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EFFECT OF PARTIAL REPLACEMENT OF FISHMEAL WITH AFRICAN YAM BEAN (*SPHENOSTYLIS STENOCARPA*) MEAL ON GROWTH PERFORMANCE AND GONAD DEVELOPMENT OF AFRICAN CATFISH HYBRID (*HETEROCLARIAS*) FINGERLINGS

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Abstract

The efficacy of replacing fishmeal with African yam bean (AYB) (*Sphenostylis stenocarpa*) meal in the feed of African catfish hybrid (*Clarias gariepinus* ♂ x *Heterobranchus bidorsalis*♀) on growth and gonad development was evaluated for a period of 10 weeks. The experimental diets contained African yam bean meal at levels of 0% (Diet 0), 25% (Diet 1), 50% (Diet 2), 75% (Diet 3) and 100% (Diet 4) of the total dietary protein respectively. A total of 165 fingerlings of homogenous size were introduced into 15 aquaria of 50 litres volume, each randomly assigned to the five diets. Each treatment was replicated thrice with 11fingerlings in each aquarium. The following growth indices were monitored: weight gain, percentage weight gain, specific growth rate, food conversion ratio and protein efficiency ratio. Histological analysis of the ovary samples harvested from the fish in the different feeding groups was also conducted. The group fed control diet had significantly higher weight gain, percentage weight gain, specific growth rate and protein efficiency ratio than those fed AYB 75% diet. Oocyte development in the various sampled gonads was observed to be in different development stages (immature, early maturing and late maturing). The least oocyte development was seen in the group of fish fed with AYB 75% and AYB 100% diet. Thus fishmeal is a better protein source for *Heteroclarias* than *Sphenostylis stenocarpa*.

Keywords: Partial replacement, African yam bean, Growth performance, Gonad development Heteroclarias

Introduction

Aquaculture has grown in leaps and bounds in response to the increasing demand for fish as a source of protein (Akinrotimi *et al.*, 2007a). This is because production from capture fisheries has reached its maximum potential, as the catch is dwindling with each passing day (Gabriel *et al.*, 2007). According to FAO (2006), fish supplies from capture fisheries will not be able to meet the growing global demand for aquatic food. Hence, there is need for a viable alternative fish production system that can sufficiently meet this demand and aquaculture fits exactly into this role.

However, fish feed is a significant factor in increasing the productivity and profitability of aquaculture as it becomes more intensive in Nigeria (Akinrotimi *et al.*, 2007b). This is because feed management determines the viability of aquaculture as it accounts for at least 60% of the cost of fish production (Jamiu *et al.*, 2003). Also, good nutrition in animal production systems is essential to economically produce a healthy, high quality product. Fish nutrition has advanced dramatically in recent years with the development of new, balanced commercial diets that promote optimal fish growth and health. Manufactured feed is an important part of modern commercial aquaculture, providing the balanced nutrition needed by farmed fish (Craig and Helfrich, 2009). 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 (Houliban *et al.*, 2001).

Aquaculture feeds characteristically contain a higher percent of protein than feeds used in agriculture for poultry, swine and beef (Miles and Chapman, 2006b). This is because fish require less energy for maintenance of normal body functions than warm blooded animals like poultry, and horses. Protein is typically the most costly nutrient in a formulated feed and depends greatly on fishmeal in the majority of formulated fish diets. Fishmeal is also more costly than high quality plant-based protein sources such as soy protein. This fishmeal comes mainly from the processing of fish from the wild catch (Miles and Chapman, 2006).

With the growing demand from aquaculture and foreseeable leveling off in fishmeal and fish oil production from fisheries, it appeared necessary to reduce the proportion of fishmeal in feeds for aquaculture. Research has therefore developed on alternative sources of protein to replace fishmeal and fish oil especially by using plant raw materials, while seeking to conserve the nutritional and organoleptic qualities of aqua cultured fish. The aim of this work is to determine the suitability and effectiveness of African yam bean (AYB) (*Sphenostylis stenocarpa*) as a plant protein source and a replacement for fish meal in the feed of African catfish (*Heteroclarias*) fingerlings.

Materials and Method

Experimental Location

This study was conducted at the Fisheries and Aquaculture Unit of the Department of Zoology, Faculty of Biosciences, Nnamdi Azikiwe University, Awka, South East of Nigeria and lies within coordinates 6°12′N and 7°04′E. It is in the tropical zone of Nigeria and wooded savannah grassland predominates the north and east of the city (Onyido *et al*., 2011).

Experimental Design

A total of 165 fish of *Heteroclarias* species used in this study were cultured in 50 litres volume plastic tank for 70 days (10 weeks). There were 5 treatments with three replicates each. Fish were randomly selected and stocked at 11 fish per tank. They were fed allotted experimental diets at 5% of their body weight twice daily to evaluate the effect of the feed on their growth and gonad development. Fish meal concentrations were decreasing with increasing concentrations of African yam bean meal for diets D_0 (AYB 0%), D_1 (AYB 25%), D_2 (AYB 50%), D_3 (AYB 75%), and D_4 (AYB 100%). The weights of the fish were measured weekly.

