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Original article

COMPARATIVE GROWTH ASSESSMENT OF AFRICAN CATFISH (*Clarias gariepinus)* FED SWEET POTATO (*Ipomea batata*) LEAF MEAL AND RICE BRAN AS ALTERNATIVE FEED MEAL

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ABSTRACT

The study compared growth performance of *Clarias gariepinus* fingerlings fed sweet potato leaf meal and rice bran as alternative feed meal. Five diets, that contain 0%, 25%, 50%, 75% and 100% inclusion levels were formulated and designated as SPM_1 SPM_2 SPM_3 SPM_4 SPM_5 and RBM_1 RBM_2 RBM_3 RBM_4 RBM_5. Highest initial weight in $SPLM_3$ (50%) differ significantly ($p>0.05$) from $SPLM_1$ (0%) while RBM4 (75%) can be compared to RBM_1 (0%). Final weight and body weight gain follow similar trend with $SPLM_2$ (50%) recorded highest, which differ significantly ($p>0.05$) with other diets. Decrease of SPLM inclusion level increase fish weight. Highest SGR in $SPLM_2$ (25%) can be compared favorably with $SPLM_1$ (0%) and other diets while RBM_2 (25%) differ significantly ($p>0.05$) with RBM_1 (0%). Diet $SPLM_5$ (100%) can be compared with other diets in SGR with RBM3 (50%) that differ significantly ($p>0.05$) with only RBM1 (0%). Highest FE in $SPLM_1$ (0%) can be compared favorably with $SPLM_3$ (50%) and $SPLM_4$ (75%) in feed acceptability. RBM_5 (100%), which is highest differ significantly ($p>0.05$) with RBM_1 (0%). Apart from RBM4 (75%) other diets were accepted by the fish. It is therefore recommended that 25% inclusion level of SPM should be used in the diet of *C. gariepinus* for better performance than even 75% inclusion of rice bran, study on lower inclusion level of SPM need to be carried out, this type of study need to carried out on other cultured species of fish such as *Heterobranchus* (catfish) and even Tilapia, study on the use of other processing methods of sweet potato leaf and rice bran for feed formulation should be carried out and this type of study need to be carried out in other culture system.

Keywords: Growth Assessment, *Clarias gareipinus*, Sweet potato leaf, Rice bran, meal.

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INTRODUCTION

Fish is an important source of food that accounts for over 40% of protein requirement in diet of two - third of global population [1]. The demand for fish as source of proteins has been on the increase due to the ever-increasing human population. The production from wild cannot cope with such demand and therefore aquaculture has to contribute to reduce the gap between demand and supply. Fish feed is an important component because the venture depends mostly on that to be profitable and it account for over 60% of production cost [2]. Several plants materials have been used as ingredients in the production of fish feed. Their availability (quantity), quality and cost is very important in such practice. Therefore, many more materials that are not competed by humans, with nutritional value and reduce cost of feed production need to be assessed and compared as potential ingredients in the production of fish feed of *Clarias gariepinus* and other cultured fishes.

Aquaculture has remained undeveloped over the years and one of the major obstacles is the unavailability of quality feed. The reliance on commercial feeds by most farmers cannot be sustained because they are expensive and unaffordable, hence increases the cost of production thereby indirectly reducing the benefits to farmers. Plant materials such as sweet potato leaf and rice bran, which are wastes or by-products from farms have not been given much attention over the years. There is no well documented information comparing the performance of fish using non - conventional materials to produce local feeds.

Sweet potato leaf and rice bran are commonly found plant materials, which are more or less wastes and not used by humans as source of food. Their nutritional constituents differs and their usage as alternative feed meals could reduce cost of feed production.

Clarias gareipinus is commonly found in freshwater bodies in Nigeria been cultured in small to large scale [3]. Therefore, there is need for continuous research work on this fish especially as it relates to feed. Optimal feeding promotes fish growth, survival and size uniformity, which help to minimize wastage and boost production [4]. This study compares the growth performance of *Clarias gariepinus* fed varying inclusion levels of sweet potato (*Ipomoea batata*) leaf and rice bran as alternative feed meal.

MATERIALS AND METHODS

Study Area

This research work was carried out at the Department of Biological Science Laboratory in Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria.

