Growth performance of African catfish (*Clarias gariepinus*) juvenile fed cattle hoof meal reference and test diets

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1. Introduction

Valoration of keratin will reduce the environmental issues of disposal. Value addition to inedible abattoir waste can be a way out of the fishmeal trap in the livestock industry. Nutritional composition of keratin has been widely studied. Keratin usage especially feather meal has impacted on the animal feed industry in no small measure. Keratins of ruminant and monogastric have received little attention in recent times despite the abundance and availability. Abattoir waste of the alpha and beta keratin can be an alternative to the high cost of fishmeal. Nutrient composition of cattle hoof (Falaye and Sule, 2020), pig hoof (Sule et al. 2020a) and goat horn and hoof (Sule et al. 2020b) can be a suitable alternative if well studied. The objective of this study is to assess the performance of *Clarias gariepinus* juvenile fed cattle hoof meal as test diet.

2. Materials and Methods

2.1. Processing of Hoof meal:

Samples of hoof were autoclaved, treated with 10% Na$_2$CO$_3$ washing soda, fermented in water, hydrolysed with 10% wood ash for sixty hours before autoclaving for one hour while raw unprocessed hoof was sundried for two weeks according to Falaye and Sule (2020).

2.2. Experimental procedure:

The experiment was set up in Aquaculture and Fisheries laboratory, University of Ibadan, Ibadan, Oyo State. 15 *Clarias gariepinus* (14.82±0.23g) juveniles in plastic tanks according to Mubarak et al. (2011) randomly stocked in each rectangular plastic tank (0.6m X 0.3m X 0.3m) in replicate per treatment. The experimental fish was kept in rearing tanks and acclimatized for 7 days.
2.3. Feed formulation:
A reference diet was formulated and then adjusted according to Hussain et al., (2011) to 70% reference diet and test diet/processed Cattle hoof 30% (Table 1). Cattle hoof meal subjected to different processing methods of autoclaving, fermentation, wood ash fermentation, soda ash treatment and raw-unprocessed hoof were mixed with other feedstuff were ground to fine powder, mixed into dough and pelletized to 2mm size using motorized pelletizer. The fish in each tank was batch-weighted forth-nightly. Feeding was done twice daily at 3% fish body weight. The duration of the trial was 56 days. Fish weight was recorded from each tank forthnightly and mortality in each tank was recorded daily.

2.4. Proximate analysis:
Analysis of diets (n=6), (Table 2), initial and final fish carcass (n=7) (Table 5) for their nutritional compositions (AOAC, 2005) and amino acid analysis of the feed (n=6) was according to Falaye and Sule (2020).

2.5. Determination of growth, nutrient utilization
The following parameters:
Mean Weight Gain
MWG (g): Final mean weight – Initial mean weight
Specific Growth Rate
SGR (%): \( \frac{\text{ln Final Weight} - \text{ln Initial Weight}}{\text{Time}} \times 100 \)
Percentage Weight Gain
PWG (%): \( \frac{\text{Total Weight Gain}}{\text{Initial Weight}} \times 100 \)
Food Conversion Ratio
FCR (g): \( \frac{\text{Food Intake (g)}}{\text{Weight Gain (g)}} \)
Protein Intake
PI (g): Total feed intake (g) x protein in feed (%)
Net metabolism
Nm: \( \frac{0.549 \times (\text{Initial Weight} + \text{Final Weight})}{2} \times \text{Time} \)
Where 0.549 is metabolism factor constant
Net Protein Utilization
NPU: \( \frac{\text{Final Fish Nitrogen} - \text{Initial Fish Nitrogen} + N}{\text{Nitrogen in Diet}} \)
Survival rate
SR (%): \( \frac{\text{Initial Number of Fish Stocked – Morta}}{\text{Initial Number of Fish Stocked}} \times 100 \)

2.6. Haematology
Blood was collected from the caudal peduncle into EDTA bottles and analysed using haematology analyser (Model: Sysmex XN350). MCV=mean corpuscular volume, MCH= mean corpuscular haemoglobin, MCHC= mean corpuscular haemoglobin concentration were calculated.

2.7. Statistical analysis
The experiment was a Complete Randomized Design and data subjected to one-way ANOVA using statistical package SPSS 20 and individual differences (P<0.05) among treatment means were separated using Duncan Multiple Range test.

3. Result and Discussion
3.1. Diet analysis
3.1.1. Proximate composition of diet
The results of diets indicated significant difference (P<0.05) from reference diets (Table 2).

