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NUTRIENT VALUES AND UTILIZATION OF RUMEN EPITHELIA MEAL BY AFRICAN CATFISH FOR SUSTAINABLE AQUACULTURE PRACTICES

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ABSTRACT

This study was carried out to determine the nutrient potentials and utilization of Rumen Epithelia Meal (REM) in replacement of fishmeal as high cost of aquafeed continued to hinder successful fish farming. Triplicate groups of catfish were fed with four graded diets of REM which replaced fishmeal at 0%, 25%, 50% and 75% inclusion levels for 12 weeks. Diets and fish were analyzed before and after the experiment. Data collected on fish growth performance, nutrient utilization and Cost of production were subjected to ANOVA and correlation analysis. Water quality was monitored to ensure optimum fish performance. Results showed that fish responded to diets significantly ($p<0.05$). Mean Weight Gain (MWG) and Specific Growth Rate were not significantly different between diets 1 and 2 but they were significantly higher than those of diets 3 and 4. Protein efficiency ratio was highest in fish fed diet 2 (2.50) but least in fish fed diet 4 (2.07) while MWG of fish significantly ($p<0.05$) correlated with REM inclusion levels ($r=-0.74$). Fish fed diet 1 exhibited significantly ($p<0.05$) highest Profit Index (43.3) while fish fed diet 4 has the lowest Profit Index (31.1). Replacement of fishmeal with Rumen Epithelia Meal (REM) at 25% inclusion in the diet of catfish gave better growth performance for profitable fish farming.

Key words : Rumen Epithelia Meal, Fishmeal, Fish farming, Aquafeed, Cost of production

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Introduction

Fishmeal has been described as an indispensable protein source in the preparation of aquafeed (Francis, 2002). Going by its increasing global demand by the livestock industry including aquaculture, the trend is capable of causing further increase in the price of fishmeal (Asche and Tveteras, 2000; Jianhua, 2007) and creating more pressure on wild fish stock. High cost of fishmeal importation into the country was said to have a negative impact on the Nigeria economy (Dublin-Green and Tobor, 1992) and hampering the development of aquaculture in the country (Nwanna, 2003). The fear of adulteration of the fishmeal further exacerbates the position of fishmeal in aquafeed production as reported by Delgado *et al*., (2002) thus, the inevitability of continuous search for alternative protein sources in animal feeding especially for aquaculture purposes whose share of the global fishmeal demand has been on the increase for the past decade (IFOMA, 1999; Hardy and Tacon, 2002; New and Wijkstrom, 2002). Large quantities of ruminal contents from slaughterhouses constitute waste disposal problems and environmental nuisance, especially in small slaughter plants in markets within the country (Fajemisin, 2002). Dried rumen epithelia contents can be used by ruminants (Messersmith *et al*., 1974**;** Prokop *et al*., 1974**)** or poultry (Javanovic and Cuperlovic, 1977) and the crude protein content (C.P) - 63.11% of the rumen epithelia meal has been found comparable to fishmeal (Fajemisin, 2002). Rumen Epithelia Meal (REM) is readily available from various slaughter houses in the country and African catfish (*Clarias gariepinus*) has been a commercially acceptable fish species for culture in Nigeria which readily accept different kinds of feed ingredients included in its diet (Faturoti, 2000; Fasakin, 2008). This study therefore, considered rumen epithelia meal (REM) as a replacer of fishmeal in the diet of *Clarias gariepinus* as a way of ensuring profitable fish farming.

MATERIALS AND METHODS

Sample collection: Fresh Rumen Epithelia Waste (REW) was collected from the slaughter house of Bodija International Market, Ibadan and transported to the Department of Wildlife and Fisheries Management University of Ibadan, Ibadan. The sample was immediately spread on a slab in thin layer and allowed to dry in the sun for five between hours of 8:30-4:30 days with occasional turning for homogeneity. Other feedstuffs used include fishmeal, soya bean meal, groundnut cake, yellow maize, brewer's grain, vegetable oil, bone meal, vitamin premix, and binder. Experimental fish of 21.5±0.2g average weight were transported in oxygenated polythene bags from Justino fish farm-a reputable fish farm in Ibadan to the Laboratory of the Department of Wildlife and Fisheries Management, University of Ibadan, Ibadan.

