IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 14, Issue 1 Ser. I (January 2021), PP 27-37
www.iosrjournals.org

Growth Performance and Haematological Indices of African Catfish (*Clarias Gariepinus* Burchell 1822) Fed Graded Levels of Processed *Jatropha Curcas* Leaf Meals in Southeastern Zone Of Nigeria.

Onu, E. O[1]., N. I. Ossai[3]., C. C. Nworga[2] and A. E. Onyimonyi[2]

Department of Crop Science University of Nigeria Nsukka Enugu State Nigeria, Department of Animal Science, University of Nigeria Nsukka Enugu State Nigeria. Department of Zoology, University of Nigeria Nsukka, Enugu State Nigeria.

Corresponding Author: Onu, Ernest Onyemaechi.

Abstract

An experiment which lasted for twenty four (24) weeks was conducted to determine the growth response of African catfish (Clarias gariepinus) fed processed Jatropha curcas leaf meal (JLM). Four experimental diets were formulated at 0%, 1.5%, 3.0% and 4.5% inclusion levels and at substitution levels of SBM at 0%, 3.5%, 7.0% and 10.5% to represent T_1, T_2, T_3 and T_4 respectively. The fifth treatment group (T_5) was the internationally made diet (coppens) which equally served as control. A total of six hundred (600) fingerlings were used for this study. They were replicated thrice given a total of fifteen treatment groups. Each treatment group contains fourty fingerlings that were given a particular diet based on five percent of their body weight. At the end of the trial the growth performance and the haematological indices were determined. The results showed that J. curcas leaf meal was able to improve the performance of African catfish fed the treatment diets. The response variables increased as the inclusion levels of J. curcas leaf meal increased to a certain level and were statistically different ($p<0.05$) in almost all the parameters evaluated. The haematological parameters showed that there was significant ($p < 0.05$) increase in the performance of those catfish fed the treatment diets. This however revealed that JLM did not show any detrimental effects but rather had some beneficial implications on the C. gariepinus. And finally, T_3 performed better ($p< 0.05$) than the control diet in most of the parameters evaluated. Therefore indicating that J. curcas leaf meal could serve as a veritable source of protein ingredient in the diets of aquaculture that could help beat down cost of production.

Key Words: *Performance, Jatropha curcas, Haematology, Clarias gariepinus*.

Date of Submission: 26-12-2020 Date of Acceptance: 07-01-2021

I. Introduction

The recent advances in the growth and development of aquaculture have placed the industry in the forefront as one of the world's fastest growing agro sector (FAO, 2018). This is because of its numerous health implications to man. African catfish is very rich in protein and essential amino acid needed by the body for its speedy growth and development. Fish is rich in omega 3 fatty acid with very low cholesterol content. Because of the nutritional importance attached to fish, there has been a speedy increase in demand without a corresponding increase in production (Oziogbo *et al.*, 2014) leading to shortage in supply. This acute shortfall in supply with an increasing population is a call for farmers to wake up in order to avert the looming inadequacy in protein intake of an average Nigerian. Furthermore, fish feed has been observed to contribute about 60 to 70% of the total reoccurring cost of production (Gabriel, 2007; Sighn, 2010) making it almost impossible for fish farmers to break even. This is due to the scarcity of conventional fish feed as well as the high cost of the ingredients due to its competitiveness with man and the industries. In view of the scarcity and increasing costs of most conventional animal feed ingredients, it becomes necessary to evaluate alternative nutrient sources to improve aquaculture production.

Jactropha curcas is one of the many non conventional feed resources (NCFR) of great interest to animal nutritionists globally. This is due largely to its nutritional benefits and accessibility (Kumar, *et al*., 2013). *Jatropha curcas* has been identified as one of the plants with unique qualities that can serve as protein ingredients in aqua feed production. *Jactropha curcas* is rich in micro and macro mineral elements such as manganese, Iron, Zinc and potassium, calcium, sodium, magnesium and phosphorus respectively (Abou-Arab and Abu- Salem, 2010). There are so many varieties of *Jactropha curcas*, ranging from toxic nto non toxic varieties (Valdes-Rodriguez, 2013) perhaps the need to identify the toxic varieties. The level of toxicity depends on the concentration of diterpenes/ phorbol ester in the plant (Osuna-Canizales *et al*., 2015). To improve the nutritional quality of J. *curcas* the biological as well as chemical processing methods could be used in other to reduce the concentration of the anti nutritional factors (ANFs).

There is dearth of information on the use of *J. curcas* leaf meal (JLM) as protein source for fish and so, the need to investigate its efficacy in feeding of aquaculture. It is believed that if JLM is properly harnessed and incorporated into the diets of *Clarias gariepinus* could serve as a remedy to ameliorating the high cost of feed as well as increasing the quality of aqua-feeds. It will largely contribute in increasing fish production in Nigeria. This work was designed to investigate the nutritional effects of processed JLM on growth and haematological indices of African catfish (*Clarias gariepinus*).

II. Materials And Method

Experimental Animals and Management

Six hundred fingerlings (62.25 ± 1.42) of African catfish (*Clarias gariepinus*) were used for this study which lasted for twenty four (24) weeks. They were procured from Freedom fisheries, Nsukka, Nigeria. After collection, they were relocated to the Farm Operation unit of the Faculty of Agriculture, University of Nigeria, Nsukka and allowed to acclimatize for two weeks in one of the newly reconstructed ponds.

Identification of Plant Material

The leaves of *Jatropha curcas* were collected from the Department of Crop Science farm of the University of Nigeria Nsukka. Leaves and stems of the plant was taken to the Herbarium of the Department of Plant Science and Biotechnology for proper identification by comparing the *J. curcas* leaves and pods with that in the plant press.

Collection and Processing of Jatropha curcas Leaf Meal (JLM)

Jatropha curcas leaves were freshly plucked from their branches in the Department of Crop Science research farm, University of Nigeria Nsukka. The leaves were removed by hand and thereafter soaked in water for twenty four (24) hours to reduce anti nutrient factors (Adejoro, *et al*., 2013). They were dried directly in the Greenhouse of the Department of Crop Science for three days within which they become crispy. The dried leaves were ground into powdery form using the Department of Crop Science milling machine. The milled *J. curcas* leaves were sieved with 2mm mosquito net to separate the fine powder from the remaining fibre to produce the leaf meal.

Experimental Diets

Four treatment diets containing varying levels of *Jatropha curcas* leaf meal (0%, 1.5%, 3.0%, and 4.5% were prepared (see table 1). The experimental diets with crude protein levels of 40% were formulated. The ingredients were thoroughly mixed together by hand. Warm water were added to the mixed ingredients and homogenized to a dough-like paste. The diets were pelletized using a 2-mm pellet press. The diets were sun-dried for three (3) days and stored in airtight containers throughout the experimental period. The proximate analysis of the experimental diets were carried out using the method as described by AOAC (1990)

Experimental Ponds

Fifteen ponds measuring 2 x 3.0 x 1.8 m. each were used for the experiment. The ponds were first cleaned, disinfected with a quick lime at the rate of 750 to 1250 kg/ha and allowed to dry for one week. Afterwards the ponds were washed with clean water and fertilized by filling 25 kg bag of poultry manure each for every pond. The bags of manure were allowed to float on each pond for the period of one month.. At the end of fertilization the ponds were refreshed and fingerlings stocked.

Determination of Growth Parameters

Various parameters used in evaluation of growth performance were carried out using the formula documented by Adewolu and Adamson (2011) which are: (i) Average Weight Gain (AWTG), (ii) Specific Growth Rate (SGR), (iii) Percentage Weight Gain (PWTG) and (iv) Average Daily Growth (ADG).

