

## Effect of Dietary Inclusion of Fermented *Mucuna pruriens* Leaf Meal on Growth and Feed Utilisation of *Clarias gariepinus* Fingerlings

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### Authors' contributions

This work was carried out in collaboration between all authors. Author RI designed the study, monitored data collection for the whole trial, performed the statistical analysis, interpretation of data, wrote the protocol and wrote the first draft of the manuscript. Authors PIB and JAA managed the literature searches and critical revision of the manuscript. All authors read and approved the final manuscript.

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### ABSTRACT

Feeding trial was conducted in 18 plastic tanks (60 x 45 x 30 cm) to assess the performance of *Clarias gariepinus* fingerlings fed diets containing fermented *Mucuna pruriens* leaf meal as an alternative protein source to soya bean meal. Five isonitrogenous (crude protein-40%) diets were formulated containing fermented *Mucuna* leaf meal (FMLM) at A<sub>(100% FMLM)</sub>, B<sub>(75% FMLM)</sub>, C<sub>(50% FMLM)</sub>, D<sub>(25% FMLM)</sub> and E<sub>(0% FMLM)</sub> and were fed at 5% body weight to triplicate groups of 10 fingerlings (initial mean weight ranged from 6.20± 1.96g – 6.80± 1.97 g) of *C. gariepinus* for a period of twelve (12) weeks. Growth performance and feed utilisation parameters indicate that E<sub>(0% FMLM)</sub> diet gave the highest weight gain (168.87± 3.97g) but did not significantly (P≥0.05) differ from D<sub>(25% FMLM)</sub>.

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(161.30±6.12 g), and the lowest weight gain (89.70± 1.96 g) was recorded in A<sub>(100% FMLM)</sub>. Similarly, the highest specific growth rate (3.79±0.03 g) was recorded in E<sub>(0% FMLM)</sub> followed by D<sub>(25% FMLM)</sub> (3.74±0.04 g), and the least value (3.10±0.02 g) was obtained in A<sub>(100% FMLM)</sub>. However, feed conversion ratio (FCR), protein efficiency ratio (PER) and gross feed conversion efficiency (GFCE) were not significantly different (P≥0.05) among the dietary treatments. The highest (1.72±0.12) and least (1.50±0.02) FCR were obtained in A<sub>(100% FMLM)</sub> and E<sub>(0% FMLM)</sub> respectively. The result from this study indicates that fermented *Mucuna* leaf meal could replace soya bean meal up to 25% in the diets for *C. gariepinus* fingerlings without compromising growth and feed utilisation.

**Keywords:** Fermented *Mucuna* leaf meal; *Clarias gariepinus*; soya bean meal.

## 1. INTRODUCTION

Some of the most popularly cultured fish species in Nigeria and other parts of Africa are the *Clarias gariepinus* and *Heterobranchus bidorsalis* which are members of the catfish family (family: *Clariidae*) [1,2]. The Clariids exhibit many qualities which make them suitable for culture; these include fast growth rate, high resistance to disease, tolerance to adverse environmental conditions, ability to feed on wide range of feed and capacity to withstand low pH and oxygen [3]. It also has a high feed efficiency and utilisation [4].

The intensive production of farmed fish with compound feeds has been largely increased mainly due to the growth of aquaculture production, and also because it is the most efficient way of production to meet the fish demand [5]. Feed is a significant factor in increasing the productivity and profitability of aquaculture. Feed determines the viability of fish farming as it accounts for about 60 and 62% of the total production cost [6,7]. Protein component represents about 50% of the feed cost in intensive culture [8]. Therefore, the selection of proper quantity and quality of dietary proteins is a necessary tool for successful fish culture practices.

Soya bean is widely used in conventional intensive animal feeding systems because of its known high protein content (38-42%), good amino acid balance and digestibility [9]. The increasing demand, price, competitions with human needs and its use in other animal feeds of soya bean has emphasised the need for alternative protein sources in aquafeeds. It has, therefore, become vital to search for an alternative that is not in direct competition with human and other animals.

*Mucuna pruriens* belongs to the family Fabaceae and has been described as a multipurpose plant

which is used extensively both for its nutritional and medicinal properties [10]. Ibrahim et al. [11] has reported the information on the effects of different processing methods on the proximate and anti-nutritional contents of *M. pruriens* leaf meal, and concluded that fermented *M. pruriens* leaf meal has a potential to be utilised as a source of protein and energy for animals. There is, however, no information on the utilisation of fermented *M. pruriens* leaf meal in the diets of *Clarias gariepinus* fingerlings. Therefore, this research aims to evaluate the effect of dietary inclusion levels of fermented *M. pruriens* leaf meal on growth performance and feed utilisation of *Clarias gariepinus* fingerlings.