Preparation of REM based diets: The sundried REW was powdered by the Thomas Wiley miller. Proximate analysis of the powdered REW with other ingredients was done in the laboratory for Crude protein, Crude fat, Ash Moisture content. Four (4) isonitrogenous diets {40% Crude Protein (C.P)} were formulated which contained increasing levels of REM in replacements of fishmeal at 0% (control diet), 25%, 50%, and 75%. These were thoroughly mixed with other ingredients using a Hobart A-200T pelleting and mixing machine for homogenous mass substance. The 2-mm pellets produced were broken into smaller sizes that are suitable for the experimental fish to feed upon. They were air-dried and stored in an airtight polythene bags ready for use.

Laboratory analysis: Samples of each of the four diets and sample of experimental fish already oven-dried at 48^0C for five days were taken for laboratory analysis according to the methods of A.O.A.C. (2000). Samples were analyzed for their proximate and mineral compositions.
Water quality parameters such temperature, pH and dissolved oxygen were monitored weekly using combined digital YSI meter (YSI model 57, VWR Company New Jersey and Metler Toledo-320 model, U.K) to ensure optimum fish performance in the fish culture tanks.

Feeding trial: Fish were allowed to acclimate for three days without feeding and this prepared them enough to accept the experimental feed at the commencement of the experiment. Fish were stocked at 10 fish/m^2 given rise to a total of 25 fish/plastic tank. The four treatments were replicated three times and were all distributed randomly using table of random numbers. Fish were fed three times a day to satiation at 9:00-9:30 h, 13:00-13:30 h and 17:00-17:30 h for 84 days.

Data collection and analysis: Data were collected fortnightly on mean weight changes of fish which were used to assess growth performance of fish and nutrient utilization parameters such as Mean Weight Gain (MWG), Specific Growth Rate (SGR), Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER) and Total Feed Intake (TFI). The parameters were given as follow;

$$MWG = (W_2 - W_1)\ g$$

Where; W_1 = initial mean weight (g) and W_2 = final mean weight (g)

$$SGR = \frac{Log_e W_2 - Log_e W_1}{T_2 - T_1} \times 100$$

Where; W_2 = final weight (g) at time T_2 (final time) and
W_1 = Initial weight (g) at time T_1 (initial time)

$$PER = \frac{\text{Mean Weight Gain}}{\text{Protein Intake}}$$

$$I.C = \frac{\text{Cost of feed consumed}}{\text{Mean weight gain by fish}}$$

$$FRC = \frac{\text{Feed intake}}{\text{Wet Weight Gain}}$$

Where, Protein Intake (P.In.) = Feed Intake X % Protein in the diet (40%).

The initial and final values of growth performance of fish and nutrient utilization alongside cost of feed produced and consumed by fish were used to evaluate profitability of *C. gariepinus* production using REM based diet. The parameters used for this

assessment are Incidence of Cost (I.C) and Profit Index (P.I) according to Vincke (1969). The assumptions that follow are;
(i) Cost of feed production is the only variable operating cost while all other operating cost remained fixed.

(ii) The cost of REM is US $ 450/ton based on current exchange rate of N 120: US $ 1.0

$$P.I = \frac{\text{Value of fish produced}}{\text{Cost of feed consumed}}$$

Water qualities of the culture media were monitored fortnightly throughout the experimental period and set of data collected were processed and analyzed statistically. Data collected during the experiment were subjected to one-way analysis of variance ANOVA using the SPSS (Statistical Package Software of the Social Sciences Version 9.0). Duncan multiple range test was conducted to determine least significant difference among individual mean values at 0.05 probability level (Duncan, 1955).

Results

Proximate analysis of the Rumen Epithelia Meal (REM) used in this study revealed that it contained 59.06% Crude Protein and the fibre content as 4.66%. It also contained minerals such as Phosphorus, Calcium and sodium with details shown in table 1. Experimental diets prepared following the proximate analysis were as shown in table 2. The study further revealed that REM-based diets were acceptable to the experimental fish producing direct effect on fish growth and performance although fish fed diet 1 consumed more feed than others while fish fed diet 4 consumed the least amount of feed (Table 4). All fish fed REM based-diets fed voraciously during the experiment as survival rates were generally high (Table 4).