(i)*Average Weight Gain = AWTG*

AWTG = Average Final Body Weight – Average Initial Body Weight.

(ii) *Specific Growth Rate = SGR*

$$SGR = \frac{\text{In FBW} - \text{In IBW}}{D} \times \frac{100}{1}$$

In = Natural Logarithm

D = Number of days between weighing

FBW = Final Body Weight

IBW = Initial Body Weight

ADG = Average Daily Growth

ADG = $\frac{\text{Av.weight gain}}{\text{Duration of feeding trial}}$

(iii) ***Percentage Weight Gain = (PWTG)***

PWG = $\frac{\text{Av.weight gain}}{\text{Av.initial weight gain}} \text{ x } \frac{100}{1}$

(iv) ***Average Daily Growth Rate (ADGR).***

ADGR = Average daily growth divided by the number of animal

Determination of Feed Utilization

Protein Efficiency Ratio (PER), Apparent Net protein utilization (ANPU), Feed Intake (FI), Protein Intake (PI), Feed Conversion Ratio (FCR), Survival rate (S) were calculated as follows;

FCR = $\frac{\text{Weight of the dry feed fed}}{\text{Weight gain of fish}}$

Apparent Net Protein Utilization (ANPU)

ANPU = $\frac{\text{Fish protein gain}}{\text{Protein consumed}} \text{ x } \frac{100}{1}$

Protein Efficiency Ratio (PER)

PER = $\frac{\text{Gain in weight of fish (g)}}{\text{Protein intake (PI)(g)}}$

Protein intake = feed intake (FI) x % protein in the diet
Where:
Feed intake = 5% body weight of fish per day
Percentage Survival Rate of the Fish were Calculated;

Survival rate (%) = $\frac{S1}{S2} \text{ x } \frac{100}{1}$

Where:
S1 = number of fish at the of the experiment
S2 = number of fish at the beginning of the experiment (Steel and Torne, 1981).
Condition factor (K) was computed according the method as described by Achinonye-Nzeh *et al.*, 2012.

K = $\frac{100W}{L_3}$

Where:
W = Final body weight (g)
L = Final Standard length of the fish (cm)

Water Quality Parameters

Water quality parameters were monitored throughout the feeding trial. Water temperature (^{0}C) and pH were measured with Mercury in glass thermometer and digital pH meter respectively. While dissolved oxygen (DO) was measured using dissolved oxygen meter (Mettle Toledo InLab 650-ISM 10m**)**

Cost Benefit Analysis

The cost benefit of *C. gariepinus* fingerlings was estimated using weight gain and specific growth rate against management and construction cost.
The cost of feeding the fish was computed using (Lipton and Harrel, 2004):

$C_{feed} = \frac{\text{P x WA x FCR}}{1-(0.5(1-S)}$

Where,
C_{feed} = Cost contribution of feed to produce a pound of fish, P = per pound price of fish, WA = Weight added from purchase seed to harvest size (Harvest size - seed weight),
FCR = Feed Conversion Ratio, and S=Percentage of fish surviving from seed to market size.

Mean Standard Length Increase: The mean length increase (MLI) was calculated by adopting the method as described by Abubakar *et al.*, 2013.

MLI (mm) = MLf - MLi

Where: MLI = Mean length increase; MLf = Mean final length; MLi = Mean initial length.

Haematological Determination**:**

The Red Blood Cell (RBC), White Blood Cell (WBC), Haemoglobin (Hb), Packed Cell Volume (PCV), Mean Cellular Haemoglobin Concentration (MCHC), and Mean Cellular Haemoglobin (MCH) were assessed at the end of the trial using the method as described by Baker and Silverton (1985). The differential Leucocyte counts were prepared using the method as described by Barbara (1975).

Statistical Analysis

Data collected from the response variables were subjected to a one way analysis of variance (ANOVA) using SPSS version 21 while statistically different means were separated using Duncan option as found in the statistical package/ soft ware (Duncan 1995) at 0.05% level of probability.

III. Results

The water chemistry parameters of the ponds used for this experiment were determined periodically and the values obtained were recorded accordingly. For the temperature, the values recorded were considered to be good enough for the normal growth of *Clarias gariepinus* as the values fall within the range of 27.5-32°C. The pH ranges of 6.60 to 7.18 were obtained while the values of dissolved oxygen recorded fell within the recommended values of 4-6 ppm for the rearing of *Clarias gariepinus.* The proximate compositions of the experimental diets were analyzed and the results showed that the parameters were all significant ($P < 0.05$) except in dry matter percentage. In crude protein, the values of 47.66 and 47.50 reported for T_5 and T_3 respectively were statistically similar ($P>0.05$) but differed from T_1, T_2 and T_4 which were themselves similar. In crude fiber percentage, T_3 and T_5 had the lowest crude fiber values of 4.90% and 4.75% respectively which differed from the values of 5.45%, 5.50% and 5.85% obtained from T_1, T_2 and T_4 respectively. In Nitrogen Free Extract, $T_{5,}$ T_2 and T_4 had the highest values of 25.74%, 23.47% and 22.85% respectively which were themselves similar but differ significantly ($P<0.05$) from the other treatment means. In Nitrogen Free Extract (NFE) T_1 and T_3 had the lowest values of 19.36% and 20.45% respectively which were statistically similar ($P>0.05$) but different from the other treatment groups.

The growth performance of African catfish fed graded levels of *J. curcas* leaf meal in this study were statistically different $p<0.05$ in almost all the parameters evaluated. In average final weight, T_3 and T_5 had the highest values of 712.96g and 763.04g respectively that were themselves similar but differed from the other treatment groups. However, T_4 had the lowest average final weight which was statistically different from the other treatment groups. In average weight gain, T_5 had the highest weight gain which was statistically ($p< 0.05$) higher than T_3. However, T_1 and T_4 were significantly similar but differed from the other treatment groups. In feed intake, T_5 had the highest feed intake which was significantly different from T_3 and T_2 which were themselves similar but differed from T_1 and T_4 which had the lowest feed cost per kg weight. In feed conversion ratio (FCR), T_3 and T_5 had the best feed conversion ratio 1.16± 0.04 and 1.11±0.03 respectively which were themselves similar but differed ($p < 0.05$) from the values of 1.49± 0.05, 1.45± 0.06 and 1.54± 0.06 reported for T_1, T_2 and T_4 respectively that were themselves similar. Feed efficiency ratio (FER) inversely followed the same trend with FCR. Similarly, SGR and CF followed the same trend with FCR in which T_3 and T_5 had the highest values of (0.59± 0.02; 1.05± 0.03); (0.61 ± 0.02; 1.09 ± 0.01) respectively which differed ($p< 0.05$) statistically form the other treatment groups. In acceptability, T_5 had the highest value of which differed ($p < 0.05$) significantly from the other treatment groups that were themselves similar. The time to strike index inversely followed a similar trend with acceptability in which T_5 had shortest time to strike index. In feed cost/kg weight, T_5 had the highest cost /kg weight of N640 while T_4 which had the lowest feed cost/kg weight of N353.56 that differed ($p < 0.05$) significantly from the other treatment groups. However, in survival rate, T_3, T_4 and T_5 had the highest values of 97.14 ± 1.46, 100 ± 00 and 100 ± 00 respectively which were themselves similar but differed significantly ($p < 0.05$) from the values of 90.47 ± 1.33 and 94.38 ± 3.18 for T_1 and T_2 respectively.