Experimental Fish

Fingerlings of African catfish hybrid (*Heteroclarias*) were obtained from ACJ Service Farm Asaba, Delta State, Nigeria. The age of the fish was one month and weighed between 5.12g and 5.14g. They were acclimatized in the experimental unit (50 litres tank) for a period of 14 days. The fish were not fed with the experimental diets during the acclimatization period for two weeks to flush their systems before starting the study.

Physicochemical parameters

The following water quality parameters were monitored at the beginning and end of the experiment, Temperature, pH, Dissolved oxygen (DO) Total alkalinity and Biochemical oxygen demand (BOD) using APHA methods (1998).

Experimental Diet

The experimental diet was formulated from conventional feed materials which included fish meal, soya bean meal, African yam bean which is the test ingredient, bone meal, groundnut cake, palm oil, maize and salt vitamin and mineral premix, (Table 1).

Seeds of African yam bean *(S. stenocarpa)* was boiled for 60 minutes to reduce the anti-nutritional factors (ANFs) thereby increasing its nutritional quality as in Adeparusi *et al.* (1998). The AYB meal and other ingredients were properly measured out and mixed to formulate the experimental diets Oso *et al.* (2013), which were designated as D_o, **(0%)** D1(25%,), D_2, (50%), D_3 (75%) and D_4. (100%) respectively.

Table 1: Composition of Experimental Diets (per 100/g)

Ingredients	Control (D0-0%)	AYB (DI-25%)	AYB (D2-50%)	AYB (D3-75%)	AYB (D4-100%)
Fishmeal	25	19	12	6	-
Maize	22	22	22	22	22
African Yam bean	-	6	12	19	25
Groundnut cake	25	25	25	25	25
Soyabean meal	25	25	25	25	25
Palm Oil	1.00	1.00	1.00	1.00	1.00
Bone meal	1.00	1.00	1.00	1.00	1.00
Premix	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100

Proximate Analysis of Diet

The test diets (D_0, D_1, D_2, D_3 and D_4) were analyzed for proximate composition at the Biochemistry laboratory of Nnamdi Azikiwe University, Awka, utilizing the methods of the Association of Official Analytical Chemists (AOAC, 1999) for moisture content (MC), crude protein (CP), total ash, crude fat and crude fibre contents. Samples of 5g weight of each trial diet were used for the proximate analysis.

Determination of Indices of Growth and Feed Utilization

1. **Weight gain**

The weight gain was expressed as the weight gain of individual in the organism's life time ($T_2 – T_1$) and was expressed as weekly final mean weight minus initial mean weight divided by duration of the study.

$$\mathrm{WG} = \frac{\mathrm{W2} - \mathrm{W1}}{\mathrm{T2} - \mathrm{T1}} \times 100$$

Where W_1 = Initial weight of sample
W_2 = final weight of sample
T_1 = Initial time
T_2 = Final time

2. **Percentage weight gain (PWG)**

This was determined using the formula below:

$$\mathrm{PWG} = \frac{\text{Mean final weight} - \text{Mean initial weight}}{\text{Mean initial weight}} \times 100$$

3. **Specific growth rate (SGR)**

This determines the actual weight gain for the time interval of the study and expressed as:

$$SGR = \frac{\text{Loge W2} - \text{Loge W1}}{\text{T2} - \text{T1}} \text{ x } 100$$

Where W_2 = Final weight of fish at time T_2

W_1 = Initial weight of fish at time T_1

e = Base of natural logarithm.

4. **Food conversion ratio (FCR)**

This was determined as the ratio of food consumed by the fish to the weight gain of the fish and expressed as:

$$FCR = \frac{\text{Weight of food offered}}{\text{Weight gain}}$$

5. **Protein efficiency ratio (PER)**

Protein efficiency ratio assesses an individual protein ability to sustain growth. It is also used to evaluate the quality of protein in the diet (Cozzalino and Labandera, 2002). It is expressed as:

$$PER = \frac{\text{Mean weight gain of fish}}{\text{Protein intake}}$$

Where Protein intake

$$PI = \frac{\text{Total feed consumed x \% crude protein in feed}}{100}$$

Statistical Analysis

The data obtained were subjected to Analysis of Variance (ANOVA) using SPSS Statistical Package (version 20) and means from the various treatments were separated using Fisher's least significant difference (LSD) at ($P<0.05$).

RESULTS

Water Quality Parameters

The water quality parameters monitored during the study which included Temperature, pH, dissolved oxygen, total alkalinity, and biological oxygen demand, are represented in Table 3. The result values were within the acceptable range for fish culture in the tropics as reported by Boyd (1979).

Table 3: Water Quality Parameters Monitored During the Experimental Period

Water Quality Parameters	Mean Value ±SD
Temperature (ºC)	26.95±2.76
pH	5.75±0.49
Dissolved oxygen (ppm)	8.61±0.03
Total alkalinity (ppm)	19.95±0.07
Biological oxygen demand (ppm)	0.83±0.10

Proximate Analysis of the Diets Used for the Experiment

Results of proximate analysis of the formulated diets are presented in Table 2. From the table, the diet with 100% AYB inclusion had the highest crude protein content (32.29%) which met the protein quantity for the growth of fish as stipulated by Houliban *et al.* (2001), while the least crude protein was in the control diet of

0% AYB inclusion (20.14%). The fat and crude fibre content was also highest in the diet with 100% AYB inclusion and least in the control diet of 0% AYB inclusion.

