Ukrainian Journal of
Veterinary and Agricultural Sciences
http://ujvas.com.ua
Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies Lviv
Volume 3
Number 3
original article | UDC 639.3 | doi: 10.32718/ujvas3-3.05

Digestibility Coefficients of Cattle Hoof Meal Diet by African Catfish *Clarias gariepinus* Juvenile

A. E. Falaye[1], S. O. Sule[1,2]

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

Article info
Received 14.07.2020
Received in revised form 17.08.2020
Accepted 18.08.2020

Correspondence author
S. O. Sule
Tel.: +234-8056705169
E-mail: okanlawon.sule@yahoo.com

Contents
1. Introduction ……..…….. 25
2. Materials and methods ….. 25
3. Results and discussion ….. 26
4. Conclusions …… 27
References …….. 27

Abstract

Digestibility trial of Cattle hoof waste subjected to five processing methods was conducted on *Clarias gariepinus* juveniles. A reference diet 70 % and test diet 30 % was formulated with chromic oxide biomarker. Feed and feacal samples collected at 8h interval after feeding were analysed for proximate parameters and digestibility coefficient calculated. There was significant difference ($P < 0.05$) among treatments crude protein digestibility was highest in Reference diet (88.26 ± 0.04) < soda ash diet (87.49 ± 0.04) < fermented diet (82.15 ± 0.10) < wood ash diet (81.26 ± 0.03) < raw hoof diet (79.57 ± 0.05) and lowest in Autoclaved diet (77.69 ± 0.02). Nutrient digestibility also showed significant difference ($P < 0.05$) among treatments with highest values for soda ash diets parameters and least protein nutrient in autoclaved diet (58.99±0.08); fat, dry matter and energy nutrient in raw hoof diet (56.41 ± 3.49; 23.39 ± 0.16; 25.71 ± 0.75). This study concludes that *Clarias gariepinus* juveniles can be fed soda ash treated cattle hoof waste.

Key words: Digestibility, keratin, Cattle-hoof-meal.

Citation:
Falaye, A. E., & Sule, S. O. (2020). Digestibility Coefficients of Cattle Hoof Meal Diet by African Catfish *Clarias gariepinus* Juvenile. *Ukrainian Journal of Veterinary and Agricultural Sciences*, 3(3), 25–28.

1. Introduction

Studying the digestibility of new feed ingredient in animal nutrition is in order to make recommendation for optimal inclusion in animal diet. Falaye A. E. (1992) stated that utilization of crop and animal by-product which are inexpensive will reduce cost of nutritive high value feed, increase fish production and farmers profit. Utilization of animal by-product has expanded the aquaculture industry worldwide (Erturk & Sevgili, 2003; Nwanna, 2003). Scarcity and high cost of fish meal had stimulated scientific interest in finding utilization for waste to replace either partially or wholly fish meal in diet of cultured fish (Nwanna, 2003).

Much information exists on the utilization of feather meal in fish diet (Falaye, 1982; Omitoyin, 1995; Falaye et al., 1999; Olaniran & Falaye, 2007). However, Cattle and pig hoof has been used in the nutrition of poultry (Wagner & Elvehjem, 1942; 1943; Slinger et al., 1944; Qureishi et al., 1962) while there is dearth of information on the digestibility of this rich protein keratin source in aquaculture nutrition to justify for its inclusion as a dietary protein source. The objective of this study is to assess the digestibility of Cattle hoof meal on *Clarias gariepinus* juvenile.

2. Materials and methods

Experimental procedure: The experiment was set up in Aquaculture and Fisheries Management laboratory, University of Ibadan, Ibadan, Oyo State. 720 *Clarias gariepinus* juveniles were stocked in rectangular plastic tank of 65litre (0.6m X 0.3m X 0.3m) in replicate according to Mubarak et al., (2011) and experimental fish was acclimatized for 7 days.

