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Growth Performance and Nutrient Utilization of Fermented Cocoa Husk Meal in the Diet of *Clarias gariepinus* (Burchell, 1822) Fingerlings

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Abstract
This study investigated the use of fermented cocoa husk meal (FCHM) as a dietary ingredient for *Clarias gariepinus*. The proximate composition of FCHM revealed a crude protein content of 15.94% and a crude fiber content of 48.39%. Four experimental diets were formulated to contain varying levels of FCHM, and a control diet was formulated using commercial feed. *Clarias gariepinus* fingerlings were fed the experimental diets for 56 days. Growth performance, nutrient utilization and hematological parameters were evaluated. The results showed that fish fed the diet containing 25% FCHM (D2) had the highest mean final weight, mean weight gain, and specific growth rate. The feed conversion ratio (FCR) and protein efficiency ratio (PER) were also improved in fish fed the D2 diet. Hematological parameters, including white blood cell count, red blood cell count, and hemoglobin, were within normal ranges for fish fed all the experimental diets. The study concludes that FCHM can be used as a dietary ingredient for *Clarias gariepinus*, and a diet containing 25% FCHM can support optimal growth performance and nutrient utilization without any detrimental effect on the haematology of the fish.

Keywords: FCHM, *Clarias Gariepinus*, Growth Performance, Nutrient Utilization, Haematological Parameters

Introduction
Cocoa husk is a byproduct of cocoa processing that is obtained from the outer covering of the cocoa bean (Aderolu et al., 2020). Meal (2024) reported that a waste by-product of the cocoa industry, CPH is obtained by removing the cocoa beans from the fruits. CPH makes up 70%–80% of the dry weight of the whole fruit. It has three distinct layers: epicarp, mesocarp, and endocarp or outer, middle, and inner layer, respectively. The fruit is oval, rough, and thick. It comes in different colours, depending on the variety and the rough texture protects it against natural elements, plagues, and damage from impacts. Its high nutritive value and bioactive compounds make it a potential raw material for a wide range of activities. The increasing organic waste has environmental and financial burden on the processing industry. So, solution of this problem depends on the development of new technologies for the efficient use of raw materials in the production process. Cocoa husk is rich in protein, dietary fiber and ash, and other valuable biologically active compounds, such as methylxanthines and phenols (Grechkina et al., 2021). The fermentation of cocoa husk can enhance its nutritional value by increasing its protein content and reducing its anti-nutritional factors, which can improve its suitability as a fish feed ingredient. Several studies have demonstrated the potential of fermented cocoa husk meal as a feed ingredient for various fish species, including tilapia and catfish (Oluwaniyi et al., 2018; Adeniyi & Omitogun, 2019; Ajani et al., 2020). Several studies have demonstrated the potential of cocoa husk meal as a feed ingredient for various fish species, including tilapia and catfish (Obirikorang et al., 2013) and (Ajani et al., 2020). This study justifies the utilization of fermented cocoa husk meal on growth of *Clarias gariepinus* fingerlings

Materials and Methods
Study Area
The experiment was conducted at the wet laboratory of Department of Fisheries, Faculty of Agriculture, Modibbo Adama University, Yola, Adamawa State.

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Sample Collection and Preparations

Fresh cocoa husks were collected from cocoa farm in Ussa LGA, Taraba State. They were cleaned and sun-dried before transported to the laboratory in Yola, Adamawa state. The cocoa husk size was reduced and was fermented for seven (7days) under laboratory condition, then sun-dried, mill to fine powder.

Preparation of Experimental Diets

40% crude protein diet were formulated with varying inclusion levels of fermented cocoa husk meal as a partial replacement of soybean meal with other feed ingredients and were analyzed for proximate composition according to (AOAC, 2005) method, Table 1.

Table 1: Formulation and Nutrient Composition of Experimental Diets with varying inclusion levels of Cocoa Husk Meal