The results of the female haematological parameters showed that the values evaluated were not statistically different except in haemoglobin concentration (Hb). The values from the T_3 (15.95^a ± 0.18g/dl) and T_5 (16.03±0.30g/dl) were statistically the same but different from T_2 (15.57±0.38 g/dl). While T_1 had the lowest value of 14.13±0.41g/dl which differed from the other treatment means. However, there were significant ($p < 0.05$) different in the following male haematological parameters evaluated such as; haemoglobin (Hb), platelet (PLT), MCV, MCH and MCHC. In haemoglobin concentration (Hb) the values of 15.0±0.52g/dl, 15.33±0.56g/dl and 15.33±0.43g/dl reported for T_2, T_3 and T_5 respectively were statistically similar but different from T_4 (14.36±0.49g/dl) which was statistically better than T_1 (13.67±0.01g/dl). However, in PLT, T_3 had the highest value of 125.67±3.38% which was statistically different from T_2, T_4 and T_5 which were themselves similar but statistically higher than T_1 which had the lowest value of 107.83±1.30%. In MCV, T_1 had the highest value of 130.52±3.47 fl which was statistically different from T_3 (126.49 ±0.03fl) and T_5 (126.13±0.37 fl) which were themselves similar but different from T_2 (120.49 ±1.45fl) and T_4 (119.68±4.20 fl) which were statistically the same. However, in MCH, T_1, T_3 and T_5 had similar values ($P> 0.05$) of 54.16±1.19 pg, 52.55±0.05 pg and 52.8±0.41 pg respectively which were statistically different from T_2 (50.98±0.45 pg) while T_4 had the lowest value of 48.91±1.14 pg which was statistically lower than other treatment means. In MCHC, T_2 had the highest value of 42.92±1.09 g/dl which was statistically different from T_1, T_3 and T_5 that were themselves similar but different from the values of T_4 (40.27±0.06 g/dl).

IV. Discussion

Proximate Compositions

The proximate analysis of a particular diet reveals the nutritional components/make up of that diet. An increased fibre contents of the diet of *Clarias gariepinus* leads to reduction in weight gain. However, the reduced growth rate of T_1 and T_4 as reported in this work may be attributed to higher crude fibre contents of their diets when compared with other treatment diets. Thus, the increased weight gain of *Clarias garieinus* as recorded in T_5 and T_3 could be due to the higher crude protein content of the diets. This report is in total agreement with the works of Oluyemi *et al*. (2016) who reported similar reduction in growth rate when *Clarias gariepinus* were fed diets containing higher levels of crude fibre. The work of Hilton *et al.* (1983) equally corresponds with the present findings that high crude fibre contents negatively affected the growth of *Clarias gariepinus,* the reasons he attributed to decrease in gut passage time and diet digestibility. While Shiau (1997) reported that high dietary fibre influences the movement of nutrients along the gastrointestinal tract and will significantly affect nutrient absorption which results in lower weight gain.

Weight Gain

The improved performance obtained in this work could be attributed to the nutritional benefits inherent in processed *Jactropha. curcas* leaf meal (JLM). The weight gain recorded in this work is in harmony with the work of Olaniyi *et al*. (2013) who reported an increased weight gain above the control diet when *Clarias gariepinus* were fed diet containing *Moringa olifera* leaf meal. However, this work contradicts the earlier work of Adene (2020) who reported decreased weight gain of *Clarias gariepinus* when fed diets containing processed *Jactropha curcas* kernel meal (JCKM). He attributed the reasons to high concentration of anti nutritional factors in JCKM such as phorbol ester, saponine and curcin. Hassan *et al*. (2017); Anyanwu *et al.* (2012) equally reported reduced weight gain of *Clarias gariepinus* fed cassava leaf meal while attributing their reasons to the fact that cassava plant is not a leguminous plant and as such is low in crude protein content. While this work is in total agreement with work of Sarah and Victor, (2018) who reported an increased weight gain of *Clarias gariepinus* fed hydrothermally processed *Jactropha curcas* kernel meal. Thus, there is an improved weight gain, specific growth rate as well as feed conversion ratio at lower inclusions of *J. curcas* leaf meal in this current study. This goes to support the submissions of Tiamiyu *et al*., (2015) that at lower concentrations or inclusions of plant leaf meals results in an improved weight gain in *Clarias gariepinus* aquaculture (Fabgenro *et al*. 1999; Ritcher *et al*., 2003). This is because there is a physiological mechanism that could compensate for the presence of the plant phenolic compounds or anti nutritional factors hence the negative effect may not be felt but results in improved performance due to the consequential nutritional values.

However, the results of specific growth rate (SGR) reported in this study is in harmony with the works of Eesa and Saeed, (2019) who reported SGR range of 0.17 to 0.5 when *Clarias gariepinus* fingerlings were fed diets containing Bambara leaf meals. The values of SGR in this present study increased just as the inclusion levels of *Jatropha* leaf meal in the diets increased up to T_3. The values of 0.49 to 0.61 reported in this work were slightly lower than the values of 0.52 to 0.70 reported by Sotolu and Sule (2011) when Clarias gariepinus were fed varying levels of water hyacinth leaf meals in their diets. More so, the results of the specific growth rate recorded in this study were lower than the values reported by Adewolu (2011) who had 0.20 to 1.95 values and Tiamiyu *et al*., (2015) who reported 0.84 to 1.25 range of values.

Feed Cost/kg Weight Gain

Feed cost/kg weight gain obtained in the present study is a further confirmation of the benefit of JLM to the *Clarias gariepinus* fingerlings. The index is a product of the feed cost/ kg and the feed conversion ratio of an animal. The results of this present study were in agreement with the findings of (Bichi and Amed, (2010); Oluyemi *et al*., 2016) who observed lower feed cost/kg weight gain when *Jatropha curcas* leaf meals were fed to *Clarias gariepinus* fingerlings. The striking observation here showed that the reduction in feed cost as seen in this finding did not signify reduction in feed quality and value. Though, T_5 had the highest ($P>0.05$) feed cost/kg weight gain but not significantly differently from other treatments in terms of feed quality. Philip (1984) confirmed this when he reported that reducing feed cost does not necessarily mean to obtain a cheaper feed only but dependent on the production value. Moreso, the present study is in agreement with the work of Ikurior (1993) who reported that efficient feed is not a criterion for higher profit especially if this is obtained from a costly diet. The result from this study proofs that higher financial returns would be made when *Clarias gariepinus* fingerlings are fed T_3 diets containing 7% substitution levels of SBC with JLM.

Anti-Nutritional Factors (ANFs)

The polyphenolic compounds or anti nutritional factors are nutrient inhibitor, such as tannins, alkaloid, saponines, phytate etc. they interfere with the absorption and digestion of glucose, protein and vitamin by inhibiting the active transport and increasing the general permeability of the enterocytes (Oluyemi *et al.*, 2016). To buttress, this fact, Francis *et al.,* (2001) reported that phytate and saponnins can reduce the bioavailability of minerals and the protein digestibility through the production of phytic acid protein complexes and also the destruction of pyloric caecum thus depressing the absorption of nutrients. Spinelli *et al.*, (1983) reported that inclusion of phytic acid up to 5 – 6g in the diets of rainbow trout results in drastic reduction in weight gain. While Ritcher *et al*., (2003) reported that 0.5% of phytic acid in *Moringa olifera* leaf meal could cause growth reduction when fed to *Oreochromis niloticus.* It is also pertinent to note that any feed ingredients high in anti nutritional factors will negatively influence growth performance when supplemented at high rates. The report from this study supports this claim as T_4 which had the highest inclusions levels of *J. curcas* leaf meal recorded the lowest weight gain as compared to other treatment means. This is in agreement with the submissions of Adewolu (2008) who reported decreased weight gain when fed leaf meals at a very high rates. Leaf meals, more especially the medicinal plants often have high polyphenolic compounds. That is why they are not advised to be used in large quantities. They exhibit retrogressive properties on weight gain when fed to animals at high dosage. Afuang *et al*., (2003) reported that though we could use plant leaf meals to improve growth and health related issues in common carp aquaculture but warned that caution should be taken to determine the appropriate quantity to be used to avert its detrimental effects when used at a very high inclusion rates.