Feed formulation: Samples of raw cattle hoof waste were processed according to Falaye and Sule (2020). All five processing methods were used to formulate diets for

digestibility study. A control basal/reference diet of 40% crude protein was formulated and adjusted according to Hussain et al., (2011) to 70 % reference diet and test diet 30% with chromic oxide biomarker (Table 1). Hoof meal mixed with other feedstuff were ground to fine powder, mixed into dough and pelletized to 2 mm size using motorized pelletizer. The fish in each tank was batch-weighed forth-nightly. Feeding was done twice daily at 3 % fish body weight (Akinwole & Akinnuoye, 2012). The duration of the digestibility trial was 56 days according to Taufek et al., (2016). Fish faeces were collected from each tank daily (8 hours after feeding) from the 7th day of the experiment. The faeces were strained using 2mm hose on to filter papers, oven-dried at 50 °C for 6 hours and kept for analysis.

Table 1
Gross composition of Cattle hoof digestibility diet

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

Proximate analysis: The digestibility feeds samples (n = 6), faecal samples (n = 6) (Table 3), were subjected to proximate analysis for their nutritional compositions (AOAC, 2000) while chromic oxide analysis of feed and faeces according to Furukawa and Tsukahara (1966).

Apparent and nutrient digestibility co-efficient
Apparent digestibility coefficients (ADC) was calculated according to Fagbenro and Bello-Olusoji (1997); ADC = 100 × [1- (% faeces nutrient /% dietary nutrient) × (% dietary chromic oxide/% faeces chromic oxide)]. Dry matter according to Falaye and Oloruntuyi (1998) ADC of dry matter = 100 × [1 - (% dietary chromic oxide / % faeces chromic oxide)]; while nutrient digestibility was according to Bureau et al., (1999) ADC of nutrient = 100/30($ADC_{test\ diet}$ - 70/100$ADC_{ref\ diet}$).
Statistical analysis: The experiment was a Complete Randomized Design and data resulting from this study were 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. Results and discussion

Results
The chemical analysis of components in feed, faeces and chromic oxide is presented in Table 2. There was significant difference (P < 0.05) in faecal sample components analysed. Hoof meal apparent digestibility result showed that the Reference diet was significantly different (P < 0.05) from the Test diets while soda ash hoof sample diet showed significant difference (P < 0.05) from other Test diets (Table 3). The nutrient digestibility of processed Cattle hoof diets (Table 4) showed that soda ash hoof samples was significantly different (P < 0.05) in protein, fat, dry matter and energy when compared to other processed diets.

Table 2
Proximate analysis of digestibility diet and faecal samples

Feed component	Ref. diet	Soda Ash hf	Wood Ash hf	Fermented hf	Autoclaved hf	Raw hf
Crude protein, %	40.15 ± 0.08^{d}	52.28 ± 0.14^{c}	53.27 ± 0.14^{b}	53.14 ± 0.14^{b}	52.99 ± 0.09^{b}	54.23 ± 0.13^{a}
Fat, %	6.11 ± 0.14^{a}	4.14 ± 0.07^{c}	4.92 ± 0.04^{b}	3.99 ± 0.01^{cd}	3.52 ± 0.28^{de}	3.29 ± 0.30^{e}
Moisture content, %	9.24 ± 0.12^{a}	3.72 ± 0.11^{c}	8.61 ± 0.06^{b}	8.82 ± 0.08^{ab}	9.12 ± 0.13^{a}	9.24 ± 0.28^{a}
Energy, kcal/kg	3169.67 ± 0.21^{b}	3292.84 ± 2.47^{a}	3169.59 ± 3.37^{b}	3072.82 ± 7.27^{d}	3122.29 ± 6.42^{c}	3098.41 ± 19.27^{cd}
Chromic oxide	1	1	1	1	1	1
Faeces component						
Crude protein, %	46.68 ± 0.16^{c}	45.09 ± 0.06^{d}	34.94 ± 0.13^{e}	55.02 ± 0.17^{b}	59.13 ± 0.06^{a}	32.13 ± 0.01^{f}
Fat, %	1.26 ± 0.03c^{d}	1.32 ± 0.01^{c}	1.41 ± 0.02^{b}	1.21 ± 0.01^{d}	1.26 ± 0.03^{cd}	1.54 ± 0.02^{a}
Moisture content, %	8.28 ± 0.14^{c}	9.61 ± 0.32^{a}	9.43 ± 0.01^{ab}	8.76 ± 0.03^{bc}	8.28 ± 0.41^{c}	8.28 ± 0.29^{c}
Energy, kcal/kg	2930.28 ± 10.10^{a}	2816.56 ± 23.13^{b}	2811.81 ± 0.11^{b}	2947.80 ± 0.77^{a}	2976.17 ± 23.67^{a}	2978.62 ± 20.41^{a}
Chromic oxide	0.99	0.69	0.35	0.58	0.50	0.29

