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Carcass composition and product quality of *Clarias gariepinus* fingerlings fed varying dietary inclusion levels of blood meal

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Abstract
The study evaluates the carcass composition and product quality of *Clarias gariepinus* fingerlings fed varying dietary inclusion levels of blood meal at different level of inclusion for 49 days. Six diets of approximately 40% crude protein were formulated with Fish meal, Blood meal, Soybean meal, Corn meal, Palm oil, Table salt, vitamins C, Bone meal, vitamin/mineral premix and starch, which served as the binder were used as feed ingredient, at 0%, 5%, 10%, 15%, 20%, and 25% levels. One hundred and eighty *Clarias gariepinus* fingerlings with mean length of 5.64±0.11 cm and mean weight of 1.49±0.05 g were used for the experiment respectively, all treatment was in three replicates of 10 fingerlings each, using eighteen plastic aquaria of 250x150 cm dimension. The fish were fed at 5% body weight twice daily within the experimental period of 49 days. There were significant differences (p<0.05) in carcass composition, with fish on Treatment with 25% (BM) diet having higher crude protein value, but least in moisture and nitrogen free extract. Fish before experiment were higher in moisture and ash contents, while there was significant difference (p<0.05) with initial fish before the experiment having higher in crude fibre of 0.45±0.01 and lowest in treatment with 10% (BM). The result noted a considerable effect on carcass of the fish with blood meal inclusion.

Keywords: *Clarias gariepinus*, blood, vitamins C, blood meal, soybean meal, corn meal, palm oil

Introduction
The percentage water in fish is used as indicator on the amount of energy, protein, and lipid content. There is an opposite relationship between moisture content of fish and lipids, protein contents and energy density of fish. The live weight of majority of fish usually consists of about 70-80% of water, 20-30% of protein, and 2-12% of lipids. Nevertheless, these values vary significantly within and between species, and also with size, sexual condition, feeding, time of the year, pond depth, and physical activity. The distribution of these nutrient compositions among the various organs and tissues of the body may also show large differences (Ali, *et al.* 2005; Cox and Hartman, 2005) [13, 12]. According to Skelton (2001), *Clarias gariepinus* is a typical air-breathing catfish with a scale-less, elongated body with long dorsal and anal fins, and a helmet like head. Colour varies dorsally from dark to light brown and is often mottled with shades of olive and grey while the underside is a pale cream of white. It is a benthic-pelagic, omnivorous fish and widely tolerant to extreme environmental conditions (Yalcin *et al.*, 2001) [5]. *Clarias gariepinus* is generally considered to be one of the most important tropical catfish species for aquaculture in West Africa, but one problem facing fish culturist is the need to obtain a balance between rapid fish growth and optimum use of the supplied feed (FAO, 2009; Owodeinde and Ndimele, 2011; Solomon and Taruwa, 2011) [2, 7, 9]. Aquaculture has been said to have supported the lively hood of about 60 million people in Asia and Africa (FAO, 2014) [4].

This good development was the result of a combination of population growth, rising incomes and urbanization, and facilitated by the strong expansion of fish production and more efficient distribution channel (FAO, 2014) [4]. Ozigbo *et al.* (2014) [8], reported that this existing increase in aquaculture production in these countries (China, USA etc.) is as a result mechanization which has led to the productivity increase, labour efficiency and improved product quality. Unlike Asia and Africa that has traditional aquaculture and has been affected by a number of external problems that have prevented proper management and development despite the investment. Some countries in the sub –Sahara Africa are characterized by the low agriculture products, poor management of resource, economic stagnation, persistent political instability, the lack of technical knowhow, increase environmental damage, and severe poverty (Ozigbo *et al.*, 2014) [8].

In Nigeria, the demand for fish mostly surpasses the local production, and she happen to be the largest consumer of the product in Africa, and of the largest in the world with over 1.5 million tonnes of fish consumed annually. Over 900,000 metric tonnes of fish is imported in Nigeria while her domestic catch is 450,000 metric tonnes estimated per year. The total fish production in Nigeria was 968,283 tonnes in 2012. According to Ozigbo *et al.*, (2014) [8], aquaculture production in Nigeria has been motivated by social and economic objectives, such as improvement of nutrient in the rural areas, generation of supplementary income, diversification income activities, and the creation of employment. It is only in recent years that aquaculture has been viewed as an activity to meet national shortfalls in fish supplies, thus reducing imports. Ozigbo *et al.* (2014) [8], stated that Nigeria has the natural resources (such as land, river, streams, reservoirs and lakes, and human resource) and ability to make up the world leading aquaculture countries. In spite of the potential of natural resource and man power availability to fish farming in Nigeria, the country is still currently unable to bridge the gap constrain between total domestic fish production and total domestic demand (Ozigbo *et al.* 2014) [8]. To solve this challenge, there is need for a rise in domestic aquaculture production to bridge the gap between demand and supply of aquaculture products. Lack of readily available nutritive fish feed ingredients have continued to be a major constraint to the survival of aquaculture in the competitive global food production system (Ogunji *et al.*, 2005; FAO, 2006) [31, 1]. Consequently, fish nutrition expert's all over