Haematological Indices

However, in haematological results obtained from this study showed that the values were within the normal value for fish of the same species, size and age. The values obtained from this current work were slightly lower than the values reported by (Akinrotimi *et al*., 2013). However, the similarity in the values of haematological parameters as reported in this work could be related to nutritional adequacy and safety of the test ingredients (*Jatropha curcas* leaf meal). The values showed that those animals were well nourished as they were able to provide essential amino acid and minerals necessary for the normal functioning of the haemopoietic tissues (Ezeagu *et al*., 2002).

There was a striking observation made in this study; we observed that the haematological parameters of female catfish were higher than that of male counterpart in almost all the parameters evaluated. This fact disagree with the haematological reports in other livestock animals were male animals (pigs) have higher haematological values (Kawaguchi, *et al*., 2012). The results obtained in this study agreed with the reports of Akinrotimi *et al*. (2011) who also affirmed that female catfish has higher haematological values than the male. The gender differences may be due to larger size of female compared to male and the higher hormonal interactions of female against male (Sowunmi, 2003) and this suggest that the female are more likely to withstand adverse environmental conditions that may impact negatively on them. They are better equipped to handle stressors more than their male counterparts. Because of the distinctive haematological values observed in male and female African catfish it becomes necessary that haematological determinations in African catfish be done across the gender lines if accurate values were to be determined.

Table 1: Proximate Analysis of the Experimental Diets

Parameters	**T_1(Ctrl)**	**T_2 (1.5%)**	**T_3 (3.0%)**	**T_4 (4.5%)**	**T_5(Coppens)**
Moisture (%)	6.40 ± 0.12^{bc}	6.90 ± 0.17^{ab}	6.50 ± 0.29^{b}	7.60 ± 0.57^{a}	5.40 ± 0.23^{c}
Ash (%)	17.40 ± 0.58^{a}	11.75 ± 0.14^{c}	14.55 ± 0.57^{b}	12.30 ± 0.17^{c}	10.55 ± 0.06^{d}
Fat (%)	6.30 ± 0.12^{ab}	6.60 ± 0.29^{a}	6.07 ± 0.15^{ab}	5.30 ± 0.12^{c}	5.90 ± 0.12^{b}
Crude Fibre (%)	5.45 ± 0.09^{a}	5.05 ± 0.23^{a}	4.90 ± 0.12^{b}	5.58 ± 0.09^{a}	4.75 ± 0.14^{b}
Crude Protein (%)	45.09 ± 0.58^{b}	45.75 ± 0.06^{b}	47.50 ± 0.29^{a}	46.10 ± 0.58^{b}	47.66 ± 0.17^{a}
NFE (%)	19.36 ± 0.57^{c}	23.47 ± 1.15^{b}	20.45 ± 0.55^{c}	22.85 ± 0.64^{b}	25.74 ± 0.14^{a}
DM (%)	93.60 ± 1.15	93.10 ± 0.23	93.50 ± 0.58	92.40 ± 0.58	94.60 ± 0.67

$^{a,\ ab,\ b,\ c,\ d}$ Mean values in a row with different superscripts are significantly ($P < 0.05$) different from each other.

Table 2: Percentage Composition of the Experimental Diets

Ingredients	T1(Control)	T2 (1.5%)	T3 (3.0%)	T4 (4.5%)	T5(Coppens)
JLM	-	1.5	3.0	4.5	
SBM	50.0	48.5	47.0	45.5	
Fish meal	27.5	27.5	27.5	27.5	
Maize	8.0	8.0	8.0	8.0	
Wheat offal	7.5	7.5	7.5	7.5	
Premix	1.5	1.5	1.5	1.5	
Lysine	1.00	1.00	1.00	1.00	
Methionine	1.00	1.00	1.00	1.00	

Bone meal	2.0	2.0	2.0	2.0
Starch	0.5	0.5	0.5	0.5
Vegetable oil	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5
Total	100	100	100	100

Calculated Values;					
Crude Protein:	39.84	39.46	39.00	38.54	42.00
Energy: (kcal/kg)	1362.75	1420.94	1379.74	1368.25	1466.10

Each 1kg premix contains; vitamin A: 4000000 IU, vitamin D3: 800000 IU, vitamin E: 40000 IU, vitamin K3: 1600 mg, vitamin B1: 4000, vitamin B2: 3000, vitamin B6: 380mg, vitamin B12: 3mcg, Nicotinic acid: 18000mg, Pantothenic acid: 8000mg, Folic acid: 800mg, Biotin: 100mcg, Cholin Chloride: 120000mg, Iron: 8000mg, Copper: 800mg, Manganese: 6000mg, Zinc: 8000mg, Iodine: 400mg, Selenium: 400mcg, vitamin C (coated): 40mg, Inositol: 60000mg, Colbat: 10000mg, Lysine:150mg, Methionine: 10000mg, Anti-oxidant: 25000mg.

Table 3: Water Chemistry parameters of the ponds with varying levels of J. curcas leaf meal.

Parameters	T1	T2	T3	T4	T5
Temperature	31.86 ± 0.07	32.0 ± 0.03	32.03 ± 0.03	31.90 ± 0.06	31.90 ± 0.06
Ph	3.95 ± 0.05	3.89 ± 0.08	4.01 ± 0.02	3.88 ± 0.11	3.97 ± 0.07
DO	6.93 ± 0.06	6.91 ± 0.12	7.18 ± 0.12	6.60 ± 0.06	7.12 ± 0.06
Transparency	28.83 ± 0.44	29.16 ± 0.60	29.0 ± 1.73	30.0 ± 0.58	31.0 ± 2.52

Table 4: Phyto-chemical composition of treated and untreated Jatropha curca leaf

Parameters	Alkaloids	Flavonoids	Saponin	Tannin
Raw leaf (untreated)	3.9	3.3	0.85	0.31
Soaked leaf (treated)	2.5	3.2	0.55	0.21

Table 5. Growth Performance and Nutrient Ultilization of African catfish Fed Graded Levels of Jatropha curcas leaf meal

