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Carcass Proximate Composition and Amino acid Profiles of Hybrid Catfish fed Supplementary Cockroach Meal

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ABSTRACT

The high demand for fish as a protein source in fishmeal with the increasing production pressure on aquaculture has led to the research on the use of insects as an alternative source of protein for fish production. Studies have been reported on nutritional potentials of some insect's protein on growth indices with little attention on the fish carcass's proximate composition and amino acid analyses; thus, this study was conducted to investigate the carcass proximate and amino acid analyses of hybrid catfish fed supplemented cockroach meal. Four experimental diets were formulated with varying inclusion levels of the insect (Diet A (100% fishmeal), Diet B (100% cockroach meal), Diet C (50% fishmeal and 50% cockroach meal), and Diet D (Commercial diet)). The hybrid catfish were fed twice daily with formulated/commercial diets for 12 weeks. After, the 12-week periods, pool samples of whole fish, were sacrificed for proximate analyses and amino acid analyses. The test fish carcass revealed the highest moisture content (9.22±0.01%) and crude protein (66.23±0.02%) values in Diet A and B respectively. Similarly, the highest crude fiber, ash, and carbohydrate content of 0.73±0.03%, 13.96±0.10%, and 12.55±0.13% were recorded in fish-fed diet B. The amino acid profiles of fish carcass fed diet B recorded the highest values of lysine, phenylalanine, methionine, proline, arginine, cysteine, alanine, and glutamic acid; glycine, threonine, and serine. Whilst other amino acids monitored in fish fed Diet B were moderate amongst others. The fish fed Diet C, also recorded positive ($p<0.05$) proximate compositions and amino acid profiles compared to the control carcass. The observed carcass proximate compositions and amino acid profiles in fish-fed Diets B and C may be attributed to the presence of cockroach meal in the diets. Hence, the inclusion of cockroaches in the diets of hybrid catfish could be employed as a potential source of protein for catfish fingerlings as revealed by the hybrid catfish carcass proximate composition and amino acid analyses. this makes a potential source of protein for human consumption.

Keywords: Experimental diet; Fish nutrition; Flesh; Insect Prot.

INTRODUCTION

The formulation of fish feed to meet the nutritional requirement of fish culture in an intensive aquaculture system is very important for optimum utilization (Omitoyin,2007); thus, quality fishmeal protein is required for the sustenance of fish production. Fishmeal

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is often the principal source of protein in a fish diet because of its high percentage of proteins and its amino acids composition in meeting the fish requirement (FAO, 2003).

The uncertainty in the availability of fishmeal due to competitive demand has led to the need to identify alternative protein sources for the fish diet. According to Nyina-Wamwiza *et al*. (2007), the use of plant product sources as protein supplements in fish diets had yielded little success in providing fish with the necessary required amino acids.

Thus, the choice of researchers to source for an available nonexpensive, less competitive demand animal protein source to substitute fishmeal in fish diet. Positive potentials have been revealed in the use of insect protein to successfully replace fishmeal with high nutritional qualities such as crude protein, vitamins, and amino acids (Finke, 2007; Bukkens, 2009). Some insects have been reportedly used as a protein supplement in fishmeal; these include black soldier fly larvae (Makkar *et al*., 2014; Tran *et al*., 2015); desert locust (Alegbeleye *et al*., 2012; Abanikannda, 2012; Emehinaiye, 2012); housefly maggot (Adewolu *et al*., 2010) and mealworm (Veldkamp *et al*., 2012) amongst others.

One of the neglected insects with nuisance characteristics around man's environment and less competing interest as food is the cockroach. Cockroaches (*Periplaneta americana*) are widely distributed due to global commerce as they live in close association with people and maybe a potential candidate for fishmeal (Charlton *et al*., 2015); as they are known to consume any organic food source available to them such as sweets, meats, starches, sewage, hair, books, fresh vegetables, and decaying matter.

