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Full Length Research Article

PROXIMATE CARCASS COMPOSITION OF *CLARIAS GARIEPINUS* (TEUGELS) FED DIFFERENT DIETARY LEVELS OF *BAUHINIA MONANDRA* SEED MEAL

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ABSTRACT
The efficacy of soaked *Bauhinia monandra* (Kutz) seed as a replacement of dietary fish meal protein in the diet for *Clarias gariepinus* was evaluated and the cost of feed compounded or rather manufactured was also determined. The proximate analysis of the diet (crude protein, crude fibre, ash, moisture content and lipid) were determined according to Standard Methods of AOAC (1980). The analyses were conducted in triplicate and all reagents were of analytical grade. Data for each parameter were subjected to one way analysis of variance (ANOVA), while means of various results were compared at 5% level of significance. A preliminary study was conducted to determine the best processing method that reduced anti-nutrients to the minimum level without impairing nutrients composition. Boiled, toasted and soaked seeds were used. *Bauhinia* seeds soaked for 96 hours had least concentration of anti-nutrients. The experimental diets were formulated to contain soaked *Bauhinia* seed meal ($SBSM_{96}$) at levels of 0%, 25%, 50% and 75% inclusion (Diets 1, 2, 3 and 4 respectively) with two diets acting as control (Diets 1 and Diet 5). All diets were isonitrogenous (40% crude protein) and isocaloric (3212kcal/kg). A 12-week feeding trial was conducted using juveniles which were randomly distributed into 12 improvised non-recirculatory and semi-flow through indoor plastic tanks (52cm X 34cm X 33.5cm) at a stocking rate of 10 fish per tank and three (3) replicates per treatment. The experimental design was complete randomised. The fish were fed at 5% body weight, twice daily. The initial percentage composition of fish carcass was determined in relation to Crude Protein (CP), Ether Extract (EE) and Ash (ASH). The initial carcass composition for fish fed soaked *Bauhinia* seed meal ($SBSM_{96}$) were recorded as CP (56.91%), lipid (12.77%), Ash (17.08) respectively. The final fish composition indicated a general trend of increase in CP and lipid which increased significantly ($P < 0.05$). The fish carcass protein of all dietary treatments were higher than the initial carcass protein, indicating that there was synthesis and increased tissue protein production. The body fat in fish fed Diets-4 (75% $SBSM_{96}$) and Diet-5 (100% Commercial feed Alltech® Coppens) were significantly higher ($P<0.05$) than all other diets indicating enhanced production of lipids in these groups of fish. The results obtained from fish fed Soaked *Bauhinia* seed meal diets showed that fish carcass ash content decreased with increase in crude protein and lipid. The increased carcass protein in all the treatment diets indicated that *Bauhinia* seed meal has the potential of replacing fish meal. In terms of the relative costs of diets per unit weight gain and protein gain, Diet-2 (25% $SBSM_{96}$) was most economical and therefore could replace fish meal effectively without adverse effects.

Keywords: Proximate, Carcass Composition, *Clarias gariepinus*, *Bauhinia monandra*

INTRODUCTION

Research Problems

Conventionally, Fishmeal (FM) has been the major source of dietary protein in fish feed formulations and manufacture (Glencross *et al.,* 2020; Balogun, 2016, Solomon *et al.,* 2016; Balogun, 2011). The preference for fishmeal component in fish diet formulation is attributed to its high protein quality, balanced Essential Amino Acid (EAA) profile, high palatability and presence of growth indices which closely match fish requirement (Choi et al., 2022; Zaman *et al*., 2022; Abowei & Ekubo, 2011; Arunlertaree & Moolthongnoi, 2008).

In recent times, the high demand for fishmeal and its consequent astronomic cost plus scarcity has propelled many fish scientists to search for cheaper alternative protein sources (Balogun, 2011; Radhakrishman *et al.,* 2016) for its partial or full replacement through unconventional sources in order to reduce feed cost (Odetola & Eruvbetine, 2012; Mahboob, 2014; Mustafa, 2021). Seeds of leguminous origin provide a promising alternative (Olaniyi, 2009a ;2009b, Balogun, 2011; Balogun, 2016), one of such seeds is *Bauhinia monandra* (Kutz) which has potential for use in animal feed, fish inclusive, considering its crude protein content of 33.09% and balanced amino acid profile/composition (Anhwange *et al.,* 2004; 2005).