Ingredient	**Control** 0%	**D1** **5%**	**D2** **10%**	**D3 15%**	**D4** **20%**
Feed ingredients (kg/100kg)					
Fish Meal (60%)	20.00	20.00	20.00	20.00	20.00
Soya Bean (48%),	25.00	23.75	22.50	21.25	20.71
Fermented Cocoa Husk (15.94%)	0.00	1.25	2.50	3.75	5.00
Groundnut Cake (44%)	25.00	25.00	25.00	25.00	25.00
Maize (10%)	25.00	25.00	25.00	25.00	25.00
Vitamin Premix	0.5	0.5	0.5	0.5	0.5
Calcium	1	1	1	1	1
Salt	1	1	1	1	1
Palm Oil	1	1	1	1	1
Lysine	0.5	0.5	0.5	0.5	0.5
Methionine	0.5	0.5	0.5	0.5	0.5
Starch	0.5	0.5	0.5	0.5	0.5
Analysed Nutrient Content, %DM					
Crude protein	39.94	39.63	39.31	39.00	38.75
Fibre	4.90	4.11	4.82	4.80	4.86
Lipid	20.00	21.00	19.50	21.00	21.03
Ash	9.50	6.46	6.00	5.50	10.00
Moisture	12.50	13.00	10.00	9.50	8.00
Nitrogen free extract	13.16	15.80	20.37	21.30	17.35

Experimental Setup

Ten (10) plastic bowls of equal size and volume (30 L) was used for the experiment. Each bowl was stocked with 10 *Clarias gariepinus* fingerlings.

Fish Stocking and Feeding

One hundred (100) *Clarias gariepinus* fingerings was procured from a hatchery and acclimatized to the experimental conditions for a week before the commencement of the feeding trial. Fishes were fed twice daily for 56 days at 5% body weight. Feed was offer manually and unconsumed feed were siphoned after five hours of feeding.

Data Collection

Nutrient Utilization and Growth Performance

Fish in each treatment had their initial weight and length measured every two weeks. The new weight was used to modify the feed rations. The fish's growth performance was assessed using their weight and length, and the nutrient utilization parameters were ascertained using the methods and the feed that was provided.

Growth Performance (GP)

Weight gain (g)

The total and mean weight gains were calculated for each replicate and treatment as follows:

Weight gain / fish (g/fish) = (Wf – Wi)

Mean weekly weight gain (g/week) = $\frac{W_{f-W_i}}{n}$

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Where:
Wf = final weight of fish at the end of the experiment
Wi = Initial weight of fish at the beginning of the experiment
n = Number of weeks.

Relative growth rate (RGR)

This is the percentage ratio of the weight gain to the initial body weight and was determined as follows:

$$RGR\ (\%) = \frac{Wf - Wi}{Wi} \times 100$$

Specific Growth Rate SGR (%/day)

This represents the percentage of weight gain per day and was calculated using the formula:

$$SGR\ (\%/day) = \frac{\log Wf - \log Wi}{t} \times 100$$

Where:
Log Wf = Logarithm of the fish final weight
Log Wi = Logarithm of the fish's initial weight
t = Experimental period in days

Condition factor (K)

This represents the fish health status as a result of the experimental treatment and was calculated using Fulton's condition factor formula at the start and finish of the experiment (K1 and K2) as follows:

$$K = \frac{100W}{L^3}$$

Where:
W = Weight of fish
L = Length of fish

Survival Rate (%)

$$SR\ (\%) = \frac{Nf}{Ni} \times 100$$

Where:
Ni = Number of cultured fish stocked at the beginning of the experiment
Nf = Number of fish alive at the end of the experiment

Feed Utilization

Feed intake (FI)

This is taken as the addition of the amount of feed supplied during the experimental period.

$$FCR = \frac{\text{Feed Intake}}{\text{Weight gain (g)}}$$

Protein intake (PI)

This is the numerical value of the amount of protein in the feed fed to the fish during the experiment, Getso et al. (2017).

Protein Intake = Feed Intake X Crude protein

Protein Efficiency Ratio (PER)

Growth is used by this index to gauge the nutritional content of dietary protein as

$$PER = \frac{\text{Mean weight gain (g)}}{\text{Mean Protein Intake (g of protein in 100g of diet/fish)}}$$

Determination of Water Quality Parameters

The NIFFR (National Institute for Freshwater Fisheries Research, New Bussa, Niger State, Nigeria) innovative multitec kit (2010) was used to measure water quality parameters like temperature, pH, Dissolved oxygen, and ammonia concentration every two weeks prior to feeding. Ammonia was measured by titration method.

Haematological Examination

Blood Sample Collection

Three live fish samples from each treatment were taken out at the conclusion of the feeding trials.
according to Sveier et al. (2000) method. Using a different heparinized 10 ml disposable syringe, 10 ml of blood was drawn from each fish's caudal peduncle. The blood was then stored in appropriately labeled, sterilized bottles (EDTA-01A-500) that contained EDTA (ethylene diamine tetra-acetic acid) as an anticoagulant, and it was taken to the laboratory for analysis in accordance with Sveier et al. (2000).

