlier reasons of breed effect, age and sizes differences of snails used; body weight ranges as well as number of whorls on the shell of snails. Besides, it might also be due to the fact that \( A. \ marginata \) snails used by most of the authors cited is mainly a terrestrial snails, whereas \( A. \ achatina \) and \( A. \ fulica \) snails are mostly associated with tropical and sub-tropical moist broadleaf forest (Venette and Larson, 2004), typical of Ibadan where the snails were collected. Again, the size and wider spread of the body weight range of \( A. \ achatina \) than those of \( A. \ fulica \) snail. \( A. \ achatina \) and \( A. \ fulica \) snails with 4 whorls used for the study had higher and wider body weights ranges from 83.00 to 180.50 g (Average 138.95 g) and from 50.60 to 119.30 g (Average 59.58 g) respectively. While \( A. \ achatina \) and \( A. \ fulica \) snails were collected. Again, \( A. \ achatina \) is the largest gastropod among giant African land snails and \( A. \ fulica \) is known to be the smallest (CAB, 2003; Venette and Larson, 2004).

### Table 2b. Phenotypic coefficient of correlation (\( r_p \)) of Morphometric traits between \( Achatina achatina \) and \( Achatina fulica \) snails with 5 whorls.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>BDW</th>
<th>SHL</th>
<th>SHW</th>
<th>APL</th>
<th>APW</th>
<th>SPL</th>
<th>SPW</th>
<th>DAL</th>
<th>LAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDW</td>
<td>1.00</td>
<td>-0.500*</td>
<td>-0.163**</td>
<td>-0.613**</td>
<td>0.529*</td>
<td>0.352NS</td>
<td>-0.001NS</td>
<td>0.439NS</td>
<td>0.271</td>
</tr>
<tr>
<td>SHL</td>
<td>0.359NS</td>
<td>1.000</td>
<td>-0.335**</td>
<td>-0.314NS</td>
<td>0.090NS</td>
<td>-0.549*</td>
<td>0.003NS</td>
<td>-0.375NS</td>
<td>-0.641**</td>
</tr>
<tr>
<td>SHW</td>
<td>-0.252NS</td>
<td>-0.226NS</td>
<td>1.000</td>
<td>-0.300NS</td>
<td>0.602**</td>
<td>-0.059NS</td>
<td>0.248NS</td>
<td>-0.142NS</td>
<td>0.089NS</td>
</tr>
<tr>
<td>APL</td>
<td>0.188NS</td>
<td>-0.243NS</td>
<td>-0.298NS</td>
<td>1.000</td>
<td>-0.264NS</td>
<td>-0.181NS</td>
<td>-0.027NS</td>
<td>-0.312NS</td>
<td>-0.325NS</td>
</tr>
<tr>
<td>APW</td>
<td>-0.086NS</td>
<td>-0.067NS</td>
<td>0.113NS</td>
<td>0.136NS</td>
<td>1.000</td>
<td>0.146NS</td>
<td>0.550*</td>
<td>0.275NS</td>
<td>-0.133NS</td>
</tr>
<tr>
<td>SPL</td>
<td>0.467NS</td>
<td>-0.489NS</td>
<td>0.076NS</td>
<td>0.271NS</td>
<td>0.088NS</td>
<td>1.000</td>
<td>-0.318NS</td>
<td>0.368NS</td>
<td>0.108NS</td>
</tr>
<tr>
<td>SPW</td>
<td>0.325NS</td>
<td>-0.070NS</td>
<td>0.088NS</td>
<td>-0.000NS</td>
<td>-0.095NS</td>
<td>-0.343NS</td>
<td>1.000</td>
<td>-0.354NS</td>
<td>0.219NS</td>
</tr>
<tr>
<td>DAL</td>
<td>0.307NS</td>
<td>0.035NS</td>
<td>0.079NS</td>
<td>-0.401NS</td>
<td>-0.334NS</td>
<td>-0.346NS</td>
<td>0.046NS</td>
<td>1.000</td>
<td>-0.074NS</td>
</tr>
<tr>
<td>LAS</td>
<td>-0.141NS</td>
<td>-0.605**</td>
<td>-0.135NS</td>
<td>0.002NS</td>
<td>-0.078NS</td>
<td>-0.093NS</td>
<td>0.025NS</td>
<td>0.007</td>
<td>1.000</td>
</tr>
</tbody>
</table>