The main and specific objective of this research was to evaluate the potentials of using graded levels of *Bauhinia monandra* seed meal as alternative protein sources in the diet of juvenile *Clarias gariepinus* (Teugels), that may perhaps be cost effective.

Justification

Despite the fact that most non-conventional feedstuffs of plant origin seeds inclusive are readily available with low cost implications, their use in animal feed formulation is usually limited, due to the presence of one or more endogenous anti-nutrients (Udoessien and Ifon, 1992; Francis *et al.,* 2001; Eyo, 2003; Umar *et al.,* 2016; Tamburawa, 2010, Sogbesan *et al.,* 2006, Azaza *et al.,* 2009, Marie-Hélène *et al.,* 2017). Non reduction or destruction of these components by processing normally have adverse effects on the nutritional value of the seeds (Yusuf *et al.,* 2022). *Bauhinia monandra* plants are readily available and there is no competition between man and livestock for the seeds. The plants are found existing in most places as ornamental plants. Large quantities of *Bauhinia monandra* seeds are available during the fruiting season throughout the savannah region of Nigeria, but underutilized since they drop off to the ground from explosive dispersal from dehisced

mature pods during the fruiting season. There is no documentation regarding the use of processed seed of *B. monandra* in compounding animal diet.

Lack of comprehensive compositional data regarding essential nutrients and anti-nutrient compositions of the seed of several wild indigenous plants have limited the prospects of their utilisation as livestock feed in Nigeria. Anhwange *et al.,* (2004;2005) reported that the percentage composition of proteins, lipids, carbohydrates and fibre in *B. monandra* were 33.09, 28.70, 21.45 and 3.25 respectively. The amino acid composition in form of lysine, phenylalanine, leucine, isoleucine, methionine, valine, threonine and cysteine were 2.86, 3.77, 2.13, 2.31, 1.54, 3.54, 2.70 and 1.11g/100g protein respectively. The seed also contain 11.5mg/100g phytate, 0.32mg/100g hydrogen cyanide, 6.0% tannins and 2.05% saponins; and that based on the nutritional component of *Bauhinia* seed it offers tremendous potentials as an attractive substitute for conventional protein sources in the diet of man and his livestock provided the toxicants in the seed were adequately removed or reduced to a tolerable limit (Anhwange *et al.,* 2004; 2005).

The choice of *Clarias gariepinus* among other fish species was due to the fact that the fish species is found in nearly all fresh water bodies in Nigeria. They could be cultured in small water bodies and they also have attributes of being good converters of feed (FAO/IFAD, 1987). The fish are also cultured due to their tolerance to low dissolved oxygen, rapid growth rate, acceptability of a wide variety of food items, hardy and disease resistant, ability to spawn in captivity and respond to induced breeding (Madu, 1995; Sallenave, 2023; Adesulu, 2001; Omitoyin, 2007). The fish is in high demand, highly priced, and with high economic returns either as fresh or smoked/dried (Banyigyi *et al.,* 2001).

The main thrust of this study was therefore, to compare the mean proximate carcass composition of *Clarias gariepinus* juveniles fed unconventional *Bauhinia* Seed Meal as against a conventional commercial fish feed and to determine the suitability of *Bauhinia* Seed Meal in reducing the over-head cost of feed input.

Aim and Objective

The aim of this study is to use soaked *Bauhinia* seed meal as alternative protein sources to partially replace fish meal in the diet of *Clarias gariepinus* (Teugels) and to evaluate its effects on mean proximate carcass composition of the fish.

The specific objective of this work is to determine the mean proximate carcass composition of *Clarias gariepinus* juveniles fed with graded dietary levels of processed *Bauhinia* seed meal.

Hypothesis

The hypothesis of this work states that *Clarias gariepinus* shows the same mean proximate carcass composition when fed different levels of *Bauhinia* seed.