## 2. MATERIALS AND METHODS

### 2.1 Feed Stuff and Feed Formulation

The feed ingredients used in the experiment composed of fish meal (Clupeid), Soya bean meal, fermented *Mucuna pruriens* leaf meal, yellow maize, bone meal, palm oil, salt, vitamin premix, methionine and lysine. All the dietary ingredients were separately processed and milled to fine particle size.

One kilogram of *Mucuna pruriens* leaves was fermented (FMLM) with 2 grams of yeast (*Saccharomyces cerevisiae*) in an airtight container for 72 hours at room temperature according to the method reported by Padmavathy and Shobha, [12] and used by Ibrahim et al. [11]. The clean beans were toasted for about 15 minutes and then de-hulled, followed by winnowing, milling and sieving [13]. The ingredients were then weighed out to replace soya bean meal at various inclusion levels (A<sub>(100% FMLM)</sub>, B<sub>(75% FMLM)</sub>, C<sub>(50% FMLM)</sub>, D<sub>(25% FMLM)</sub> and E<sub>(0% FMLM)</sub>) following Pearson Square Method. The ingredients were mixed until uniformly blended. Water was added slowly to the mixture with continuous stirring to form a

dough. The dough was pelleted with a hand pelletiser.

## 2.2 Proximate Analysis

Proximate analysis of experimental diets was carried out according to AOAC [14] procedures. Components such as moisture, crude protein, crude lipid and ash were analysed.

## 2.3 Experimental Fish

A total number of 180 fingerlings of *Clarias gariepinus* of mean weight ( $6.20 \pm 1.96$  g –  $6.80 \pm 1.97$  g) and length  $7.8 \pm 0.24$  cm were procured from a reputable fish farm in Zaria, Nigeria. The fishes were transported in a 50L plastic container, where they were acclimatised and fed commercial feed for two weeks.

## 2.4 Experimental Site

The experiment was conducted in the Fisheries Research Laboratory of the Department of Biology, Ahmadu Bello University Zaria, Nigeria.

## 2.5 Experimental Design

The experimental fish were acclimated for two weeks, during which they were fed commercial feed (Coppens) at 5% of biomass with half of the daily ration fed in the morning (8:00 am) and the other half in the evening (5:00 pm). Thereafter, batch weighing and length measurement of fish was done to ascertain their initial mean weight in grams and initial mean length in centimetres, using top-load weighing balance (Meter Tolardo 567) and fish measuring board, respectively, before the commencement of the experiment and subsequently after every two weeks. The fingerlings were randomly grouped into five treatments of ten fish per fifty litres (50L) plastic tanks. The treatments were allocated as, A<sub>(100%FMLM)</sub>, B<sub>(75%FMLM)</sub>, C<sub>(50%FMLM)</sub>, D<sub>(25%FMLM)</sub>, and E<sub>(0%FMLM)</sub> respectively. Each treatment was in triplicate. The experiment lasted for 12 weeks.

## 2.6 Feeding Procedures

The fish were fed at five percent (5%) of their body weight twice daily during the week. To monitor the amount of feed administered, each tank had its own labelled container.

## 2.7 Determination of Water Quality Parameters

Water quality parameters such as temperature, dissolved oxygen and pH were monitored daily using mercury -in- glass thermometer and automatic DO/pH Analyzer (Model jpb 607) respectively.

## 2.8 Growth Measurements and Feed Utilisation

Body weight (g) and body length (cm) of individual fish of each experimental tank were recorded in every two weeks (14 days) during the experimental period using weighing balance and fish measuring board respectively. Mortalities were recorded as they occurred. Parameters used in evaluating growth performance in this study were weight gain by fish and specific growth rate (SGR). All these parameters were measured for all the treatments and their replicates. Growth performance was determined and feed utilisation was calculated as described by Sveier et al. [15] as follows:

$$\text{Weight gain} = W_2 - W_1$$

$$\text{Specific growth rate (SGR)} = 100 (\ln W_2 - \ln W_1) / T$$

$$\text{Percentage weight gain (PWG)} = 100 (W_2 - W_1) / W_1$$

Where, W<sub>1</sub> and W<sub>2</sub> are the initial and final fish weight, respectively, and T is the number of days in the feeding period.

