Haematological Responses and Nutrient Utilization of *Clarias gariepinus* Fed Fermented Groundnut Shell Diets

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Abstract

This research study was carried out to evaluate the use of fermented groundnut shell diet on growth performance and haematological parameters of *Clarias gariepinus* fingerlings. Semi flow through consist of fifteen plastic bowls were used and ten *Clarias gariepinus* fingerlings (mean weight (3.00±0.05g) per plastic bowl, each in triplicate. Five treatment bowls were fed experimental diets containing 40.00% crude protein supplemented with fermented groundnut shells. Diet 1 contain unfermented groundnut shell (control diet), diet 2 contain 12 hours fermented groundnut shell without potash, while the other diets, diet 3, 4, and 5 contain fermented groundnut shells with potash at fermentation time of 12, 24, and 48 hours respectively. The highest mean weight gain (MWG) of 5.87g, and specific growth rate (SGR), 0.51%/day was recorded in diet 5. The best feed conversion ratio (FCR) was also recorded in fish fed diet 5 (0.43). There was significant difference (p<0.05) in MWG, SGR, and FCR among the treatments. Results showed that fish fed diet 5 had the best growth performance. Weight gain by fish fed diet 1 (control diet) and diet 5 were not statistically different (p<0.05). But there was statistical difference in among the diets in specific growth rate, feed conversion ratio, and protein efficiency ratio. Results showed that there were increase in the blood parameters of *Clarias gariepinus* fermented diets compared to the control diet but were statistically different (p<0.05). Highest Packed cell volume of 22.23%, White Blood Cell, 15.50 x 10^3, red blood cell 9.35 x 10^6 and Haemoglobin, 10.35 g/dl were recorded in fish fed diet 5. All blood parameters obtained were between the range of recommended fish blood. It is concluded that using fermented groundnut shell as supplementary feed on *Clarias gariepinus* showed a slight increase in the haematological parameters compared with the control diet but it has no negative effect on the health status of the studied fish. However, diet 5 can be used as feed in aquaculture, to enhance fish health, survival and growth performance.

**Keywords:** Haematology; *Clarias gariepinus*; Growth performance; Solid state fermentation; Potash; Groundnut shell
**Introduction**

The main goals of aquaculture industry are to optimize growth and to produce high quality fish [1]. With the rise in global awareness of fish as a valuable source of protein, this has led to increased progress in aqua feeds with diets being specifically designed to meet the nutritional requirements of species, life cycle and health condition of fish [2].

The use of haematological characteristics in evaluating the health status of fish as a tool for its management under captive rearing is well established and the knowledge of the haematological profile of a fish also indicates its dietary sufficiency and physiological response to environmental stress and any change in the constituent component of blood sample when compared to the normal values could be used to interpret the metabolic state of the animal and the influence of treatment given to the animal [3-5].

Similarly, Babatunde, et al. [6] also reported that any changes in the constituent component of blood sample when compared to the normal values could be used to interpret the metabolic state of animal and state of health. Low haematological indices are indications of anaemic conditions [7].

Blood tissue truly reflects physical and chemical changes occurring in organisms. Therefore, detailed information can be obtained on general metabolism and physiological status of fish in different groups of age and habitat. Early diagnosis is also possible when evaluating haematological data [8-10]. Furthermore, it should be noted that haematological indices are of different sensitivity to various environmental factors and chemicals, previous haematological study of nutritional effects, infectious diseases and pollutants, brought knowledge that erythrocytes are the major and reliable indicators of various sources of stress [11-15].

Groundnut (Arachis hypogea) shell is a by-product of groundnut processing industry. In Nigeria, and many other neighbouring countries, in addition to industrial extraction of oil, groundnut is consumed directly as nut fresh, dry or cooked. It is also grown as cash crop for exporting. Groundnut shell is a waste produced when the nut is being processed for consumption by breaking the shell open manually or mechanically.

The proximate compositions of groundnut shells as feedstuff for livestock have been documented. Alu, et al. [16] reported the nutrient composition of untreated and potash treated groundnut shells to be 96.11% dry matter, 13.88% crude protein, 37.82% crude fibre, 1.87% ether extract, 4.30% ash, and 56.04% nitrogen free extract for the untreated groundnut shells. The chemical composition for the potash treated groundnut shells were 85.59% dry matter, 12.07% crude protein, 10.26% crude fibre, crude lipid 1.79%, 4.12% ash and 51.34% nitrogen free extract [16].

