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PERFORMANCE CHARACTERISTICS AND NUTRIENTS UTILIZATION OF AFRICAN CAT FISH FED TERMITE BASED DIETS

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Abstract: Achieving a sustainable aquaculture depends on the availability of costless or priceless feeds. Therefore, this study determined the optimal dietary level of replacing fish meal with Termite meal in the nutrition of African cat fish.
Six diets (D) containing varying levels (0% - D1, 10% -D2, 20% - D3, 30% -D4, 40% D5, 50% -D6) of Termite meals (*Macrotermes subhyalinus*), were fed to African catfish for the period twelve weeks and the following growth parameters such as mean weight gain (MWG), Specific growth rate (SGR), Percentage mean weight gain (%MWG), and nutrient utilization parameters such as feed conversion ratio (FCR), Protein efficiency ratio (PER) were determined.
The highest MWG, was recorded for Diet 5,(12.83%). The least MWG were shown by diet 4, (7.02%), The highest (%MWG), was recorded for Diet 5(25.09%), and the least were shown by Diet 4,(13.74%), Diet4 had the highest SGR (0.63%), and the least were shown by Diet 2(0.1%), However, diet 5 had the least FCR (1.92%), and the highest was shown in Diet 2,(5.38%) and the highest PER of(0.33%), was recorded for diet 5, while the least was shown by Diet 4,(0.18%).
The carcass composition of the experimental fish after the experiment showed the fish carcass for treatment 5 to be the best. An increase in crude protein of fish carcass at the end of the feeding period were recorded (61.2%), for treatment 1, treatment 2 (62.8%), treatment 3 (63.3%), treatment 4 (61.1%), treatment 5 (64.3%), and treatment 6 has carcass crude protein of (62.9%).
This study had actually shown that termite meal is very rich in nutrient and it can replace up to 40% fish meal in the diet of *Clarias gariepinus.* Therefore, Termite meal can support better growth and profit maximization if included in the diets of *Clarias gariepinus* at 40% without any adverse effect on the fish.
Keywords: dietary level, *Clarias gariepinus,* performance, nutrient, and winged termite.

Introduction

Recently, an unprecedental increase in the world population occurred, it stands at 6.4 billion. Although, a greater increase is expected from developing countries (FAO, 1993). Today, Nigeria population is 187,262,466 (Worldometer, 2015). Indirectly this uncontrolled population size will result to increase in demand for animal protein sources in man and

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animal (pig, poultry and fish) feed. In aquaculture a lot of protein is required to attain a marketable size within a short period. Therefore, to have a sustainable aquaculture, it is imperative for the fish farmers and researchers to exploit alternative sources of protein that are cheaper and not commonly used by man. Most researches on the use of plant protein sources (Mucuna seed meal Siddhuraju and Becker,(2001); potato leaf meal Olaniyi *et al*., (2010) have shown that the plant can only be used partially in the fish diet due to lesser quality of its protein compared with animal protein source. Fish meal is a conventional good source of animal protein and it is mostly used for fish feed due to its high quality balanced amino acid, vitamins, and mineral content, and because it is palatable and enhances growth (Davis and Arnold, 2000). However, the upsurge in price and limited supply of fish meal has discouraged its use in fish diets. Although, there are many reports on the use of other animal protein sources such as maggot meal Olaniyi and Salau (2013); Sogbesan *et al*., (2005), poultry dung meal Fasakin *et al*. (2000); Tadpole meal Ayinla *et al*.(1994). According to Teguia and Beynen, (2005) insects dominate the world population particularly the tropics. Insects are rich in protein, easy to come by and surplus during the raining season. Termites (*Macrotermes species*) are social insects that are commonly found at the onset of rainy season or after heavy rainfall, particularly during their breeding period termed as swarming or nuptial flight, they come out in large quantities to the extent that most are wasted and some are eaten up by toads. They make up to 95% of the soil insect biomass in lowland tropical rainforests (Donovan *et al.,* 2007). Termite is very rich in protein, very palatable, mostly consumed by man and other animals (Madu *et al.,* 2013). Ugwumba *et al.,* (2008) also reported crude protein content of 46.3% in termites. They are collected from the ground after they have shed their wings and then roasted for consumption (Banjo *et al*., 2007). This study therefore investigate the level to which termite can replace fish meal and the growth performance of African catfish fed termite meal.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the fisheries unit of Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria.