Transportation and Acclimatization of Experimental Fish

A total of 350 healthy fingerlings of *Clarias gariepinus* of same stock was purchased from A and B hatchery in New Bussa, Niger State, Nigeria. Fish were transported in 50 liters jerry can containing clean water at point of purchase to Biological Science Department, Ibrahim Badamasi Babangida University, Lapai, Niger State for the experiment. Fish were then introduced into transparent plastic tanks, acclimatized for 14 days and fed with conventional feed (Coppens) of (2mm) twice daily. Water was changed once there is feed and faecal materials accumulation.

Source and Preparation of experimental ingredients

Fresh samples of sweet potato leaves were obtained from Lapai farm. It was thoroughly washed and dried for five (5) days, then milled into power form, sieved and the fine sized particles obtained was kept in sealed polyethene bag. Rice bran obtained from Rice Mill Creek in Lapai was dried for five (5) days and rice grains that mistakenly entered during milling was thoroughly removed. Soybeans, fishmeal, yellow maize, vegetable oil, vitamin premix and starch were also purchased at Lapai main market and processed accordingly for usage.

Formulation of experimental Diets

The ingredients grounded into equal sizes with grinding machine were weighed to their proportion for feed formulation. Starch and vegetable oil were added to the feed. After adding water, it was pelleted using laboratory pelleting machine. The pellets were sun dried for 6 hours to reduce the moisture content to avoid fungal growth, sieved to obtain finer size and packaged in air tight polythene then stored in a dry place.

Two kinds of feed were formulated by adopting the Pearson's method. Five iso-nitrogenous diets containing 35% crude protein at different levels of sweet potato leaf meal and rice bran meal inclusion were formulated. The diets contained 0%, 25%, 50%, 75%, and 100% inclusion levels and designed as SPM_1, SPM_2, SPM_3, SPM_4, SPM_5 and RBM_1, RBM_2, RBM_3, RBM_4 and RBM_5. The pelleted feed was sun-dried for 3 days to completely remove the moisture, packaged in air tight polyethene bags and store in a dry place.

Experimental setup and feeding trials

Thirty (30) transparent plastic tanks of dimension (60×30×30cm) were set for the 5 treatments and triplicate (3) of 10 fingerlings in each tank secured with a net to stop fish from leaping out. The length and weight of the 300 fish used were taken before transferred into each tank, fed twice daily at 5% body weight (8am and 6pm) for the period of 90 days. The water in each tank was changed once there is remnant feed and feacal materials accumulation. Fish sampling to assess the length (cm) and weight (g) was done on weekly basis. Mortality was also determined by counting and recording dead fish in each tank.

Proximate analysis

This was done on the formulated diets of varying inclusion levels of sweet potato leaf meal and rice bran meal following standard method.

Growth parameters determination

Growth parameters, which include body weight gain, specific growth rate, feed conversion ratio and feed efficiency were evaluated according to the formulae of [5], [6] as follows:

Body Weight gain (%) = Final weight (g) – initial weight (g)

Specific growth rate (%) = $\frac{ln\ final\ weight\ (g) -\ ln\ iniitial\ weight\ (g)}{feeding\ period\ (days)} X\ 100$

Where:

In = natural logarithm

Feed Conversion Ratio (%) $= \frac{Wet\ body\ gain\ (g)}{Feed\ intake}$

Feed Efficiency (FE) $= \frac{Weight\ gain}{Feed\ intake} \times 100$

Data analysis

Data of the body weight, proximate composition and feed utilization were presented as the means, standard deviation. Data were analyzed using one-way analysis of variance (ANOVA). Differences were considered statistically significant at $P<0.05$. New Duncan Multiple Regression Test was used to separate means. Special Package for Social Sciences and Microsoft Excel packages were used for the analysis.

RESULTS

The proximate composition (%) of experimental diets of sweet potato leaf meal (SPLM) and rice bran meal (RBM) used for the study is depicted in Table 1. Variations were observed in proximate composition (%) of the experimental The diets contained 0%, 25%, 50%, 75%, and 100% inclusion levels of sweet potato (*Ipomoea batata*) leaf and rice bran.

The highest crude protein was recorded in $SPLM_2$ (25%) and lowest in $SPLM_5$ (100%) while RBM_4 (75%) and RBM_3 (50%) recorded highest and lowest respectively. The highest final moisture content was also recorded in $SPLM_4$ (75%) but lowest in $SPLM_2$ (25%) while RBM_5 (100%) and RBM_1 (0%) recorded highest and lowest respectively.