Groundnut shells are classified as low value agricultural wastes or agricultural by-products. However, new technology and innovation has converted groundnut shells to a wide range of applications. Groundnut shells which are agricultural by-products are one of the most available biomass resources in northern part of Nigeria. This unique renewable energy resource has a high potential to be an alternative for fish feed. The presence of lignin in these agrowastes limit their utilization by either herbivorous or omnivorous fish, hence there is a need to break this lignin barrier either by physical, chemical or/and biological treatments. The biological treatment such as solid state fermentation of fibrous materials is not entirely new and the biotechnological techniques are gradually being introduced into the field of aquaculture nutrition/biotechnology nutrition throughout the globe. If the huge amount could be recycled or converted to useful feedstuff, the whole environment will be cleaned of pollution, thereby improving human health [17].

Over the years, fish farmers have depended on agro-wastes and industrial by-products as sources of feed for their fish. But, the use of these ‘wastes’ as unconventional feedstuff for fish nutrition is largely limited by their high cell wall material content including lignin, cellulose and hemicellulose [18].

Production of groundnut wastes such as the shell has becomes a serious issue to environment in Yola, Adamawa state and Nigeria as a whole. The common methods in handling oilseed harvest residues such as groundnut by-products are incineration, incorporation in soil and land dumping. However, incineration will emit smokes or particulates which cause air pollutions; incorporation of agricultural waste in soil will influence physical, biological and chemical properties of soil [19]. These methods are not the good solutions in managing tremendous amount of groundnut by-products. Thus, this poses a critical problem in waste management system and subsequently causes environmental pollution if the agro waste is not managed properly [20].
Another limitation with the use of these ‘wastes’ as feed for fish is the presence of anti-nutritional factors (ANFs). The presence of anti-nutritional factors such as phytic acid, lectins, saponins, alkaloids, gluconosilates, phyto-estrogens and other anti-vitamins in plant-based feeds such groundnut shell limits its usage in animal feedstuffs as well as aquaculture feeds [21]. Nutritionists believe that anti-nutritional factors responsible to influence physiological characteristic and retard growth of animals [22]. Anti-nutritional factors are naturally-occurring compounds that exert anti-nutritional effect, anti-physiological effect and limit the nutrients availability to living organism [23,24].

Utilization of groundnut shell as fish feedstuffs can offers several benefits. First and foremost, it is cost-saving compared to conventional feedstuffs [22]. Conventional feedstuffs such as fish, crustacean and animal meal are relatively expensive than plant-based feedstuffs [25]. Sharp rises of animal feed market prices has encouraged fish farmers to seek cost-saving alternatives, which is by-products from oilseed or legumes [26].

The pre-treatment of agro-wastes is necessary to improve and maximize fish utilization of agro-waste-based diets. Besides physical pre-treatment methods such as size reduction, chemical treatment of ‘agro-wastes’ has been met with insignificant improvement of digestibility problems [27]. Because of the high cost of chemicals, and the laborious processes of using them, none of the chemical treatments known to remove considerable amounts of tannins and other anti-nutrients have been suggested to be economically friendly [28]. However, the use of biological pre-treatments such as solid state fermentation methods to ameliorate nutritional values of fibrous materials like groundnut shell for fish is an area that is worth to be explored. And its effect on the blood parameters of *Clarias gariepinus* fingerlings is also investigated in this study.

### Materials and Methods

**Experimental Site**

The experiment was carried out in the Teaching and Research Fish Farm, Department of Fisheries, Modibbo Adama University of Technology, Yola, Nigeria. Five experiment sets in triplicate were used for this experiment. The experimental set-up which is semi-flow through system consisted of fifteen (15) circular plastic tanks. The semi-flow through consist of inlet pipe through which water is supplied to the set-up, outlet pipe through which regulate water inflow to the set-up, plastic bowls that serve as aquatic environment for the experimental fish fingerlings and net which prevent fingerlings from jumping out. The plastic tanks were cleaned, disinfected and allowed to dry for 24 hours, after which water was supplied to two-third of the size of the tank and were covered with net of mesh size 3mm to protect the fish from jumping out of the tanks. The experiment lasted for a period of 12 weeks.