the world have considered the recruitment of alternative protein feed ingredients necessary for inclusion in fish diet. Several studies have shown that vegetable protein sources have high potentials for supplying fish with required protein needed for their maximum growth (Nwanna *et al.,* 2008) [10]. However, in the compounding of fish ration with plant protein sources, caution need to be exercised as to their inclusion levels in fish diets as well as ensuring their proper processing for effective utilization and protein digestibility (Francis *et al.,* 2001) [24]. The needs for such recommendations have been due to the presence of certain limiting factors in those ingredients such as high crude fibre content (Nwanna *et al.*, 2008) [10].

According to Orire *et al.* (2015) [6], fish feed has significant effect on the cost of production as it accounts for 60-80% of management cost. Fagbenro *et al.* (2003) [26], reported that the development of standard practical diets for cultured fish is a major step for aquaculture development; diet that will meet the specie nutrient requirement with the aim of obtaining maximum production at minimum cost. Feed-stuffs contain carbohydrates, protein and other nutrients but they are either classified as protein or energy feedstuffs. Protein feed stuffs are of plant and animal origin i.e. soya beans, groundnut cake, fishmeal, crayfish dust, blood-meal etc. The energy sources are of plant origin mainly corn meal, wheat bran, millet and others (Menghe and Edwin, 2013) [29]. According to (Eyo, 2003) [25], inhibitors occur virtually in all available feedstuffs of plant origin, and in most cases form a shield effect on protein molecules, thus preventing them from being assimilated by digestive enzymes. McDonald *et al.*, 1992 [28], said that blood meal is a waste-product of the slaughtering industry and is used as a protein source in the diets of non-ruminants and ruminants. The protein quality of blood meal is upsetting by modes of preparation, so is not uncommon finding. Blood meal is essential in lysine and is a good source of arginine, methionine, cystine, leucine but is very limited in isoleucine and contain minimum glycine than either fish meal or bone meal as recorded by (NRC, 1994) [11]. Particularly, blood meal has high nitrogen content but very low in digestibility can compensate the lysine and methionine deficiencies in vegetable protein based diets (McDonald *et al.*, 1992) [28]. The characteristic smell of blood meal reduces its palatability and then a 5% limit is a usual recommendation for its usage in diets. Today, mostly blood meal is being used as by-pass protein ingredient in ruminant diet (Kamalak *et al.*, 2005; Taylor, 2005) [27, 30]. Hence if the study was to incorporate in the diet of cat fish to reduce the high cost of fish meal to know its utilization on the carcass of the fish.

Experimental site

The research was conducted at the Fisheries Unit in the Teaching and Research Farm, Faculty of Agriculture; Niger Delta University, Bayelsa State, Nigeria. The experiment lasted for seven weeks (7 weeks).

Experimental Design / Set Up

Completely Randomized Design (CRD) was employed in this research. Eighteen rectangular plastic aquaria each, with a dimension of 27x37x47cm^3 were used. Each plastic aquarium had a capacity of holding 20 litres of water. Ten *Clarias gariepinus* fingerlings were randomly allocated into each of the 18 aquaria. Each of the 6 diets (Treatments) was given in triplicate.

Experimental Fish and Source and Preparation of Experimental Feed Ingredients

A total of 180 *Clarias gariepinus* fingerlings were used after transporting from Baka Farm, along Imiringi road in Yenagoa Bayelsa State, Nigeria. The fish were acclimatized for 3 days in plastic holding tanks before being distributed randomly into the 18 containers for the experimental study. The ingredients used in the formulation of the feed were as follows: *Pelonulla leonensis* (*fresh water clupeid*), blood meal, soybean meal, corn meal, palm oil, table salt and vitamin C, bone meal, vitamin/mineral premix and starch, which served as the binder. The feedstuffs were acquired from a feed store at Biogbolo community, Yenagoa, Bayelsa State and were ground using a Hammer mill except for the soybean meal and additives which were bought in already usable form.