Highest ash content was recorded in $SPLM_5$ (100%) and lowest in $SPLM_2$ (25%) while RBM_5 (100%) and RBM_1 (0%) recorded highest and lowest respectively. $SPLM_3$ (50%) and $SPLM_5$ (100%) recorded highest crude fiber while RBM_5 (100%) and RBM_2 (25%) were recorded as highest and lowest respectively in crude fat.

Table 1: Proximate composition (%) of experimental diets of sweet potato leaf meal (SPLM) and rice bran meal (RBM)

Diets	Crude Protein	Moisture Content	Ash Content	Crude Fiber	Crude Fat
$SPLM_1$ (0%)	35.02±0.02	4.51±0.01	15.75±0.02	10.15±0.01	3.38±0.01
RBM_1 (0%)	22.20±0.02	9.69±0.22	8.42±0.24	3.02±0.05	8.66±0.34
$SPLM_2$ (25%)	37.37±0.01	4.49±0.02	12.55±0.01	9.68±0.00	4.03±0.02
RBM_2 (25%)	21.28±0.05	10.96±0.36	9.52±0.02	2.42±0.04	7.63±0.60
$SPLM_3$ (50%)	34.54±0.01	4.74±0.01	13.70±0.11	10.16±0.02	4.79±0.09
RBM_3 (50%)	20.57±0.09	11.08±0.57	10.51±0.03	2.51±0.03	9.14±0.30
$SPLM_4$ (75%)	32.11±0.01	5.81±0.00	14.52±0.00	8.47±0.02	4.35±0.01
RBM_4 (75%)	23.41±0.03	10.92±0.48	10.48±0.06	2.60±0.23	9.03±0.64
$SPLM_5$ (100%)	30.49±0.01	5.19±0.01	16.42±0.03	7.52±0.03	3.29±0.00
RBM_5 (100%)	22.57±0.10	12.72±0.35	12.31±0.04	2.77±0.06	11.05±0.46

SPLM = sweet potato meal RBM = rice bran meal

Table 2 shows the growth performance of *Clarias gariepinus* based on body weight fed sweet potato leaves (SPLM) and rice bran meal (RBM). There were variations in weights of *C. gariepinus* recorded during the period of the study. The highest mean initial weight was recorded in $SPLM_3$ (50%) and lowest in $SPLM_5$ (100%) while RBM_4 (75%) and RBM_3 (50%) recorded highest and lowest respectively. The final mean weight gain was recorded as 49.33±2.50g for $SPLM_2$ (25%), which was highest and $SPLM_4$ (75%) as lowest whereas RBM_4 (75%) was highest and RBM_5 (100%) lowest. Mean body weight gain was highest in $SPLM_2$ (25%) and lowest in $SPLM_4$ (75%) while RBM_4 (75%) and RBM_5 (100%) recorded highest and lowest body weight gain respectively.

There was significant difference (p>0.05) in final weights and body weight gain between diets of sweet potato leaf meal and rice bran meals.

Table 2: Growth performance based on body weight of *Clarias gariepinus* fed sweet potato leaf meal (SPLM) and rice bran meals (RBM)

Diet	Initial Weight (g/fish)	Final Weight (g/fish)	Body Weight Gain (g/fish)
$SPLM_1$ (0%)	10.00 ± 1.41^{b}	40.67 ± 3.14^{b}	30.76 ± 9.20^{c}
RBM_1 (0%)	9.33 ± 0.71^{a}	29.56 ± 4.28^{d}	20.22 ± 4.27^{d}
$SPLM_2$ (25%)	9.63 ± 1.19^{ab}	49.33 ± 2.50^{a}	39.63 ± 2.77^{a}
RBM_2 (25%)	9.33 ± 0.71^{a}	27.00 ± 1.73^{a}	17.67 ± 2.00^{a}
$SPLM_3$ (50%)	10.60 ± 0.88^{a}	43.00 ± 4.44^{a}	32.40 ± 4.33^{ab}
RBM_3 (50%)	8.56 ± 1.01^{a}	30.00 ± 3.24^{b}	21.44 ± 3.28^{b}
$SPLM_4$ (75%)	10.11 ± 1.17^{a}	34.56 ± 2.46^{ab}	24.45 ± 2.40^{bc}
RBM_4 (75%)	10.11 ± 0.93^{a}	37.11 ± 2.76^{c}	27.00 ± 3.32^{c}
$SPLM_5$ (100%)	9.50 ± 1.18^{ab}	37.11 ± 3.76^{ab}	27.67 ± 3.71^{abc}
RBM_5 (100%)	9.22 ± 0.44^{a}	26.33 ± 2.40^{c}	17.11 ± 2.62^{cd}