In order, to validate the efficiency and effectiveness of an alternate protein source in the diet of fishmeal, the need to evaluate the carcass proximate composition and amino acid analyses cannot be overemphasized thus, studies on the carcass composition of fishes fed experimental diets have been conducted and reported in Catfish (Anyanwu *et al*., 2015; Ibhadon *et al.,* 2015; Elaigwu, 2019); *Oreochromis niloticus* (Opiyo *et al*., 2013; Hamandishe *et al*., 2018) amongst other fishes. Fish carcass proximate composition is reported as a good indicator for the physiological condition of the fish (Ali *et al.,* 2005).

The fish candidate of interest in this study was the hybrid catfish. Hybrid catfish is a product from the cross between *Heterobranchus bidorsalis* × *Clarias gariepinus*. The fish is amongst fishes that have attracted great attention for culturing in Nigeria (Adamu and Nwadukwe, 2013); that grows fast and has high fecundity, better taste, and nutritional qualities, as well as tolerance to unfavorable environmental conditions (Madu and Ufodike, 2005). As in most fishes, hybrid catfish need nitrogen and certain amino acids for growth. These amino acids play an important function as building blocks of proteins and are mainly obtained from diet thus; the quality of dietary protein is assessed from essential to non-essential amino acid ratio (Mohanty *et al*., 2014; Suvitha *et al*., 2015). Therefore, this study was conducted to evaluate carcass proximate composition and amino acid analyses of hybrid catfish fed supplemented cockroach meal.

Materials and Methods

The field study was conducted at the Fisheries section of the Department of Biological Sciences Garden, Ibrahim Badamasi Babangida University, Lapai, Niger State; whilst laboratory analyses were conducted in the Department laboratory. The fish fingerlings were purchased from Alhassan's Fish farm and transported to the study field at the early hours of the day in aerated containers. The experimental diets were Diet A (100% fishmeal), Diet B (100% cockroach meal), Diet C (50% fishmeal and 50% cockroach meal), and Diet D (Commercial diet (Blue Crown feed (Crown Flour Mill Ltd))). The diets were formulated with the Pearson square method as adopted from Adamu and Nwadukwe, (2013).

The raw materials of the experimental feed were fishmeal/and cockroach meal, maize flour, cassava flour, brown seaweed, baobab leaf powder, and vitality premix(R).

Seventy fingerlings were randomly stocked in each concrete pond in a replicated setup. Each of the setups was fed with the appropriate diet for 12 weeks. The experimental fish were fed to satiation twice (morning and evening) daily for 12 weeks. After, 12 weeks, proximate composition and amino acid analyses were determined from pool samples (twenty fish per pool) of fish in replicate.

Proximate composition (moisture, ash, fat determination (ether-extract), crude fiber, and crude protein) were conducted with the flesh of the experimental fish according to AOAC (2006). Whilst, Benitex (1989), the method was adopted for amino acid analyses. For the amino acid analyses, fish samples were dried to constant weight, defatted (using chloroform/methanol mixture (2:1)), extracted for 15hours (AOAC, 2006), hydrolyzed, and evaporated in a rotary evaporator then loaded into the Applied Biosystem PTH Amino Acid Analyzer. Whilst, Kjadhal distillation method was used for the nitrogen determination.

All data obtained were presented as mean ± standard error. Mean was compared for significant differences using students' multiple t-tests at a 5% probability level.

Results

The proximate composition (Table 1) revealed a significant difference ($p<0.05$) in ash and moisture contents of the experimental diets compared to the commercial diet (diet D). No significant difference ($p>0.05$) was recorded in carcass crude fiber content of fish fed the experimental diets and commercial diet. However, moisture content, ether extract, and ash contents were significantly ($p<0.05$) different in all the experimental diets compared to the commercial diet. The crude protein content was recorded to be only significantly ($p<0.05$) different in fish-fed diets B and C.

