Journal homepage: https://www.multiscipub.com/index.php/AgricultureReports

AG RE | Agriculture Reports

Volume 3 Issue 1 (2024) Pages 18-28

Carcass Quality and Biochemical Changes of Cultured Catfish (*Clarias gariepinus*) Fed Biodegraded Waste

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Citation: Ekinadose Orose, Okechukwu Kenneth Wokeh, Komi Gentle Wilson, Roslizawati Ab Lah and Kamariah Bakar (2024). Agriculture Reports, 3(1): 18-28.

Received: 19 January 2024
Accepted: 11 April 2024
Published: 30 June 2024
eISSN Number: 2948-4138

Keywords: Protein supply, resources efficiency, aquaculture, fisheries.

Abstract: The increasing population and recent flooding ravaging many parts of the world have necessitated the need to enhance resources through the utilization of waste products in fish culture. These waste materials usually contaminate the environment and are not utilized by humans. The study assessed the suitability of these waste as protein sources for the culture of the African catfish (*Clarias gariepinus*). Composting methods were used to degrade cow hoof, and chicken feather thereafter the feeding trial was done to determine the carcass quality and biochemical indices after 12 weeks. Fish weighing 17 gram (g.) as an initial body weight were stocked at a rate of 7 juveniles per aquarium. The basal diet contained 45% crude protein and was offered twice daily at 3% body weight. The control contained fishmeal, while treatments I, II and III were substituted with compost-feather (CFW), cow-hoof (CH) and a combination of CFW and CH, respectively. The results revealed significant differences ($P < 0.05$) among treatments. The carcass composition of the fish was not affected by the protein sources in the diets used. However, the fat content was higher in the non-conventional feed (21%) than in the conventional feed (14%). The biochemical profile showed no significant difference ($P > 0.05$) in total protein, urea, and liver enzymes with the control fish. Based on the findings it is concluded that composted feather and hoof meal have no negative effects on the carcass quality and biochemical profile of catfish and could contribute significantly to resource efficiency in fish production.

INTRODUCTION

The increasing human population, urbanization, and rising standards of living in developing countries have increased geometrically in recent times. Consequently, the demand for human food has become very intense (Tansey and Worsley, 2014). Fisheries provides means of livelihood for over 500 million people worldwide (Vincent-Akpu and Annor-Frempong, 2017).

Fish has been a significant source of food for generations, accounting for around half of many Africans' total animal protein diets (FOA, 2003). Globally, aquaculture output accounted for 42.2% of total fish production of about 158 million tonnes in 2012 from aquaculture and capture fisheries (FOA, 2014). Aquaculture is extremely vital in providing a living for millions of people all over the world Ababouch and Fipi, 2015). The aquaculture sub-sector in Nigeria has considerable potential for growth (Kaleem and Sabi, 2021), particularly because demand for fish is growing as a consequence of population increase and low production from capture fisheries, both at the domestic and global level. The African catfish is one of the most suited fish for aquaculture due to its capacity to absorb a range of diets, resist poor water quality, and sustain a fast growth rate (Patience AOB, 2020), and it has a strong market demand. It has been claimed that African catfish eat on aquatic and terrestrial insects, crabs, shrimp, snails, plankton, dead animals, fish, amphibians, reptiles, seeds, and fruits (Talamuk, 2016).

Due to the rising demand for livestock and fish diets, fishmeal is in short supply and expensive. Protein is the most limited nutrient in the diet of man, and it accounts for low protein intakes in developing countries like Nigeria. Among animal protein sources, fish is the cheapest and most readily available. However, the production of fish is inadequate to meet the demand for human protein requirements (Samadar and Kaviraj, 2015). In addition, high demand for fish products as ingredients in livestock feed production has created competitive demand for fish as a food source for humans and livestock. The high cost of feed is a major constraint in fish production (Ali *et al*., 2022). This is as a result of the cost of fishmeal, which is the bulk ingredient in fish feed. Additionally, the low supply and cost of quality fishmeal has compelled producers to substitute it with other cheap and available non- conventional ingredients that can be easily prepared by farmers (Enyidi *et al*., 2017; Ogunbode and Iyayi, 2021). One of the recent non-conventional protein sources that has attracted researchers' attention is animal waste products. The use of waste as feedstuff is expected to provide not only financial benefits but, more importantly, deal with environmental pollution (Makarichi *et al*., 2018). It has been noted that the concept of utilising animal waste is highly desirable since it will not only eliminate the problems of waste disposal but also provide cheap fish feed (Orose *et al*., 2018).