Means with the same superscript along the same row are not significantly different (P > 0.05). NOTE: hf = hoof

Table 3
Apparent digestibility of *Clarias gariepinus* fed Cattle hoof meal diets

Parameters	Ref. diet	Soda Ash hf	Wood Ash hf	Fermentation hf	Autoclaved hf	Raw hf
Protein, %	88.26 ± 0.04^{a}	87.49 ± 0.04^{b}	81.26 ± 0.03^{d}	82.15 ± 0.10^{c}	77.69 ± 0.02^{f}	79.57 ± 0.05^{e}
Fat, %	96.77 ± 0.11^{a}	95.37 ± 0.12^{ab}	91.83 ± 0.12^{c}	94.76 ± 0.16^{b}	92.77 ± 0.44^{bc}	83.59 ± 1.32^{d}
Dry Matter, %	90.94 ± 0.21^{a}	62.58 ± 0.17^{d}	68.73 ± 0.23^{c}	82.87 ± 0.09^{b}	81.52 ± 0.64^{b}	69.12 ± 0.14^{c}
Energy, %	90.66 ± 0.03^{a}	87.60 ± 0.01^{b}	74.65 ± 0.03^{e}	83.46 ± 0.04^{c}	80.94 ± 0.11^{d}	66.85 ± 0.33^{f}

Means with the same superscript along the same row are not significantly different (P > 0.05). NOTE: hf: hoof

Table 4
Nutrient digestibility of *Clarias gariepinus* fed Cattle hoof meal diets

Parameters	Soda Ash hf	Wood Ash hf	Fermentation hf	Autoclaved hf	Raw hf
Protein, %	86.15 ± 0.15^{a}	68.96 ± 0.15^{c}	73.46 ± 1.98^{b}	58.99 ± 0.08^{e}	64.55 ± 0.15^{d}
Fat, %	90.80 ± 0.22^{a}	81.13 ± 0.38^{b}	89.19 ± 0.12^{a}	83.67 ± 1.30^{b}	58.87 ± 3.49^{c}
Dry Matter, %	77.64 ± 0.01^{a}	30.94 ± 0.03^{d}	70.17 ± 0.03^{b}	62.50 ± 0.05^{c}	23.39 ± 0.16^{e}
Energy, %	82.12 ± 0.27^{a}	46.50 ± 0.12^{d}	70.76 ± 0.19^{b}	63.74 ± 0.31^{c}	25.71 ± 0.75^{e}

Means with the same superscript along the same row are not significantly different ($P > 0.05$). NOTE: hf: hoof

Discussion

Proximate analysis of Cattle hoof meal digestibility 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 findings of this study on protein digestibility were similar to the report of Richie and Williams (2010) when plant protein sources were fed to Florida pompano. The protein digestibility for the tests diet was in line with Bureau et al., (1999) on feather meal (81 %) usage in (*Onchorynchus mykiss*) except for the autoclaved hoof diet which showed slight variation. Using feather meal, protein and dry matter digestibility for Diet 4 of Falaye (1982) was similar to the Fermented hoof diet in this study. Falaye et al., (1999) fed composite diet of Cocoa husk and feather meal to *O. niloticus* and observed digestible protein and dry matter decreased with increased inclusion level of samples in diet. The reason for the variation might have been as a result of processing and diet assimilation by the fish. It was noted that lack of processing impacted on both apparent and nutrient digestibility of raw hoof diets.