**Dietary Ingredients**

The dietary ingredients for the diet formulation comprised of 5 kg weight of groundnut shells which were obtained from groundnut processing firm in Yola town; other ingredients consisted of fish meal, groundnut cake, vitamin premix, cassava starch, salt, palm oil, methionine, and lysine were bought from Jimeta main market, Yola.

**Processing of Groundnut Shells**

The groundnut shells were rinsed with distilled water to remove debris and pretreated using oven heat treatment at 100°C until a constant weight was obtained for any dry matter. This was to obtain constant dryness and to prevent groundnut shells from being infected with fungi such as aflatoxin before solid state fermentation process. Solid state fermentation was carried out in controlled laboratory under room temperature. The oven dried groundnut shells were given six different treatments of solid state fermentation for a period of 0, 12, 24, and 48 hours in accordance with Sogbesan, et al. [17] where 100ml of distilled water and 10g of potash were added to 500g groundnut shells. The addition of potash is to serve as softening agent and to serve as buffer in order to create a suitable medium for the growth of fungi [29]:

- **Control**: 500g of raw cleaned dried groundnut shells were not subjected to solid state fermentation thereby serving as control.
- **Moistened without ash for 12 hours (S12)**: 500g Groundnut shells were moistened with 100ml distilled water only and fermented for 12 hours under laboratory conditions.
- **Moistened with ash for 12 hours (S12)**: 500g Groundnut shells were moistened with 100ml distilled water and 10g of potash; fermented for 12 hours under laboratory conditions.
- **Moistened without ash for 24 hours (S24)**: 500g Groundnut shells were moistened with 100ml distilled water only and fermented for 24 hours under laboratory conditions.
(e) **Moistened with ash for 24 hours (SA24):** 500g Groundnut shells were moistened with 100ml distilled water and 10g of potash; fermented for 24 hours under laboratory conditions.

(f) **Moistened without ash for 48 hours (S48):** 500g Groundnut shells were moistened with 100ml distilled water only and fermented for 48 hours under laboratory conditions.

(g) **Moistened with ash for 48 hours (SA48):** Groundnut shells were moistened with 100ml distilled water and 10g of potash; fermented for 48 hours under laboratory conditions.

**Milling of Solid State Fermented Groundnut Shells**

The solid state fermented groundnut shells were oven dried at the end of each fermentation time of 12 hours, 24 hours and 48 hours respectively at a temperature of 100°C for 12 hours and followed by grinding using hammer mill grinding machine to a powdery form. They were sieved and kept for further use in the formulation of fish feed with other ingredients.

**Formulation of Experimental Diets**

Five isonitrogenous diets were formulated based on the proximate analysis from practical ingredients such as milled fermented groundnut shells, fish meal, groundnut cake, vitamin premix, cassava starch, salt, palm oil, methionine, and lysine. The control basal diet supplemented with maize meal was without fermented groundnut shell meal and others were supplemented with fermented groundnut shell meal at 12, 24 and 48 hours respectively. The experimental diets were formulated to contain 40% crude proteins. The ingredients were milled to give a fine particle size. And they were thoroughly mixed to obtain a homogenous mass, cassava starch was added as binder. The resultant mash was then pressed without steam through a pelleting machine with 0.2mm diameter size. The pellets were sun dried at ambient temperature (27-30°C) and stored in a refrigerator until the commencement of the experiment.

**Sampling and Monitoring of the Experimental Fish**

The length and weight of each fingerling in each tank was measured at the commencement of the experiment. Afterward, 5 fingerlings were randomly taken from each tank once a week and weighed with sensitive weighing balance to access the growth rate. The sampling exercises were carried out in the morning before feeding the fish. Any dead fish is quickly removed and recorded to determine the survival rate. The experiment lasted for 12 weeks.

**Water Quality**

The water quality parameters were monitored and average value for temperature; dissolved oxygen and hydrogen ion concentration (pH) were 28.86±0.04°C, 6.34±0.01 mg/L and 7.17 units respectively.

**Proximate Analysis**

Fish carcass and experimental diets were proximately analyzed for crude protein, crude fibre, crude lipid, ash and Nitrogen free extracts according to Association of Official Analytical Chemist Methods [30].