Mitigating this challenge requires an increase in food production, especially protein supply, is highly desirable. Malnutrition can ensue regardless of the health, quality, or condition of fish's environment if adequate nutrition is not provided. Feed purchases account for 60 – 80% of the overall cost for intensive fish growers (Ekawati *et al*., 2016). The most common keratin waste product globally is chicken feathers. Since chicken slaughterhouses create a large quantity of keratin, feathers could be utilised as a natural source to extract the keratin for use in commercial applications (Reddy *et al*., 2021). Keratin possesses high mechanical stability and resistance to proteolytic breakdown because of the presence of disulfide bonds, hydrogen bonds, salt, and cross linkages (Tesfaye *et al*., 2017). Bacteria, actinomycetes, and fungi are among microorganisms that are capable of digesting such wastes by secreting keratinolytic and proteolytic enzymes (Abirami *et al*., 2020; Bhari *et al*., 2021). Finding an alternative substance with the same nutritional content is one method to reduce feed prices.

Nutrient composition has a significant effect on fish behavior, growth, meat quality, and general well-being. The chemical composition and carcass quality of feed will determine the physiology and production of fish. The nutrient composition of three different non-conventional feedstuffs earth worm-meal (EWM), slaughterhouse-offal meal (SOM), and hydrated chicken feather meal (PFM) were determined, and the result showed that in earth worm-meal diets, there is a significantly decreased ($P < 0.05$) moisture content of the body and a greater whole-body protein content (Bag *et al*., 2012). Fish require necessary fatty acids for growth and survival, and lipids are a handy source of energy for them. In contrast to terrestrial animals, fish require more omega-3 fatty acids because they are more abundant than omega-6 fatty acids (Oso *et al*., 2011).

Moreover, changes in blood are important markers for diagnosing physiological and pathological changes (Peres *et al*., 2014; Jimoh *et al*., 2015). The biochemical profiles of fish can be studied to determine their health effects. Similarly, Satheeshkumar *et al*. (2012) said that analysing blood biochemical indices to determine the health status of farmed fish provides valid information on metabolic disorders and deficiencies. Dietary treatment, malnutrition, and disease conditions, on the other hand, have the potential to affect blood composition (Feist and Longshaw, 2000). Hence the importance of assessing the effects of animal waste on the carcass quality and the biochemical profile.

MATERIALS AND METHODS

The design used was the Complete Randomized Design (CRD) and the composting methods were adopted using fungal, *Fusarium spp.* as described by Orose et al. (2022). Composting was done using plastic bio-composters with a one-liter capacity for 42 days. After composting, four experimental diets were created which is: fish meal (FM), compose feather (CF), cow-hooves (CH), and a 50% combination of feather and cow hoof (M) for the feeding trials which lasted for 12 weeks, the feed formulation for the various experimental diets.

Experimental Organisms

A total of 100 African catfish (C*. gariepinus*) juveniles were procured from Uyi fish farm, Benin City, Edo State while the *fungi spp.* was obtained from Spendid Stand Microbiology Laboratory in Benin City, Edo State, Nigeria. The fish with initial weight of 17 g and length of 15 cm, were allowed to acclimatise for 14 days. After the acclimation period ended, the fish were not fed for 24 hours to empty their guts before the experiment began. The juveniles were divided into three replicates of each of the four treatments in a completely randomised design, seven (7) juveniles were randomly assigned to the four-food regimen. The experimental diets were created using bio-compost from non-traditional waste protein sources, such as compose feather (CF) and cow-hooves (CH), which serve as alternative dietary protein sources to the conventionally used fishmeal (FM) in fish diets containing 45% crude protein. The working composition of African Regional Aquaculture Center (ARAC), Port Harcourt, River State, acquired from the feed mill was used to formulate the feed. Fish were fed twice daily, length and weight were measured weekly using an electronic weighing scale (Model M P 2001) and a metre respectively. The water in the tanks was replaced every day.