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Haematocrit (PCV)
Suction pressure was used to fill 75% of the heparinized capillary tubes with blood samples, and plasticine was used to seal one end. A haematocrit centrifuge (CFG-12D) was used to centrifuge the tubes for five minutes at 3000 r.p.m. A haematocrit reader was used to read the packed cell volumes (PCV). Percentages were used to express the results.

Haemoglobin concentration (Hb)
The Sveier et al. (2000) cyanmethemoglobin method was applied. Four milliliters of modified Drabkins solution, a concoction of 250 mg potassium ferricyanide, 200 mg potassium cyanide, and 50 mg potassium dihydrogen phosphate were mixed with 0.02 milliliters of thoroughly mixed blood. The mixture was then diluted to one liter using distilled water. After letting the mixture stand for thirty-five minutes, the concentration of hemoglobin (g/dl-1) was measured photometrically by comparing it to the cyanmethemoglobin standard using a yellow-green filler at 625 nm.

Leucocyte count (WBC)
Using a 0.8 cm microscope objective and large squares (area = 1mm2, depth = 0.1mm), a hemocytometer was used to determine the Leucocyte count. The volume was 0.1mm3 and the dilution factor was 20. The total counts per mm3 were calculated using four squares.

20 x 1 x L cells ÷ 0.4 = 50 x L cells

Where: L = number of leucocytes counted

Erythrocytes: Red Blood Cells (RBC)
These were determined in heparinized blood diluted by Hayman solution at a ratio of 1:200. Neubauer improved haemocytometer placed on a compound Olympus Microscope (BX51) stage was used to count/estimate the erythrocyte population. The number of cells counted, R (average of two fields) was multiplied by the dilution factor and the volume of 1/4000mm3 (area = 1/4000mm3, depth = 1/10mm3) and counting were done in 80squares with the total volume of 1/50mm3 the dilution factors is 200.
200 x 500 x R cells = 10,000 x R

Determination of Mean Corpuscular Haemoglobin (MCH)
The mean corpuscular haemoglobin (MCH) was calculated using the formula

$$MCH\ (pg) = \frac{Hb}{RBC} \times 10$$

Determination of Mean Corpuscular Volume (MCV)
The mean corpuscular volume (MCV) was calculated as:

$$MCV\ (fL) = \frac{\text{Packed cell volume}}{RBC} \times 10$$

Determination of Mean Corpuscular Haemoglobin Concentration (MCHC)
The mean corpuscular haemoglobin concentration (MCHC) was calculated as

$$MCHC\ (g/dL) = \frac{Hb}{PCV} \times 100$$

Data Analysis
ANOVA, a one-way analysis of variance, was applied to the collected data. IBM SPSS statistics 20 was used to compare significant differences between treatment means using the least significant difference (LSD) at a 5% probability level.

Results
Proximate Composition of Fermented Cocoa Husk Meal (FCHM)
The proximate analysis of the fermented Cocoa husk meal (CHM) is presented in Table 2. The FCHM contained 5.4% moisture, 94.6% dry matter, crude protein was 15.94% while Crude fibre, fat, ash content and Nitrogen free extract (NFE) were 48.39%, 1.84%, 11.25% and 17.18% respectively.

Growth and Nutrient Utilization Parameters of *Clarias gariepinus* Fed Fermented Cocoa Husk Meal for 56 days

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The result of the growth performance of *Clarias gariepinus* fed the experiment diet after 56 days are presented in Table 3. The initial weight of all the fishes fed the experimental diets before the experiment were not significantly ($p > 0.05$) different. Fishes from the D2 group had the highest mean final weight (22.55g) and mean weight gain (17.27g) while D4 group had the least mean final weight (10.89g) and mean weight gain (5.40g). The mean final weight and mean weight gain in the D1 and D4 groups were significantly ($p > 0.05$) different from the value in the control group. The Initial length of the fishes before the experiment were significantly not different ($P>0.05$) from each other. The final length of fishes fed with commercial feed (control) recorded the highest (17.77cm) and that of D1 were the least (11.55cm). The values obtained for D2, D3 and D4 were 14.73, 13.22 and 11.83cm respectively. The initial condition factor was highest in the D1 group (2.10) and least in the D3 group (0.98). The values obtained for D2, control and D4 were 1.45, 1.16 and 1.12 respectively. The final condition factor was 0.73 for D1, 0.71 for D2, 0.66 for D4, 0.65 for D5 and 0.43 for the control group. The values obtained for the initial and final condition factors for all the treatment groups were not significantly different ($P>0.05$).