BDW = Body weight, SHL = Shell length, SHW = Shell width, APL = Aperture length, APW = Aperture width, SPL = Spiral length, SPW = Spiral width, DAL = Diagonal length, LAS = Length between the aperture and first spiral, NS = \( P>0.05 \) (N. Significant level), ** = \( P<0.01 \) (High significant level), * = \( P<0.05 \) (Lower significant level).
Conclusion

*Achatina achatina* snails with 4 and 5 whorls had higher values than *Achatina fulica* for all measured morphometric traits. There were high disparities which were significantly different (P<0.001) between BDW and all morphometric traits of snails with 4 and 5 whorls. *Achatina achatina* snails with 4 and 5 whorls were genetically heavier and larger than *Achatina fulica* with 4 and 5 whorls as confirmed by the test of significance of the difference (t-test). The phenotypic correlations among morphometric traits of the two breeds were negative, weak and of low significant (P<0.05) and non-significant (P>0.05) correlation coefficient (r<sub>p</sub>) between BDW and most shell components studied. These revealed that breed type, age and size differences of snails used, body weight ranges and numbers of whorls on snail shells have high effects on morphometric traits differentiation and correlation coefficient estimates. Thus, the morphometric traits of the two breeds of snails studied could be chosen to differentiate as well as characterize snails.

REFERENCES


Sam, I. M., Okon, B., Edem, W., & Ukpanah, U. A. (2016). Quantitative traits measurements as predictor of body weight in black-skinned and white-skinned *Archachatina marginata*. *Proceedings of the 5th International Conference/Workshop on Giant African Land Snails (NetGALS)*, 5<sup>th</sup> - 9<sup>th</sup> June, 2016,

The Influence of cassava peel meal on egg quality and reproductive characteristics of dominant Black Pullets in Makurdi, Benue State, Nigeria

Ezihe, C. O.¹* and Uchendu, C. I.²

¹Department of Veterinary Physiology, Pharmacology and Biochemistry, University of Agriculture, Makurdi, Nigeria. ²Department of Veterinary Physiology and Pharmacology, University of Nigeria Nsukka, Nigeria.

*Corresponding author. Email: chrisezihe@yahoo.com

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ABSTRACT: This work was designed to determine the effect of cassava peel meal on egg quality and reproductive characteristics of Dominant Black pullets. One hundred and twenty (120) dominant black layer breed, comprising 108 pullets at the point of lay and 12 cocks were used in this study. The birds were assigned to three dietary groups containing cassava peel meal at 0% (T1), 10% (T2) and 20% (T3), in a completely randomized design (CRD). The birds were given feed and water ad libitum. Ages of birds at first egg as well as weight of first egg were recorded. Data were collected on egg weight, egg length, egg width, shell weight, shell thickness, egg shape index and albumen height. Data were also collected on infertility and hatchability. Data were subjected to analysis of variance, and significant means were separated using Duncan’s multiple range test. The results of this study revealed that inclusion of cassava peel meal in the diets of pullets did not significantly (P > 0.05) affect the mean egg length, egg width, egg shape index, egg weight, shell weight, shell thickness and albumen height of eggs from the three dietary groups. However, a negative trend in egg weight could be observed as the level of inclusion of cassava peel meal increased in the diets. This suggests that increase in the inclusion level of cassava peel meal could result in a decline in egg weight. Significant differences (P < 0.05) were observed in age at first egg (AFE), weight of first egg (WFE), hatchability and infertility of eggs of pullets on the three dietary groups. Pullets on the control diet had the lowest AFE, 138±0.80 days, which suggests that inclusion of cassava peel meal in the diet of pullets may have prolonged AFE.

Keywords: Diets, hatchability, infertility, Layers, Pullets, Egg quality.

INTRODUCTION

Poultry production is one of the veritable sources of protein in the form of meat and egg to the world. Among the numerous species of poultry is the domestic chicken. Pullets are chickens, which are characteristically kept majorly for their proficiency in egg production and subsequently for meat as old layers. Several breeds of layer chickens, including dominant black pullets, have been developed in different regions of the world, specifically for egg production. For the egg industry worldwide, the production of eggs which are of good egg shell quality and good internal quality is critical to the economic viability of the industry (Ahmadi and Rahimi, 2011).