Diet Formulation and Preparation

Six experimental diets which had approximately 40% crude protein content were prepared using the Trial and Error method of feed formulation (Adejoro, 2004). The diets were contained varied inclusion levels of blood meal at 0%, 5%, 10%, 15%, 20%, and 25%. The diet with 0% blood meal served as a control with no blood meal inclusion.

Ground feedstuffs were sieved with mosquito-net to remove poorly groud materials. The sieved feedstuffs were measured using Emerald Jewelry scale (Model Ohaus-JE120) in their right proportion into a plastic basin and hand mixed thoroughly. A prepared gelatinized starch and a measured quantity of water were further added to the mixed feedstuffs and mixed thoroughly to form a dough. The dough was then pelleted using meat- mincer (Model JCW-46). The pellets were collected into a stainless tray, and sun- dried for 2 days, allowed to cool and stored in labeled plastic containers. This procedure was repeated for each of the 6 diets used for this experiment based on the composition (Table 1).

One hundred and eighty fingerlings were stocked into the aquaria at a rate of 10 fingerlings per aquarium. The initial length and weight were also measured. The fingerlings were fed with 5% of their body weight, divided into two equal halves and fed twice at 1000hr. and 1700hr daily. The fingerlings in each aquaria were weighed and their lengths measured on weekly basis. The quantity of feed was adjusted to reflect the new weight. Uneaten feed and wastes were siphoned daily during the experiment. The aquaria were drained every 2 days, washed and refilled with fresh, clean water to the desired level and aerated.

Carcass analysis

Three fishes were randomly chosen from each treatment and the whole fish was used for proximate analysis according to AOAC, 2012. Statistical analysis Data collected were analyzed statistically using Analysis of variance; while differences between the means were separated using Duncan Multiple Range Test (DMRT) using SAS (Statistical Analysis System) version 8.

Table 1: Gross composition of experimental feed

Feed ingredient	Diet					
	T1 (0%)	T2 (5%)	T3 (10%)	T4 (15%)	T5 (20%)	T6 (25%)
Blood meal (81% CP)	0	1.5	3.0	4.5	6.0	7.5
Fish meal (*Pellonula leonensis* 70%CP)	30	28.5	27	25.5	24	22.5
Soya bean meal (45%CP)	33.3	33.3	33.3	32.5	32.5	32

Wheat bran (16%CP)	15	12	12	12	12	12
Maize meal (9%CP)	12	15	15	15.8	15.8	16.3
Bone meal	1.0	1.0	1.0	1.0	1.0	1.0
Vitamin/mineral premix	0.5	0.5	0.5	0.5	0.5	0.5
Vitamin .c.	0.1	0.1	0.1	0.1	0.1	0.1
Table salt (NaCl)	0.1	0.1	0.1	0.1	0.1	0.1
Palm oil	5.0	5.0	5.0	5.0	5.0	5.0
Starch	3.0	3.0	3.0	3.0	3.0	3.0
Total	100	100	100	100	100	100

Result and Discuss

Proximate Analysis of experimental feed

Table 2 showed the proximate composition of each experimental diet. The results displayed that the crude protein content of the experimental diets varying inclusion levels of blood meal. The crude protein from the six diet ranged from 39.98% to 42.68%; which have similarity with the report of (Ochokwu *et al.*,2021) [14] with protein rage of 39.79 in diet 5 to 40.60 in diet 3, crude lipid ranged from 5.10% in diet 6 to 6.10% in diet 1, mean while the crude fibre content ranged from 5.50% to 6.30%; ash content ranged between 3.30% to 4.32%; Moisture level ranged from 6.40% to 8.20% and NFE value ranged between 35.21% to 38.10%; all observation corroborate with the report of (Tiamiyu *et al.*,2015) [15] but his study was based using of water melon seed as additive in the production of cat fish feed. It is an indication that formulated cat fish feed are similar in all area of the world based on its tropical level. The varying percentage inclusion of blood meal with high nitrogen level than fish meal did not increase vastly on the gross composition of the fed formulated but wit in cordiality with (Laurat *et al.*, 2017) [16] with minute value increase.

Table 2: Proximate composition of experimental diets fed to *Clarias gariepinus* fingerlings.