Table 2: Proximate Composition of Experimental Diets (in %)

Parameter	Control (0%)	AYB 25%	AYB 50%	AYB 75%	AYB 100%
Moisture	**12.00**	**12.50**	**13.50**	**15.00**	**11.00**
Ash	**21.00**	**19.00**	**15.00**	**12.00**	**8.00**
Fat	**2.00**	**2.50**	**2.50**	**3.00**	**3.20**
Crude protein	**20.14**	**25.39**	**29.77**	**31.52**	**32.39**
Crude fibre	**5.00**	**5.02**	**5.43**	**7.65**	**10.01**
Nitrogen free extract	**39.86**	**35.59**	**33.80**	**30.83**	**35.40**

Indices of Feed Utilization

The weekly weight gain, percentage weight gain, specific growth rate, food conversion ratio and protein efficiency ratio of *Heteroclarias* fingerlings (173.67±2.64) fed with different percentage inclusions (0%, 25%, 50%, 75% and 100%) of *S. stenocarpa* respectively for 10 weeks are presented in table 4.

The result revealed that the highest weekly weight gain was recorded by the fish fed with 0% AYB inclusion diet (674.40g) followed by those fed with 100% AYB inclusion diet (573.80g), while the least was recorded by those fed with 75% AYB inclusion diet (234.97g). The analysis of variance result revealed that there was a significant difference between the weight gain of *Heteroclarias* fingerlings fed with various percentage inclusions of *S. stenocarpa* ($P<0.05$).

The percentage weight gain of *Heteroclarias* fingerlings was highest (384.86) in those fed with the 0% AYB inclusion diet followed by those fed with AYB100% diet (332.89). However, the lowest percentage weight gain was evidently shown by *Heteroclarias* fingerlings fed AYB 75% diet (133.55). This indicates that there was significant difference in the percentage weight gain between *Heteroclarias* fingerlings fed with various inclusions of *S. stenocarpa* for 10 weeks ($P<0.05$).

However, the highest mean specific growth rate was recorded by *Heteroclarias* fingerlings fed with the control diet (4.03) while the least specific growth rate was recorded in *Heteroclarias* fingerlings fed with the AYB 75% diet (3.29). There was significant difference between specific growth rates of *Heteroclarias* fingerlings fed with various percentage inclusions of *S. stenocarpa* ($P<0.05$).

The best food conversion ratio was recorded in *Heteroclarias* fingerlings fed with the control diet (2.35), while the poorest was recorded in the *Heteroclarias* fingerlings fed with AYB 75% diet (5.07) for 10 weeks. There was significant difference between food conversion ratio (FCR) of *Heteroclarias* fingerlings fed with various percentage inclusions of *S. stenocarpa* ($P<0.05$).

The best value for protein efficiency ratio was recorded in the *Heteroclarias* fingerlings fed with the control diet (2.12). However, the poorest protein efficiency ratio was evident in the *Heteroclarias* fingerlings fed with the AYB 75% diet (0.71). There was significant difference ($P<0.05$) in the protein efficiency ratio between *Heteroclarias* fingerlings fed with various inclusion levels of *S. stenocarpa* for 10 weeks.

Table 4: Mean Growth Performance of African Catfish Hybrid (*Heteroclarias*) Fingerlings fed with Various Percentage Inclusions of *S. stenocarpa* for 10 Weeks

Treatments	Control (0%)	AYB 25%	AYB 50%	AYB 75%	AYB 100%
Initial weight gain (g)	175.23±3.97^{ab}	169.63±2.87^{a}	175.20±4.43^{ab}	175.93±1.33^{b}	172.37±1.27^{ab}
Final weight gain (g)	849.63±116.52^{b}	608.27±59.71^{ab}	651.30±125.33^{ab}	410.90±169.76^{a}	746.17±186.70^{b}
Mean weight gain (g)	674.40±112.55^{b}	438.63±56.84^{ab}	476.10±120.90^{ab}	234.97±168.43^{a}	573.80±185.43^{b}
Mean % weight gain (g)	384.86±73.12^{b}	258.58±38.70^{ab}	271.75±81.23^{ab}	133.55±95.34^{a}	332.89±110.97^{b}
Specific growth rate (SGR)	4.03±0.11^{b}	3.77±0.09^{b}	3.81±0.09^{b}	3.29±0.41^{a}	3.92±0.21^{b}
Food conversion ratio (FCR)	2.35±0.13^{a}	2.75±0.26^{a}	2.68±0.39^{a}	5.07±1.90^{b}	2.72±0.45^{a}
Protein efficiency ratio (PER)	2.12±0.11^{c}	1.44±0.13^{b}	1.27±0.20^{b}	0.71±0.33^{a}	1.16±0.19^{b}

Rows sharing similar superscripts are not significantly different at P>0.05

Histological Analysis of the Gonads (Ovary)

Histological analysis and examination of the gonad (ovaries) of the *Heteroclarias* fed with various percentage inclusions of *S. stenocarpa* for 10th and 15th weeks are presented in plates (1, 2,3,4,5 and 6,7,8,9,10 respectively).