**Transportation and Acclimatization of Experimental Fish**

One hundred and fifty fingerlings of *C. gariepinus* were obtained from Salihu farm in Yola and transported to the laboratory in 50 litre water storage can. They were held in circular plastic tanks for one week for acclimation. They were also randomly stocked at the rate of ten (10) fingerlings per plastic bowl in triplicate into 15 plastic bowls for growth trials. They were aerated with electric powered aerator. All fishes were considered healthy on the basis of their appearance and the absence of obvious signs of disease.

**Growth Performance and Nutrient Utilization**

Growth performance was expressed as weight gain, relative weight gain, specific growth rate, metabolic growth rate, condition factors and survival rate [31,32]. Feed utilization indices were expressed as feed conversion ratio, protein efficiency ratio and protein rating as follows [33,34]:

\[
\text{Mean weight gain} = \frac{W_n - W_i}{n}
\]

\[
\text{Relative growth rate} = \frac{W^n - W_i}{W_i} \times 100
\]

\[
\text{Specific growth rate (SGR)} = \frac{\log W_n - \log W_i}{t} \times 100
\]

\[
\text{Metabolic growth rate} = \frac{(W_n + W_i)^{0.8}}{2000} \times \frac{1}{\text{Experimental period (days)}}
\]
Condition factor, \( k = \frac{100W}{l^3} \)

Survival rate, \( SR(\%) = \frac{N_f \times 100}{N_i} \)

Feed conversion ratio, \( FCR = \frac{\text{Weight gain (g)}}{\text{Feed intake (g)}} \)

Protein intake, \( PI \) (g of protein in 100 g diet/fish) = Total feed intake \( x \) % crude protein in the diet.

Protein efficiency ratio, \( PER = \frac{\text{Mean weight gain (g)}}{\text{Mean protein intake (g of protein in 100g of diet / fish)}} \)

Net protein utilization, \( NPU = \frac{\text{CP f} - \text{CP i}}{\text{PI}} \)

**Haematological Profile**

Blood was collected from the caudal vein of each fish using heparinized disposable syringes and hypodemic needles at the beginning and end of the experimental period. Red blood cells (RBC) White Blood cells (WBC) hemoglobin (Hb), packed cell volume (PCV) and leukocyte differential were analyzed according to Schalm, et al. [35]. The PCV was analyzed using micro haematocrit method;

\[
\text{MCV} = \frac{\text{PCV} \times 10 \text{(fentolitre)}}{\text{RBC}}
\]

\[
\text{MCH} = \frac{\text{Hb} \times 10 \text{(fentolitre)}}{\text{RBC}}
\]

\[
\text{MCHC} = \frac{\text{Hb} \times 100\%}{\text{PCV}}
\]

**Statistical Analysis**

All data collected were subjected to analysis of variance (ANOVA). Comparisons among treatment means were carried out by one way analysis of variance followed by Turkey's test (0.05). Least significance differences (LSD) was used to determine the level of significance among treatments. Correlation and regression analysis was carried out to determine the relationship between the treatments using SPSS 10.0 Window 2000.

| Ingredients (g/kg) | Diet 1 | Diet 2 | Diet 3 | Diet 4 | Diet 5 |
|-------------------|--------|--------|--------|--------|--------|
| Fish Meal         | 30     | 30     | 30     | 30     | 30     |
| Maize             | 30     | 0      | 0      | 0      | 0      |
| Fermented Groundnut shell | 34     | 34     | 34     | 34     | 34     |
| Groundnut cake    | 0      | 30     | 30     | 30     | 30     |
| Vitamin Premix    | 2      | 2      | 2      | 2      | 2      |
| Starch            | 1      | 1      | 1      | 1      | 1      |
| Salt              | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    |
| Palm-Oil          | 0.5    | 0.5    | 0.5    | 0.5    | 0.5    |
| Methionine        | 1      | 1      | 1      | 1      | 1      |
| Lysine            | 1      | 1      | 1      | 1      | 1      |
| Total             | 100    | 100    | 100    | 100    | 100    |
| Calculated Crude Protein (%) | 40.02 | 40.02 | 40.02 | 40.02 | 40.02 |
| Calculated gross energy (kcal/100g) | 12.07 | 12.07 | 12.07 | 12.07 | 12.07 |
| Protein/Energy ratio | 3.32 | 3.32 | 3.32 | 3.32 | 3.32 |