The result in table 4 shows that the highest specific growth rate (1.15) was recorded in D2 followed by D3, Control, D1 and D4 (0.95, 0.93, 0.62 and 0.54 respectively). The specific growth rate was not significantly different ($P>0.05$) across the different treatment groups. The fishes fed D1 diet recorded highest voluntary feed intake of 0.40 while D2 and D3 had the least protein intake of 0.36. Control and D3 groups had voluntary intake of 0.37 and 0.38 respectively. The voluntary feed intake of the fish fed each of the experimental diets did not differ significantly ($P>0.05$). Fish fed D4 had the lowest growth rate (103.8), while fish fed D2 had the highest relative growth rate (390.4). The fish fed commercial feed (control), D1, and D3 had respective growth rates of 234.2, 124.5, and 242.4. Compared to the fish fed commercial feed (Control), the relative growth rates for D2 and D4 were significantly ($P < 0.05$) different. The fish fed with the commercial feed (Control) and D4 had the best survival rate (90%), the least survival rate of (70%) was recorded in D1. D2 and D3 had a survival rate of 80% each. There was no significant difference ($P>0.05$) in the survival rate of the fish fed with all the experimental diets. The fish fed D2 had the highest protein intake of 214.7 while D4 had the least protein intake. Control, D1 and D3 groups had protein intake of 214.7, 145.9 and 156.2 respectively. The protein intake of the fish fed each of the experimental diets did not differ significantly ($P>0.05$). The range of the feed conversion ratio (FCR) was 0.32 to 0.64. The protein intake of the fish fed each of the experimental diets did not differ significantly ($P>0.05$). The range of the feed conversion ratio (FCR) was 0.32 to 0.64. The fish fed D2 had the least FCR while D4 had the highest. There was significant difference ($P < 0.05$) between the FCR of Fish fed D1 and D4 when compared with the control. The protein efficiency ratio (PER) of the fish fed the experimental diets ranged from 1.53 to 3.17. Fish fed D2 had the highest PER (3.17) while D4 had the least (1.53). There was significant difference ($P < 0.05$) between the PER of Fish fed D1 and D4 when compared with the control.

Water Quality Analysis of the Experimental Tank

Table 4 shows the mean pH, temperature, dissolved oxygen and ammonia of the control group are 7.05 ± 0.04, 25.50 ± 0.24^0C, 3.53 ± 0.00/mg/l and 1.66 ± 0.86/mg/l respectively. The water parameters of the experimental tank do not differ significantly ($P > 0.05$) across the different treatment groups.

Heamatological Profile of *Clarias gariepinus* fed varying levels of Fermented Cocoa Husk Meal

The result in table 5 showed the haematological parameters of *Clarias gariepinus* fed varying levels of Cocoa Husk Meal designated as D1, D2, D3 and D4. D4 group recorded the highest WBC of $147.6x10^3$/µL while D2 recorded 113.7 $x10^3$/µL. The least value was recorded in the control group (11.4 $x10^3$/µL) while D3 and D1 recorded 96.5 and 46.5 $x10^3$/µL respectively. The highest RBC value of $1.96x10^6$ µL was recorded for D4; while the lowest value of $0.47x10^6$µL was recorded for D1. Control, D2 and D3 groups recorded values of 1.24, 1.29 and 0.98 $x10^6$ µL respectively. D3 recorded the highest value (8.9g/dL) for haemaglobin (Hb), D1 recorded the least (3.1 g/dL). The MCV value of 111.9, 111.6, 110.6, 107.8 and 103.0fL were recorded in control, D4, D2, D3 and D1 respectively. MCH values of 66pg marked the highest for D1, while MCH values of 39.9pg marked the lowest in D3. The highest value of MCHC of 64.6g/dL was recorded in D1; while D3 recorded the lowest value of 36.8g/dL. Platelet count of $107x10^3$ µL was recorded in the Control group which marked the highest and $6.4x10^3$µL in D4 marked the lowest. The values for PCV was highest in the D3 group with a value of 26.7 while the lowest was in the D1 group (9.3). Control, D2 and D4 recorded values of 16.5, 17.7 and 24.3 respectively.