Parameters	T_1(Ctrl)	T_2 (1.5%)	T_3 (3.0%)	T_4 (4.5%)	T_5(Coppens)
IWT (g)	61.67± 4.09	63.32± 4.29	62.62 ± 3.26	62.0 ± 3.04	61.64 ± 3.75
AV. INIWT (g)	61.67± 4.09	63.32± 4.29	62.62 ± 3.26	62.0 ± 3.04	61.64 ± 3.75
Av. Initial Length	19.25±0.18	19.50±0.21	19.25±0.23	19.08±0.02	19.42±0.14
AV. FWT (g)	491.67± 29.17^{bc}	536.67 ± 8.67^{b}	712.96± 12.52^{a}	478.67± 12.37^{c}	763.04 ± 12.49^{a}
AV. WTG (g)	430.00± 12.50^{d}	473.33± 11.61^{c}	650.34 ± 15.16^{b}	416.67± 9.64^{d}	701.40± 16.33^{a}
Av. Length Gain	29.83 ±120.65	30.68±0.44	31.53±0.70	29.86±1.06	31.83±0.32
Feed Intake (g)	643.33 ±38.44^{b}	690.0 ± 43.59^{ab}	756.67± 39.30^{ab}	646.67 ± 40.96^{b}	776.67 ± 28.48^{a}
FCR	1.49 ± 0.05^{a}	1.45± 0.06^{a}	1.16± 0.04^{b}	1.54± 0.06^{a}	1.11 ±0.03^{b}
FER	0.67 ± 0.02^{b}	0.69 ± 0.03^{b}	0.86 ± 0.03^{a}	0.65 ± 0.03^{b}	0.90 ± 0.02^{a}
SGR	0.51 ± 0.02^{b}	0.51 ± 0.03^{b}	0.59 ± 0.02^{a}	0.49 ± 0.02^{b}	0.61± 0.02^{a}
CF (K)	0.82 ± 0.02^{b}	0.83 ± 0.02^{b}	1.05 ± 0.03^{a}	0.81 ± 0.01^{b}	1.09 ± 0.01^{a}
PER	0.82 ± 0.29	0.87± 0.28	0.91 ±0.35	0.79 ± 0.28	0.91 ± 0.34
ANPU	57.15 ± 0.61^{c}	57.70 ± 1.21^{c}	77.46 ± 0.58^{a}	58.69 ± 0.58^{c}	61.50 ± 0.64^{b}
%PU	48.24±1.17^{c}	48.24± 0.60^{c}	63.89 ± 0.57^{a}	47.76 ± 0.59^{c}	54 ± 1.17^{b}
Acceptability	0.15± 0.02^{b}	0.16 ±0.02^{b}	0.15 ±0.02^{b}	0.12 ±0.01^{b}	0.31±0.01^{a}
Time to Strike (s)	9.27± 0.79^{a}	9.74 ± 0.05^{a}	8.96 ± 0.39^{a}	9.74 ± 0.44^{a}	3.85± 0.34^{b}
Feed cost/kg	368.82 ± 0.37^{b}	363.67 ± 0.66^{c}	358.23 ± 1.62^{d}	353.56 ± 0.12^{e}	640 ± 1.36^{a}
Feed cost/kg Gain	549.54±1.73^{b}	527.32±2.89^{c}	415.55±1.73^{d}	544.48±1.17^{b}	710.40±3.18^{a}
% Weight Gain	87.77±0.32^{b}	88.17±0.77^{b}	91.20±1.23^{a}	87.08±1.21^{b}	91.90±0.62^{a}
% Length Gain	76.33±1.95	76.36±2.02	77.32±0.68	76.68±1.37	77.16±1.60

$^{a, b, bc, c, d, e}$ Mean values in a row with different superscripts are significantly ($P < 0.05$) different from each other. AV. INIWT = Average Initial weight; AV. FWT = Average Final weight; AV. WTG = Average Weight gain; FCR = Feed conversion ratio; FER = Feed efficiency ratio; CF = Condition factor; SGR = Specific growth rate, PER = protein efficiency ratio; ANPU = apparent net protein ultilization; %PU = Percentage protein ultilization, SR = survival rates

Table 6: Male haematological parameters of African catfish Clarias gariepinus fed graded levels of Jatropha curcas leaf meal inclusion

Parameters	T_1(Control)	T_2 (1.5%)	T_3 (3.0%)	T_4 (4.5%)	T_5(Coppens)
Hb (g/dl)	13.67 ±0.01^{b}	15.0±0.52^{a}	15.33±0.56^{a}	14.36±0.49^{ab}	15.33±0.43^{a}
PCV (%)	33.17±0.44	33.90±1.13	33.67±1.20	32.0±1.16	34.50±0.87
RBC ($x10^6mm^{-3}$)	2.55±0.04	2.73±0.08	2.60±0.04	2.76±0.20	2.73±0.06
WBC (mm^{-3})	20.97±0.30	22.23±0.99	20.69±1.88	20.87±0.41	22.67±0.56
L	22.17±1.90	33.47±2.62	33.24±2.00	34.27±2.74	33.52±1.23

N	61.17±0.52	62.60±1.87	63.47±1.72	62.63±2.00	63.03±0.83
M	2.07±0.37	2.23±0.47	2.60±0.53	3.17±0.34	3.20±0.35
PLT (%)	107.83±1.30[b]	112.0±4.16[ab]	125.67±3.38[a]	123.67±4.18[ab]	124.0±8.33[ab]
MCV (fl)	130.52±3.47[a]	120.49±1.45[b]	126.49±0.03[ab]	119.68±4.20[b]	126.13±0.37[ab]
MCH (pg)	54.16±1.19[a]	50.98±0.45[ab]	52.55±0.05[a]	48.91±1.14[b]	52.81±0.41[a]
MCHC (g/dl)	41.51±0.19[ab]	42.92±1.09[a]	41.85±0.03[ab]	40.27±0.06[b]	41.85±0.21[ab]

[a, ab, b] Mean values in a row with different superscripts are significantly ($P < 0.05$) different from each other.
Hb = Haemoglobin Concentration; PCV = Packed Cell Volume; RBC = Red Blood Cell; WBC = White Blood Cell; L = leucocyte; N =Neutrophyl; M = Monocyte; PLT = Blood Platelet; MCV = Mean Corpuscular Volume; MCH = Mean Corpuscular Hemoglobin; MCHC = Mean Corpuscular Hemoglobin Concentration

Table 8: Mean female haematological parameters of African catfish Clarias gariepinus fed graded levels of JLM

Parameters	T_1(Ctrl)	T_2 (1.5%)	T_3 (3.0%)	T_4 (4.5%)	T_5(Coppens)
Hb (g/dl)	14.13±0.41[c]	15.57±0.38[ab]	15.95±0.18[a]	14.90±0.25[bc]	16.03 ±0.30[a]
PCV (%)	36.02±0.38	36.45±1.19	37.51±1.06	35.93±0.92	37.20± 0.94
RBC($x10^6mm^{-3}$)	4.11±0.27	3.45±0.09	4.18±0.18	3.78±0.26	4.0±0.41
WBC (mm^{-3})	22.25±0.45	23.37±1.19	22.67±1.80	21.70±0.91	23.63±0.44
L	63.07±1.18	64.0±2.13	65.17±2.04	65.27±1.92	65.40±1.04
N	34.90±1.57	37.07±1.24	34.87±2.17	35.40±1.60	32.63±0.80
M	2.27±0.19	2.53±0.20	2.43±0.32	2.97±0.19	2.77±0.44
PLT (%)	116.0±3.06	115.67±3.18	129.0±0.58	125.0±5.50	120.0±5.77
MCV (fl)	88.29±4.90	92.79±1.37	89.79±1.40	95.85±0.67	93.05±1.46
MCH (pg)	34.68±2.49	39.44±1.60	38.68±1.80	39.73±2.54	40.11±0.39
MCHC (g/dl)	39.26±1.47	42.80±1.84	42.58±0.95	41.49±0.50	43.12±0.30

[a, ab, bc, c,] Mean values in a row with different superscripts are significantly (l$P < 0.05$) different from each other.
Hb = Haemoglobin Concentration; PCV = Packed Cell Volume; RBC = Red Blood Cell; WBC = White Blood Cell; L = leucocyte; N =Neutrophyl; M = Monocyte; PLT = Blood Platelet; MCV = Mean Corpuscular Volume; MCH = Mean Corpuscular Hemoglobin; MCHC = Mean Corpuscular Hemoglobin Concentration