Table 1: Mean± Standard Error of Proximate Composition of hybrid catfish carcass fed Supplemented cockroach meal

Diets	Proximate composition (%)				
	Crude Protein	Crude Fibre	Moisture	Ether Extract	Ash
Diet A*	49.74 ± 0.52^a	0.68 ± 0.02^a	10.35 ± 0.27^b	12.87 ± 0.14^b	13.04 ± 1.73^b
Diet B**	66.23 ± 0.20^b	0.63 ± 0.03^a	7.61 ± 0.41^b	12.55 ± 0.13^b	13.96 ± 0.10^b
Diet C***	65.89 ± 0.59^b	0.63 ± 0.04^a	10.49 ± 0.23^b	12.73 ± 0.18^b	13.01 ± 0.01^b
Diet D****	50.96 ± 0.71^a	0.67 ± 0.06^a	7.26 ± 0.02^a	11.57 ± 0.11^a	10.37 ± 0.15^a

* -100% Fishmeal; **-100% Cockroach meal; ***-50% Fishmeal and 50% Cockroach meal; ****- commercial diet (Blue Crown feed (Crown Flour Mill Ltd)); the same superscript on the same column: $p>0.05$; different superscript on the same column: $p<0.05$

The essential amino acid monitored in the carcass of the test fish fed the experimental diets (Table 2) revealed a significant difference ($p<0.05$) in all profiles except histidine in fish-fed diets B and C compared to the commercial feed. Eight (cysteine, proline, glycine, glutamic acid, serine, alanine, tyrosine, and aspartic acid) non-essential amino acid determined (Table 3) revealed significant ($p<0.05$) differences in all carcass when compared with Diet D.

Table 2: Mean ± Standard Error of essential amino acid analyses of hybrid catfish carcass fed Supplemented cockroach meal.

Amino acid profiles	Experimental diets			
	Diet A*	Diet B**	Diet C***	Diet D****
Leucine	6.45±0.01[b]	6.89±0.01[b]	6.95±0.01[b]	6.06±0.01[a]
Lysine	6.05±0.01[a]	6.84±0.02[b]	6.84±0.01[b]	6.03±0.01[a]
Isoleucine	3.14±0.01[a]	3.73±0.01[b]	3.86±0.01[b]	3.15±0.01[a]
Phenylalanine	3.55±0.01[a]	3.90±0.01[b]	3.90±0.01[b]	3.55±0.00[a]
Tryptophan	0.80±0.02[b]	0.79±0.01[a]	0.84±0.01[b]	0.78±0.01[a]
Valine	3.39±0.01[a]	3.51±0.02[b]	3.68±0.02[c]	3.39±0.01[a]
Methionine	2.30±0.01[a]	2.35±0.01[a]	2.48±0.04[b]	2.32±0.02[a]
Histidine	2.24±0.01[a]	2.24±0.01[a]	2.24±0.01[a]	2.26±0.01[a]
Arginine	5.33±0.01[a]	5.68±0.01[b]	5.68±0.01[b]	5.33±0.02[a]
Threonine	3.54±0.02[a]	4.22±0.02[b]	4.22±0.01[b]	3.56±0.01[a]

* -100% Fishmeal; **-100% Cockroach meal; ***-50% Fishmeal and 50% Cockroach meal; ****- commercial diet (Blue Crown feed (Crown Flour Mill Ltd)); the same superscript on the same row: P>0.05; different superscript on the same row: P<0.05

Table 3: Mean ± Standard Error of non-essential amino acid analyses of hybrid catfish carcass fed Supplemented cockroach meal