Parameter (%)	Diet					
	T_1 (0%)	T_2 (1%)	T_3 (2%)	T_4 (3%)	T_5 (4%)	T_6 (5%)
Moisture	6.42	7.80	8.20	7.10	7.50	6.40
Crude protein	39.98	40.78	41.10	41.12	41.50	42.68
Crude Lipid	6.10	5.50	5.20	5.28	5.49	5.10
Crude Fibre	5.70	5.60	5.60	5.50	6.30	5.47
Ash	3.70	3.50	4.32	3.90	4.00	3.30
NFE	38.10	36.82	35.58	37.10	35.21	37.05

NFE- Nitrogen Free Extract

Carcass quality

Carcass composition of experimental fish fed different dietary level of blood meal at start and after the experimental period are shown in Table 3. The initial crude protein was 12.64±0.03% (before the experiment), while there was increase in protein Level which ranged from 14.91±0.03% to 18.11±0.03%; did not vary much with the reports of Akorada, (1990) [18] and Edeoga *et al.*, (2006). The initial ether extract (lipid) before the feeding trial was 3.60±0.16%, at the end of the experiment it ranged from 2.01±0.16% to 4.09±0.16%; showing an increase in the lipid content. The crude fibre before the feeding trial was 0.45±0.01%. The crude fibre after the feeding trial ranged from 0.21±0.01% to 0.35±0.01% which shows that the crude fibre decreased after the feeding trial. The moisture before at start of feeding trial was 80.29±0.12%, while the content after the feeding trial ranged from 76.01±0.12% to 79.90±0.12% showing a slight decrease during and after the experimental period. Body composition of fish were significantly affected ($P < 0.05$) by treatments. This object slightly the results of Hasan, *et al.* (1997) [21] and Adewolu, (2008) [17, 22]. Moisture content for the control diet (0%) and (25%) were not significantly different but were significantly lower than the initial and other treatments. Fanullah and Jafri (1998) [19, 32] reported considerable relationship between moisture content of fish and the energy level of their diets. This however was not recorded in this study, as the diets with blood meal inclusion did not produce fish with higher moisture content at (25%) though they were of lower energy level. Crude protein was significantly higher for fish fed 25% which is significantly different with the initial, but was not significantly different for other treatments. This may be attributed to the supposed limited Essential Amino Acid (EAA) content of blood meal (Edeoga, 2006). Lipid content was least for fish fed the control diet (0%) but was significantly highest ($p<0.05$) in fish fed diet 10% blood meal inclusion level. This agrees with the findings of Yilmaz *et al.* (2004). Ibrahim and Mahmet (2002) [20] had suspected a negative correlation between gross lipid content of diet and lipid content of fish. Ash content was not significantly affected in fish fed 0%, 5%, 15, 20%, and 25%, but was significantly moderate in all experimental diets. This probably indicates a poor mineral composition of blood meal. This trend is traceable to the crude fibre contents of the blood meals.

Table 3: Carcass compositions of experimental fish (*Clarias gariepinus*) fed different dietary level of blood meal

Parameters (%)	Wet sample						
	After Experiment						
	Before Experiment	T_1 (0%)	T_2 (5%)	T_3 (10%)	T_4 (15%)	T_5 (20%)	T_6 (25%)
Crude Protein	66.01 ± 0.12^{b}	69.96 ± 0.12^{ab}	67.20 ± 0.12^{ab}	67.70 ± 0.12^{ab}	67.40 ± 0.12^{ab}	67.10 ± 0.12^{ab}	70.29 ± 0.12^{a}
Ether Extract (lipid)	3.60 ± 0.16^{ab}	2.01 ± 0.16^{b}	3.40 ± 0.16^{ab}	4.09 ± 0.16^{a}	2.52 ± 0.16^{b}	4.00 ± 0.16^{a}	3.00 ± 0.16^{ab}
Crude Fibre	0.45 ± 0.01^{a}	0.28 ± 0.01^{bc}	0.19 ± 0.01^{c}	0.28 ± 0.01^{b}	0.21 ± 0.01^{b}	0.30 ± 0.01^{bc}	0.35 ± 0.01^{bc}
Ash	2.40 ± 0.12^{a}	2.20 ± 0.12^{a}	2.30 ± 0.12^{a}	2.29 ± 0.12^{a}	2.18 ± 0.12^{a}	1.00 ± 0.12^{a}	2.30 ± 0.12^{a}
Moisture	28.11 ± 0.03^{a}	24.91 ± 0.03^{b}	26.50 ± 0.03^{a}	25.30 ± 0.03^{ab}	26.20 ± 0.03^{ab}	27.21 ± 0.03^{ab}	22.64 ± 0.03^{c}
NFE	0.62 ± 0.02^{a}	0.64 ± 0.02^{a}	0.41 ± 0.02^{ab}	0.34 ± 0.04^{bc}	0.50 ± 0.02^{a}	0.39 ± 0.04^{bc}	0.23 ± 0.05^{c}

Means with the same alphabets for a given parameter in the same horizontal row not significantly different ($p<0.05$)

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