**Table 1:** Formulation and Composition of Experimental Diets.

**Keys:** Control=Diet 1; Diet 2 (S12), Diet 3 (SA12), Diet 4 (SA24) and SA48 (Diet 5).
Table 2: Proximate Composition of Experimental Diets (g/100g).

| Component              | Diet 1   | Diet 2   | Diet 3   | Diet 4   | Diet 5   | SEM  |
|------------------------|----------|----------|----------|----------|----------|------|
| Crude Protein          | 41.61    | 42.51    | 42.77    | 43.28    | 43.41    | 0.32 |
| Ether Extract          | 9.3      | 8.51     | 7.2      | 7.22     | 7.15     | 0.44 |
| Crude fibre            | 3.31     | 2.15     | 1.1      | 1.14     | 1.08     | 0.44 |
| Ash                    | 4        | 4.51     | 4.72     | 4.81     | 4.85     | 0.16 |
| Dry matter             | 86.89    | 86.8     | 87.75    | 87.7     | 88.03    | 0.25 |
| Nitrogen free extract  | 28.67    | 29.12    | 31.96    | 31.25    | 31.54    | 0.67 |
| Calculated Gross Energy| 1842.47  | 1840.25  | 1843.48  | 1844.1   | 1849.39  | 1.26 |

Table 3: Proximate Carcass Composition of *Clarias gariepinus* fed Fermented Groundnut Shell Diet at the beginning and end of the Feeding Trial.

| Component (%)     | Initial Fish | Fish fed diet 1 (Control) | Fish fed diet 2 (S12) | Fish fed diet 3 (SA12) | Fish fed diet 4 (SA24) | Fish fed diet 5 (SA48) |
|-------------------|--------------|----------------------------|-----------------------|------------------------|------------------------|------------------------|
| Moisture          | 4.15         | 4.1                        | 3.65                  | 3.7                    | 4.05                   | 4.11                   |
| Crude protein     | 61.38        | 63.3                       | 65.1                  | 67.15                  | 68.05                  | 68.9                   |
| Crude lipid       | 9.6          | 8.96                       | 9.55                  | 9.6                    | 10.4                   | 9.58                   |
| Ash               | 5.51         | 5.3                        | 5.2                   | 3.8                    | 3.05                   | 3.95                   |
| Crude fibre       | 2.1          | 2.15                       | 2.12                  | 1.94                   | 1.73                   | 1.82                   |
| NFE               | 17.26        | 17.24                      | 17.23                 | 17.01                  | 17.02                  | 16.14                  |

Table 4: Growth Parameters and Feed Utilization Indices of *Clarias gariepinus* fingerlings fed Fermented Groundnut Shell Diets.

| Parameter                  | Diet 1 (Control) | Diet 2 (S12) | Diet 3 (SA12) | Diet 4 (SA24) | Diet 5 (SA48) | SEM  |
|----------------------------|------------------|--------------|--------------|--------------|--------------|------|
| Initial mean weight (g)    | 3                | 3.22         | 3.65         | 3.6          | 3.5          | 0.12 |
| Final mean weight (g)      | 7.96             | 7.8          | 9            | 7.44         | 9.37         | 0.37 |
| Mean weight gain (g/fish)  | 4.96±0.02a       | 4.58±0.05ab  | 5.35±0.04ac  | 3.84±0.02ad  | 5.87±0.01a   | 0.34 |
| Relative growth rate (%)   | 165              | 142          | 147          | 107          | 168          | 10.92|
| Metabolic growth rate      | 17.42            | 15.99        | 16.72        | 13.37        | 18.1         | 0.82 |
| Specific growth rate (%)   | 0.50±0.00a       | 0.46±0.01b   | 0.47±0.01b   | 0.38±0.02a   | 0.51±0.00ab  | 0.02 |
| Mean feed intake (g)       | 2.56±0.01a       | 2.60±0.01ac  | 2.53±0.00ad  | 2.54±0.01ad  | 2.51±0.01bd  | 0.02 |
| Feed conversion rate (FCR) | 0.52±0.01a       | 0.57±0.01a   | 0.47±0.01bc  | 0.66±0.01ac  | 0.43±0.01bd  | 0.04 |
| Survival (%)               | 87               | 83           | 93           | 87           | 80           | 2.19 |
| Protein intake             | 10.75            | 10.92        | 10.63        | 10.67        | 10.54        | 0.06 |
| Protein efficiency ratio   | 0.46±0.02a       | 0.42±0.01ac  | 0.50±0.01ac  | 0.36±0.02bc  | 0.56±0.02ac  | 0.03 |
| Protein rating             | 4.95             | 4.59         | 5.32         | 3.84         | 5.9          | 0.35 |
| Condition factor (k)       | 2.17             | 2.54         | 1.86         | 3.63         | 1.55         | 0.36 |
| Net Protein Utilization (NPU) | 0.18           | 0.34         | 0.54         | 0.63         | 0.71         | 0.09 |
Results