Collection and Processing of the Test Ingredient (Winged Termite)

Termites normally swarm seasonally especially at the unset of raining season or after the unset of a heavy rainfall. Ray of light of light is one of the major factors that influence their movement most especially bright electricity light.

The winged termites were collected from some specific areas where there is constant electricity at night, around LAUTECH main gate and Adenike area in Ogbomoso. After collection, they were submerged inside water, dirt and other foreign body were removed, then the termites were poured in a plastic sieve to drain out water oven dried at temperature of 180^0C to for easy wing removal. The wings were blown away and sundried prior milling.

Excess oil was extracted from the milled termite with the use of a cloth sieve. The sieve was used to ensure the removal of oil only from the milled Termite. The remaining portion of the termite was kept in an air tight container until it was needed.

Experimental Diets

Feed ingredients were purchased from a feed ingredient store in Ogbomoso. The major feed ingredients used were yellow maize, wheat offal, fish meal, groundnut cake (GNC), blood meal, bone meal, lysine, methionine, oyster shell and salt. Six experimental diets (D) with varying levels of termite meal were formulated: D1 contain 0% of extracted termite meal (control), Dt2 (10% extracted termite meal), D3 (20% extracted termite meal), D4 (30% extracted termite meal), D5 (40% extracted termite meal), D6 (50% extracted termite meal)**.**

The feed were made into pellets using pelleting machine of 3mm Die. The pellets were sundried for three days to reduce the moisture content and to prevent moulding. The feed were packed into six different polythene bags respectively.

Table 1: Gross Composition of the Experimental Diets (%)

PARAMETERS	Control 0%	TI 10%	T2 20%	T3 30%	T4 40%	T5 50%
Yellow maize	27.46	26.46	26.46	25.46	25.46	24.46
Wheat offal	9.15	8.95	8.65	8.65	7.65	7.55
Fish meal	26.95	26.95	23.96	20.96	17.97	14.98
Termite meal	-	3.00	5.99	8.99	11.98	14.98
Groundnut cake	19.96	21.16	20.46	21.46	21.96	22.96
Blood meal	9.98	9.98	10.98	11.80	11.48	11.48
Bone meal	1.60	1.60	1.60	1.60	1.60	1.60
Lysin	1.00	1.00	1.00	1.00	1.00	1.00
Methionine	0.50	0.50	0.50	0.50	0.50	0.50
Oyster shell	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.05	0.05	0.05	0.05	0.05	0.05
Total	100.00	100.00	100.00	100.00	100.00	100.00
Crude protein (%)	39.46	39.89	39.80	39.75	39.54	39.50

EXPERIMENTAL PROCEDURE

A total of two hundred and twenty African Catfish (*Clarias gariepinus*) fingerlings were procured from a reputable fish farm and randomly allotted to six treatments at the rate of fifteen fingerlings in 50litre tank and replicated two times. The fishes were acclimatized for two weeks prior the commencement of the experiment during which they were fed commercial floating feed to empty their gut in readiness for the experiment.

After acclimatization period, the fishes were fed experimental diets, 3% of their body weight, twice daily at 7hours and 16hours (morning and evening).The water in the fish tanks were changed every 4days with aerated, clean water. The water were also siphoned to get rid of dirt and waste feed.

Weighing

Fish were weighted every two weeks using digital weighing balance (ACCULAB) records of the fish were taken and feeding were adjusted

Growth Performance and Nutrient Utilization

The growth performance and nutrient utilization of the fish were determined by the following indices.