Tabel 1
Composition of Cattle hoof reference and test diets.

| Ingredient                  | Reference diet 70% | Test diet 30% |
|----------------------------|-------------------|--------------|
| Fish meal                  | 23.07             | 16.15        |
| Soya bean meal             | 23.07             | 16.15        |
| Groundnut cake             | 23.07             | 16.15        |
| Maize                      | 20.19             | 20.43        |
| Vitamin premix             | 0.6               | 0.42         |
| Chronic oxide              | 1.0               | 1.0          |
| TEST ingredient            | 29.70             |              |
| Total                      | 100kg             | 100kg        |

Tabel 2
Proximate analysis of Cattle hoof reference and test diets.

| Feed                          | Ref. diet       | Soda ash hf | Wood.ash hf | Ferment hf | Autoclave hf | Raw hf |
|-------------------------------|----------------|-------------|-------------|------------|--------------|-------|
| Protein %                     | 40.15^a        | 52.28^b     | 53.27^b     | 53.14^b    | 52.99^b      | 54.23^b|
| Fat %                         | 6.11^a         | 4.14^c      | 4.92^b      | 3.99^d     | 3.52^e       | 3.29^f|
| Moisture %                    | 9.24^b         | 3.72^e      | 6.81^g      | 8.82^h     | 9.12^i       | 9.24^j|
| Ash %                         | 9.03^b         | 6.37^f      | 6.35^f      | 10.20^d    | 7.04^d       | 6.08^f|
| Fibre %                       | 1.64^a         | 4.36^g      | 4.09^g      | 1.56^e     | 3.23^g       | 3.66^f|
| NFE %                         | 33.83^a        | 29.13^b     | 22.74^d     | 22.29^d    | 24.96^d      | 23.50^c|
| ME kcal/kg                    | 3169.67^a      | 3292.84^b   | 3169.59^b   | 3072.82^c  | 3122.29^d    | 3098.41^d|

Row values with same superscript are not significantly different (p>0.05) NOTE: hf= hoof. ME; Metabolizable energy.

Proximate analysis of Cattle hoof meal diet revealed significant variations (P<0.05) among treatments. This is in line with Bureau et al. (1999), Olaniran and Falaye (2007), Hussain et al. (2011) who all reported similar variations in composition of feed due to the crude protein of the test ingredient used in formulation which affected the final crude protein analysis of diet. The reference diet crude protein and nitrogen free extract was in line with the study of Falaye et al. (2016) on a plant protein serving as the basal diet for digestibility. The fibre content of fish feed should not be high so as to aid the easy passage of feed through the fish gut and this was within the range reported for fish culture by Ajani et al. (2011).

3.1.2. Amino acid composition of diets
The amino acid profile analysis of the reference diet was least compared to other dietary treatments. These amino acids met the nutritional requirement of the fish cultured in this study with no difference in the weight gain of reference diet and Soda ash hf treatment. The essential amino acid for this study were higher than reported by Falaye (1982) for tilapia and Fagbenro and Nwanna (1999) and Fagbenro et al. (1999) for catfish. The high protein content of the test diets is responsible for this increase as amino acids are known to be the main constituent component of protein. The high values of lysine and methionine in soda ash hf may have been responsible for the improved performance of the diet over other test diets in the study.

Tabel 3
Amino acid analysis of Cattle hoof reference and test diets.

| EAA g/100g protein | Ref. diet | Soda ash hf | Wood.ash hf | Ferment hf | Autoclave hf | Raw hf |
|--------------------|-----------|-------------|-------------|------------|--------------|-------|
| Lysine             | 3.50      | 5.51        | 5.25        | 4.24       | 4.83         | 4.93  |
| Histidine          | 2.17      | 2.30        | 3.00        | 2.30       | 2.43         | 2.62  |
| Arginine           | 5.25      | 6.71        | 6.54        | 5.33       | 5.85         | 6.11  |
| Threonine          | 2.27      | 3.22        | 3.27        | 2.55       | 3.00         | 2.89  |
| Valine             | 3.39      | 4.62        | 4.44        | 3.39       | 3.92         | 3.97  |
| Methionine         | 1.82      | 2.24        | 2.24        | 2.19       | 2.19         | 2.24  |
| Isoleucine         | 2.49      | 3.34        | 3.40        | 2.62       | 3.27         | 3.27  |
3.2. Growth

There was no significant difference in the reference diet and soda ash hf in all analysed growth and utilization parameters. The best FCR was in soda ash hf while FCR was highest in Wood ash hf with corresponding least final weight gain. SGR of Diet 5 in Falaye (1982) was similar to Soda ash hf while order treatments were higher than this study. The FCR of Soda ash hf was slightly lower to Diet 8 in Falaye (1982) with higher rates in other treatment. The PER in this study were higher rates in other treatment. This is an indication that the method of processing can affect the availability of amino acid in diets.