MATERIALS AND METHOD

Experimental Fish

Clarias gariepinus (Teugels) used in the experiment were obtained from Bagiwa farms along Funtua-Gusau road, Katsina State. Three hundred and fifty (350) *Clarias juveniles* were transported in two (50litres) containers between 0700 and 0800 hours, to an outdoor concrete tank (100cm x 150cm x 120cm) of the Department of Biological Sciences, Ahmadu Bello University, Zaria, to acclimatise for 14days prior to feeding trials.

Experimental Design

During acclimatisation, fish were fed with 42% crude protein of a commercial feed (control diet) at 5% body weight twice daily. The water temperature, pH and dissolved oxygen (D.O) were monitored following the model of Arunlertaree and Rakyuttithamkul (2006). The model range measured for physico chemical parameters in this study were temperature 19.6^{o}C-27.8^{o}C ($\bar{x}$ 23.7), pH 7.3-8.7 ($\bar{x}$ 7.65), and D.O 3.4-6.8mg/l ($\bar{x}$ 5.1mg/l). Water in the outdoor concrete tank was replaced every two days to remove nitrates, ammonia and other toxins. At the end of the acclimatisation period, the fish were introduced into non-recirculatory but flow through indoor plastic tanks (52cm x 34cm x 33.5cm). The experimental design was a complete randomized design. A total of one hundred and twenty (120) juvenile fish (mean weight 20±3g) were randomly distributed into the tanks at a stocking rate of 10 fish per tank. The twelve (12) tanks were assigned to four (4) treatments (control inclusive) at the rate of one treatment per experimental diet with three (3) replicates per treatment.

Experimental Diet

Bauhinia Seed Meal ($SBSM_{96}$) soaked for 96 hours in water medium was used as protein source that progressively replaced fish meal on an isonitrogenous (40% CP) and isocaloric (3212Kcal/Kg) basis at graded inclusion levels of 0% ($SBSM_{96}$), 25% ($SBSM_{96}$), 50% ($SBSM_{96}$) and 75% ($SBSM_{96}$) in the ration formulated. A fifth ration comprised of the Commercial fish diet Alltech® Coppens which served as the reference diet (Table 1)

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Table 1: Gross Composition of Experimental Diets (%)

Ingredients	Dietary treatments: Soaked *Bauhinia* Seed Meal Replacement Levels SBSM$_{96}$ (%) 0% (Control Diet)	25%	50%	75%	Reference Diet 100% Commercial Feed
(Alltech® Coppens)					
Maize	25	18	8	3	
Soyacake	12	21	31.65	37.25	
Wheat offal	5.95	3.75	1	-	
Palm oil	4.0	3.20	5.0	5.0	
Bone meal	1	1	1	1	
Cassava	2	2	2	2	
Fish meal	44	33	22	11	
Bauhinia	0	11	22	33	
Salt	0.3	0.3	0.3	0.3	
Premix	0.25	0.25	0.25	0.25	
DL-Methionine	2.0	2.2	2.4	2.6	
Lysine	3.5	4.0	4.4	4.8	
Total	**100**	**100**	**100**	**100**	
Calculated nutrient composition analysis					
Crude Protein %	40.00	40.00	40.00	40.00	
Metabolizable Energy (Kcal/Kg)	3212	3208	3209	3206	
Ether Extract %	4.69	4.50	4.88	5.01	
Crude Fibre %	2.52	2.59	2.81	3.11	
Calcium %	1.82	1.68	1.77	1.80	
Phosphorus %	1.27	1.17	1.01	1.12	
Lysine %	5.09	5.01	5.11	5.09	
DL-Methionine %	3.05	3.04	3.04	3.02	
Feed Cost ₦/Kg	119.51	114.23	110.08	105.18	320

Composition per 25kg of Bio premix is Vitamin A 4,000iu; Vitamin D 800,000iu; Vitamin E1 500mg; Niacin 10,000mg; Panthotenic acid 3,500mg; Biotin 15mg; Vitamin B 10mg; Folic acid 200mg; Chloric chloride 130,000mg; Manganese 60,000mg; Iron 15,000mg; Zinc 15,000mg; Copper 800mg; Iodine 400mg; Cobalt, 80mg; Selenium 400mg; Antioxidant 40,000mg.
All vitamins and minerals included in the composition met the NRC (1993) recommendations.