Poultry production in Nigeria is presently facing many problems triggered by rising cost of conventional feed ingredients. This is worsened largely by competition from the increasing human population in Nigeria. Consequently, there is competition between man and farm livestock on the available conventional feed ingredients, particularly maize. For example, maize being a multi-purpose farm produce in Nigeria serves not only as staple food for a large proportion of Nigerians but also as a raw material for the beer brewing industries among others (Obiakonu and Udedibie, 2007). Thus, the option has been to source locally available plant materials, which are not directly consumed by humans for mono-
gastric animal production (Esonu et al., 2004).

One of the potentially available crop wastes is cassava peels, which is a waste from cassava root (Manihot utilissima) obtained by removing the outer cover of cassava root with sharp knife. Cassava peel could serve as a cheap and alternative source of energy to poultry species, and in ruminant feeding systems, serving either as the main basal diet or as a supplement (Anaeto et al., 2013). Although cassava peel has lower crude protein and energy than maize, the greatest limitation in the use of cassava peel as a substitute for maize is that of its hydrocyanic acid (HCN) content which is harmful to the monogastric animals (Salami and Odunsi, 2003). In order to increase acceptability and subsequent utilization of cassava peel, the HCN content of fresh cassava peels has to be reduced greatly (Salami and Odunsi, 2003). The inclusion of cassava peel meal up to 30% in the diets of growing pigs has been performed without resultant deleterious effect (Irekhore et al., 2006).

With the ever growing cost of poultry feed, there is need to evaluate the potential of cassava peel meal as an alternative feed ingredient in laying hen diets. The objective of this study therefore was to determine the effect of cassava peel meal on egg quality and reproductive characteristics of dominant black pullets.

MATERIALS AND METHODS

Location of study

This study was carried out in Makurdi, Benue state. Makurdi is located in the Guinea Savannah belt of Nigeria on latitude 74°3′N and longitude 8°3′E. The area is warm with a minimum temperature range of 17.3°C to 24.5°C and a maximum temperature range of 29.8°C to 35.6°C (TAC, 2002). The area is characterized by two seasons - a period of dry season from October to March, and a period of rainy season from April to September. Annual rainfall in Makurdi ranges from 973 to 1324 mm.

Preparation of experimental diet

Fresh cassava peels were collected from garri processing centers in Agan community of Benue state. The cassava peels used in this study were prepared by thoroughly washing the peels to remove sand particles and debris. The peels were soaked in a closed metal drum containing water, for five days. The peels were then drained with basket and subsequently sun-dried for 3 to 5 days. The peels were hammer-milled to give cassava peel meal. The experimental diets were thereafter prepared to contain 0% (T1), 10% (T2) and 20% (T3) cassava peel meal, with T1 serving as the control diet (Table 1). Other feed ingredients added were fish meal, maize bran, maize, bone meal, limestone, Methionine, vitamin premix (layer) and salt.

Experimental birds and management

One hundred and twenty (120) Dominant Black layer breed, comprising 108 pullets at the point of lay and 12 cocks were used in this study. The pullets were randomly assigned to three experimental layer diets (treatments) with each dietary group containing thirty-six (36) pullets, in a completely randomized design (CRD). The cocks were also assigned to the three dietary groups with each group containing four (4) cocks. Feed and water were given to the birds ad libitum. The pullets were housed in a deep litter system. Standard vaccination programme for layer chicken management was carried out at appropriate periods. Other management practices such as deworming, debeaking and administration of antibiotics and vitamins were also carried out at appropriate periods.

Data collection

As soon as the pullets started laying, their ages at first egg (AFE) were recorded. The weight of the first eggs (WFE) dropped were also measured and recorded. Egg weight was measured using a sensitive electronic weighing balance (Mettler SB 12001). The egg length and egg width were measured with the venier calipers. Eggshell thickness (in mm) was measured using the micrometer screw gauge. The average of two egg shell measurements per egg was taken as the eggshell thickness. Eggshell weight was also recorded as the weight after breaking the egg and the content poured onto a separate plate. Albumen height was measured with vernier calipers. Egg shape index was calculated as defined in the following formula.

Egg shape index (%) = \frac{\text{egg width}}{\text{egg length}} \times 100

Forty (40) eggs from each treatment group were set on incubator in order to determine the infertility and hatchability of eggs. Infertility and hatchability were defined by the following expressions.

\text{Infertility} = \frac{T_e - F_e}{T_e} \times 100

Where: \(T_e\) = total number of eggs incubated and \(F_e\) = total number of fertile eggs

\text{Hatchability} = \frac{H_e}{V_e} \times 100

Where: \(H_e\) = total number of hatched eggs and \(V_e\) = total number of viable eggs after candling.