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Table 2: Proximate Analysis of Fermented Cocoa Husk

Parameters	Values (%)
Dry Matter	94.6
Moisture	5.4
Crude Protein	15.94
Crude Fibre	48.39
Fat	1.84
Ash	11.25
NFE	17.18

Table 3: Growth and Nutrient Utilization Performance of *Clarias gariepinus* fed varying levels of Fermented Cocoa Husk Meal

Parameters	Control	D1 (25%)	D2(50%)	D3 (75%)	D4 (100%)
Initial Weight	6.06 ± 0.44	5.030 ± 0.10	5.095 ± 0.26	4.475 ± 0.67	5.490 ± 1.48
Final Weight	20.18 ± 0.74^{b}	11.28 ± 1.70^{d}	22.55 ± 2.73^{a}	15.47 ± 4.22^{c}	10.89 ± 0.79^{d}
Mean Weight Gain	14.12 ± 1.18^{b}	6.25 ± 1.80^{d}	17.27 ± 2.72^{a}	10.99 ± 3.55^{c}	5.395 ± 0.70^{d}
Initial Length	8.07 ± 0.38	7.10 ± 0.57	7.07 ± 0.19	7.68 ± 0.31	7.58 0.53
Final Length	17.77 ± 4.62^{a}	11.55 ± 0.26^{d}	14.73 ± 1.41^{b}	13.22 ± 0.72^{c}	11.83 ± 0.28^{d}
Initial Condition Factor	1.16 ± 0.08	2.10 ± 1.26	1.45 ± 0.05	0.98 ± 0.03	1.12 ± 0.25
Final Condition Factor	0.43 ± 0.30	0.73 ± 0.06	0.71 ± 0.13	0.65 ± 0.05	0.66 ± 0.00
Specific growth rate	0.93 ± 0.09^{b}	0.62 ± 0.13^{c}	1.15 ± 0.12^{a}	0.95 ± 0.10^{b}	0.54 ± 0.15^{c}
Voluntary Feed Intake	0.37 ± 0.03	0.40 ± 0.02	0.36 ± 0.04	0.36 ± 0.02	0.38 ± 0.04
Relative Growth Rate	234.2 ± 36.44^{b}	124.5 ± 38.30^{c}	390.4 ± 0.14^{a}	242.4 ± 42.94^{b}	103.8 ± 40.82^{d}
Survival	90.00 ± 0.00^{a}	70.00 ± 14.14^{c}	80.00 ± 14.14^{b}	80.00 ± 0.00^{b}	90.00 ± 14.14^{a}
Protein Intake	214.7 ± 21.60^{a}	145.9 ± 21.15^{c}	216.8 ± 39.39^{a}	156.2 ± 39.27^{b}	132.5 ± 5.28^{d}
Feed Conversion Ratio	0.38 ± 0.01^{b}	0.60 ± 0.09^{a}	0.32 ± 0.01^{b}	0.37 ± 0.03^{b}	0.64 ± 0.11^{a}
Protein Efficiency Ratio	2.63 ± 0.05^{b}	1.68 ± 0.25^{c}	3.17 ± 0.12^{a}	2.72 ± 0.20^{b}	1.53 ± 0.19^{c}

Mean values in the row with superscript are significantly ($p < 0.05$) different

Table 4: Mean Water Quality Parameters of Fish Fed Fermented Cocoa Husk Meal

Parameters	Control	D1 (25%)	D2(50%)	D3 (75%)	D4 (100%)
Ph	7.05 ± 0.04	7.02 ± 0.08	6.94 ± 0.10	7.18 ± 0.20	7.00 ± 0.02
Temperature (^{0}C)	25.50 ± 0.24	25.33 ± 0.00	25.33 ± 0.00	25.50 ± 0.23	25.00 0.05
Dissolve Oxygen (mg/l)	3.53 ± 0.00	3.87 ± 0.47	3.53 ± 0.00	3.87 ± 0.47	3.87 ± 0.47
Ammonium (mg/l)	1.66 ± 0.86	1.66 ± 0.86	1.05 ± 0.00	2.27 ± 1.72	2.88 ± 0.86

Note: Mean values in the same row do not differ significantly ($P > 0.05$)

Table 5: Heamatological Profile of *Clarias gariepinus* fed varying levels of Fermented Cocoa Husk Meal