Proximate Composition of Experimental Diets

The proximate composition of the experimental diets is presented in Table II. The highest crude protein of 43.41% was recorded in diet 5 while the lowest crude protein was in diet 1. Ether extract was highest in diet 1 with 9.30% composition and the lowest ether extract was recorded with the value of 7.15% in diet 5. The crude fibre of 3.31% was the highest in diet 1 while 1.08% value is the lowest in diet 5. The gross energy values range from 1842.47 to 1849.39 KJ/100g for diet 1 and diet 5 respectively. The gross energy values increases as the fermentation time increases from diet 1 to diet 5.

Chemical Composition of the Carcass of *Clarias gariepinus* after 12 Weeks of Feeding Fermented Groundnut Shell Meal Diets

Proximate analysis of the whole fish body at the end of the 12 weeks experimental period is summarized Table III. These data indicated that moisture content (4.11%) was highest in the fish fed diet 5 while the lowest moisture content was in the fish fed diet 2 with the value of 3.65%. Highest crude protein 68.90% composition was recorded for fish fed diet 5 and 61.38% being the lowest value in the initial fish. 10.40% of ether extract composition was noted for fish fed diet 4 and fish fed diet 1 had 8.90% of ether extract. The crude fibre for the fish fed experimental diets range from 1.73% to 2.15%. The
The best diet 4. The best observation is in agreement with the version of the fermented diets. This observation is in agreement with the report of Shabbir, et al. [41] and Jabeen, et al. [42] in related studies on feeding trials. The general well-being of the fish fed fermented groundnut shell diets are expressed by the condition of the fish. This observation is in agreement with the report of Fagbenro and Arowosoge [38] as well as Eyo and Olatunde [39]. Fish fed diet 5 had the highest mean weight gain 5.87g and the least was recorded in fish fed diet 4 (3.84g) respectively.

**Specific growth rate (SGR)** was highest (0.51%/day) in diet 5 and the least (0.38%/day) in the diet 4. SGR values obtained for diet 1, 2, 3 and diet 5 were not statistically different but differed significantly from the values obtained for diet 4 and diet 1. The best feed conversion ratio (FCR) 0.43 recorded for diet 5 is an indication of an optimum level of utilization of the groundnut shell diet by the Clarias gariepinus fingerlings. This corresponds with Adikwu [40] who stated that the lower the FCR, the better the feed utilization by the fish. In this study, the lowest FCR value is an indication of better feed utilization by the fish and this account for better growth performance of C. gariepinus fed diet 5 among other diets. This corresponds with observation made by Shabbir, et al. [41] and Jabeen, et al. [42] in related studies on feeding trials.

Protein efficiency ratio (PER) is known to be regulated by non-protein energy input of the diet and is a good measure of protein-sparing effect of lipid and/or carbohydrate [43,44]. PER recorded in this research work exhibited significant differences in all treatments. The significantly higher PER value obtained in diet 5 indicated maximum utilization of inherent nutrients in the diet at this level which was not in other diets. This does not agree with the observation made by Adejumo [45] who reported highest PER value at 20% inclusion level of replacing maize with fermented millet.

Net Protein Utilization (NPU) signifies protein retention in the body of the fish. This is a factor of the quality, digestibility and utilization of the protein fed to the fish. NPU of this study showed a significant difference between the diet 1 and the fermented groundnut shell diets 2, 3, 4, and 5. Diet 5 recorded better NPU compared to diet 1 and other fermented diets. This observation agrees with the report of Sogbesan [46] who recorded highest value at 25% inclusion level of earthworm meal.