Statistical analysis

Data were subjected to Analysis of Variance (ANOVA) using Statistical Package for the Social Sciences (SPSS,
Table 1. Percentage Composition of Layer Diets.

<table>
<thead>
<tr>
<th>Feedstuff</th>
<th>T1 (0%)</th>
<th>T2 (10%)</th>
<th>T3 (20%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava Peel Meal</td>
<td>0.00</td>
<td>10.00</td>
<td>20.00</td>
</tr>
<tr>
<td>Fish Meal</td>
<td>2.00</td>
<td>2.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Soyabean Meal</td>
<td>30.00</td>
<td>30.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Maize Bran</td>
<td>9.60</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Maize</td>
<td>48.00</td>
<td>47.60</td>
<td>43.70</td>
</tr>
<tr>
<td>Bone Meal</td>
<td>3.50</td>
<td>3.50</td>
<td>3.50</td>
</tr>
<tr>
<td>Limestone</td>
<td>6.00</td>
<td>6.00</td>
<td>4.50</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Premix (Layers)</td>
<td>0.30</td>
<td>0.30</td>
<td>0.25</td>
</tr>
<tr>
<td>Salt</td>
<td>0.30</td>
<td>0.30</td>
<td>0.25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Calculated Analysis

<table>
<thead>
<tr>
<th></th>
<th>T1 (0%)</th>
<th>T2 (10%)</th>
<th>T3 (20%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Protein %</td>
<td>17.51</td>
<td>18.20</td>
<td>17.40</td>
</tr>
<tr>
<td>Energy Kcal/kg ME</td>
<td>2733</td>
<td>2705</td>
<td>2630</td>
</tr>
<tr>
<td>Calcium %</td>
<td>3.50</td>
<td>3.67</td>
<td>2.93</td>
</tr>
<tr>
<td>Phosphorus %</td>
<td>0.845</td>
<td>0.840</td>
<td>0.851</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.574</td>
<td>0.592</td>
<td>0.541</td>
</tr>
<tr>
<td>Lysine %</td>
<td>1.021</td>
<td>1.022</td>
<td>0.921</td>
</tr>
</tbody>
</table>

Table 2. The Influence of Cassava Peel Meal on Egg Characteristics of Dominant Black Pullets.

<table>
<thead>
<tr>
<th>Egg Characteristics</th>
<th>Diets (Mean±SEM)</th>
<th>LS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T1 (0%)</td>
<td>T2 (10%)</td>
</tr>
<tr>
<td>Egg length (cm)</td>
<td>5.88±0.03</td>
<td>5.93±0.04</td>
</tr>
<tr>
<td>Egg width (cm)</td>
<td>4.46±0.03</td>
<td>4.37±0.03</td>
</tr>
<tr>
<td>Egg Shape Index</td>
<td>1.31±0.02</td>
<td>1.33±0.02</td>
</tr>
<tr>
<td>Egg Weight (g)</td>
<td>61.74±0.99</td>
<td>60.95±1.02</td>
</tr>
<tr>
<td>Shell Weight (g)</td>
<td>5.42±0.11</td>
<td>5.38±0.13</td>
</tr>
<tr>
<td>Shell Thickness (mm)</td>
<td>0.38±0.01</td>
<td>0.37±0.01</td>
</tr>
<tr>
<td>Albumen Height (cm)</td>
<td>0.66±0.02</td>
<td>0.76±0.03</td>
</tr>
</tbody>
</table>

SEM= Standard error of the mean; LS= Level of significance; NS= non-significant (P > 0.05).

RESULTS AND DISCUSSIONS

The results of influence of cassava peel meal on egg characteristics of Dominant Black layers are shown in Table 2, while the influence of cassava peel meal on reproductive characteristics of Dominant Black pullets were shown in Table 3. The results of this study showed that there were no significant differences (P > 0.05) in the mean egg length, egg width, egg shape index, egg weight, shell weight, shell thickness and albumen height of eggs from the three dietary groups. However, a negative trend in egg weight could be observed as the level of inclusion of cassava peel meal increased in the diets. This suggests that increase in the inclusion level of cassava peel meal could result in a decline in egg weight. Again, egg shell weight decreased as the inclusion level of cassava peel meal in the diets increased. In addition, egg width also increased as the inclusion level of cassava peel meal in the diets increased. There was no significant differences in external egg characteristics of pullets fed diets containing graded levels of cassava peel meal had been reported. Olowofeso and Omisami (2008) observed that egg laying chickens fed varying levels of sun-dried cassava peel treated with yeast did not affect egg weight, egg width, egg length, egg shell weight, egg shell thickness, shape index and albumen weight. Mean
Table 3. The influence of Cassava Peel Meal on Reproductive Characteristics of Dominant Black Pullets.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Diets (Mean±SEM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T1 (0%)</td>
</tr>
<tr>
<td>Number of Egg Set</td>
<td>40</td>
</tr>
<tr>
<td>Dead in Shell %</td>
<td>45.50±0.08&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Infertility %</td>
<td>50.00±0.79&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Hatchability %</td>
<td>5.26±0.01&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Age at First Egg (AFG) (days)</td>
<td>138±0.80&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Weight of First Egg (WFE) (g)</td>
<td>43.28±0.05&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

