p-ISSN. 2406-9825
e-ISSN. 2614-3178
Acta Aquatica: Aquatic Sciences Journal, 9:1 (April, 2022): 22-25
DOI: 10.29103/aa.v9i1.5777

Acta Aquatica
Aquatic Sciences Journal

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

Falaye Augustine Eyiwunmi[a], and Sule Shakiru Okanlawon[a,b*]

[a.] *Department of Aquaculture and Fisheries Management, University of Ibadan, Ibadan.*
[b.] *Department of Forestry, Wildlife and Fisheries, College of Agricultural Sciences, Olabisi Onabanjo University, Ayetoro Campus, Ogun State, Nigeria.*

Abstract

Cattle hoof meal was processed by autoclaving, fermentation, wood ash fermentation, soda ash treatment and raw-unprocessed hoof. This was studied on *Clarias gariepinus* juveniles 14.22±0.23g stocked at 15 fish per tank in replicate. Treated samples were used in compounding six isonitrogenous diets of a reference diet 70%: test diet 30% and fed at 3% body weight. Significant difference ($P<0.05$) was observed among dietary treatments. Weight gain, specific growth rate feed conversion ratio percentage weight gain in soda ash diet was enhanced followed by raw hoof diet while wood ash treated diet showed the least response on fish growth. Fish carcass quality was enhanced with raw hoof treated diets over other diets. Utilization of soda ash treated hoof meal can be used in enhancing growth of *C. gariepinus.*

Keywords: Cattle-hoof-meal; Fishmeal; haematology; keratin.

1. Introduction

Valorisation 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 industy 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_2CO_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 Management laboratory, University of Ibadan, Ibadan, Oyo State. 15 *Clarias gariepinus* (14.80±0.22g) 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.

* *Author correspondence: Department of Forestry, Wildlife and Fisheries, College of Agricultural Sciences, Olabisi Onabanjo University, Ayetoro Campus, Ogun State, Nigeria.*
Tel: +234 90 33 169 759.
e-mail:sule.okanlawon@oouagoiwoye.edu.ng, okanlawon.sule@yahoo.com

DOI: 10.29103/aa.v9i1.5777

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-weighed 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.

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	29.19	20.43
Vitamin premix	0.6	0.42
Chromic oxide	1.0	1.0
TEST ingredient	----------	29.70
Total	100kg	100kg

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

$$\text{SGR (\%)}: \frac{(Ln\ Final\ Weight - Ln\ Initial\ Weight}{Time}\ x\ 100$$

Percentage Weight Gain

$$\text{PWG (\%)}: \frac{Total\ Weight\ Gain}{Initial\ Weight}\ x\ 100$$

Food Conversion Ratio

$$\text{FCR (g)}: \frac{Food\ Intake\ (g)}{Weight\ Gain\ (g)}$$

Protein Intake

PI (g): Total feed intake (g) x protein in feed (%)

Net metabolism

$$\text{Nm}: \frac{0{,}549\ x\ (Initial\ Weight + Final\ Weight)}{2}\ x\ Time$$

Where 0.549 is metabolism factor constant

Net Protein Utilization

$$\text{NPU}: \frac{Final\ Fish\ Nitrogen - Initial\ Fish\ Nitrogen + N}{Nitrogen\ in\ Diet}$$

Survival rate

$$\text{SR (\%)}: \frac{Initial\ Number\ of\ Fish\ Stocked - Morta}{Initial\ Number\ of\ Fish\ Stocked}\ x\ 100$$

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 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^{d}	52.28^{c}	53.27^{b}	53.14^{b}	52.99^{b}	54.23^{a}
Fat %	6.11^{a}	4.14^{c}	4.92^{b}	3.99^{cd}	3.52^{de}	3.29^{e}
Moisture %	9.24^{a}	3.72^{c}	8.61^{b}	8.82^{ab}	9.12^{a}	9.24^{a}
Ash %	9.03^{b}	6.37^{d}	6.35^{d}	10.20^{a}	7.04^{c}	6.08^{d}
Fibre %	1.64^{d}	4.36^{a}	4.09^{ab}	1.56^{d}	2.32^{c}	3.66^{b}
NFE %	33.83^{a}	29.13^{b}	22.74^{d}	22.29^{d}	24.96^{c}	23.50^{cd}
ME kcal/kg	3169.67^{b}	3292.84^{a}	3169.59^{b}	3072.82^{d}	3122.29^{c}	3098.41^{cd}