Omitoyin (1995) and Bureau et al., (1999) reported highest apparent digestibility in control diet for dry matter, protein, lipid and energy which corroborates this research. Similar protein digestibility had been reported by Erturk and Sevigili (2003) for poultry by-product meal (89.3–78.0 %) for Rainbow trout (*Onchorynchus mykiss*). The values in this study was higher than values reported for Blunt nose black bream (*Megalobrama ambylcephala*) fed feather meal (-5.7 %); extruded feather meal (76.0 %) and cooked dried feather meal (65.5 %) (Zhou et al., 2008). Significant reduction in lipid digestibility for rainbow trout fed poultry by product and feather meal was reported by Bureau et al., (1999); Erturk and Sevgili (2003), which was in line with this study. Allan *et al.,* (1998) reported that Silver perch showed low protein and energy digestibility when fed poultry and feather meal (15.3 %, 35.1 % vs. 15.5 %, 38.6 %) which contradicts this study. The variability report of digestibility showed the effect of different methods of processing that was used in preparing test ingredient for diet as stated by Morris (1972) and Bureau et al., (1999). Also, NRA (2008) had stated that the equipment used in hydrolysing under high pressure will help achieve up to 80 % digestibility for rendered animal by-products. Utilisation of finely ground cattle horn/hoof soda ash treated sample can aid its digestibility by livestock AFRIS/Feedipedia (2017).

4. Conclusions

Soda ash treated samples diet of cattle hoof was well digested by *C. gariepinus* juveniles over other processed sample diets. Hence utilization of soda ash treated hoof meal in juvenile catfish diet hereby suggested.

References

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

AFRIS/Feedipedia. (2017). Animal Feed Resources Information System (AFRIS), Cattle hoof and horn meal. www.feedipedia.org/node/216. Date accessed 29/1/2019.

Akinwole, A. O., & Akinnuoye, F. C. (2012). Effects of the shape of culture tanks on production of the African Catfish *Clarias gariepinus* juveniles. *Journal of Agriculture and Social Research,* 12(1), 11–18. URL: https://www.ajol.info/index.php/jasr/article/view/81675.

Allan, G. L., Frances, J., Booth, M., & Warner-Smith, R. (1998). Replacement of Fishmeal in diets for Silver perch *Bidyanus bidyanus:* V. Effects of increased poultry offal meal and feathermeal content on growth and body composition. In Allan and Rowland (Eds.) Fishmeal replacement in aquaculture feeds for Silver perch. Project 93/120-03. NSW Fisheries Final Report Series- Report No. 6.

Bureau, D. P., Harris, A. M. & Cho, C. Y. (1999). Apparent digestibility of rendered animal protein ingredients for Rainbow Trout (*Oncorhynchus mykiss*). *Aquaculture*, 180(3–4), 345–358. doi: 10.1016/S0044-8486(99)00210-0.

Erturk, M. M. & Sevgili, I. H. (2003). Effects of replacement of Fish meal with poultry by-product meals on apparent digestibility, body composition and protein efficiency ratio in a practical diets for Rainbow Trout, *Onchorynchus mykiss*. *Asian-Australian Journal of Animal Science,* 16(9), 1355–1359. doi: 10.5713/ajas.2003.1355.

Fagbenro, O. A. & Bello-Olusoji, O. A. (1997). Preparation, nutrient composition and digestibility of fermented shrimp head silage. *Food Chemistry,* 60(4), 489–493. doi: 10.1016/S0308-8146(96)00314-7.

Falaye, A. E. & Oloruntuyi, O. O. (1998). Nutritive potential of plantain peel meal and replacement value of Maize in diets of African catfish *Clarias gariepinus* fingerlings. *Tropical Agriculture (Trinidad),* 75(4), 488–492. URL: https://www.semanticscholar.org/paper/Nutritive-potential-of-plantain-peel-meal-and-value-Falaye-Oloruntuyi/44b6fe8d6e3aca38051b11f4372545c146b9ee9d.

Falaye, A. E. & 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. doi: 10.32718/ujvas3-1.09.