$$\text{Percentage survival rate (PSR)} = 100 (\text{Number of fish survived} / \text{Initial number of fish stocked}).$$

$$\text{Feed conversion ratio (FCR)} = \text{Feed intake} / \text{Weight gain}$$

$$\text{Gross feed conversion efficiency (GFCE)} = 100 (1 / \text{FCR})$$

$$\text{Protein efficiency ratio (PER)} = \text{Weight gain} / \text{Protein intake}.$$

## 2.9 Data Analysis

The data obtained were subjected to Analysis of Variance (ANOVA) to test the significance of treatment means. Where there was a significant difference, Duncan multiple range tests were

applied to rank treatment means ( $p < 0.05$ ). All statistical analyses were computed using SPSS (IBM) Statistical package Version 20 for Windows.

### 3. RESULTS AND DISCUSSION

#### 3.1 Proximate Composition of Experimental Diets

The proximate composition of the experimental diets fed to *C. gariepinus* is given in Table 1. The diets were isonitrogenous as there was no significant difference ( $p \geq 0.05$ ) in the protein composition of the diets at 40% crude protein and they all met the set targets specification for the experiment. The crude protein ranged from  $40.00 \pm 0.19\%$  to  $40.47 \pm 0.27\%$ . The ether extract in the feeds ranged from  $10.57 \pm 0.17\%$  to  $11.99 \pm 0.52\%$  while the nitrogen free extract ranged from  $20.31 \pm 0.19\%$  to  $25.37 \pm 0.32\%$ . The growth of fish depends on the nutritive quality of feeds, especially its crude protein. The proximate composition of the experimental diets for crude protein were similar (40%) for  $A_{(100\% \text{ FMLM})}$ ,  $B_{(75\% \text{ FMLM})}$ ,  $C_{(50\% \text{ FMLM})}$ , and for D ( $40.20\%$ ) ( $25\% \text{ FMLM}$ ), and  $E_{(0\% \text{ FMLM})}$  ( $40.47\%$ ) respectively, in dietary inclusion levels of *Mucuna pruriens* leaf meal. Comparing the crude protein recorded in this study, they did not differ from the values estimated by Bolorunduro [16] of 20-25% crude protein for catfish in the semi-intensive system and 40-48% for fingerlings production in the intensive system.

#### 3.2 Growth Performance and Nutrient Utilisation of *Clarias gariepinus* Fingerlings

The result of the statistical analysis is presented in Table 2. Fish fed control diet  $E_{(0\% \text{ FMLM})}$  had the highest weight gain (g) per fish ( $168.87 \pm 3.97$ ),

followed by fish fed with,  $D_{(25\% \text{ FMLM})}$  ( $161.30 \pm 6.32$ ),  $C_{(50\% \text{ FMLM})}$  ( $115.77 \pm 5.08$ ),  $B_{(75\% \text{ FMLM})}$  ( $104.00 \pm 4.26$ ), while the fish fed diet  $A_{(100\% \text{ FMLM})}$  had the lowest weight gain per fish ( $89.70 \pm 1.96$ ). The total length (cm) ranged from  $11.13 \pm 0.48$  to  $16.40 \pm 0.23$ . Specific Growth Rate (SGR) with the highest value was observed in the fish fed with diet  $E_{(0\% \text{ FMLM})}$  ( $3.79 \pm 0.03$ ), next to it was  $D_{(25\% \text{ FMLM})}$  ( $3.74 \pm 0.04$ ),  $C_{(50\% \text{ FMLM})}$  ( $3.37 \pm 0.06$ ),  $B_{(75\% \text{ FMLM})}$  ( $3.26 \pm 0.05$ ), and the fish fed diet  $A_{(100\% \text{ FMLM})}$  ( $3.10 \pm 0.02$ ) had the lowest growth rate. Percentage live Weight Gain (PWG) fish with the highest value was observed in the fish fed with diet  $E_{(0\% \text{ FMLM})}$  ( $96.29 \pm 0.08$ ), followed by  $D_{(25\% \text{ FMLM})}$  ( $96.11 \pm 0.14$ ),  $C_{(50\% \text{ FMLM})}$  ( $94.67 \pm 0.24$ ),  $B_{(75\% \text{ FMLM})}$  ( $94.09 \pm 0.24$ ), and the fish fed diet  $A_{(100\% \text{ FMLM})}$  ( $93.24 \pm 0.12$ ) had the lowest PWG. Percentage Survival Rate (PSR) for fish fed different experimental diets ranged between  $90.00 \pm 0.00$  –  $96.67 \pm 3.33$ . The value for Feed Conversion Ratio (FCR) ranged from  $1.50 \pm 0.02$  to  $1.72 \pm 0.12$  and no significant variation ( $p \geq 0.05$ ) was observed among the treatments. Gross Feed Conversion Efficiency (GFCE) obtained showed that fish fed with diet  $E_{(0\% \text{ FMLM})}$  had the highest ( $66.54 \pm 0.98$ ) while, the least was recorded by fish fed with diet  $A_{(100\% \text{ FMLM})}$  ( $58.67 \pm 4.47$ ). The Protein Efficiency Ratio (PER) ranged from  $1.47 \pm 0.11$  to  $1.65 \pm 0.05$ .