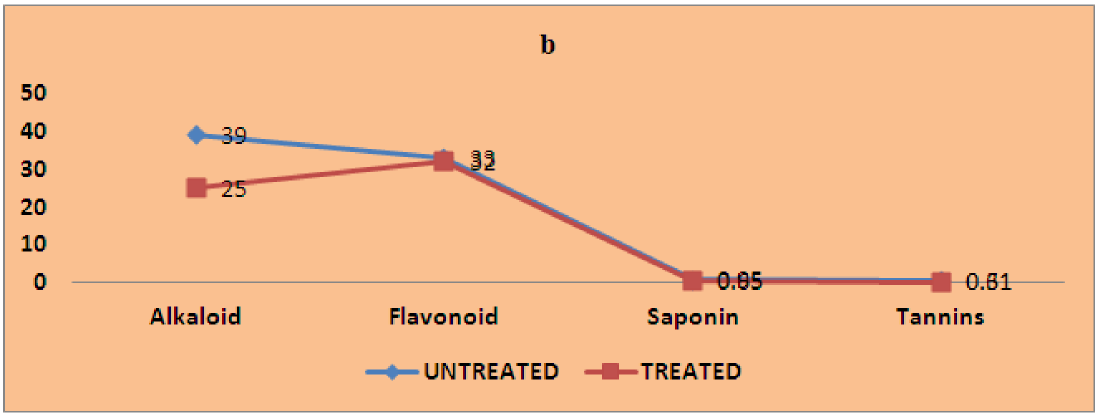


Figure one: Phyto-chemical composition of treated (soaked) and untreated (not soaked) *Jatropha curcas* leaf meal.

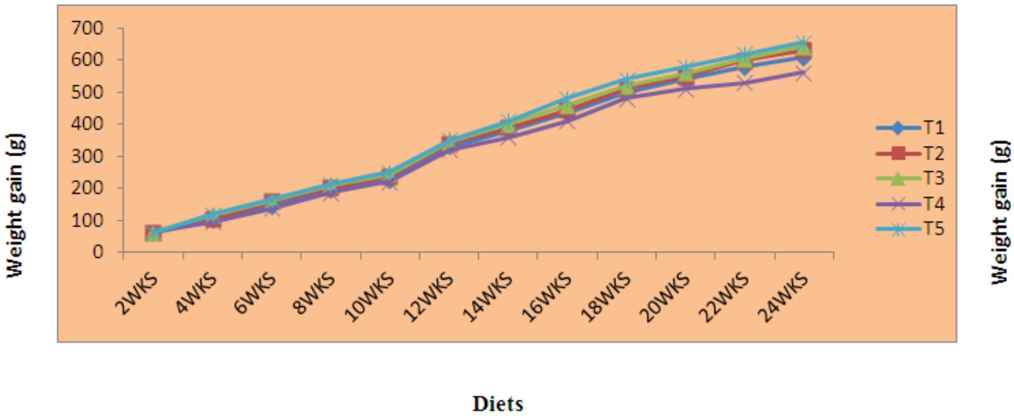
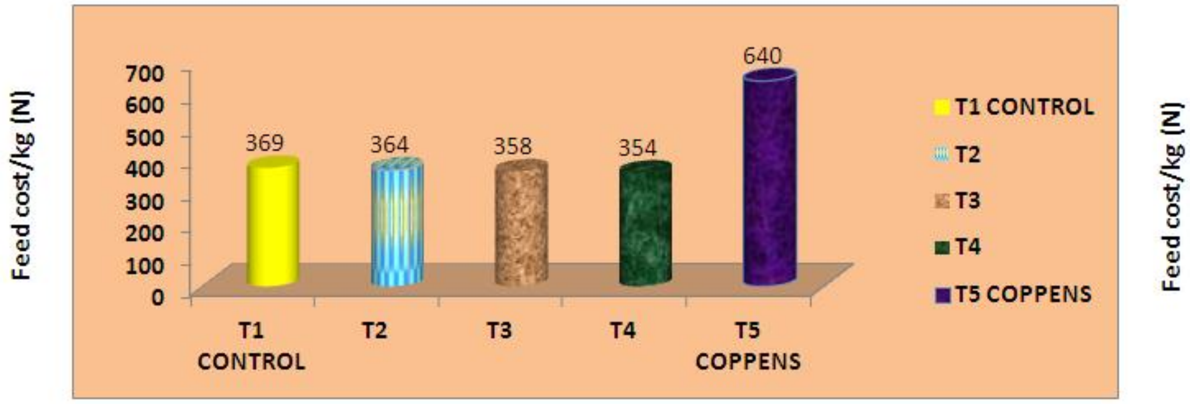
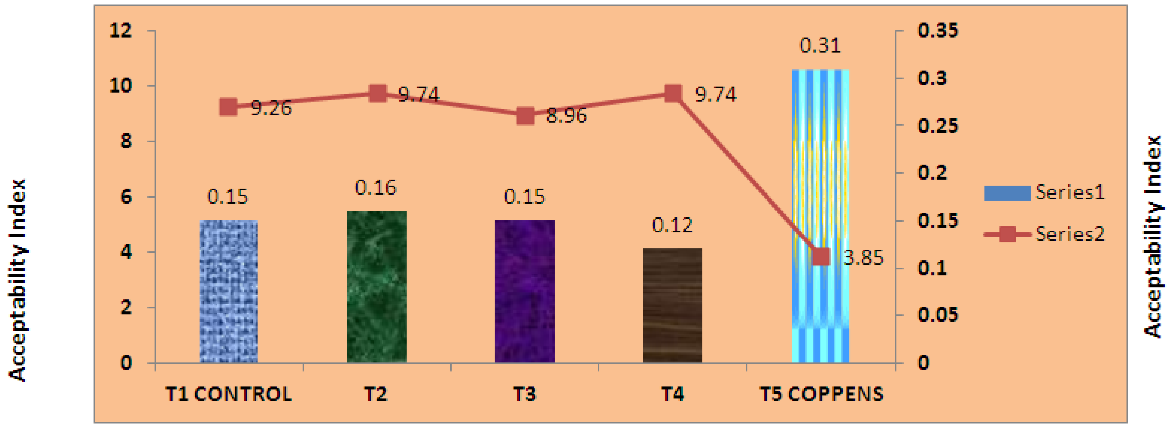


Figure two: The graph represents the growth pattern of African catfish fed graded levels of *J. curcas* leaf meal measured on fortnightly basis.



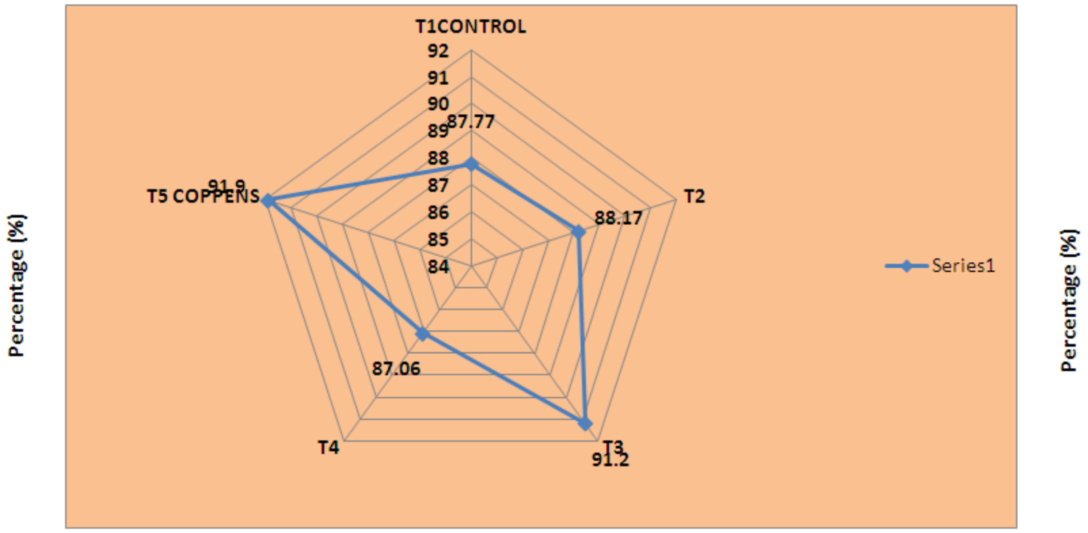
Diets

Figure three: Graph representing the feed cost/kg weight of the experimental diets fed African catfish.