Proximate Analysis Procedure of Non - Conventional Protein Sources

The proximate analysis for the non-conventional protein sources and pelleted feed were determined. These were collected and analysed at the Federal University of Agriculture Abeokuta, college of veterinary science. The parameters analysed were ash content, fat content, moisture content, crude fibre content, crude protein and nitrogen free extract using the standard method of A.O.A.C (2005).

Table 1 Feed composition of experimental materials

	Feed Composition				
Ingredients	Crude Fibre	Crude Fat	Crude Protein	Ash	Moisture
White Maize	3.10	2.96	5.00	1.67	9.58
Wheat Offal	10.00	13.00	14.00	5.40	13.90
Rice Bran	14.79	13.00	12.00	9.00	9.70
Brewer's Dried Grain	21.00	6.35	18.00	4.70	10.50
Soya Bean	5.11	2.68	44.05	4.50	5.76
Groundnut Cake	4.87	6.94	40.10	13.90	6.37
Fish Meal	1.41	11.19	72.00	15.10	9.07
Compost Feather Meal	I.13	5.60	61.00	13.08	4.20
Compost Cow Hoof	6.70	6.80	58.70	9.20	6.90

Determination of Biochemical Parameters

Total Protein (TP)

The total protein in blood serum, urea, creatinine, bilirubin was determined by the methods described by Tietz *et al*., (1995).

Liver Function Analysis

The enzymes alanine aminotransferase (ALT) and aspartate aminotransferase (AST) were done as described by the Randox automated method (Charles and Minakiri, 2018).

Data analysis

The differences among the various groups were determined using one-way and two-way analysis of variance (ANOVA), while the Duncan multiple range test (DMRT) was used to determine differences between group means (SE) at a 5% level of probability using version 21 of the Statistical Package for Social Sciences (SPSS).

RESULTS

Proximate Composition of Experimental Diets

The results of the proximate composition of experimental diets are shown in Table 2. There were significant differences ($P < 0.05$) in all experimental diet's treatment (Table 2). Treatments II (compost cow-hoof, CCH), treatment III (compost chicken-feather, CCF and cow-hoof, CH), and the control, treatment I (fishmeal) had the highest ash concentration among the tested diets, although with no significant ($P > 0.05$) difference (10.33 ± 033%, 10.17 ± 0.60%, and 9.0 ± 0.30%) respectively, while treatment I (compost-feather) 8.53 ± 0.02%, and III (9.00 ± 0.30%) were not significantly different and showed the least ash content. Treatment II (13.17 ± 0.06), III (14.00 ± 0.58%), and the control (14.00 ± 0.58%) were not significantly ($P > 0.05$) different in lipid content, but treatment I (11.00 ± 0.00) was significantly different and had the least lipid content. The crude fibre content in the control, treatment I to III, was not significant ($P > 0.05$) with mean values of 5.33 ± 0.33%, 5.00 ± 0.00%, 5.00 ± 0.58%, and 5.00 ± 0.58% respectively. The crude protein content (CP) revealed that fish fed with all the experimental diets showed no significant difference. The control and treatments I to III had values of 45.13 ± 0.21%, 45.02 ± 0.03%, 44.98 ± 0.02%, and 45.04 ± 0.04% respectively. Also, there was no significant ($P > 0.05$) difference in dry matter content with values of 85.00 ± 0.58, 85.00 ± 0.00, 85.00 ± 0.58 and 85.00 ± 0.58 for the control, treatments I to III. The nitrogen-free extract differed significantly from the others. Treatment I (30.45 ± 0.02) was significantly higher than the control (25.21 ± 0.45), treatment II (26.69 ± 0.86), and treatment III (26.96 ± 0.96).