Histological result of the ovaries of the *Heteroclarias* fed with various percentage inclusions of *S. stenocarpa* for 10th week

Histological analysis revealed that the ovary sample harvested from the group of fish fed with the control diet was in the early maturing phase at the 10th week as proven by the presence of the features labeled in plate 1. In the early maturing phase, the oocytes were still connected to one another which explain the presence of the non-fibrous connective tissue. Similarly, the ovary sample harvested from the group of fish fed with AYB 25% diet was in the early maturing phase at the 10th week as proven by the presence of the features labeled in plate 2. In addition, the histological analysis result further revealed that the ovary sample harvested from the group of fish fed with AYB 50% diet was in the early maturing phase at the 10th week as proven by the presence of the features labeled in plate 3. The oocytes were still held together by the non-connective tissue in the early maturing phase and there were no prominent nucleus.

In contrast, ovary sample harvested from the group of fish fed with AYB 75% diet was in the immature phase at the 10th week as proven by the presence of the features labeled in plate 4. In the immature phase, most oocytes are still tiny and gathered in the nest of oogonia. Histological analysis further revealed that the ovary sample harvested from the group of fish fed with AYB 100% diet was in the immature phase at the 10th week as proven by the presence of the features shown in plate 5. The oocytes were tiny and immature in the immature phase.

Histological result of the ovaries of the *Heteroclarias* fed with various percentage inclusions of *S. stenocarpa* for 15th week

Histological analysis revealed that the ovary sample harvested from the group of fish fed with control diet was in the late maturing phase at the 15th week as proven by the presence of the features labeled in plate 6. In the late maturing phase, the oocytes were separated from each other and the migrating nucleus was prominent. Blood capillaries were also conspicuous at the 15th week. Similarly, the ovary samples harvested from the group of fish fed with AYB 25% diet were in the late maturing phase at the 15th week as proven by the presence of the features labeled in plate 7. In the group of fish fed AYB 50% diet, the ovary sample was in the late maturing phase (Plate 8) at the 15th week. In the late maturing phase, the oocytes are mature with prominent nucleus and the oocyte v has also become conspicuous.

More so, the histology result revealed that the ovary sample harvested from the group of fish fed with AYB 75% diet was in the early maturing phase at the 15th week (plate 9). Furthermore, the ovary sample of the group of fish fed AYB 100% diet was in the early maturing phase in the 15th week (Plate10). In the early maturing phase the oocytes were bigger. The yolk vessicle and vitelline membrane were also present.

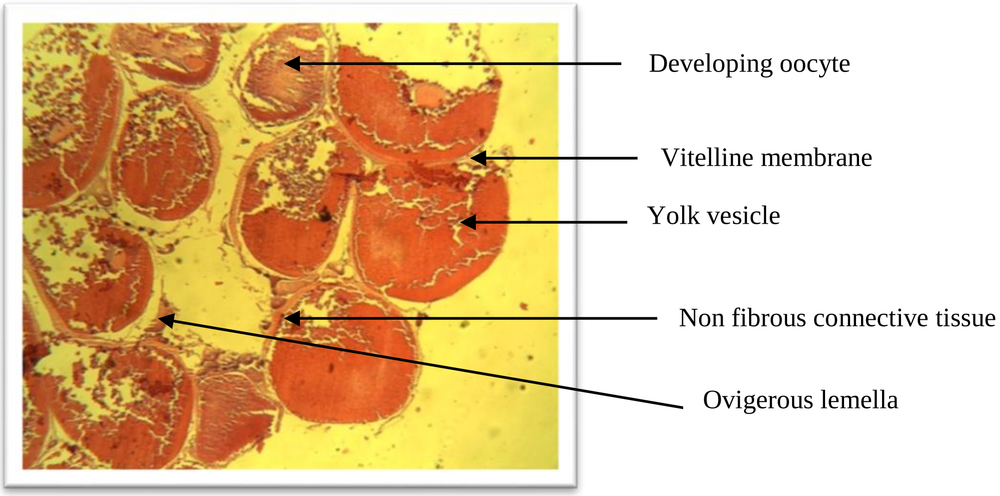

Plate 1: Photomicrograph of the ovary samples from group of fish fed with control diet (AYB 0%) showing early maturing phase of the ovary at the 10th week.