The general well-being of the fish fed fermented groundnut shell diets are expressed by the condition...
factor (K) which is significantly different from the diet 1. Survival rate was high in all treatments. The highest value (93%) was recorded in diet 3 and least (80%) was recorded in diet 5. The mortality occur in this study might be due to the antinutrients present in the diets and some other extraneous factors which agreed with Alegebeleye [47] who reported that mortality might not be due to the antinutrients in the diets alone but also to some other extraneous factors such as stress resulting from handling.

The applications of haematological techniques have proved valuable for fishery biologists in assessing the health of fish and monitoring stress responses. Some of the values were fluctuating due to the condition under which the fishes were kept, the condition based on the fact that the fishes are not in their natural habitat and also because of sizes of the fishes, blood values such as the white blood cell, red blood cell and haemoglobin value as reported by Osuigwe, et al. [48] that the haematological parameters of fish are affected by a range of factor which includes size age, physiological status and environmental conditions and dietary regime (e.g quality and quantity of food dietary ingredients, protein sources, vitamins etc).

The haematology results of the present study showed that white blood cell (WBC) red blood cell (RBC), and packed cell volume (PCV) was affected by diet treatment. The positive effect of the experimental diets on the fish growth and physiology indicated that incorporation of fermented groundnut shell into the fish feed will not hampered both the development and health being of fish.

Generally, erythrocyte counts are used as indicators for anaemia. The erythrocyte counts obtained for diet C, S12, SA12, SA24 and SA48 were 9.10, 8.25, 9.22, 9.35 and 10.04 x 10⁶/µ respectively and were comparable to those reported for Clarias gariepinus, but were higher than values of 1.33-1.77 reported for other African freshwater fishes [49]. Similarly, there was decline in red blood cell (RBC) value compared with the normal value (24 x 10⁶/µ) reported by Adedeji, et al. [50]. The reduced erythrocyte count may preclude the possibility of haemolytic anaemia stated by Kelly [51] who may be due to toxic factor, infections and metabolic diseases. Blaxhall and Daisley [52] noted that fish biologist rely more on haematocrit and haemoglobin concentration estimates as indicators of anaemia.

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. There is marked increase in the white blood cell (WBC) counts across the treatments compare with normal value (6.6 x 10⁶/µ) recommended by Fagbenro, et al. (1993) for freshwater fishes such as Clarias gariepinus, Clarias isheriensis, Heterobranchus longifilis and Heterobranchus bidorsalis. PCV is important as an 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 [53]. There is therefore the possibility of using haematocrit as a tool in aquaculture and fisheries management for checking anaemic condition in fishes.

In fish blood, oxygen is carried in physical solution and also in combination with haemoglobin [3,4]. Haemoglobin is crucial for the survival of the fish as its role is directly related to the oxygen binding capacity of blood. The haemoglobin concentration values obtained in this study ranged between 10.04 and 10.55g/dl. This is higher than the values of 7.44-8.66 g/dl reported for estuarine catfishes, C. nigrodigitatus and C. furcatus [49,54], but were lower to the values of 11.64-15.43 g/dl reported for air breathing clarid catfishes, C. isheriensis, C. gariepinus, H. longifilis and H. bidorsalis [49,55].

The mean corpuscular haemoglobin concentration (MCHC) values (46.33-52.57 g/dl) were significantly higher than the value 30-35 g/dl recommended by Adejide, et al. [50]. Similarly, in this study there are wide variations in both the mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH). And the lowest blood glucose was recorded in SA48, 33.33mg/dl and highest value of blood glucose 43.29mg/dl in control diet.

Conclusion

The result of 12 weeks feeding trial of Clarias gariepinus with fermented groundnut shell diets showed that fermented groundnut shells could be used in fish production. However, growth performance and blood parameter could be improved in fish by incorporating...
groundnut shells with potash fermented for 48 hours. It can be deduced from this research study that feed incorporated with fermented groundnut shells at 489 hours fermentation can be used as fish feed in catfish culture, to enhance fish health, survival, better feed efficiency and growth performance.

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