Table 2. Proximate composition of experimental diets

Parameters	Treatments			
%	Control (FM)	I (CFM)	II (CCH)	III (M)
Ash	10.33 ± 0.33^{a}	8.53 ± 0.02^{b}	10.17 ± 0.60^{a}	9.00 ± 0.30^{ab}
Crude Fat	14.00 ± 0.58^{a}	11.00 ± 0.00^{b}	13.17 ± 0.60^{a}	14.00 ± 0.58^{a}
Crude Protein	45.13 ± 0.21^{a}	45.02 ± 0.03^{a}	44.98 ± 0.02^{a}	45.04 ± 0.04^{a}
Crude Fibre	5.33 ± 0.33^{a}	5.00 ± 0.00^{a}	5.00 ± 0.58^{a}	5.00 ± 0.58^{a}
Dry matter	85.00 ± 0.58^{a}	85.00±0.00^{a}	85.00±0.58^{a}	85.00±0.58^{a}
Nitrogen free extract	25.21 ± 0.45^{b}	30.45 ± 0.02^{a}	26.69±0.86^{b}	26.96±0.96^{b}

*Mean values (mean ± standard error) in the same row with different superscript are significantly different (P < 0.05). FM-Fishmeal, CFM- Compost Feather-meal, CCH- Compost Cow-hoof, M- combination of 50% each of Compost Cow-hoof and Feather-meal.

Proximate composition of carcass

The results of the proximate composition of fish carcass showed no significant differences ($P > 0.05$) in crude fibre (1.40 ± 0.58, 2.00 ± 0.58, 2.00 ± 0.58, and1.00 ± 0.00) ash content (9.60 ± 0.58, 10.00 ± 0.88, 9.00 ± 0.16 and 9.60 ± 0.37) among all experimental organisms fed the control diet, treatment I, II and III (Table 3) whereas there were significant differences ($P < 0.05$) in all other parameters tested. The control group (fishmeal) had the least lipid content (14.33 ± 0.67) followed by treatment I (compost-feather), II (compost cow-hoof) and III (mixture of compost-feather and cow-hoof) which were not significantly different from one another with values of 21.00 ± 0.58, 20.77 ± 0.37, and 20.50 ± 0.52 respectively. There was no significant difference in the crude fibre content between the control and treatments I to III, which had mean values of 5.33 ± 0.33%, 5.00 ± 0.00%, 5.00 ± 0.58%, and 5.00 ± 0.58% respectively. The dry matter content of the fish carcass showed that the control was highest (58.15 ± 0.41[a]), treatment I (35.38 ± 0.01%) and II (35.95 ± 0.56) were significantly different, while treatment III had the least dry matter content (30.61 ± 0.57[c]). Nitrogen free extract in the control (16.10 ± 1.09) and diet 3 (17.49 ± 0.58%) were the highest with no significant difference but significantly different from treatment I (11.97 ± 0.02%) and II (10.62 ± 0.57%).

Table 3. Proximate composition of fish carcass

Parameters	Treatment			
%	Control (FM)	I (CFM)	II (CCH)	III (M)
Ash	9.60 ± 0.58[a]	10.00 ± 0.88[a]	9.00 ± 0.16[a]	9.60 ± 0.37[a]
Crude Fat	14.33 ± 0.67[b]	21.00 ± 0.58[a]	20.77 ± 0.37[a]	20.50 ± 0.52[a]
Crude Fibre	1.40 ± 0.58[a]	2.00 ± 0.58[a]	2.00 ± 0.58[a]	1.00 ± 0.00[a]
Dry Matter	58.15 ± 0.41[a]	35.38 ± 0.01[b]	35.95 ± 0.56[b]	30.61 ± 0.57[c]
Crude Protein	59.74 ± 0.12[b]	65.02 ± 0.01[a]	65.88 ± 0.02[a]	65.50 ± 0.52[a]
Nitrogen Free Extract	16.10 ± 1.09[a]	11.97 ± 0.02[b]	10.62 ± 0.57[b]	17.49 ± 0.58[a]

*Mean values (mean ± standard error) in the same row with different superscript are significantly different ($P < 0.05$). FM-Fish-meal, CFM- Compost Feather-meal, CCH- Compost Cow-hoof, M- combination of 50% each of Compost Cow-hoof and Feather-meal.