Fish Sampling
The total weight of fish per tank was determined immediately after acclimatisation using an electronic top-loading Mettler Toledo PB3002-S Precision Balance with a maximum capacity of 3100g along with a readability/sensibility of 0.01g. Fish were weighed biweekly until the experiment terminated. The biweekly weighing allowed for adjustment of feeding levels for the subsequent weeks.

Physicochemical Parameters of Water
Water temperature and pH were measured weekly using HANNA Combo pH/EC/TDS/C/PPM Tester Model: HI-98129 and HI-987130 respectively, while dissolved oxygen (DO) was measured using test kit (HANNA instruments model: HI-3810). Unconsumed diets and faecal matter were siphoned off daily using an aquatic gravel vacuum.

Biochemical Analyses of Feed and Fish Sample
Prior to the onset of the experiment, the proximate analysis of feed samples were determined using AOAC method (1980). On completion of the experiment, eviscerated whole carcasses of the entire fish population per tank/treatment were collected, dried and ground into fine powder, subjected to proximate analysis. The AOAC (1980) method was used to determine moisture content, ash, lipid and crude fibre while nitrogen/crude protein contents of the samples were determined as described by Pearson (1976).

Fish Feed and Feeding
Fish were fed twice daily (manually) at 5% total biomass per treatment for 12 weeks

Statistical Analysis
Data obtained were pooled and subjected to one way analysis of variance (ANOVA) at 5% level of probability. Least Significant Difference (LSD) was used to compare the means.

RESULTS

Mean Proximate Composition of Soaked Bauhinia Seed Meal
There was no significant difference in the mean crude protein values in soaked *Bauhinia* seed meal diets. The crude protein content of Diet-5 (42.09%) was significantly higher ($P<0.05$) than diets 1, 2, 3 and 4 which gave 40.00%, 40.15%, 39.60%, and 39.57% respectively. (Table 2)

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Table 2: Mean proximate composition of soaked *Bauhinia* seed meal diet

Proximate Composition (%)	Diets				
	0%SBSM$_{96}$	25%SBSM$_{96}$	50%SBSM$_{96}$	75%SBSM$_{96}$	100% Commercial Feed (Alltech® Coppens)
Dry matter (DM)	93.89	93.04	93.77	93.94	93.79
Ash (ASH)	4.90	4.08	4.38	3.89	5.85
Crude protein (CP)	40.00^{b}	40.15^{b}	39.60^{b}	39.57^{b}	42.09^{a}
Ether Extract (EE)	8.67	8.11	8.51	8.72	8.99
Crude fibre (CF)	2.16	4.09	4.14	4.15	2.50
Nitrogen free extract (NFE)	38.16	36.61	37.14	37.61	34.36
SED±	0.008	0.006	0.004	0.004	0.010
LSD (P<0.05)	0.026	0.024	0.022	0.023	0.028

Values with the same superscripts in the same row are not significantly different (P > 0.05) LSD.
Key: LSD= Least Significant Difference, SED = Standard Error of Difference, SBSM$_{96}$ = Soaked *Bauhinia* Seed Meal