Mean weight – this is expressed as; MW =Total weight / No of fish

Mean Weight Gain (MWG) = FMW – IMW

Where, IMW= initial weight gain, FMW = final weight gain

Percentage Weight gain: PMW (%) = mean weight (g) / initial weight x 100

Mean weight gain /day (mg) = MWG / No of days

Specific growth rate (SGR) = Log e FMW –Log e IMW / Experimental period in days X100

Total feed intake (TFI) = 3/100 X weight of fish X weight of feed (fed daily) X no of days

Average Feed Intake (AFI) = TFI/ Fish stocked / Experimental periods

Feed Conversion Ratio (FCR) = Average feed intake (g) / Mean weight gain (g).

Protein Intake (PI) = Total feed consumed X protein in feed /100

Protein Efficiency Ratio (PER) = MWG/ PI

Gross Feed Conversion Efficiency (GFCR) % = 1 / FCR X 100

Chemical Analysis

At the end of the experiment, six experimental diets and carcass of the fish from the six treatments were analysed for proximate composition according to the method of A.O.A.C, (2001).

Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) using completely randomised design (CRD) SPSS computer package (Field,2000), means were separated by Duncan's option of the same statistical package (Duncan 1955).

Results

The proximate composition and Energy level of non -extracted termite is shown in Table 2. They were as follows: the crude protein content is 42.03%, Crude fat is 34.00%, Moisture is 3.53%, Crude fibre is 10.87%, Ash is 3.30%, and the energy present is 4555.71Kcal.

Also, the proximate composition and Energy level of extracted termite is shown in Table 3 The extracted termite were also analysed and the Crude protein content is 47.46%, Crude fat is 31.93%, Moisture content is 5.52%, Chitin is 8.24%, Ash is 3.69%, and energy present is 44.78.49Kcal.It is evident from this table that when excess oil is being extracted from termites, it results in excellent increase in its nutritional values.

The Growth performance and feed utilization of *Clarias gariepinus* fingerlings fed diet containing varying inclusion levels of extracted termite meal is shown in table 4.

Initial weight was highest ($p>0.05$) in T_1 (11.17), T_3 (11.17) and T_6 (11.17) while the least ($p<0.05$) value (11.16) was observed in T_2, T_4 and T_5. Final weight was significantly ($p<0.05$) highest in T_5 (21.96) while the least value (17.22) was observed in T_2. Mean weight gain was significantly ($p<0.05$) highest in T_5 (10.80) while the least value (6.06) was observed in T_2. Weight was significantly ($p<0.05$) highest in T_5 (96.77) while the least value (54.30) was observed in T_2. Daily Mean Weight gain was significantly ($p<0.05$) highest in T_5 (0.154) while the least value (0.087) was observed in T_2.

Specific growth rate was highest ($p>0.05$) in T_5 (0.0041) while the least ($p<0.05$) value (0.0027) were observed in T_1 and T_2. Total feed intake was significantly ($p<0.05$) highest in T_5 (320.57) while the least value (154.88) was observed in T_6. Average feed intake was highest ($p>0.05$) in T_4 (21.37) and T_5 (21.37) while the least ($p<0.05$) value (18.99) were observed in T_1 and T_2. Feed conversion ratio was significantly ($p<0.05$) highest in T_2 (3.13) while the least value (1.98) was observed in T_5.

Protein intake was significantly ($p<0.05$) highest in T_4 (8.49) while the least (7.49) was observed in T_1.Gross feed conversion efficiency was significantly ($p<0.05$) highest in T_5 (50.51) while the least value (31.98) was observed in T_2. Protein efficiency ratio was significantly ($p<0.05$) highest in T_5 (1.28) while the least (0.75^e) was observed in T_3.

Proximate Carcass Composition of *Clariasgariepinus* sample before and after the feeding trials is shown in Table 5.