Weight gain was highest in fish fed diet 1 (43.30g) which was not significantly different ($p>0.05$) from 40.00g of fish fed diet 2 while the least (31.10g) was obtained in fish fed diet 4. The mean weight gain of experimental fish significantly ($p<0.05$) correlated inversely with REM inclusion levels ($r= -0.74$) and the pattern changes are as shown in Fig.1. Similarly, Specific Growth Rate (SGR) was highest fish fed diet 1 which was not significantly different ($p>0.05$) from that of fish fed diet 2 but fish fed diet 3 and 4 had significantly lower SGR than those of diet 1 and 2. Feed Conversion Ratio (FCR) in fish fed diet 4 (14.45) was significantly higher than that of fish fed diet 1 (12.12). However, Protein Efficiency Ratio (PER) was highest in fish fed diet 1 (2.47) which was not significantly ($p>0.05$) higher than 2.50 in fish fed diet 2 but were significantly higher ($p<0.05$) than 2.39 in fish fed diet 3 and 2.07 in fish fed diet 4 (Table 4).

Carcass lipid and protein values increased from their initial values (3.42% and 16.45%) by the end of the experiment in all treatment and the highest values for lipid and protein were recorded as 5.76% in diet 3 and 69.20% in diet 1 respectively (Table 3). Fish carcass calcium had the highest initial mineral value (2.41%) which varied slightly in all diets at the end of the experiment (Table 3). However, fish carcass produced tremendous increase in the phosphorus contents of fish fed all the test diets from initial 0.36% to 25.50% in diet 1 and 25.64% in diet 2 as the least and highest values respectively.

Table 1: Proximate and mineral composition of Rumen Epithelia Meal (REM)

Parameters	% Dry Weight
Crude protein	59.06
Crude fibre	4.66
Fat	7.82
Ash	14.44
Moisture	8.61
N.F.E.	3.61
Phosphorus (g/kg)	2.23
Calcium (g/kg)	7.14
Sodium (g/kg)	6.45

There was an increasing pattern in the final values of energy in fish fed all the diets from the initial 2.69(Kcal/g) which increased to 2.87(Kcal/g) in diet 4 and 3.41(Kcal/g) in diet 3 being the least and the highest respectively.

Economic evaluation of REM utilization by fish indicated marginal differences in the values obtained in all the treatments. Incidence of Cost (IC) was least in fish fed diet 1 (1.99) while fish fed diet 4 produced the highest value (2.22). Diet 4 however had the least Profit Index (PI) 31.10 while diet 2 had 40.0. Table 5 showed detail results obtained on the economic evaluation of utilized REM based-diets by fish.

Table 2: Gross Ingredients and Proximate Composition of Experimental Diets

Ingredient (g/100g/DM)	Diet 1	Diet 2	Diet 3	Diet 4
Fish meal (72% C.P)	31.86	23.97	17.09	9.18
Rumen epithelia meal (59.06% C.P)	0	8.89	15.78	23.69
Soya bean meal (47% C.P)	25.78	25.78	25.78	25.78
Groundnut cake (42% C.P)	17.67	16.67	16.67	16.67
Yellow maize (9% C.P)	18.69	18.69	18.68	18.68
Vitamin and mineral premix	2.00	2.00	2.00	2.00
Fish oil	2.50	2.50	2.50	2.50
Binder	1.50	1.50	1.50	1.50
Proximate composition (g/10g/DM)				
Crude protein	40.01	40.11	40.12	40.02
Crude fibre	2.77	3.47	3.12	2.67
Fat	7.48	6.32	6.15	7.25
Ash	13.50	14.10	14.17	13.50
Moisture	0.37	0.20	1.80	1.66
NFE	36.21	36.43	36.88	36.72
Gross Energy (Kcal/g/DM)	413.87	417.22	421.50	420.03

Table 3: Carcass and mineral composition (g/100g/DM) of *C. gariepinus* fed REM-based diets before and after the 84 days.