Amino acid profiles	Experimental diets			
	Diet A*	Diet B**	Diet C***	Diet D****
Proline	3.44±0.02[a]	3.65±0.01[b]	3.65±0.01[b]	3.47±0.05[a]
Glycine	5.61±0.01[a]	6.32±0.01[b]	6.22±0.01[b]	5.65±0.02[a]
Tyrosine	2.75±0.01[a]	2.92±0.01[b]	3.34±0.23[b]	2.75±0.01[a]
Cysteine	0.73±0.01[a]	0.85±0.01[b]	0.85±0.01[b]	0.75±0.01[a]
Alanine	5.00±0.01[a]	5.61±0.01[b]	5.54±0.01[b]	5.08±0.05[a]
Glutamic acid	12.27±0.01[a]	13.17±0.01[b]	13.02±0.01[b]	12.26±0.01[a]
Serine	3.03±0.01[a]	3.51±0.01[b]	3.46±0.01[b]	3.03±0.00[a]
Aspartic acid	8.06±0.01[a]	8.68±0.01[b]	8.81±0.01[b]	8.06±0.00[a]

* -100% Fishmeal; **-100% Cockroach meal; ***-50% Fishmeal and 50% Cockroach meal; ****- commercial diet (Blue Crown feed (Crown Flour Mill Ltd)); the same superscript on the same row: p>0.05; different superscript on the same row: p<0.05

Discussion

In this study, the ash content in the experimental groups was higher than that of the control group representing a good proportion of minerals in the tissue of the hybrid catfish. As Obeg *et al.,* (2015) reported that ash content is a measure of the total amount of mineral elements such as calcium and phosphorous in the tissue of the fish. However, lower ash content had been reported in both wild and farm-raised catfish (Osibona *et al.* 2009; Ibhadon *et al.,* 2015; Elaigwu, 2019). This thereof revealed that the experimental fishes have a higher content of minerals compared to the earlier reported studies; implying that the protein source organism (cockroach) has promoted the level of the ash contents in the fish tissue.

The high crude fat recorded in this study may be an indication that supplemented cockroach meal may play role in enhancing energy production and the hence better growth rate recorded as supported by Audu *et al.* (2008). The lower fiber content recorded in the test fish fed supplemented cockroach meal has been shown to support the high crude fat recorded an indication of improved growth rate which is within the range reported by Elaigwu, (2019) in *Clarias angular* from the wild.

Fishes fed diets A and C recorded higher moisture content, however, the study had revealed that they were within an acceptable range (Ibhadon *et al.,* 2015) for healthy fish, similarly, the study conducted by Elaigwu, (2019) on *Clarias anguillaris* from the wild recorded higher values than that reported in diets A and D. This study recorded high crude protein content compared to those reported by Osibona *et al.* (2009); Ibhadon *et al.,* (2015) and Elaigwu, (2019) in both wild and farm-raised catfish. An indication that the presence of cockroach meal in the diet of hybrid catfish improved the proximate composition especially the crude protein content as recorded in diets B and C.

According to Elagba *et al*. (2010), the knowledge of amino acid content in commercial fishes should be one of the major elements used by a consumer for choosing the type of fish to be consumed. Thus, Ozden (2005) and Peng *et al.* (2013) reported the most vital amino acids required by fish as alanine, arginine, and glutamic acid, glycine, histidine, isoleucine, phenylalanine, and serine to support the growth and tissue healing in fish. Thus, this study examined these amino acids in addition to others. The determined amino acids profiles recorded in this study were slightly higher than those reported in both wild and farm-raised catfish (Ibhadon *et al.,* 2015; Elaigwu, 2019)

The ten pre-requisite (indispensable) amino acids (methionine, arginine, threonine, tryptophan, histidine, isoleucine, lysine, leucine, valine, and phenylalanine) revealed higher values in fish fed supplemented cockroach meal. Thus, the catfish fed diet B and C had significantly higher ($p<0.05$) essential amino acid values. It has been earlier reported that leucine is necessary for hemoglobin formation, stabilizes, and regulates blood sugar and energy (Osibano *et al*., 2009). The higher crude protein level recorded in the fish may be responsible for the higher pre-requisite amino acids level revealed in this study. Thus, by implication, the high level observed in Diet B could be useful in influencing higher growth performance, survival, and high quality of the fingerlings. In addition, leucine has been reported to retard the degradation of muscle tissues by increasing the synthesis of muscle proteins (Mohanty *et al*., 2014).