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. (1992). Utilization of Agro-industrial wastes as Fish feedstuffs in Nigeria. In Proceedings of the 10th Annual Conference. of the FISON, Abeokuta, 16–20, November pg. 47–46.

Falaye, A. E., Jauncey, K. & Tewe, O. O. (1999). Growth performance of Tilapia (*Oreochromis niloticus*) fingerlings fed varying levels of Cocoa husk diets. *Journal of Aquaculture in the Tropics*, 14(1), 1–10.

Furukawa, A., & Tsukahara, H. (1966). On the acid digestion method for the determination of chromic-oxide as an index substance in the study of digestibility of fish feed. *Bulletin of the Japanese Society of Scientific Fisheries,* 32(6), 502–508. doi: 10.2331/suisan.32.502.

Hussain, S. M., Afzal, M., Salim, M., Javid, A., Khichi, T. A. A., Hussain, M., & Raza, S. A. (2011). Apparent digestibility of Fish meal, blood meal and meat meal for *Labeo rohita* fingerlings. *The Journal of Animal & Plant Sciences*, 21(4), 807–811. URL: https://pdfs.semanticscholar.org/f190/845cac7064957366214e1c5a251923e77dbc.pdf.

Morris, W. C. (1972). Effect of processing methods on utilization of feather meal by broiler chicks Ph.d Thesis, Agriculture: Animal Science (Animal Nutrition). *Iowa State University* Ames, Iowa. Digital Repository, Retrospective Theses and Dissertation.

Mubarak, E. A. T., Amiza, M. A., Baksh, H. K. & 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. doi: 10.3923/aj.2011.322.326.

NRA. (2008). National Renderers Association, Inc. Pocket Information Manual a Buyer's Guide to Rendered Products, 44.

Nwanna, L. C. (2003). Nutritional value and digestibility of fermented Shrimp head waste meal by African catfish *Clarias gariepinus*. *Pakistan Journal of Nutrition*, 2(6), 339–345. doi: 10.3923/pjn.2003.339.345.

Olaniran, T. S., & Falaye, A. E. (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.

Qureshi, M. S., Khan, I., & Schneider, B. (1962). Use of hoof and horn meal to replace meat meal as a source of protein in rations for growing chicks. *Agriculture Pakistan*, 13(1), 45–56.

Richie, M., & Williams, T. N. (2010). Apparent digestibility protein, energy and amino acid availability of three plant protein in Florida pompano, *Trachinotus carolinus* L. in seawater and low salinity water. *Aquaculture Nutrition,* 16(3), 223–230. doi: 10.1111/j.1365-2095.2009.00654.x.

Slinger, S. J., Evans, E. V., Kelham, W. L., & Maecellus, F. N. (1944). The use of a hoof and horn meal to replace animal and vegetable protein in rations for growing chicks. *Poultry science,* 23(5), 431–436. doi: 10.3382/ps.0230431.

Taufek, N. M., Muin, H., Raji, A. A., & Razak, S. A. (2016). Apparent digestibility coefficients and amino acid availability of Cricket Meal, *Gryllus bimaculatus*, and Fishmeal in Afrcican Catfish *Clarias gariepinus*, Diet. *Journal of the World Aquaculture Society,* 47(6), 798–805. doi: 10.1111/jwas.12302.

Wagner, J. R., & Elvehjem, C. A. (1942). Nutritive value of keratins. I. Powdered Swine hoofs. *Proceedings of the Society for Experimental Biology and Medicine*, 51(3), 394–396. doi: 10.3181/2F00379727-51-13989.

Wagner, J. R., & Elvehjem, C. A. (1943). The nutritive value of keratins. II. Powdered Swine hoofs in poultry rations. *Poultry Science*, 22(4), 275–277. doi: 10.3382/ps.0220275.

Zhou, Z., Ren, Z., Zeng, H. & Yao, B. (2008). Apparent digestibility of various feedstuffs for Blunt nose Black Bream *Megalobrama amblycephala* Yih. *Aquaculture Nutrition*, 14(2), 153–165. doi: 10.1111/j.1365-2095.2007.00515.x.