Parameter (%)	Initial	Diet 1	Diet 2	Diet 3	Diet 4
Crude protein	16.45	69.20	68.75	67.25	64.15
Crude fat	3.42	4.94	5.26	5.76	5.28
Crude fibre	1.06	1.44	1.17	1.08	1.13
Ash	11.26	14.17	14.21	13.30	13.09
Moisture	27.58	6.98	7.26	6.87	7.06
Energy (Kcal/g)	2.69	3.23	3.05	3.41	2.87
Ca	2.41	2.35	2.38	2.34	2.39
Mg	0.82	0.76	0.79	0.77	0.79
P	0.36	25.50	25.64	25.59	25.56
Na	0.24	0.26	0.26	0.25	0.25

Table 4: Growth and nutrient utilization of *C. gariepinus* fed REM for 84 days

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	SEM
Mean initial weight (g)	21.5±0.2	21.5±0.2	21.5±0.2	21.5±0.2	-
Mean final weight (g)	64.81±0.4	61.33±0.3	58.63±0.4	53.06±0.6	-
S.G.R (%/day)	5.15[a]	4.76[a]	4.32[b]	3.70[b]	0.91
Weight Gain (%)	43.30[a]	40.00[a]	36.30[b]	31.10[b]	5.76
Total Feed Intake	52.49[a]	48.14[a]	45.60[a]	44.95[a]	7.45
F.C.R	12.12[a]	12.04[a]	12.56[a]	14.45[b]	0.87
G.F.C.E (%)	82.50[a]	83.09[a]	79.61[b]	69.19[c]	5.04
P.E.R	2.47[a]	2.50[a]	2.39[b]	2.07[c]	0.14
Number of fish stocked	25	25	25	25	-
Experimental period (days)	84	84	84	84	-
Survival rate (%)	92	96	88	92	-

Fig. 1: Forthnight mean weight changes (g) of fish fed different inclusion levels of REM-based diets for 84 days