Diets

Figure four: Time to Strike and Acceptability index of African catfish fed varying levels of *J. curcas* leaf meal.



Diets

Figure five: The graph representing the percentage growth rate of African fish fed varying levels of *J. curcas* leaf meal.

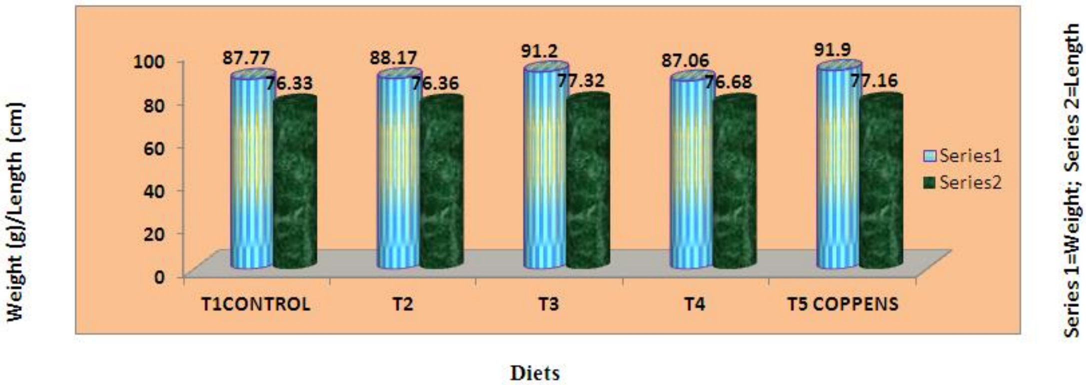


Figure six: Weight-length relationship of African catfish fed graded levels of *J. curcas* leaf meal

V. Conclusion

The study has been able to reveal that *J. curcas* leaf meal could be a veritable source of feed ingredients for *Clarias gariepinus* without any detrimental effects on their growth performance and nutrient utilization. The study showed that the treatment diets were able to compete favourably with treatment 5 (coppens) as there were no significant different ($p > 0.05$) between T_3 and T_5 in almost all the parameters evaluated. The feed cost per kg weight were significantly ($p<0.05$) cheaper in those treatment diets that had inclusion of *J. curcas* leaf meal. The haematological parameters obtained showed that all the values were within the normal range of African catfish of their age and size. Thus, were able to show that JLM did not exhibit any detrimental effects on the animals. The improved values recorded in the haematological parameters as the inclusion levels increased were able to distinctively proof the nutritional efficacy JLM. I therefore advice farmers to adopt the use T_3 diet (7%) for improved growth rate as well as increased profit margins.

VI. Recommendation

I therefore recommend that fish farmers should adopt the use of T_3 diet for better growth performance and reduced cost of production for *Clarias gariepinus* aquaculture.

References

[1]. Association of official Analytical chemists (AOAC) (1990). Official method of analysis K. Helrich (ed). 15th edn, vol 1, AOAC, Arlington, VA, 684 pp. Agrien G, Liede

[2]. Abubakar M. Y., Ipinjolu, J. K., Hassan , W. A. and Alegbeleye, W. O. (2013). Survival and growth of C. gariepinus (burchell, 1822) fry on cultured zooplankton and decapsulated arttemia. Scientific Journal of Zoology 2(6) 54-63.

[3]. Achionye-Nzeh, G. C., Olumuji, K., Bello, N. (2012). Effect of artmianauplii and formulated diets on growth and survival of larvae and pot larvae of *C. gariepinus* (L) International Journal of Life Science And Pharmaceutical Research 2(2): 29-34.

[4]. Adejoro, F.A., Ijadunola, T.I., Odetola, O.M. and Omoniyi, B.A. (2013). Effect of Sun-dried, soaked and cooked wild cocoyam (*Colocasia esculenta*) meal on the growth performance and carcass characteristics of broilers. *Livestock Research for Rural Development*. 25(6): 9pp

[5]. Adewolu, M.A. (2008). Potentials of sweet potato (*Ipomoea batatas*) leaf meal as Dietary ingredient for *Tilapia zilli* fingerlings. *Pakistan Journal of Nutrition*, 7(3): 444-449.

[6]. Adene, I. C., (2020). Growth performance and feed ultilization sufficiency of juvenile catfish (Clarias gariepinus) fed heat processed and dehulled Jactropha curcas meal. Global Journal of Agricultural Research. Vol. 8 (2) pp 1-6.

[7]. Adewolu, M.A. and Adamson, A.A. (2011). *Amaranthus spinosus* Leaf Meal as Potential Dietary Protein Source in the Practical Diets for *Clarias gariepinus* (Burchell, 1822) f*ingerlings*. *International Journal of Zoological Research, 7:128-137.*

[8]. Afunga, W., Siddhurju, P. and Becker, K., (2003). Comparative evaluation evaluation of raw methanol extracted residues and methanol extracts of (*Moringa olifera* Lam.) leaves on growth performance and feed utilization in Nile Tilapia (*Oreochromis niloticus* L.) Aquaculture Research. Vol.34: 1147 – 1159.

[9]. Akinrotimi, O.A., Bekibele D.O., Orokotan, O.O. (2011). Selected haematological values of African catfsh (Clarias gariepinus) raised in water recirculating system. International Recirculating Aquaculture 12**,** 1-12.

[10]. Akinrotimi, O.A., Orlu, E.E., Gabriel, U.U. (2013). Haematological Responses of Tilapia guineensis treated with industrial effluents. Applied Ecol Environment Sci 1, 10-13.

[11]. Anyanwu DC, Umeh OI,Maduka BC,Mbchu MU (2012).Nutrient utilization and growth of catfish *(Clarias gariepinus* fed dietary levels of cassava leaf meal. Pak. J. Nutr.11(11):1037-1040.

[12]. AOAC., 1990. Official Method of Analysis. 15th Edn., Association of Official Analytical Chemists (AOAC), Washington, DC., USA

[13]. Azza A. Abou-Arab and Ferial M. Abu-Salem (2010). Nutritional quality of *Jatropha curcas* seeds and effect of some physical and chemical treatments on their anti-nutritional factors. African Journal of Food Science Vol. 4(3) pp. 93-103.

[14]. Baker, F. J. and R. E. Silverton (1985). Introduction to Medical Labouratory Technology. Butter Worth and Co-publishers Ltd. 6th ed. Pg. 12-14.

[15]. Barbara, A.B. (1975). Hematology: Principle and Procedures. Published in Great Britain by Henry Kempton Publishers London. Pp 71-87.

[16]. Bichi, A. H. ; Ahmad, M. K., (2010). Growth performance and nutrient utilization of African Catfish (*Clarias gariepinus*) fed varying dietary levels of processed cassava leaves. *Bayero J. Pure Appl. Sci.*, 3 (1): 118-122.

[17]. Duncan, B.D. (1955). Multiple Range and Multiple F-Tests. Biometrics 11: 1-42.