3.3. Carcass analysis of fish

Table 5 revealed the carcass composition of fish fed Hoof meal diet. Crude protein, fat and mineral ash was highest in Raw hf and significantly different (P<0.05) from other carcasses in the treatment. While Crude protein, fat and mineral ash was lowest in Initial fish. The protein quality of fish produced by the treatments was significantly different among the initial and final fish Falaye (1982) the best results were obtained with amino acid supplementation at 30% inclusion. The ash content of fish in this study was low in initial fish with an increase in digestibility treatment, this is in contrast to the findings of Falaye (1982) and Solotu and Sule (2011) who reported vice versa. The increased ash content of fish carcass revealed the inability of the test ingredient to supply mineral to the experimental fish (Falaye and Sule, 2020).

3.4. Haematological parameters

Table 6 showed the haematological analysis of blood samples of fish fed Hoof meal diets. RBC, HCT, WBC HGB and LYM were highest in Raw hf while the same haematological parameters were lowest in Control fish. This result indicated that the health of fish fed test diets was greatly enhanced. This could be one of the reasons for the low mortality in the study, despite the poor performance of some of the test diets.

4. Conclusion

The growth, nutrient utilization and fish carcass quality of C. gariepinus fed differently processed Cattle hoof meal showed varied results with 30% soda ash hf treated diet and...
raw hf diets showed improved and appreciable response on studied parameters.

References

A.O.A.C. (Association of Official Analytical Chemicals). 2000. Official Methods of Analysis.17th ed. Gaithersburg, Maryland, USA.

Bureau, D.P., Harris, A.M., and Cho, C.Y. 1999. Apparent Digestibility of Rendered Animal Protein Ingredients for Rainbow Trout (Oncorhynchus mykiss). Aquaculture, 180(3-4):345-358.

Fagbenro, O.A., and Nwanna, L.C. 1999. Dietary Tryptophan Requirement of the African catfish, Clarias gariepinus. Journal of Applied Aquaculture, 9(1):65-72.

Fagbenro, O.A., Nwanna, L.C., and Adebayo, O.T. 1999. Dietary Arginine Requirement of the African catfish, Clarias gariepinus. Journal of Applied Aquaculture, 9(1):59-64.

Falaye, A.E. 1982. The use of Hydrolysed Feather meal alone or in combination with supplemental amino acids, as dietary protein source for Tilapia Oreochromis niloticus. M.Sc. Dissertation, Institute of Aquaculture, University of Stirling, Stirling, Scotland.

Falaye, A.E., Elezuo, K.O., Ajani, E.K., and Omoike, A. 2016. Digestibility and Nutrient Utilization of Differently Processed Tropical Almond (Terminalia catappa) Kernel Meal and Cake based Diets by Clarias gariepinus Juveniles. Jomo Kenyatta University of Agriculture and Technology. 17(1):42-60.

Falaye, A.E., and Sule, S.O. 2020. Chemical composition of differently processed cattle hoof meal waste as feedstuff ingredient. Ukrainian Journal of Veterinary and Agricultural Sciences, 3(1):47-51.

Hussain, S.M., Afzal, M., Salim, M., Javid, A., Khichi, T.A.A., Hussain, M., and Raza, S.A. 2011. Apparent Digestibility of Fish Meal, Blood Meal and Meat Meal for Labeo rohita Fingerlings. J. Anim. Plant Sci. 21(4):807-811.

Mubarak, E.A.T., Amiza, M.A., Baksh, H.K., and Abol-Munafi, A.B. 2011. Apparent Digestibility Coefficient of Pelleted Feed Incorporated with Water Hyacinth Echhornia crassipes Fed to Red Tilapia Oreochromis mossambicus (Peters, 1852) X Oreochromis niloticus (Linnaeus, 1758). Agricultural Journal. 6(6):322-326.

Olaniran, T.S., and Falaye AE. 2007. Growth performance and nutrient utilization of Hybrid Red Tilapia (Oreochromis niloticus X Oreochromis aureus) fingerlings fed increasing dietary levels of hydrolysed poultry feather meal. Tropical Animal Investigation. 10:11-17.

Omitoyin, B.O. 1995. Utilization of Poultry By-products (Feather and Offal) in the Diets of African Catfish Clarias gariepinus (Burchell) Ph.D Thesis, Department of Wildlife and Fisheries Management, University of Ibadan Nigeria.

Sotolu, A.O., and Sule, S.O. 2011. Digestibility and performance of Water Hyacinth Meal in the Diets of Clarias gariepinus (Burchell, 1822). Tropical Subtropical Agroecosystem 14: 245-250.

Sule, S.O., Durojaiye, F.A., Ojetayo, T.A., Adewale, R.A., and Sotolu, A.O. 2020a. Potential and nutritive evaluation of pig hoof meal as dietary protein feed ingredient. FUW Trends in Science & Technology Journal. 5(3):735–739.