The decreasing trend in growth performance may be due to the residual anti-nutritional compounds inherent in the leaf meal. The better growth performances recorded in diet  $E_{(0\% \text{ FMLM})}$  and  $D_{(25\% \text{ FMLM})}$  may be due to a lower level of inclusion which enhanced its nutritional composition, palatability and bioavailability. The specific growth rate (SGR) also displayed a decreasing trend with increasing levels of fermented *Mucuna* leaf meal in the diets. The best performance was obtained in fish fed the control diet  $E_{(0\% \text{ FMLM})}$  followed by fish fed diet

Table 1. Proximate composition of experimental diets fed

Parameters	Treatments				
	A	B	C	D	E
	(100% FMLM) ±S.E	(75% FMLM) ±S.E	(50% FMLM) ±S.E	(25% FMLM) ±S.E	(0% FMLM) ±S.E
Dry matter	$90.40 \pm 0.29^a$	$91.06 \pm 0.35^a$	$91.20 \pm 0.17^a$	$90.10 \pm 0.46^a$	$91.20 \pm 0.17^a$
Crude protein	$40.00 \pm 0.19^a$	$40.00 \pm 0.19^a$	$40.00 \pm 0.06^a$	$40.20 \pm 0.12^a$	$40.47 \pm 0.27^a$
Ether extract	$11.99 \pm 0.52^a$	$11.27 \pm 0.35^{ab}$	$10.57 \pm 0.17^b$	$11.06 \pm 0.52^{ab}$	$10.27 \pm 0.15^b$
Ash content	$10.85 \pm 0.52^a$	$10.42 \pm 0.24^a$	$9.89 \pm 0.51^a$	$9.92 \pm 0.40^a$	$9.64 \pm 0.40^a$
Moisture content	$9.43 \pm 0.28^a$	$8.99 \pm 0.05^a$	$8.91 \pm 0.35^a$	$9.21 \pm 0.46^a$	$8.87 \pm 0.09^a$
Crude fibre	$7.42 \pm 0.24^a$	$7.23 \pm 0.13^a$	$6.23 \pm 0.13^b$	$5.89 \pm 0.08^b$	$5.28 \pm 0.16^c$
Nitrogen free extract	$20.31 \pm 0.19^c$	$22.09 \pm 0.76^b$	$24.40 \pm 0.69^a$	$23.72 \pm 0.14^{ab}$	$25.37 \pm 0.32^a$

Means with the same superscript along row were not significantly different ( $P \geq 0.05$ )  
% FMLM = Fermented Mucuna Leaf Meal with respective percentage levels of inclusion

D<sub>(25% FMLM)</sub>, while the lowest value was recorded in fish fed with A<sub>(100% FMLM)</sub> and B<sub>(75% FMLM)</sub>, diet. The trend in SGR of the experimental fish might be an indication of their relative responses to the varied dietary inclusion levels of fermented *Mucuna* leaf meal. Nutrients seemed to be best converted into flesh by the fish on the E<sub>(0% FMLM)</sub>, leaf meal dietary treatment, followed by that of the D<sub>(25% FMLM)</sub>, while the ones of B<sub>(75% FMLM)</sub> and A<sub>(100% FMLM)</sub> were least converted. Sotolu and Adejumoh, [17] reported varying nutrient levels to affect growth responses of fish, where they found out that fish fed cassava-based diet had inferior growth response to the control of zero cassava peel.

Poor feed conversion ratio will lead to poor growth and may be due to the high fibre content of the plant-based diets. The high fibre content in diets causes dilution of the nutrients, and therefore reduces digestibility, resulting in growth depression, as the diets become inconsistent [18].