Blood Biochemical Parameters of Experimental Fish

The result of the biochemical study of catfish fed with experimental diets treatment is shown in Tables 4. Total protein and globulin indicated a significant difference($P \leq 0.05$) between treatments, with the maximum values recorded for the control (fishmeal) with values of 7.85 ± 0.14 g/dL and 4.35 ± 0.14 g/dL respectively, followed by treatments II (7.65 ± 0.14 g/dL and 3.75 ± 0.14 g/dL), III (7.38 ± 0.11 g/dL and 3.88 ± 0.11 g/dL), and 1 (7.05 ± 0.14 g/dL and 4.05 ± 0.14 g/dL). Results of serum albumin (g/dL) indicated a significant difference ($P < 0.05$) between treatments, with maximum values recorded for the control (3.50 ± 0.00 g/dL) and minimum values for treatments I (compost-feather), II (compost cow-hoof) and III (compost-feather and cow-hoof) with values of 3.00 ± 0.00 g/dL, 3.90 ± 0.00 g/dL, and 3.50 ± 0.00 g/dL respectively. There were no significant differences for the control, treatments I, II, and III in creatinine (2.05 ± 0.14 mg/dL, 1.75 ± 0.14 mg/dL, 1.95 ± 0.14 mg/dL, and 1.88 ± 0.11 mg/dL), urea (3.65 ± 0.14 mg/dL, 3.45 ± 0.14 mg/dL, 3.55 ± 0.14 mg/dL and 3.28 ± 0.11 mg/dL), and bilirubin with values of 1.05 ± 0.14 mg/dL, 0.85 ± 0.14 mg/dL, 0.75 ± 0.14 mg/dL, and 0.98 ± 0.11 mg/dL, respectively. The means of alanine aminotransferases (ALT), aspartate aminotransferase (AST), and phosphate was significant. The lowest values of ALT were recorded in the control (23.25 ± 0.14 u/L), followed by treatments I (30.25 ± 0.14 u/L), and III (31.28 ± 0.11 u/L). The highest ALT value was observed in treatment II (33.25 ± 0.14 u/L). Treatment III had the highest AST value (55.28 ± 0.11 u/L) and the lowest (48.25 ± 0.14 u/L), and control (49.25 ± 0.14 u/L). Treatments I (3.35 ± 0.14 mEq/L) and III (3.28 ± 0.11 mEq/L) had the highest phosphorus values, followed by treatments II (3.05 ± 0.14 mEq/L) and the control (2.75 ± 0.14 mEq/L). Data analysis of serum bicarbonate indicated that the maximum value was observed in treatment I (2.35 ± 0.14 mEq/L), followed by treatments II (2.90 ± 0.58 mEq/L), III (2.44 ± 0.21 mEq/L) and the control (2.05 ± 0.14 mEq/L) which were not significantly different from each other and the control.

Table 4. Biochemical analysis of fish fed the experimental diet

Parameters	Treatments			
	Control (FM)	I (CFM)	II (CHF)	III (M)
Total protein g/dL	7.85 ± 0.14[a]	7.05 ± 0.14[c]	7.65 ± 0.14[ab]	7.38 ± 0.11[bc]
Globulin g/dL	4.35 ± 0.14[a]	4.05 ± 0.14[ab]	3.75 ± 0.14[b]	3.88 ± 0.11[b]
Albumin g/dL	3.50 ± 0.00[b]	3.00 ± 0.00[c]	3.90 ± 0.00[a]	3.50 ± 0.0[b]
Creatinine mg/dL	2.05 ± 0.14[a]	1.75 ± 0.14[a]	1.95 ± 0.14[a]	1.88 ± 0.11[a]
Urea mg/dL	3.65 ± 0.14[a]	3.45 ± 0.14[a]	3.55 ± 0.14[a]	3.28 ± 0.11[a]
Bilirubin mg/dL	1.05 ± 0.14[a]	0.85 ± 0.14[a]	0.75 ± 0.14[a]	0.98 ± 0.11[a]
Aspartate aminotransferase u/L	49.25 ± 0.14[c]	53.25 ± 0.14[b]	48.25 ± 0.14[d]	55.28 ± 0.11[a]
Alanine aminotransferases u/L	23.25 ± 0.14[d]	30.25 ± 0.14[c]	33.25 ± 0.14[a]	31.28 ± 0.11[b]
Phosphate mEq/L	2.75 ± 0.14[b]	3.35 ± 0.14[a]	3.05 ± 0.14[ab]	3.28 ± 0.11[a]
Bicarbonate mEq/L	2.05 ± 0.14[ab]	2.35 ± 0.14[a]	2.90 ± 0.58[ab]	2.44 ± 0.21[ab]