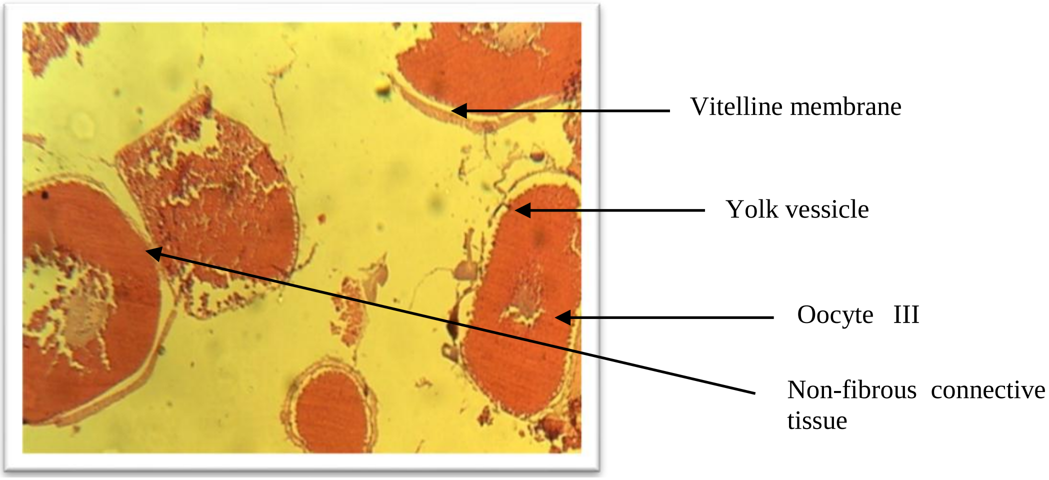

Plate 2: Photomicrograph of the ovary samples from group of fish fed with AYB 25% showing early maturing phase of the ovary at the 10th week

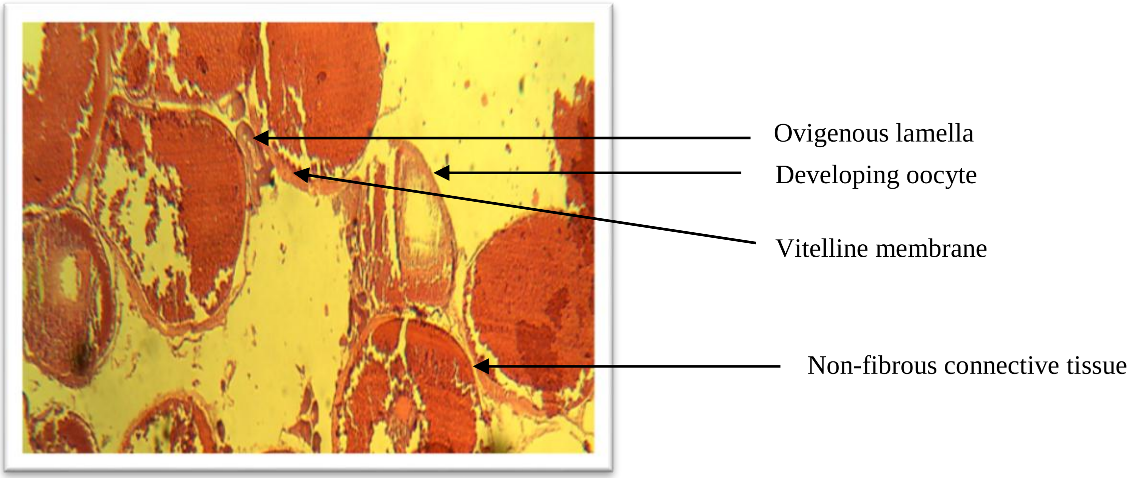

Plate 3: Photomicrograph of the ovary samples from group of fish fed with AYB 50% showing early maturing phase of the ovary at the 10th week

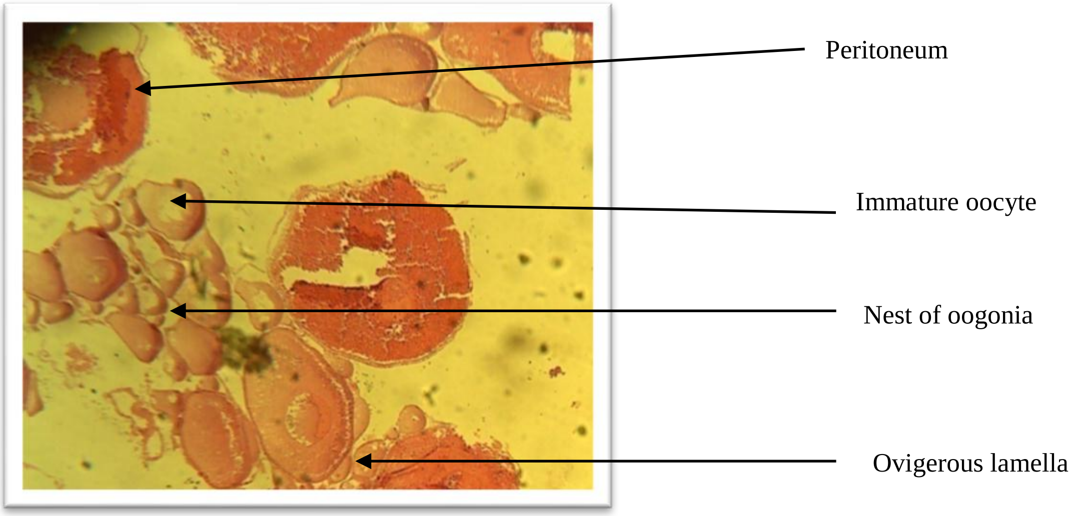

Plate 4: Photomicrograph of the ovary samples from group of fish fed with AYB 75% showing immature phase of the ovary at the 10th week