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 consitutuent 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

DOI: 10.29103/aa.v9i1.5777

Leucine	5.02	7.30	6.95	5.78	6.48	6.65
Phenylalanine	3.37	4.52	4.43	3.55	4.08	4.26
Tryptophan	0.79	1.15	1.16	0.84	1.10	1.05
NEAA g/100g protein						
Aspartic acid	7.63	9.30	9.37	8.50	8.87	9.30
Serine	2.27	3.73	3.57	2.92	3.29	3.29
Glutamic acid	10.45	13.63	12.87	11.92	12.64	12.57
Proline	3.05	3.35	3.45	2.94	3.25	3.15
Alanine	3.26	4.55	4.32	3.41	4.56	3.56
Cysteine	0.85	1.21	1.21	0.97	1.08	1.09
Tyrosine	2.41	3.27	3.44	2.75	3.18	3.18
Glycine	3.18	4.37	4.51	3.51	4.18	4.32

NOTE: hf= hoof. EAA: Essential amino acid, NEAA: Non- Essential amino acid

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 lower than Falaye (1982) and Omitoyin (1995). The complete amino acid necessary for optimal growth present in diets over the reference ration did not transform to feed utilization among all treatments. This is an indication that the method of processing can affect the availability of amino acid in diets.

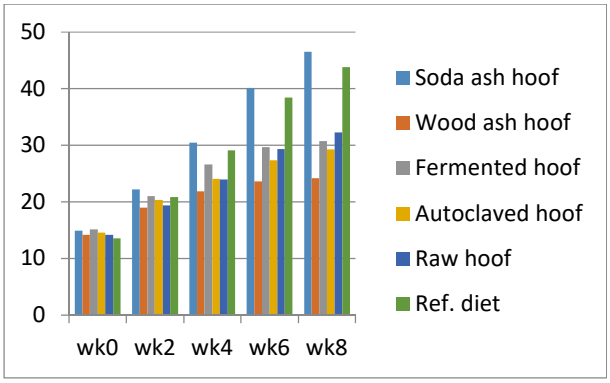

Figure 1. Final weight gains *Clarias gariepinus* fed Cattle hoof meal diets.

Mortality was greatly reduced with no difference among treatment, this is similar to the report of Falaye (1982) and Omitoyin (1995) thus indicated that the test ingredient had no deleterious effect on the fish been studied hence further research into the inclusion level be conducted.

Tabel 4
Growth and utilization pattern of *Clarias gariepinus* fed Cattle hoof reference and testl diets.

Parameters	Ref. diet	Soda Ash hf	Wood Ash hf	Ferment hf	Autoclave hf	Raw hf
IAW (g)	13.59^{a}	14.89^{a}	14.18^{a}	15.13^{a}	14.59^{a}	14.17^{a}
FAW (g)	43.82^{a}	46.55^{a}	24.19^{b}	30.72^{b}	29.24^{b}	32.31^{b}
WG (g)	30.22^{a}	31.66^{a}	10.01^{c}	15.59^{bc}	14.64^{bc}	18.14^{b}
PWG (%)	68.95^{a}	67.56^{a}	40.57^{c}	50.55^{b}	49.69^{b}	55.59^{b}
SGR	1.62^{a}	1.64^{a}	1.36^{c}	1.47^{bc}	1.44^{bc}	1.48^{b}
FCR	3.22^{a}	3.02^{a}	7.12^{c}	5.62^{b}	5.44^{b}	4.43^{ab}
SR (%)	97.78^{a}	88.89^{a}	88.89^{a}	95.56^{a}	93.33^{a}	93.33^{a}
PI	376.03^{b}	489.72^{a}	498.88^{a}	495.14^{a}	495.98^{a}	507.09^{a}
NM	882.55^{a}	944.49^{a}	589.84^{b}	704.90^{b}	673.79^{b}	714.44^{b}
NPU %	22.47^{a}	18.40^{b}	11.46^{c}	13.67^{c}	13.05^{c}	13.65^{c}

Row values with same superscript are not significantly different (p>0.05). NOTE: hf: hoof, IAW: Initial average weight, FAWG: Final average weight gained, WG: Weight Gain, PWG: Percentage Weight Gain, SGR: Specific Growth Rate, FCR: Feed Conversion Ratio, SR: Survival rate, PI: Protein intake, NM: Net Metabolism, NPU: Net Protein Utilisation.