Parameters	Control	D1	D2	D3	D4
WBC ($x10^{3}$/µL)	11.4^{e}	46.4^{d}	113.7^{b}	96.5^{c}	147.6^{a}
RBC ($x10^{6}$/µL)	1.24^{b}	0.47^{c}	1.29^{b}	0.98^{c}	1.96^{a}
Hb (g/dL)	5.5^{b}	3.1^{c}	5.9^{b}	8.9^{a}	8.1^{a}
HCT (%)	13.8^{c}	4.8^{e}	14.3^{b}	10.6^{d}	21.9^{a}
MCV (fL)	111.9^{a}	103^{c}	110.6^{a}	107.8^{b}	111.6^{a}
MCH (pg)	44.4^{b}	66^{a}	45.7^{b}	39.9^{d}	41.3^{c}
MCHC (g/dL)	39.6^{c}	64.6^{a}	41.3^{b}	36.8^{d}	38.7^{c}
PLT ($x10^{3}$/µL)	107^{a}	51^{b}	12.6^{d}	42^{c}	6.4^{e}
PCV	16.5^{c}	9.3^{d}	17.7^{c}	26.7^{a}	24.3^{b}

Values in the row with different superscript differ significantly ($P > 0.05$)

Discussion

Fermentation improves the crude protein value of cocoa husk meal in this study, and this agrees with the report of Meal (2024) where Cocoa Husk Meal was fermented with A. oryzae enzyme and fed to sheep. Fermented Cocoa Husk diet has crude protein (38.75% - 39.94%), which is within the range of 39.75% - 43.75% in African palm (Agbanimu & Adeparusi, 2020), 39.96 - 40.08% in tropical almond kernel meal (Elezuo et al., 2018) and

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39.10% - 39.88% in Fermented mango seed kernel (Falaye et al., 2021). Weight gain and specific growth rate are typically regarded as the most significant indicators of diet productivity in applied research and practice (Sogbesan et al., 2008) and a trustworthy gauge of economic assessment as a marketable product. According to Sogbesan et al. (2008), the fish's ability to convert the protein in the feed into muscles was demonstrated by the growth that was observed from all experimental diets. According to the report by Hasanna et al. (2018), the control treatment had higher values than the FCe treatment. For the FCe treatments, the 25% and 50% FCe treatments performed better. This study's explanation for the variations in diet acceptability across treatments is consistent with the authors' previous findings (Bake et al., 2015) suggested that when alternative protein sources especially plant protein sources are used in the fish diet, palatability and attractiveness of the diets are usually affected as seen in the case of treatments 50%, 75% and 100% inclusion of fermented *Canavalia ensiformis* diets. The result of the white blood cell is in agreement with the findings of Aderolu & Akinremi (2009) who showed that survival of fish can be correlated with increase in antibody production which helps in the survival and recovery of fish. White blood cell counts are useful as indicators of disease condition or response to infection, and significantly elevated or depressed values are obtained in abnormal conditions. Similarly, it is a function of the immunity and this makes fish resistance to some vulnerable diseases**.** The red blood cells (erythrocyte) counts are used as indicators for anaemia. The erythrocyte counts obtained in this study agrees with the trend (1.33 – 1.77) reported by Erondu et al. (1993) for fresh water fishes but disagrees with the findings of Adedeji, et al. (2000). The packed cell volume (PCV) is an important indicator of the percentage of the packed red blood cells and the colour of the plasma layer above the packed cells, and could be used to detect haemolysis (Michael et al., 2019). According to Fagbenro et al. (2000), oxygen is transported in fish blood both physically and in conjunction with hemoglobin. Since hemoglobin's function is directly tied to blood's ability to bind oxygen, it is essential to the fish's survival. While the mean corpuscular hemoglobin concentration (MCHC) was higher than that reported by Adedeji et al. (2000) and Torsabo et al. (2019), the results of this study are lower than those of Torsabo et al. (2019). However, they are consistent with the findings of Michael et al. (2019).

Conclusion

A great source of plant protein is fermented cocoa husk meal. The best growth performance and feed utilization were achieved when it was included at a 50% level. Although the fish demonstrated good growth performance for all treatment diets, the fermented cocoa husk meal can be added up to 100%. The survival rate indicates that adding fermented cocoa husk meal to the diet has no negative effects on *Clarias gariepinus*.

Recommendations

If fish require floating and stable feeds on water,

1. it is therefore recommended that *Cissus populnea* Stem at 40% inclusions be used in fish feed formulation.
2. Further studies on the other parts of the *Cissus populnea* such as leaves, roots and fruits should be carried out to known their effect on the floatability and stability of feeds on water.

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