The moisture contents of the *Clarias gariepinus* carcass was recorded to be highest in value (9.40%) in T_2, followed insignificantly by 9.33% of T_1 (initial) while the least ($p>0.05$) value (8.67%) was observed in T_7.

Crude protein (%) ranged from 61.80 to 68.17 with T_4 having the highest ($p<0.05$) value while the least ($p<0.05$) value was significantly noted in T_1 (61.80%).

The EE% was observed higher ($p<0.05$) in T_1(13.10%), followed significantly by T_4(6.70%) which was similar ($p>0.05$) to T_5 (6.50%) and T_7 (6.43%). The least value (5.53%) was recorded in T_2 which was similar ($p>0.05$) to 5.60% observed in T_3.

Ash content (%) was higher ($p<0.05$) in T_2 (18.80%) followed by 17.87% of T_3 while the least ($p<0.05$) value (15.77%) was noted in T_1.

Table 2. The proximate composition and energy level of non-extracted termite.

PARAMETRES	%
PROTIEN	42.03
FAT	34.00
MOISTURE	3.53
CHITIN	10.87
ASH	3.30
ENERGY	4555.71 Kcal

Table 3. The proximate composition and energy level of extracted termite.

PARAMETRES	%
ROTIEN	47.46
FAT	31.93
MOISTURE	5.52
CHITIN	8.24
ASH	3.69
ENERGY	4478.49 Kcal/Kg

Table 4. Growth performance and Feed utilization of *Clarias gariepinus* fingerlings fed diet containing varying inclusion levels of extracted termite meal.

PARAMETERS	T1 0%	T2(10%)	T3 20%)	T4(30%)	T5(40%)	T6(50%)	SEM
Initial weight (g)	11.17^{a}	11.16^{b}	11.17^{a}	11.16^{b}	11.16^{b}	11.17^{a}	0.0005
Final weight(g)	17.42^{e}	17.22^{f}	18.76^{d}	20.66^{b}	21.96^{a}	20.34^{c}	0.145
Mean weight(g)	6.25^{e}	6.06^{f}	7.59^{d}	9.50^{b}	10.80^{a}	9.17^{c}	0.145
%MWG (g)	55.95^{e}	54.30^{f}	67.95^{d}	85.13^{b}	96.77^{a}	82.09^{c}	1.303
MWG/day(g)	0.089^{e}	0.087^{f}	0.108^{d}	0.136^{b}	0.154^{a}	0.131^{c}	0.002

SGR(g)	0.0027	0.0027	0.0031	0.0039	0.0041	0.0037	0.0002
TFI(g)	284.85^{d}	284.80^{e}	302.62^{c}	320.55^{b}	320.57^{a}	154.88^{f}	4.764
AFI (g)	18.99^{d}	18.99^{d}	20.17^{c}	21.37^{a}	21.37^{a}	20.65^{b}	0.083
FCR	3.04^{b}	3.13^{a}	2.66^{c}	2.45^{e}	1.98^{f}	2.52^{d}	0.032
PI	7.49^{f}	7.56^{e}	8.05^{d}	8.45^{b}	8.49^{a}	8.16^{c}	0.033
PER	0.83^{d}	1.00^{c}	0.75^{e}	1.12^{b}	1.28^{a}	1.12^{b}	0.034
GFCE	32.89^{e}	31.98^{f}	37.59^{d}	40.82^{b}	50.51^{a}	39.68^{c}	0.51

Mean within the row with difference superscripts are significantly different ($p<0.05$)
PMWG:- Percentage mean weight gain, MWG/day:- Mean weight gain / day, SGR:- Specific growth rate, TFI:- Total feed intake, AFI:- Average feed intake, FCR:- Feed conversion ratio PI:- Protein intake, PER; Protein efficiency ratio.

Table 5. Proximate Carcass Composition (% dry weight basis) of *Clarias gariepinus* sample before and after the feeding trials.