Note: Values in the same column with different superscript letters are significantly different (p<0.05) from each other using Duncan Multiple Range Test

The utilization of diets of sweet potato leaf and rice bran meals by *C. gariepinus* is shown on Table 3. Specific growth rate was highest in both $SPLM_2$ (25%) and RBM_2 (25%) and lowest in $SPLM_4$ (75%) and RBM_5 (100%). Feed conversion ratio was highest in $SPLM_2$ (25%) with RBM_4 (75%) also as highest while $SPLM_5$ (100%) and RBM_3 (50%) were lowest respectively. Feeding efficiency was highest in $SPLM_5$ (100%) and RBM_5 (100%) and lowest in $SPLM_2$ (25%) and RBM_4 (75%).

There was significant difference (p>0.05) in specific growth SGR and FCR between diets of rice bran meal. There was significant difference (p>0.05) in FE between diets of sweet potato leaf meal and rice bran meal.

Table 3: Feed utilization of *Clarias gariepinus* fed sweet potato leaf and rice bran meals

Diet	Specific Growth Rate (SGR)	Feed Conversion Ratio (FCR)	Feed Efficiency (FE)
$SPLM_1$ (0%)	1.10 ± 0.15^{a}	1.02 ± 0.33^{a}	1.07 ± 0.32^{ab}
RBM_1 (0%)	0.82 ± 0.11^{ab}	0.87 ± 0.09^{a}	1.01 ± 0.09^{b}
$SPLM_2$ (25%)	1.39 ± 0.15^{a}	1.24 ± 0.09^{a}	0.81 ± 0.06^{b}
RBM_2 (25%)	1.04 ± 0.15^{a}	1.04 ± 0.15^{b}	0.98 ± 0.13^{a}
$SPLM_3$ (50%)	1.14 ± 0.12^{a}	1.09 ± 0.14^{a}	0.93 ± 0.12^{ab}
RBM_3 (50%)	1.01 ± 0.17^{a}	0.84 ± 0.15^{b}	0.96 ± 0.11^{a}
$SPLM_4$ (75%)	0.98 ± 0.13^{a}	0.82 ± 0.08^{a}	0.91 ± 0.09^{ab}
RBM_4 (75%)	0.89 ± 0.17^{b}	1.41 ± 0.42^{b}	0.41 ± 0.09^{a}
$SPLM_5$ (100%)	1.12 ± 0.16^{a}	0.77 ± 0.12^{a}	1.10 ± 0.14^{a}
RBM_5 (100%)	0.79 ± 0.13^{b}	0.95 ± 0.10^{b}	1.05 ± 0.35^{a}

Note: Values in the same column with different superscript letters are significantly different ($p<0.05$) from each other using Duncan Multiple Range Test (DMRT)
SPLM = sweet potato meal RBM = rice bran meal SGR: - Specific Growth Rate FCR: - Feed Conversion Ratio FE: - Feed Efficiency

DISCUSSION

Nutrition is very important in fish growth performance, which is key to a successful aquaculture business. The percentage composition of this feed, which include carbohydrate, proteins and fat amongst others determines the quality of feed. Diet $SPLM_2$ (25%), which is highest in crude protein, low moisture content and crude fat over $SPLM_1$ (0%) and even other diets, which is also similar with RBM_4 (75%) shows that these diets have better potential to be used as alternative feed materials. High protein contents, adequate levels of fat and carbohydrate according to [7] support fish growth adequately. This is in line with findings of this study. Therefore, it is important to formulate quality feed for best performance using these materials identified in this study.