*Mean values (mean ± standard error) in the same row with different superscript are significantly different (P < 0.05). FM- Fish-meal, CFM- Compost Feather-meal, CCH- Compost Cow-hoof, M- combination of 50% each of Compost Cow-hoof and Feather-meal.

DISCUSSION

Proximate Composition of Experimental fish

The proximate composition of the fish carcass fed with the experimental diet showed significant differences, excluding the crude fibre and ash content, which were not significant (Table 3). This is consistent with the findings of Njieassam (2016), who found no significant difference in crude fibre content after 12 weeks. Although keratin is fibrous in nature but showed no variation with the control diet, this might be as a result of the microbial degrading process. Meanwhile, Solomon *et al*. (2017) reported that the carcass was significantly affected by dried brewer's yeast meal (DBYM) after the inclusion of African catfish, *C. gariepinus.* However, Mamoon *et al*. (2018) stated that the body composition of *C. gariepinus* was unaffected by the replacement of fishmeal with poultry offal meal in regard to ash, protein, and lipid content. Similarly, Abdel-Warith *et al.* (2001) reported that when the African catfish, *C. gariepinus*, fed fish meal-based diet as the control, 20%, 40%, and 60 % of poultry by-product meal, there was no variation in the crude protein and lipid concentration, while fish given 80% and 100 % PBM diets exhibited somewhat decreased protein levels in their carcasses.

The percentage of crude protein ranged from 59.74 to 65.88, which is in line with the findings of El-feky *et al*. (2017). They stated that their data exhibited higher values than control groups, the ether extracts and ash were significantly higher than control in all the groups. Similarly, Bag *et al*. (2012), found higher whole-body protein in earthworm diets. This might be because of the lipid content in treatment I and III that might add to the energy level. On the other hand, Ebrahim and Abou-Seif, (2008) discovered that the dry matter, crude protein, fat, and ash levels of Nile tilapia fingerlings differed significantly but not significantly across all experimental diets, with no variations in carcass composition. Further work carried out by Aziza and EL-Wahab, (2019), reported a decrease in the ash content of fish carcass fed hydrolyzed feather-meal. However, our study revealed no significant ash content of whole fish in formulated diets.

The whole-body fat content of treatments I, II and III fed with the various protein sources was higher than the control fish. This is in line with the study conducted by Djissou *et al*. (2016), who reported higher lipid content in the carcass and fillets of fish fed earthworm and maggot than that of those fed a fish meal-based diet. They also emphasised the significant weight gain in fish fed diets HFM10 and HFM12 compared to other diets with much lower fat content in the carcass. However, our research found that the lipid content of the carcass of the control was the highest and had the highest weight gain. In addition, Abwao *et al*. (2017) studied the impacts of replacing freshwater shrimp meal with hydrolyzed feather meal on body composition in Tilapia, *Oreochromis mossambicus* and found that increasing the amount of HFM by decreasing carcass moisture and lipids had a considerable impact on final body composition.