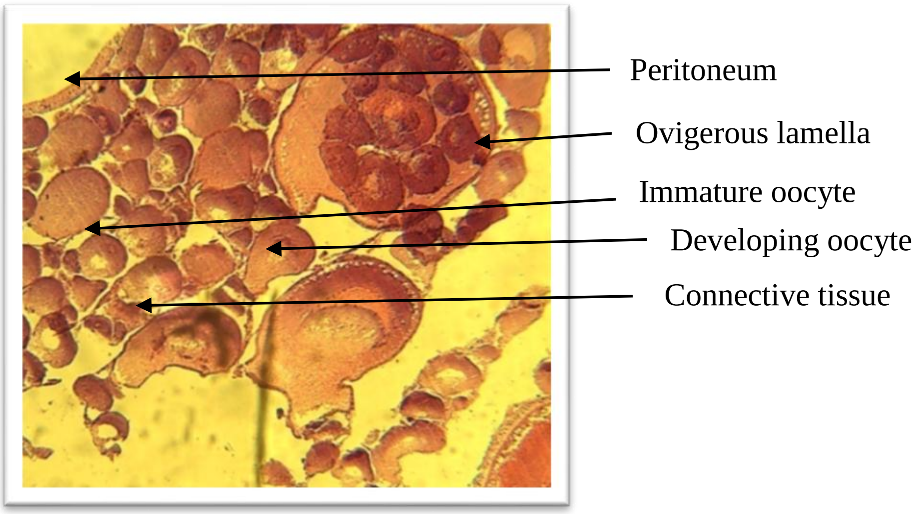

Plate 5: Photomicrograph of the ovary samples from group of fish fed with AYB 100% showing immature phase of the ovary at the 10th week

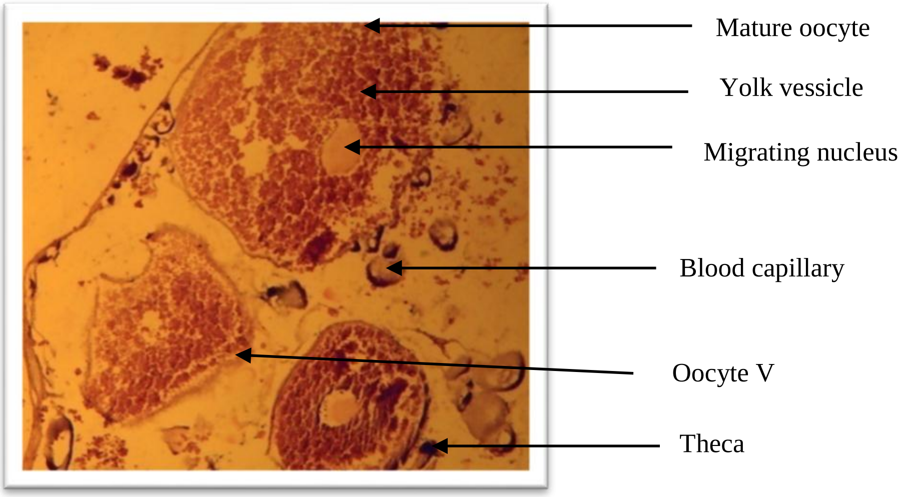

Plate 6: Photomicrograph of the ovary samples from group of fish fed with control diet (AYB 0%) showing late maturing phase of the ovary at 15th week.

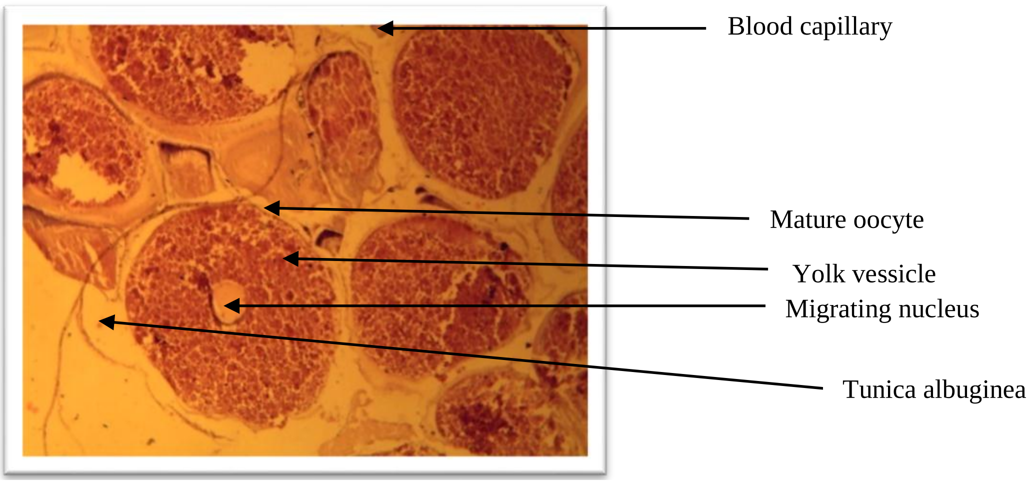

Plate 7: Photomicrograph of the ovary samples from group of fish fed with AYB 25% showing late maturing phase of ovary at 15th week