Weight gain, which is an indicator of growth performance is very important in determining the suitability of diet for fish. Weight changes, with highest initial weight in $SPLM_3$ (50%), differ significantly ($p>0.05$) from $SPLM_1$ (0%) and RBM4 (75%) without any difference can be compared to RBM_1 (0%). This could be due to quantity of feed consumed or difference in the sizes of fish samples even though they belong to the same age group. This is a common observation in animals including fish where there is difference in growth. This could be attributed to the quantity of feed ingested by fish and water temperature amongst other factors.

The final weight recorded in the fishes and the body weight gain follows similar trend where $SPLM_2$ (50%) was highest whereas this was recorded in RBM4 (75%) differing significantly (P>0.05) with other diets. Decrease of SPLM inclusion level increases fish weight implying that required nutrients for fish growth was provided at the inclusion levels. [8] report similar finding, with the body weight gain being highest in $SPLM_2$ (25%), which was significantly different (P>0.05) from other diets, with the highest being in RBM (75%) inclusion level. This implies that there was better provision of nutrients and higher ingestion of the feed by fish. This means more quantity of the RBM is needed to meet the nutritional requirement of the fish. [8] reported a trend of reduced growth with increasing levels of rice bran in fish diet. This is similar to the findings of this study. Reduced digestibility of the diets could also a major limiting factor on the use of many other plant-protein based diets. The lowest body weight gain recorded in $SPLM_4$ (75%) and RBM_5 (100%) could be due to difference in the nutritional values of the diets, deficiencies in some required nutrients or utilization of the diets.

There are important parameters measured in feed trials, which helps to determine the acceptability and utilization of such feed. The highest SGR value observed in $SPLM_2$ (25%), which can be compared with $SPLM_1$ (0%) and other diets while RBM_2 (25%) differ significantly (p>0.05) with RBM_1 (0%) shows better acceptability of meals inclusion than non-inclusion (0%). This implies that inclusion of these diets were better utilized than non-inclusion (0%). Diet $SPLM_5$ (100%) even though with lowest FCR value can be compared with other diets, and also since the lowest in RBM_3 (50%), differ significantly (p>0.05) with only RBM1 (0%) implying acceptability of feed. The difference observed could be due the quantity of the feed consumed by the fish or needed to convert the diet into product. FCR below 1.50 shows efficient usage of feed [6], which was observed in this study. Nevertheless, there could be more benefit using sweet potato leaf meal over rice bran meal at low levels of inclusion. The difference observed could be due to nutritional value of the feed and amount of feed ingested amongst others. The significant difference (p>0.05) of FE in 0%, 25% and 75% inclusion levels could be due to acceptability of feed by the fish. Once it is greater than 50% it is generally considered acceptable. Highest FE in $SPLM_1$ (0%) can be compared favorably with $SPLM_3$ (50%) and $SPLM_4$ (75%) in acceptability. RBM_5 (100%), which is highest differ significantly (p>0.05) with RBM_1 (0%) implies difference in acceptability or feed utilized by fish. Value greater than 50% is considered acceptable. Apart from RBM4 (75%) other diets were accepted by the fish. Rice bran meal can be used up to 80% to replace other feed materials [8]. The observation made in this study of 50% level of inclusion falls within the range and could also be due to difference in fish sizes as fingerlings were used or some of the energy in feed is used for metabolic activities, swimming and other activities.

CONCLUSION

Sweet potato leaf meal and rice bran meal can be used in *C. gariepinus* diet at low inclusion and high inclusion levels respectively. Body weight increases with decrease in SPM inclusion while body weight increases with increase in RBM. SGR and FCR ratio signified good performance of diet SPM_2 (20%) while FE was good in other diets except RBM_4 (75%). Specific growth rate and feed conversion ratio were both highest in SPM_2 (20%) and SPM_2 (25%). Feed efficiency was good in other diets with the exception of diet RBM_4 (75%).

RECOMMENDATIONS

From the findings of this study, it is therefore recommended as follows:

25% inclusion level of SPM should be used as soybean replacement in the diet of *C. gariepinus* because of better performance than even 75% inclusion for rice bran

Study using lower inclusion level of especially SPM need to be carried out

This type of study need to carried out on other cultured species of fish such as *Heterobranchus* (catfish) and even Tilapia

Study on the use of other processing methods of sweet potato leaf and rice bran for feed formulation should be carried out

This type of study needs to be carried out in other culture system

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