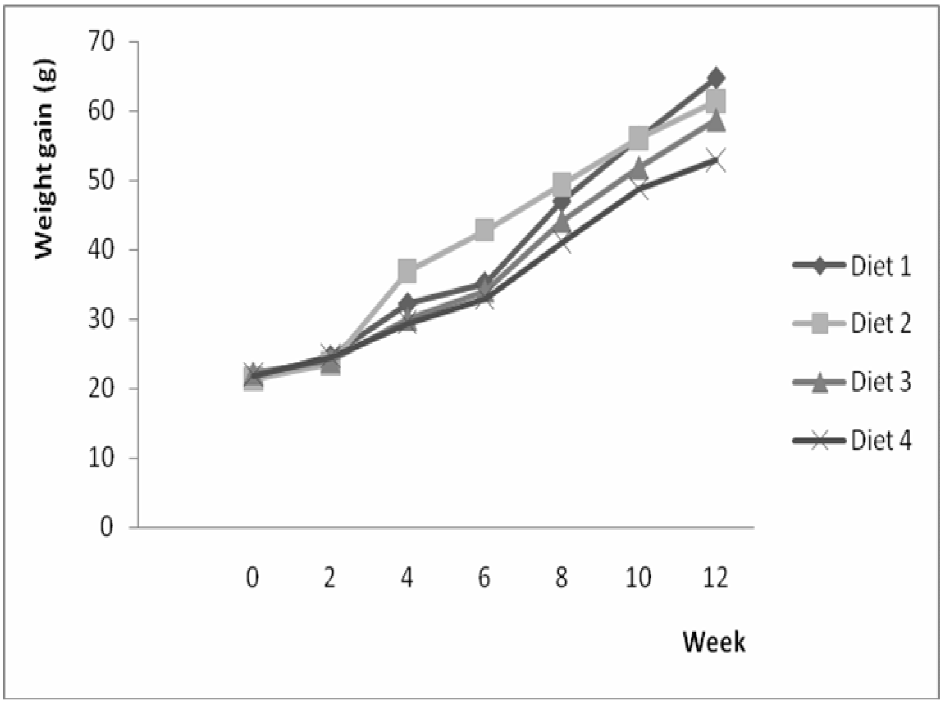

Table 5: Cost evaluation of REM utilization by *C. gariepinus*

Factors	Diet 1	Diet 2	Diet 3	Diet 4
Total feed consumed by fish (g)	524.92	481.44	456.07	449.51
Cost of feed consumed by fish (US$)	0.72	0.59	0.56	0.49
Mean weight gain by fish (g)	1.43	1.31	1.20	1.02
Value of fish produced (US$)	0.02	0.02	0.01	0.01
Incidence of Cost (IC)	1.99	2.22	2.11	2.08
Profit Index (PI)	43.30	40.00	36.30	31.10
Rate of Return (RR)	2.18	1.80	1.72	1.50

Discussion

The marginal difference recorded in the average weight gain and SGR between fish fed diet 1 and 2 that were significantly ($p<0.05$) higher than those of fish fed diet 1 and 2 appeared to be responsible for the similar trend in the values of FCR, PER and Gross Feed Conversion Efficiency (GFCE) as expressed in all the treatments. This trend of direct effects of test diets utilization by fish had earlier been established by Faturoti *et al.,* (1995), who said that nutrient utilization efficiency of a diet produces direct positive effects on fish weight gain and growth rate. The work of Fasakin *et al.,* (2004) using maggot meal and Fasakin *et al*., (2005) further confirmed the assertion. Higher carcass protein in diets 1 and 2 further revealed that fish were able to utilize REM better at low inclusion rate especially at 25% inclusion level which was significantly superior compared to fish fed 50% and 75% REM inclusions. This observation is similar to the ones made in previous studies by Adeyemo (2005) who stated that nutrient utilization of unconventional feed ingredients by fish is one of the factors determining fish carcass quality from a nutrition experiment and Sotolu (2008a) where similar results were recorded for the carcass protein of fish fed water hyacinth meal.

The economic analysis made in this study further confirmed the superior performance of fish fed diet 2 to those fed diets 3 and 4 that contained higher REM. The higher Profit Index (PI) produced by diet 2 compared to diet 3 and 4 could be as a result of higher weight gain recorded in fish fed diet 2 as the economic indices relates value of fish produced (which is in terms of the weight of that fish) to that of feed consumed by the fish. This higher PI obtained was termed best profit margin in the production of fish using specific unconventional feed ingredient in the diet of fish as reported by Nwanna (2003) and Sotolu (2008b) in their respective studies. This superiority was further established in this study with diet 2 having higher Rate of Return (RR) than diets 3 and 4 even though the latter both had lower Incidence of Cost (IC) compared with that of diet 2.

CONCLUSION

Considering the outcomes of the biological and economic assessment of REM utilization in this study, it clearly shows that rumen epithelia meal possesses a high nutritive value that is well relished by catfish. As an animal based protein source in the diets of fish, REM is capable of successfully replacing the expensive fishmeal at 25% inclusion level for sustainable aquaculture practices.

REFERENCES

A.O.A.C. 2000: Association of Official Analytical Chemists International (AOAC) 2000. Official methods of analysis, 17th edition. A.O.A.C. International, Gaithersburg, Maryland.

Adeyemo, O.K. 2005: Haematological and Histopathological effects of cassava mill effluent in *Clarias gariepinus*. *Afr. J. of Biomed. Res*., Vol. 8 (2005): 179-183.

Asche, F. and S. Tveteras, 2000. On the Relationship Between Aquaculture and Reduction Fisheries. IIFET 2000 Proceedings

Delgado, C.L., Rosegrant, M., Meijer, S., Wada, N. and Ahmed, M. 2002. Fish as food: Projection to 2020. Paper presented at the biennial meetings of the International Institute of Fisheries Economics and Trade, held in Wellington, New Zealand, August 19-23,2002.

Dublin-Green, C.O. and Tobor, J.G. 1992: Marine resources and activities in Nigeria. *NIOMR Tech. Paper* No. 84, 25 pp.

Duncan, D.B. 1955: Multiple Range & Multiple F-Tests. Biometrics 11: 1-42 pp.