Fig. 1 revealed a growth response of *Clarias gariepinus* fingerlings fed with experimental diets. There was a uniform pattern of growth for all diets for the first week. Fish fed diets E<sub>(0% FMLM)</sub> and D<sub>(25% FMLM)</sub> increased in weight above the other treatments after week one and continued this trend until week twelve. This was followed by fish fed diets C<sub>(50% FMLM)</sub> and B<sub>(75% FMLM)</sub>. Fish fed diet A<sub>(100% FMLM)</sub> lagged behind those of diets C<sub>(50% FMLM)</sub> and B<sub>(75% FMLM)</sub> after the eighth week. Therefore, the growth response of E<sub>(0% FMLM)</sub> and D<sub>(25% FMLM)</sub> were far better than the others.

The growth and nutrient utilisation by fish decreased as the level of fermented *Mucuna* leaf

meal inclusion increased in the diets. These differences of mean weight gained, and nutrients utilisation can be attributed to the differences in crude fibre and nitrogen-free extract of experimental diets because crude protein is known to be very important in optimal growth. Crude fibre can affect digestibility and carbohydrate is known to have a protein sparing effect [19,20]. FCR increased with increase in inclusion level of fermented *Mucuna* leaf meal, but there was no significant difference ( $p \geq 0.05$ ) among the experimental treatments, however, contradicts the reports of Dienye and Olumuji [21] who observed that FCR increased with increase in inclusion level of *Moringa* leaf meal fed to *Clarias gariepinus*. A number of studies stated that a low level of FCR is an indicator of better utilisation of the feed by the fish [22,23].

### 3.3 Physico-chemical Parameters of Water

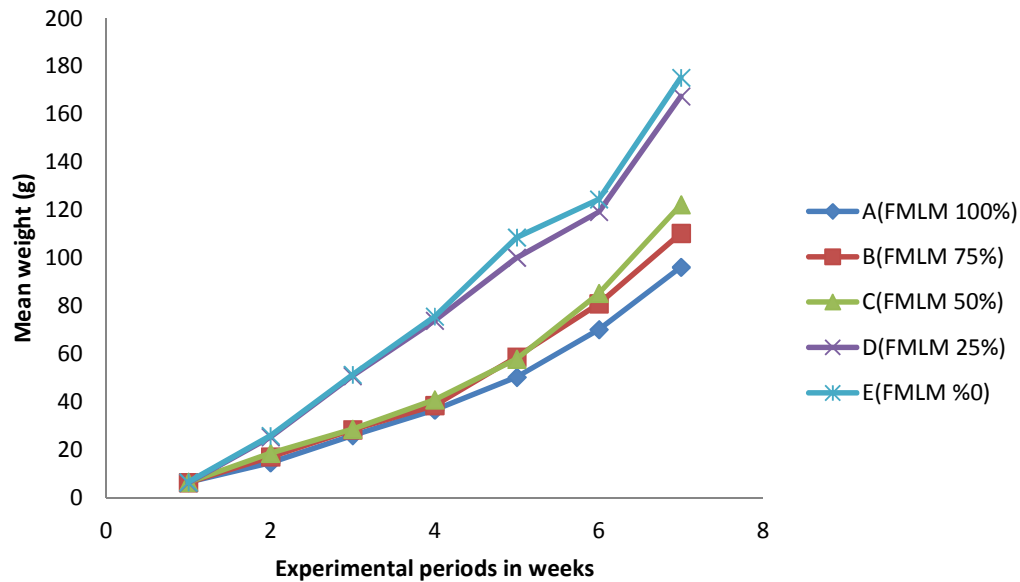
The examined physicochemical parameters of water are presented in Table 3. The hydrogen ion concentration (pH) ranged between 7.56 - 7.86 in all the treatments. The dissolved oxygen ranged between 6.54 - 6.75, and the temperature range was 27.94 - 28.13. The result indicates an insignificant variation ( $p \geq 0.05$ ) among the experimental tanks. The water quality parameters obtained in this work were within the range recommended for the culture of *Clarias gariepinus* [24,25]. Boyd [24] reported temperature range of 22 - 27°C, pH range from 6.5 - 9.0 and dissolved oxygen of 6.3 - 9.6 mg/l, as optimum and best for high growth performance in cultured tropical fishes.