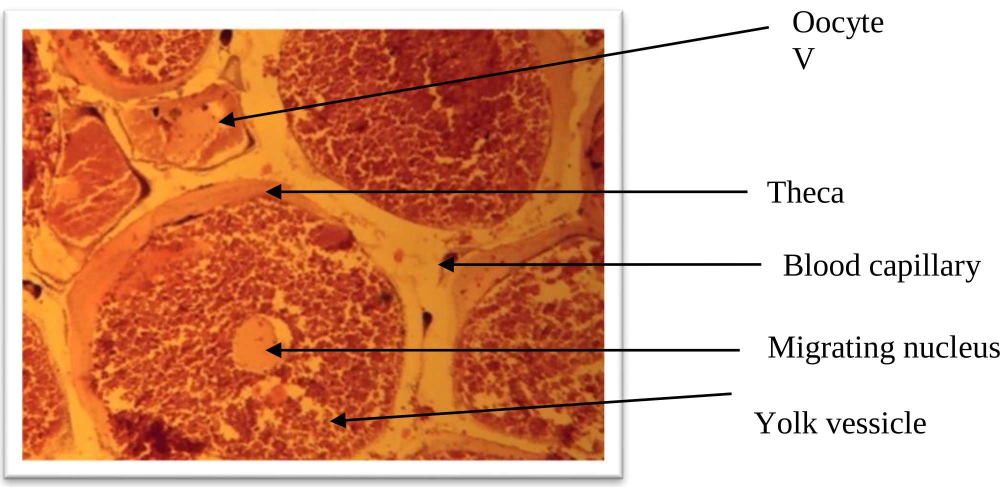

Plate 8: Photomicrograph of the ovary samples from group of fish fed with AYB 50% showing maturing phase of the ovary at the 15th week

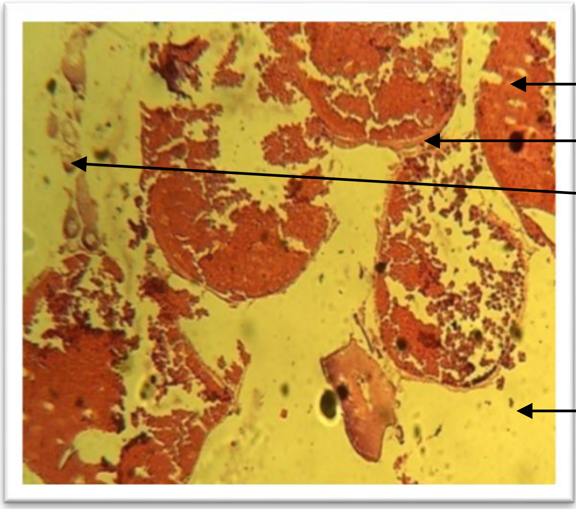

Plate 9: Photomicrograph of the ovary samples from group of fish fed with AYB 75% showing early maturing phase of the ovary at the 15th week

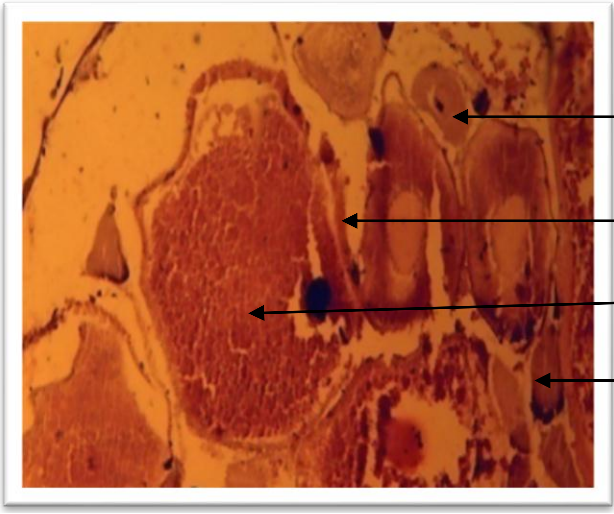

Plate 10: Photomicrograph of the ovary samples from group of fish fed with AYB 100% showing early maturing phase of ovary at 15th week

DISCUSSION

Results obtained from the proximate analysis of the experimental diets showed that the crude protein and fat content were lowest in the control diet and highest in AYB 100% diet. The crude protein contents of the diets showed a pattern of increase with increasing inclusion of African yam bean meal. The levels of these dietary components have been found to be adequate for normal growth for the size of fish used in this study. Quite a point of concern is the fact that the group of fish fed with the control diet performed better than other groups both in their growth response and gonad development, though the diet had the lowest crude protein content. This suggests difference in the quality of protein contained in the two protein sources. If fish growth depends on the protein content of the fish feed, then the group of fish fed with test diet D_4, with 100% AYB inclusion should have shown better growth and development. This agrees with the report of MAFES (2007) which opined that Catfish do not require as much dietary protein for maximum growth as has typically been assumed. MAFES (2007) examined dietary protein levels from 10 to 40% in various studies and found no difference in weight gain and feed conversion in fish feed diets, containing as low as 24% protein. They also found that fish fed 10 to 20% dietary protein had 80 to 90% of the growth of fish fed a 32% protein diet.

The result of this study indicate that when fish were fed with test diets of different percentage inclusion of African yam bean (*S. stenocarpa*) and a control diet with no inclusion of African yam bean that the fish fed with the control diet showed the highest percentage weight gain. The least percentage weight gain was attained by the group fed with test diet D_3 with 75% AYB inclusion. Not only was the highest percentage weight gain of *Heteroclarias* recorded in the group fed with the control diet but also the weight gain and specific growth rate value were also highest (Table 4). This group was followed by the group of fish fed with test diet D_4 with 100% AYB inclusion which attained the second best weight gain, percentage weight gain and specific growth rate.