The initial percentage composition of fish carcass was determined in relation to CP, EE and Ash. The initial carcass composition for fish fed soaked Bauhinia seed meal (SBSM$_{96}$) were recorded as CP (56.91%), lipid (12.77%), Ash (17.08) respectively. The final fish composition indicated a general trend of increase in CP and lipid which increased significantly (P < 0.05). These trends were similar to that obtained in fish fed locust meal with the exception of Ash content which had no particular trend in fish fed Bauhinia seed meal and Locust meal diets (Table 3).
The final fish carcass composition indicated that CP increased in all the diets compared to the initial carcass value (56.91%) of all the treatments. There were significant differences (P<0.05) in the protein contents of the fish fed the five diets. Diet-1 was highest 69.02% followed by Diet-5 (67.88%), Diet-2 (67.60%), Diet-3 (66.74%) and Diet-4 (62.16%) respectively.
The percentage lipid content of all the treatment groups were significantly higher (P< 0.05) than the initial lipid content (12.77%). There were significant differences (P<0.05) in the lipid contents of the fish fed experimental diets. The highest lipid content was recorded in Diet-5 (15.01%) followed by Diet-4 (14.65%), Diet-3 (14.58%), Diet-1 (13.89%) respectively. The least was in Diet-2 (13.62%).
The percentage Ash content of the initial carcass was higher (17.08%) than the final carcass contents in all the experimental diets. There were significant differences (P<0.05) in percentage ash content of the fish fed the five diets. The highest Ash content was recorded in Diet-5 (16.50%), Diet-1 (16.39%), Diet-2 (16.01%), Diet-3 (15.07%) the least ash content was obtained in Diet-4 (14.83%). It decreased in all the diets with the exception of Diet-5.

Table 3: Mean carcass composition (%) of *Clarias gariepinus* fed graded levels of soaked *Bauhinia* seed meal

Diets	Parameters (%) Ash	Crude Protein (CP)	Ether Extract (EE)
Initial composition	17.08^{a}	56.91^{f}	12.77^{f}
0%SBSM$_{96}$	16.39^{c}	69.02^{a}	13.89^{d}
25%SBSM$_{96}$	16.01^{d}	67.60^{c}	13.62^{e}
50%SBSM$_{96}$	15.07^{e}	66.74^{d}	14.58^{c}
75%SBSM$_{96}$	14.83^{f}	62.16^{e}	14.65^{b}
100% Commercial FeedAlltech® Coppens	16.50^{b}	67.88^{b}	15.01^{a}
SED ±	0.016	0.019	0.014
LSD(P<0.05)	0.039	0.049	0.035

Values with the same superscripts in the same column are not significantly different (P > 0.05) LSD.
Key: LSD= Least Significant Difference, SED = Standard Error of Difference, SBSM$_{96}$ = Soaked *Bauhinia* Seed Meal

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Least Cost Analysis, Economy of Weight Gain (EWG) and Economy of Protein Gain (EPG)

Table 4: Economy of Weight Gain and Protein Gain

Parameters	Diet-1 0%SBSM$_{96}$	Diet-2 25%SBSM$_{96}$	Diet-3 50%SBSM$_{96}$	Diet-4 75%SBSM$_{96}$	Diet-5 100% Commercial Feed Alltech® Coppens
Cost/ ₦/kg of experimental diet	119.51^{b}	114.23^{c}	110.08^{d}	105.18^{e}	320.00^{a}
Cost of feed ₦/unit weight gain (g)	1.91^{a}	5.39^{c}	8.79^{e}	8.64^{d}	4.40^{b}
Cost of feed ₦/unit protein gain (g)	9.87^{a}	16.87^{b}	9.90^{a}	47.81^{d}	29.30^{c}
SED±	0.006	0.007	0.017	0.011	0.073
LSD (P<0.05)	0.019	0.021	0.050	0.030	0.205

Values with the same superscripts in the same row are not significantly different (P > 0.05) LSD.
Key: LSD= Least Significant Difference, SED = Standard Error of Difference, SBSM$_{96}$ = Soaked *Bauhinia* Seed Meal

Diet-4 had the least production cost of ₦105.18/kg followed by Diet-3 with ₦110.08 and Diet-2 with ₦114.23. The most expensive diets were the reference and control diets which had ₦320.00 and ₦119.51/kg as production costs respectively (Table 4).

Diet-1 had the least and best EWG value of ₦1.91 followed by Diet-5 (reference diet) 100% Commercial Feed Alltech® Coppens (₦4.40) and Diet- 2 (₦5.39) respectively. The most uneconomical diets were Diet-3 (₦8.79) and Diet-4 (₦8.64) (Table 4).
In terms of economy of protein gain Diet-1 (₦9.87) and Diet-3 (₦9.90) were the most economical followed by Diet-2 which had EPG value of ₦16.87 (Table 4). The most uneconomical diet was Diet-4 followed by Diet-5, the reference diet.