a,b,c = Means in the same row with different superscript differ significantly (P>0.05). SEM= standard error of the mean.

Egg widths observed in this study were slightly higher than values reported by Amaefule et al. (2007) who recorded values ranging from 4.23 to 4.31 cm in layers fed raw or processed pigeon pea seed meal during laying stage. The average egg widths observed in this study were also higher than the value 3.3 cm reported by Oladunjoye et al. (2010) who substituted maize with 50 to 80% sun-dried cassava peel meal and treated cassava peel meal respectively. The mean values of egg weight observed in this study were comparable to the values reported by Mosobolaja et al. (2010) and Abeke et al. (2007) who fed processed pigeon pea and graded levels of Lalabpurpurus bean diets to layers of comparable age bracket. However, mean egg weights obtained in this study were higher than those obtained by Oladunjoye et al. (2010) who fed 50 to 80% graded levels of sun-dried and lye-treated cassava peel meal to pullets from 32 weeks of age. Salami and Odunsi (2003) reported higher egg weights (60.20 to 66.70 g) in older birds (66 to 72 weeks) fed retted cassava peel meal based diets.

Significant differences (P < 0.05) were also observed in age at first egg (AFE) among pullets on the three dietary groups. Pullets on the control diet had the lowest AFE, 138±0.80 days, which suggests that inclusion of cassava peel meal in the diet of pullets may have prolonged AFE. Abeke et al. (2007) obtained higher AFE values in layers fed grower diets containing graded levels of Lalabpurpurus beans meal. Akanni et al. (2008) reported AFE values of 190.93, 138.24, 160.76, 188.73 and 177.00 days for Nera black, White Leghorn, Giriraja, local and B-Alpha breeds of chicken respectively. Significant differences (P < 0.05) were also observed in weight at first egg (WFE) of pullets on the three dietary groups. Pullets on the control diet also recorded highest WFE, 43.28±0.05 g, although WFE did not follow any defined pattern.

There were also significant differences in hatchability and infertility of eggs on the three dietary groups (P < 0.05). Hatchability of eggs from the three dietary groups did not follow any defined pattern as revealed in this study. Factors that could be responsible for the low hatchability values in this study were the status of breeding stock, environmental temperature and inadequate turning of eggs. However, the result revealed that as the inclusion level of cassava peel meal in the diets increased, infertility of eggs decreased. Hatchability is a function of fertility except when there is occurrence of major genes that reduce embryonic livability (Akanni et al., 2008). The fertility rate observed in this study is low compared to the ideal, which is supposed to be between 90 to 95%. Akanni et al. (2008) obtained percentage fertility rate of 73.85 to 77.00% for black Nera, local and B-Alpha improved indigenous crossbreds. The hatchability observed in this study, which is based on number of fertile eggs, was too low compared to established levels of 85 to 87% (Jadhav and Siddiqui, 2007). Bovans (2004) obtained hatchability value of 80% for Bovan breed of pullets. Akanni et al. (2008) recorded hatchability values of 86, 73 and 75% for black Nera and B-Alpha improved indigenous crossbreds respectively. The low hatchability observed in this study could be because hatching was done in the dry season when the environmental temperature was too high for keeping of eggs. The humidity, levels of oxygen and carbon (iv) oxide may not have been adequate because of environmental temperature.

Conclusion and recommendation

Cassava peel meal is a good alternative source of energy to chickens and can be included up to a level of 20% in the diets of pullets without any deleterious effect on egg length, egg width, egg shape index, egg weight, shell weight, shell thickness and albumen height. It is therefore recommended that cassava peel meal could be used to replace maize up to 20% in the diets of layer chickens.

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