Biochemical Profile of Fish Fed the Experimental Diets

The total protein and globulin levels were highest on the control than in the other treatments diet (Table 4). This supported the findings of Chen *et al*. (2003) and Hrubec and Smith, (2004), who found total protein levels of 4.29 g/dL and 3.7 to 5 g/dL, respectively. This contradicts the findings of Owolabi, (2011), who reported a range of 25 - 48 g/dL. This could be due to the fish's age and the fact that they were raised in their natural environment.

Hrubec and Smith, (2004) reported a blood reference value of 3.1 - 4.2 g/dL for adult yellow perch (*Perca ftavescens*) in a recirculating system, and the globulin readings were within that range. However, the values of 0.73 - 1.44 g/dL published by Okorie-kanu and Unakalamba, (2015) for healthy *Heterobranchus longifilis* did not match those found in our investigation. This could be attributed to age and weight of the fish used. The urea, creatinine, and bilirubin were not significantly different from one another. This shows that the diets used did not affect the fish kidney. This observation is not in line with Soyinka and Soneye, (2016), who observed urea values to be significantly greater (P < 0.05) than fish fed the control feed. Owolabi, (2001) also observed urea reference value of 3.05 mg/dL.

The functions of ALT and AST in the blood were significantly higher in all the diets fed than in the control. Increased serum levels of ALT and AST indicate an up-regulated tendency, which depict compromised liver health (Mingxu *et al*., 2021), and this has the capacity to reduce fish performance thereby affecting productivity negatively. This contradicts data on both ALT and AST activities obtained by Rathore and Yusufzai, (2018), who observed that the elevated aminotransferase activity in the blood has been considered to be a sign of cell damage. Their findings showed no significant differences between the experimental and control groups. Hoseinifar *et al.* (2011) showed comparable results in beluga sturgeon (*Huso huso*) serum, but they were lower than the results obtained by Zaki andTaha, (2010), namely AST (81.00 u/l) and ALT (22.00 u/l) were found in the blood serum of *Tilapia zilli*. Feed and fish species employed in both trials were not the same as those in ours. This could account for the discrepancies in the results. Furthermore, sample procedure, analysis methodologies, age, and nutrition can all alter blood parameters in fish (Sakamoto *et al*., 2001).

CONCLUSION

One important issue for aquaculturists in Nigeria is the scarcity of inexpensive quality fish feed. Aquaculture needs to reduce reliance on fishmeal to expand sustainably, as it is the fastest-growing animal food-producing sector. The carcass proximate compositions (in terms of percentage protein, lipid, and ash) were not affected by the protein sources of the diets (feed) used. However, the fat content of the non-conventional feed used was higher than that of the conventional feed. Similarly, the crude protein content of the experimental meals used showed that the non-conventional feed used was higher than that of the conventional feed. The conventional feed (control fishmeal) recorded the highest dry matter content than the non-conventional feed. The total protein and globulin concentration of the conventional diets was higher compared to the other experimental diets used. However, the ASP, AST, albumin, and phosphate concentration of the non-conventional feed used was higher than the control but had no negative influence on the fish blood profile. The overall result of this study indicates that compost-feather and cow-hoof can be used as alternative animal protein sources as it does not negatively affect carcass quality and blood constituents. Microbial processing significantly improved the degradation of the substrates and so can further be used for feedstuff preparation. These protein sources can be used on other potential aquaculture species to ascertain its efficacy.

Patents

Not applicable.

Author Contribution: Writing—original draft preparation and review: Ekinadose Orose, Okechukwu Kenneth Wokeh, Komi Gentle Wilson, Roslizawati Ab Lah and Kamariah Bakar

Acknowledgement: The present research was also supported by the Ministry of Higher Education (MOHE), under the Malaysia's Long-Term Research Grant Scheme (LRGS; project code: LRGS/1/2019/UPM/1) at Universiti Malaysia Terengganu, as part of the project entitled Stock Enhancement, Sustainable Production, and Culture of Patin Buah (Pangasius nasutus) for Improvement of Fishermen's Livelihood and Aquaculture Industry in Malaysia (53340) to MNA.

Institutional Review Board Statement: Not applicable

Informed Consent Statement: Not applicable

Conflicts of Interest: Authors declare no conflict of interest

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