The best food conversion ratio was recorded in the group fed the control diet with 0% AYB inclusion. Similarly, Alegbeleye *et al*. (2002) reported a trend of reduced food conversion ratio with increased inclusion of toasted AYB meal in the feed of *Oreochromis niloticus*, this work shows that the food conversion ratio of all the groups of fish that were fed with AYB diets were not better than that of the group of fish fed with the control diet. But, the mean FCR of the control group was only significantly different ($P<0.05$) with those of AYB 75%. The best value for protein efficiency ratio was obtained in fish fed the control diet. It was also significantly different from the protein efficiency ratio of other feeding groups. The lowest protein efficiency ratio (0.71) was recorded in the group of fish fed with diet D_3 (75% AYB diet).

The response of ovary development to different inclusions of AYB meal in the test diets is also of interest (Plates 1 to 10). The histological observation revealed that the maturation stages of the ovaries varied with treatment and time of sampling. The result of the recent study revealed that increasing inclusion level of AYB affected gonad development adversely. This is because the least development was seen in the gonads of the group of fish fed with AYB 75% diet and AYB 100% diet. Okpani *et al.* (2014), who worked on the effect of partial replacement of fishmeal with African yam bean meal on eggs, sperm quality and spawning performance of *C. gariepinus,* reported that the group of fish fed formulated feed (with different inclusion levels of African yam bean meal), showed significant difference in reproductive performance over those fed with the control diet. The difference in result could be caused by age difference between the fish used for both studies. They worked with adult *C. gariepinus* of 12 months old whose gonads are well developed while this study was conducted with 3 months old *Heteroclarias* whose gonads are still developing. Thus in overall, comparing both studies showed that age was a factor, and level of inclusion in this study showed decrease in development i.e. as inclusion levels increased, there was noticed decrease in gonad development (Plate 1 - 10).

The overall result showed that using fishmeal as the major protein source in the feed of *Heteroclarias* fingerlings resulted in a high weight gain, percentage weight gain and specific growth rate. Although there was weight increase in the fishes fed with diets with different percentages of AYB inclusion, the value of the percentage weight gain of the group fed with 0% AYB diet was significantly different from that of the group fed 75% AYB diet. Adeparusi *et al.* (1998) who evaluated the replacement of soyabean meal with Africa yam bean meal (both raw and processed) in the feed of *Clarias gariepinus* reported normal growth of fish fed a control diet, 60 minutes - cooked AYB (which was also used in this study), 9 hour–soaked AYB and 15–minutes-toasted AYB diets. They concluded that the suitability of *S. stenocarpa* as a partial protein source is supported by the high growth performance of fish fed on the various processed meal diets. The result of this work agrees with her own as there was weight gain in all the groups of fish fed with AYB diets although it was more in the group fed with 100% AYB inclusion diet. This could be as a result of the high crude protein content (32.39%). This group also expressed the lowest oocyte development in the ovary. This proves that fishmeal is still the best protein source for catfish production. This agrees with the work of MAFES (2007) which reported that proteins of animal origin, particularly fishmeal prepared from whole fish are considered to be nutritionally superior to proteins of plant origins because they contain higher level of indispensable amino acids and are more highly digestible by catfish than plant proteins. Okeke *et al.* (2014) studied the effect of lead plant (*Leucena leucocephala*), which is a plant protein source, and reported that the best growth performance and specific growth rate was observed in the group of fish fed 20% lead plant inclusion diet. This means that this group performed better than those fed with the control diet.

Alegbeleye *et al.* (2002) who evaluated the replacement of soyabean meal with Africa yam bean meal in the feed of Nile tilapia (*Oreochromis niloticus*) reported a trend of reduced growth performance and feed utilization efficiency with increased inclusion of toasted *S. stenocarpa.* Contrary to the above report, this study shows a trend of increased growth performance with increased inclusion of boiled *S. stenocarpa* apart from the poor growth performance of the group fed with test diet D_3 of 75% AYB inclusion. The difference could be caused by the difference in the method of processing used for the African yam bean seeds.

Conclusion

The seed of *S. stenocarpa* has the potential of making considerable contribution to the growth of *Heteroclarias* fingerlings as proven by the growth performance of the group of fish fed 100% AYB inclusion diet. However fishmeal is a better protein source for *Heteroclarias* than *S. stenocarpa* as observed in the growth performance and gonad development of the group fed the control diet. This study has revealed that the weight gain of fingerlings fed AYB 100% diet was not significantly different from those fed the control diet hence it is recommended. The result of this study has shown that inclusion of *S. stenocarpa* in the feed of *Heteroclarias* at a percentage level lower than 100% (25g/100g as used in the feed composition of this study) did not produce good growth.

Recommendations

Although the African Yam Beans (*Sphenostylis stenocarpa*) revealed good potentials for growth at low level of inclusion ,it is not very efficient for the growth of Heteroclarias.Thus for proper growth and gonad development in this fish, fish meal has proven to be the most appropriate and thus recommended

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