The high glutamic acid recorded in this study, especially in fish-fed diet B were within the range reported in catfish sampled from the wild (Osibona *et al.* 2009; Ibhadon *et al.,* 2015). The low values of histidine and cysteine reported in this study are supported by the findings of Ibhadon *et al.* (2015) that the former can lead to chemical sensitivity and even cause food allergy whilst the latter can aggravate rheumatoid, arthritis, anemia, and imbalance of intestinal bacterial flora.

Conclusion

This research revealed that proximate composition and amino acid profiles of hybrid catfish carcass fed inclusion of cockroach in the diets of hybrid catfish could be employed as a potential source of protein for catfish fingerlings without obstructing the nutrient utilization and digestibility. Therefore, the high content of crude protein and ash content as well as the concentration of some of the essential amino acids in the fish tissue could be a result of cockroach meal in the diet. Thus, cockroach meal is a good source of proximate composition and amino acid profile of hybrid catfish.

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التركيب التقريبي واكثر الاحماض الامينية الموجودة في اسماك السنور الميت المتغذي على وجبة تكميلية من الصراصير

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الملخص

ادى ارتفاع الطلب على الاسماك لمصدر البروتين مع ازدياد ضغط الانتاج على تربيه الاحياء المائية الى البحث عن استخدام الحشرات كمصدر بيدل للبروتين لانتاج الاسماك. وجدت تقارير عن دراسات حول الامكانات الغذائية لبعض بروتينات الحشرات على مؤشرات النمو مع القليل من الاهتمام بالتركيب التقريبي وتحليل الاحماض الامينية في اجسام الاسماك. لذا تم اجراء هذه الدراسة للتحقق من التركيب التقريبي وتحليل الاحماض الامينية في اسماك السلور المهجنة التي تغذت على وجبة تكميلية من الصراصير. تم تجهيز اربعة اغذية تجريبية تتضمن مستويات مختلفة من الحشرة. غذاء A(100% وجبة سمك), غذاء B (100% وجبة صراصير), غذاء C (50% وجبة سمك و 50% وجبة صراصير) وغذاء D (غذاء تجاري). تم تغذية اسماك السلور المهجنة مرتين يوميا على الاغذية المحضرة والغذاء التجاري لفترة 12 اسبوعا. وبعدها تم قتل عينات الاسماك الكاملة لتحاليل التركيب التقريبي والاحماض الامينية. اضهرت الاسماك الميتة اعلى قيم محتوى في الرطوبة (9.22±0.01%) والبروتين الخام (66.23±0.02%)في غذائي Aو B بالتوالي. وبالمثل تم تسجيل اعلى قيم محتوى الالياف الخام، الرماد، والكربوهيدرات (0.73±0.03% 13.96 ±0.10%، و 12,55±0.01%) في الاسماك التي تغذت على غذاء B. وسجلت اعلى قيم محتوى من الاحماض الامينية الليسين، الفينيل لانين,المثيونين,البرولين,الارجنين,السيستيين,الالانين وحامض الجلوتاميك, والجليسين والثريونين والسيرين, بينما الاحماض الامينية الاخرى كانت قيمها متواضعة لمجموعة B. وسجلت مجموعة Cايضا (P<0.05)مقارنة مع مجموعة الغذاء التجاري. وقد تكون قيم المحتوى للتركييب التقريبي والاحماض الامينية في اغذية B وC تعود الى وجود وجبة صراصير. لذا قد يؤدي وجود وجبة الصراصير من ضمن غذاء اسماك السلور المهجنة الى ان تكون هذه الاسماك مصدر بروتين محتمل للاستهلاك البشري.

الكلمات الدالة: النظام الغذائي التجريبي,تغذية الاسماك,لحم,بروتين الحشرات.