DISCUSSION

The mean proximate composition of the experimental diets obtained from the laboratory analysis is at variance with that of the computer calculated report of this same study which gave a 40% CP for all the diets as desired implying that there was no significant difference (P>0.05) among the diets. However, between treatments there was significant difference (P<0.05) in mean proximate composition of experimental diets in relation to the 40% CP, the experimental diets of this study ranged between 39.57% and 40.15% which is within the acceptable range of ±2, standard variation in such types of prepared feeds (Agboola, 2004). According to Lall (1991) and Fasakin *et al.* (1998) linear programming offers considerable potential in the development of "least cost formulation" of fish feed. However, wide fluctuations occur in the composition of feeds ingredients due to seasonal and geographic variations, thus formulation should be modified accordingly since physical characteristics, milling and composition of the feed ingredients may have significant effect on the processing and quality of finished feed.
The crude lipid content of the diets ranged between 8.11 and 8.99 %, this value is within the acceptable standard lipid requirement of most tropical fishes (Adikwu, 2003).
The result of the carcass composition after feeding trial experiment indicated that crude protein values of all the diet treatments were significantly higher than the initial CP (P<0.05). Nwanna and Bolarinwa (2001) indicated that the crude protein and lipid contents of the African catfish increased after feeding trials. It also agrees with the findings of Arunlertaree and Moolthongnoi (2008) who reported that final protein in experimental fish carcass was related to the percentage of lipid content in carcass. The fish carcass protein of all dietary treatments were higher than the initial carcass protein, indicating that there was synthesis and increased tissue protein production, thus the growth of fish was not due to increase in weight only as reported by Fuller (1969); Ipinloju and Faturoti (1999) and Banyigyi *et al*. (2001). Fish fed the control diets (Diet-1, 100% fish meal and Diet-5, 100% Commercial Feed Alltech® Coppens) had significantly (P<0.05) higher carcass protein (69.02% and 67.88% respectively) than those fed the experimental diets containing graded levels of soaked *Bauhinia* seed meal which indicated that the control diets were superior in terms of crude protein due to their relatively high amino acid profile.

The lipid profile (ether extract) in fish fed Diets-4 (25 fish meal and 75% soaked *Bauhinia* seed meal) and Diet-5 (100% Commercial Feed Alltech® Coppens) were significantly higher (P<0.05) than all other diets indicating enhanced production of lipids in these groups of fish. Lipid has been associated with increased efficiency of metabolism (Aderolu *et al.,* 2010).

The results obtained from fish fed on Soaked *Bauhinia* seed meal diets showed that fish carcass ash content decreased with increase in crude protein and lipid. Nwanna and Bolarinwa (2001) reported that ash and moisture contents of African catfish decreased after feeding trials while the crude protein and lipid contents increased. The ash content of the control diets which were however significantly higher(P<0.05) than the experimental diets imply higher retention of ash which could be attributed to high efficiency and high nutrient contents associated with fish meal. Since the commercially formulated diets also have been noted for established high nutritive composition (ash inclusive) the high ash retention values obtained in the groups of fish fed the control diets is expected. In terms of relative cost of feed per unit of biomass yield, Diet-2 (25% *Bauhinia* seed meal) was the most economical. However, in terms of economy of protein gain Diet-3 (50% *Bauhinia* seed meal) was the most economical followed by Diet-2 (25% *Bauhinia* seed meal), which was the cheapest. The increased carcass protein in all the treatment diets indicated that Bauhinia seed meal has the potential of replacing fish meal in the diet of

Clarias gariepinus (Teugels) with particular reference to 25% and 50% Soaked *Bauhinia* Seed Meal inclusion levels.

Conclusion and Recommendations

The increase carcass protein in all treatment diets indicated that *Bauhinia* seed meal has the potential of replacing fishmeal in the diet of *Clarias gariepinus.* The present study has therefore shown that replacement of fish meal with between 25-50% Soaked *Bauhinia* seed meal ($SBSM_{96}$) can be recommended for optimal protein synthesis in *Clarias gariepinus* in situations where fishmeal is expensive and not readily available.

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