[18]. Eesa Jasim Mohammed Al-Gburi and Saeed AbdualsadaAl-Shawi (2019). Effect of water hyacinth leaves (*Eichhornia crassipes*) substitution with maize on some growth parameters of common carp(*Cyprinus carpio*) Plant Achives vol. 19, Supplement 2, pp 1833-1835

[19]. Ezeagu, I. E. Ologbobo, A. D. Akinsoyimu, A. O. and T ona, G. O. (2002). Haemato,-BIO chemistry of albino rats fed African Kudzu (*Puriera phaseulides* Roxb. Benth) seed dust. Trop. J. Anim. Science.5 (2): 109-114.

[20]. Fabgenro, O. A., Balogun, A. M. and Anyanwu C. N. (1999). Optimal dietary protein level for *Heterobranchus bidorsalis* fingerlings fed compounded diets. *Isr. J. Aquacult*. Bamidach 44: 87-92.

[21]. FAO, (2018).The State of World Fisheries and Aquaculture. FAO Fisheries and Aquaculture Department, Food and Agriculture Organization of the United Nations, Rome, Italy, cited March 2018) www.fao.org./e/fisheries/proc. htm.

[22]. Francis G., Makkar, HPS and K. Becker. (2001). Antinutritional factors present in plant-derived alternate fish feed ingredients and their effects in fish. 199, 197-227.

[23]. Gabriel UO, Akinrotimi OA, Ananwu PE, Bekibele DO , Onunkwo DN (2007). Locally produced fish feed potential for aquaculture development in sub-Saharan Africa. J. Agric. Res. 2:287-295.

[24]. Hassan, M., Wakil, U. B., A. I. Gamawa (2017). Effects of Cassava Leaf Meal on growth performance and utilization of African catfiah in the semi arid zone of Nigeria. International journal of science and Technology vol. 6 (2) pp 689 – 694.

[25]. Hilton, J. W. Atkinson, J. L. and Slinger, S. J. (1983). Effect of increased dietary fiber on the growth of rainbow trout (*Salmo gairdneri*). Canadian Journal of and Fish Aquatic Sciences, 40: 81-85.

[26]. Ikurior, S. A. (1993). Replacement of dietary soyabean meal protein with that from roasted or cooked full fat soyabean for weaner grower pigs. Trop. Oil seed J., 1: 90 - 97.

[27]. Kawaguchi H., Yamada, T., Naoki, M., Takahashi, Y., Yoshikawa, T., Izumi, H., Kawaguchi, T., Miyoshi, N. and A. Tanimoto (2012). Reference values of Haematological and Biochemical Parameters for the world Smallest Micromini pigs. J. Vet. Med. Sci. 74 (7): 933-936.

[28]. Kumar, V., Khalil, W. K., Weiler, U. and Becker, K. (2013). Influences of incorporating detoxified *Jactropha curcas* kernel meal in common carp (*Cyprinus carpio* L.) diet on the expression of growth factor-1- encoding genes. J. Anim. Physiol. Nutr. (Berl) 97 (1) 97-108 doi:10.1111/J.1439-0396,2011.01247.x

[29]. Lipton D, and Harrel R (2004). Figuring Production Cost in Finfish aquaculture. Publication number: UM-SG-MAP-90:02. 10 p.http://www.mdsg.umd.edu/ Assessed August 12, 2011.

[30]. Olaniyi, c. o. Babasanmi G. O. (2013). Performance Characteristics of African catfish (*Clarias gariepinus*) fed varying inclusions of silk worm pupae (*Anaphe infracta*) 42 (1), 76-80

[31]. Oluyemi K., Gbadamosi and Nelson R. Osungbemiro (2016). Growth and nutritional performance of African catfish *Clarias gariepinus* (Burchell, 1922) fed varying inclusion levels of dietary *Moringa olifera* leaf meal. Livestock Research for Rural Development. Vol.: 28 (11).

[32]. Osuna-Canizales, F. J., Atkison , C. J., Vazquez-Alvarado, J. M. P., Barrios-Gomez, E. J. Hernandez-Arenas, M., Rengel-Estrada, S. E. , Cruz-Cruz, E. (2015) State of the art of Science and Technology for production and processing non toxic *Jatropha curcas*. Secretaria de Agricultura, Ganaderia, Desarrolla rura, PescayAlimentacio. institutoNacional de investiacionesForestales, Agricolas y Pecuarias. Centrom de investigacion Regional pacific sur. Camp Experimental Zacatepec. Mexico.Special publication. 60: 100pp

[33]. Ozigbo, E., Anyadike, C., Adegbite, O. and Kolawole, P. (2014). Review of aquaculture production and management in Nigeria. *American Journal of Experimental Agriculture*. 4(10): 1137-1151. http://www.sciencedomain.org.

[34]. Phillips, G.D. (1984). Feed utilization: Principles and new development in physiology Can. J. Anim. Sci. 64: Pp 543-549.

[35]. Richter, N., Siddhuraju, A. and Becker, K., (2003). Evaluation of nutritional quality of moringa (Moringa olifera Lam.) leaves as alternative protein source for Tilapia (Oreochromis niloticus L.) Aquaculture, 217: 599-611.

[36]. Sarah O. M. and Victor T. O. (2018). Nutritional values of hydrothermally processed *Jactropha curcas* kernel meal and its effects on growth and haematological parameters of (*Clarias gariepinus*: Burchell, 1822) fingerliongs

[37]. Shiau, S. Y. (1997). Utilisation of carbohydrates in warmwater fish – with particular reference to tilapia, *Oreochromis niloticus* x *O. aureus* .Aquaculture 151 (1-4):79-96.

[38]. Singh, R.K., Singh, D., Mahendrakar, A.G. (2010). *Jatropha* poisoning in children. Medical Journal of Armed Forces India, 66: 80-84

[39]. Sotolu, A. O. and Sule, S. O. (2011). Digestibility and performance of water hyacinth meal in thediet of African catfish (*Clarias gariepinus*: Burchell, 1822). Tropical abd subtropical agroecosystem.. 14: 245-250.

[40]. Spinelli, J. Houle, C. R. and Wekell, J. C. **(**1983). The effect of phytates on the growth of rainbow trout (*Salmo gairdneri*) fed purified diets containing varying quantities of calcium and magnesium. Aquaculture 30 (1-4):71-83. Sowummi, A.A. (2003) Hematology of the African catfish (*Clarias gariepinus*) from Eleyele Reservoir, Ibadan South-West Nigeria. *The Zoologist* 2:85-91.

[41]. Sowummi, A.A. (2003) Hematology of the African catfish (*Clarias gariepinus*) from Eleyele Reservoir, Ibadan South-West Nigeria. *The Zoologist* 2:85-91.

[42]. Steel, R.G.D. and Torie, J.A. (1981). Principles and Procedures of Statistics. Bionietrical Approach. 2nd Edition. MCGraw - Hill. International, Auckland. 102pp.

[43]. Tiamiyu, L. O., Okomoda, V.T.N., and Agbo A. O. (2015). Ntritional suitability of leucana leaf meal in the diets of Clarias gariepinus. Journal of Fishery Science.

[44]. Valdes-Rodrigues, O. A., Sanchez-Sanchez, O., Perez-Vazques, A., Caplan, J. (2013). The Mexican non toxic Jactropha curcas L. Food resources or biofuel? Ethanobotany Research and Application. 11: 001-007.

Onu, Ernest Onyemaechi. “Growth Performance and Haematological Indices of African Catfish (Clarias Gariepinus Burchell 1822) Fed Graded Levels Of Processed Jatropha Curcas Leaf Meals In Southeastern Zone Of Nigeria.” *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, 14(1), 2021, pp. 27-37.