**Table 2. Growth performance and nutrient utilisation of *Clarias gariepinus* fingerlings**

Parameters	Treatments				
	A (100% FMLM) ±S.E	B (75% FMLM) ±S.E	C (50% FMLM) ±S.E	D (25% FMLM) ±S.E	E (0% FMLM) ±S.E
Mean weight gain (g)	89.70±1.96 <sup>c</sup>	104.00±4.26 <sup>cb</sup>	115.77±5.08 <sup>b</sup>	161.30±6.12 <sup>a</sup>	168.87±3.97 <sup>a</sup>
Total length gain (cm)	11.13±0.48 <sup>c</sup>	13.87±0.37 <sup>b</sup>	13.10±0.55 <sup>b</sup>	16.20±0.10 <sup>a</sup>	16.40±0.23 <sup>a</sup>
SGR	3.10±0.02 <sup>c</sup>	3.26±0.05 <sup>b</sup>	3.37±0.06 <sup>b</sup>	3.74±0.04 <sup>a</sup>	3.79±0.03 <sup>a</sup>
PWG	93.24±0.12 <sup>d</sup>	94.09±0.24 <sup>c</sup>	94.67±0.24 <sup>b</sup>	96.11±0.14 <sup>a</sup>	96.29±0.08 <sup>a</sup>
PSR	96.67±3.33 <sup>a</sup>	93.33±3.33 <sup>a</sup>	93.33±3.33 <sup>a</sup>	90.00±0.00 <sup>a</sup>	90.00±0.00 <sup>a</sup>
FCR	1.72±0.12 <sup>a</sup>	1.63±0.07 <sup>a</sup>	1.54±0.10 <sup>a</sup>	1.50±0.04 <sup>a</sup>	1.50±0.02 <sup>a</sup>
GFCE	58.67±4.47 <sup>a</sup>	61.47±2.83 <sup>a</sup>	65.50±4.25 <sup>a</sup>	66.61±1.73 <sup>a</sup>	66.54±0.98 <sup>a</sup>
PER	1.47±0.11 <sup>a</sup>	1.54±0.07 <sup>a</sup>	1.64±0.11 <sup>a</sup>	1.65±0.05 <sup>a</sup>	1.64±0.03 <sup>a</sup>

Means with same superscripts along row were not significantly different ( $P \geq 0.05$ )

SGR = Specific Growth Rate, FCR = Feed Conversion Ratio, GFCE = Gross Feed Conversion Efficiency, PWG = Percentage Live Weight Gained, PER = Protein Efficiency Ratio, PSR = Percentage Survival Rate, % FMLM = Fermented *Mucuna* Leaf Meal with respective percentage levels of inclusion.



**Fig. 1. Growth response of *Clarias gariepinus* fingerlings fed experimental diets**  
 %FMLM = Fermented Mucuna Leaf Meal with respective percentage levels of inclusion

**Table 3. Physicochemical parameters recorded during experimental period**

Treatments	Physico-chemical parameters				
	pH ±S.E	Temp(°C) ±S.E	DO(mg/l) ±S.E	Electrical conductivity (µs)±S.E	TDS(ppt) ±S.E
A <sub>(100% FMLM)</sub>	7.74±0.02	28.23±0.09	6.70±0.05	205.00±0.01	101±0.00
B <sub>(75% FMLM)</sub>	7.68±0.03	28.10±0.07	6.64±0.05	205.00±0.01	101±0.00
C <sub>(50% FMLM)</sub>	7.74±0.03	28.18±0.07	6.63±0.07	205.00±0.00	101±0.01
D <sub>(25% FMLM)</sub>	7.56±0.04	27.94±0.07	6.65±0.09	205.00±0.00	102±0.00
E <sub>(0% FMLM)</sub>	7.68±0.04	28.13±0.09	6.54±0.07	205.00±0.00	101±0.01

Statistical analysis showed no significant difference ( $P \geq 0.05$ ) among the experimental tanks

Temp. = Temperature, pH = Hydrogen ion concentration, DO = Dissolved oxygen, TDS = Total Dissolved Solid,  
 %FMLM = Fermented Mucuna Leaf Meal with respective percentage levels of inclusion.

#### 4. CONCLUSION

Fermented *Mucuna pruriens* leaf meal can be used to partially replace the soya bean meal in the diet of *Claria gariepinus* fingerlings up to 25% level of inclusion without significant reduction in the growth performance.

#### ETHICAL DISCLAIMER

As per international standard or university standard written ethical approval has been collected and preserved by the authors.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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