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 carcass 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 Sotolu and Sule (2011) who reported vice versa. The increased ash content of fish carcass revealed the ability of the test ingredient to supply mineral to the experiemtal fish (Falaye and Sule, 2020)

Tabel 5
Carcass analysis of *C. gariepinus* fed Cattle hoof reference and test diets.

Proximate	Initial Fish	Ref. diet	Soda Ash hf	Wood Ash hf	Ferment hf	Autoclave hf	Raw hf
Protein %	37.13^{e}	48.86^{b}	47.28^{c}	49.36^{b}	46.45^{cd}	46.66^{cd}	53.67^{a}
Fat %	4.45^{d}	7.06^{b}	6.78^{c}	7.22^{b}	7.28^{b}	6.78^{c}	8.10^{a}
MC %	14.04^{b}	11.24^{d}	13.62^{b}	12.80^{c}	15.44^{a}	12.24^{c}	13.72^{b}
Ash %	7.65^{d}	11.86^{b}	13.56^{a}	11.86^{b}	11.68^{b}	9.91^{c}	13.27^{a}

Row values with same superscript are not significantly different (p>0.05). MC: Moisture content

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.

Tabel 6
Haematological profile of *C. gariepinus* fed Cattle hoof reference and test diets.

Parameters	Ref. diet	Soda Ash hf	Wood Ash hf	Ferment hf	Autoclave hf	Raw hf
RBC (10^{12}/L)	1.65^{e}	2.23^{d}	2.26^{c}	2.25^{c}	2.32^{b}	2.72^{a}
MCV (fl)	141.80^{c}	147.30^{b}	141.00^{c}	135.60^{e}	149.10^{a}	139.30^{d}
RDW (%)	20.80^{a}	18.10^{c}	19.20^{b}	17.20^{c}	19.00^{b}	16.90^{d}
RDWa (fl)	134.40^{a}	127.10^{c}	130.00^{b}	129.80^{b}	125.10^{c}	115.60^{d}
HCT (%)	23.40^{e}	32.90^{c}	31.90^{c}	30.50^{d}	34.60^{b}	37.90^{a}
PLT (10^{9}/L)	18.00^{a}	18.00^{a}	8.00^{c}	10.00^{b}	5.00^{d}	3.00^{e}
WBC(10^{9}/L)	29.40^{e}	38.10^{c}	39.90^{c}	30.50^{d}	45.30^{b}	51.50^{a}
HGB (g/dL)	9.70^{d}	12.90^{c}	13.00^{c}	13.50^{c}	14.30^{b}	15.10^{a}
MCH (pg)	58.90^{b}	58.00^{bc}	57.30^{c}	60.00^{b}	61.60^{a}	55.60^{d}
MCHC(g/dL)	41.50^{b}	39.30^{c}	40.60^{b}	44.30^{a}	41.30^{b}	39.90^{c}
LYM (10^{9}/L)	29.20^{e}	37.80^{c}	39.70^{b}	40.60^{b}	33.30^{d}	51.30^{a}
GRAN(10^{9}/L)	0.10	0.00	0.00	0.00	0.00	0.00
MID (10^{9}/L)	0.10^{c}	0.30^{a}	0.20^{b}	0.10^{c}	0.20^{b}	0.20^{b}
LYM (%)	99.20^{a}	99.30^{a}	99.40^{a}	99.60^{a}	98.70^{a}	99.50^{a}
GRA (%)	0.30^{a}	0.20^{b}	0.20^{b}	0.30^{a}	0.20^{b}	0.10^{c}
MID (%)	0.50^{a}	0.40^{b}	0.40^{b}	0.50^{a}	0.40^{b}	0.40^{b}

Row values with same superscript are not significantly different (p>0.05) RBC=red blood cell, MCV=mean corpuscular volume, RDW= red csll distribuyion wifth HCT= haematocrit, PLT= platelet, WBC=white blood cell, HGB=haemoglobin, MCH= mean coepuscular haemoglobin, MCHC= mean corpuscular haemoglobin concentration, LYM= lymphocyte GRAN= granulocyte MID= combined value of WBC excude LYM and GRAN.

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

DOI: 10.29103/aa.v9i1.5777

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.

Sule, S.O., Sotolu, A.O., Ojetayo, T.A., and Owodeinde, F.G. 2020b. Evaluation and potential generation of Goat hoof and horn waste as protein feedstuffs. African Journal of Science and Nature. 11:75-82.