Fajemisin, A. 2002: Mineral utilization by WAD goats fed rumen epithelium based diets. Ph.D Thesis, University of Ibadan, Ibadan.

Fasakin, E.A, Serwata, R.D. and Davies S.J. 2005: Comparative utilization of rendered animal derived products with or without composite mixture of soyabean meal in hybrid tilapia (*Oreochromis niloticus* x *Oreochromis mosambicus*) diets. *Aquaculture* 249: 329-338.

Fasakin, E.A. 2008: Fish as food: Yesterday, today and forever. Inaugural lecture series 48, The Federal University of Technology, Akure. 52 pp.

Fasakin, E.A., Balogun, A.M. and Edomwagogbon O. 2004: Aspects of chemical and biological evaluation of dried maggot meals in production diets for Clarid Catfish, *Clarias gariepinus. World Journal of Biotechnology*. 5: 753-762.

Faturoti, E.O. 2000: Beneath the ripples and sustainable fish production. Inaugural lecture, University of Ibadan. 54 pp.

Faturoti, E.O., Obasa S.O. and Bakare A.L. 1995: Growth and nutrient utilization of *Clarias gariepinus* fed life maggots in sustainable utilization of Aquatic/Wetland resources. 182 pp.

Francis, G. 2002: In; Challenges to organic farming and sustainable land use in the tropics and subtropics: Perspectives in the search for future fish feed ingredients. George Francis, Univ. of Hohenhein, Dept. of Aquaculture System and Animal, Nutrition. Deutscher Tropentag , October 9-11, 2002,Witzenhausen, Germany. 2 pp.

Hardy, R.W. and Tacon, A.G.J. 2002: Fish meal; Historical uses, production trends and future outlook for supplies. Pp 311-325. In Stickney R.R and Macvey J.P. (Eds.) *Responsible Marine Aquaculture*, CABI Publishing, New York 391 pp.

IFOMA (International Fishmeal and Fish Oil Manufacturers Association) 1999: Recovery of fishmeal and oil production continues to be slow. IFOMA News release, May 19, 1999.http://www.ifoma.com/servlet/Releases/view/ifoma?name=9941.

Javanovic. M. and Cuperlovic, M. 1977: Nutritive value of rumen contents for monogastric animals. *Anim. Feed Sci. Technol.* 2351.

Jianhua, L. 2007: Developing sustainable aquaculture industry, establishing a new order for harmonious International trade. A keynote speech at the conference (May 29th, 2007) Ministry of Agriculture, P. R.China.

Messersmith, T. L., Fulton, W. R. and Klopfenstein, T. J. 1974: Dried paunch feed as a roughage source in beef finishing rations. *J. Anim. Sci*. 39: 246-249.

New, M.B. and Wijkstrom, U.N. 2002: Use of fishmeal and fish oil in aquafeed: Further thoughts on the fishmeal trap. FAO Fisheries Circular No. 975. Rome: Food and Agriculture Organization. In: Fish to 2020 Supply and Demand in Changing Global Markets. Christopher L. Delgado, Nikolas Wada, Mark W. Rosegrant, Siet Meijer, and Mahfuzuddin Ahmed (Eds.). 226 pp.

Nwanna, L.C. 2003: Nutritional value and digestibility of shrimp head waste meal by Africa Catfish *Clarias gariepinus*. *Pak. J. of Nut*. 2 (6): 339-345. of the United Nations.

Prokop, M. J., Klopfenstein, T.J. and Messemnith, T. 1974: Blood and paunch meal in ruminant rations. *J. Anim.Sci*. 39: 250-257.

Sotolu, A.O. 2008a: Nutrient potentials of water hyacinth as a feed supplement in sustainable aquaculture: *Obeche Vol*. 26 (1), 45-51 pp.

Sotolu, A.O. 2008b: Growth performance and nutrient utilization of *Clarias gariepinus* (Burchell, 1822) fed *Leucaena leucocephala* (Lam. De Wit) seed meal-based diets. Ph.D Thesis, University of Ibadan, Ibadan, Nigeria. 157 pp + xix.

Vincke, M. 1969: Compte-render d'activite annee 1969. Division d Recherches Piscicoles, Tananarive, Madagascar.