PARAMETERS	Initial	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	SEM
MC (%)	9.33^{a}	9.40^{a}	$8.83cd^{cd}$ 8.80^{cd}		9.23^{ab}	9.03^{bc}	8.67^{d}	0.05
CP (%)	61.80^{e}	66.27^{d}	67.70^{b}	68.17^{a}	67.70^{c}	67.83^{b}	67.70^{b}	0.46
EE (%)	13.10^{a}	5.53^{d}	5.60^{d}	6.70^{b}	6.50^{bc}	6.23^{c}	6.43^{bc}	0.55
ASH (%)	15.77^{f}	18.80^{a}	17.87^{b}	16.33^{e}	16.93^{d}	16.90^{d}	17.23^{c}	0.12
CF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CARBOHYDRATES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Meanwithin the rows with difference superscripts are significantly different ($p<0.05$).
M=Moisture content (%), CP= Crude protein (%), EE= Ether extract (%), CF = Crude fibre, Carbohydrates (by difference)

DISCUSSION

The crude protein of extracted termite meal in this work is 47%, higher than 37% and 44% reported by Aduku (1993) but lower than 48% as reported by Fadiyimu *et al*. (2003) for *Macrotermites* species but higher than the result (46.30%) obtained by Tiroesele and Moreki (2012) The increment in the value may be as a result of the extraction of oil which contributes to the increase in protein.

Termite meal is poor in mineral composition, this result is in accordance with the report of Barker et al. (1998) that insects are low in major mineral compositions most especially phosphorus.

Lipid content, fibre and ash content of the termite used in this research are 31.93, 8.24 and 3.69% respectively which is higher compared to that of Tiroesele and Moreki, (2012) 30.1,

7.3 and 3.6% respectively. This in an indication that when excess oil is being extracted from termite this contribute more to the increase in lipid, fibre and ash content.

The results observed from the growth performance considering: Mean weight gain, percentage mean weight gain and specific growth rate, showed that the best growth response was achieved at 40% extracted termite meal inclusion level (Trt 5), this disagree with Sogbesan and Ugwumba (2008). Fish fed 40% extracted termite meal inclusion level (Trt 5) recorded the lowest feed conversion ratio (1.98). All the six treatments were accepted and utilize by the fingerlings with the highest total feed intake observed in Trt 5 (40% extracted termite meal while Trt 6 (50%) shows the lowest value. This is an indication of better feed utilization by converting the feed to flesh by the fish. De Silver and Anderson (1995) reported that protein efficiency ratio is a measurement of how well the protein sources could provide the essential amino acids requirement of the fish fed.

The Crude protein content of the fish at the feeding trials. Carcass of fish sample fed 20% termite meal (Trt3) had the highest crude protein content (68.17%) while the least were observed in the initial carcass (61.80%). Moisture content were high at the Initial carcass and T1(0%) fish fed extracted meal (9.33% and 9.40%) , while the least values were observed in Trt 6 (50%) 8.67%. The ether extract in the Initial carcass shows the highest value (13.10%), while the least value was recorded in Trt 1and 2 (5.53% and 5.60%). The highest value of Ash content was recorded in Trt1 (18.80%), while the least value were recorded at the Initial. The Crude fibre and Carbohydrates shows no value in all treatments including the Initial carcass. This means that fishes performed better with the experimental diets than fish fed the commercial floating feed.

CONCLUSION

From the result obtained, diet 5 (40% extracted termite) has the best performance in terms of Mean weight gain, Percentage weight gain, Specific growth rate, Average feed intake, Gross feed conversion efficiency. These revealed that extracted termite meal will best replace fish meal at 40% in the diet of *Clarias gariepinus* without any adverse effect.

RECOMMENDATION

Therefore, it is advisable for fish farmers to include extracted termite meal up to 40% in the diets of *Clarias gariepinus* fingerlings. This will enhance the optimum growth of catfish and profit maximization for the fish farmers.

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