

EFFECTS OF DIFFERENT DIETARY INCLUSION LEVELS OF *Adansonia digitata* LEAF MEAL ON THE GROWTH PERFORMANCE, HEMATOLOGICAL PROFILE, AND CARCASS COMPOSITION OF *Oreochromis niloticus* FINGERLINGS

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ABSTRACT

This study was carried out to evaluate the effects of dietary inclusion of *Adansonia digitata* leaf meal on the growth, hematological parameters, and carcass composition of *Oreochromis niloticus* for 56 days. Five isonitrogenous diets, each containing (35 % crude protein), were prepared using standard feed formulation techniques with varying levels of *A. digitata* leaf meal labelled as AD1 (0.0 g/kg. Control), AD2 (0.5 g/kg), AD3 (1.0 g/kg), AD4 (1.5 g/kg), and AD5 (2.0 g/kg). A total of 225 *O. niloticus* fingerlings (6.56 ± 0.16g) were randomly stocked into 15 glass tanks (70litre) each measuring (70cmx45cmx45cm) at the rate of 15 fish per tank representing five treatments and three replicates. Results indicated significant differences ($P < 0.05$) in all growth performance parameters. The highest mean weight gain was 5.54 g in fish fed AD3 (1.0 g/kg), while the lowest was 3.61 g in AD5 (2.0 g/kg). Haematological analysis showed significant ($p < 0.05$) health improvements with increasing *A. digitata* inclusion: packed cell volume (PCV) increased from 26.50% (AD1) to 32.00% (AD5), red blood cell (RBC) count rose from $2.90 \pm 0.17 \times 10^3/\text{mm}^3$ to $3.66 \times 10^3/\text{mm}^3$, and white blood cell (WBC) count peaked at $7.50 \times 10^3/\text{mm}^3$ in AD5. Haemoglobin (Hb) levels showed no significant difference but trended upward. Proximate analysis revealed protein content increased from $50.12 \pm 0.58\%$ (AD1) to 58.50% (AD5), lipid content decreased from 16.33% (AD1) to 11.70% (AD5), and ash content declined from 18.77% to 15.63%. Moisture and nitrogen-free extract (NFE) values remained unchanged. Based on the results, it was concluded that *A. digitata* leaf meal can be safely included in the diet of *O. niloticus* at levels up to 1.0 g/kg without negatively affecting growth, health, and nutritional quality in *O. niloticus* culture.

Keywords: *Adansonia digitata* leaf, growth, haematology, carcass, *Oreochromis niloticus*

INTRODUCTION

Fish are the fastest-growing source of animal protein in the developing world, providing an affordable and widely accepted protein option for the rapidly increasing global population (Omitoyin, 2017). Beyond their role in food security, fish also offer critical income opportunities in many developing countries, including Nigeria (FAO, 2016). Among farmed species, Nile tilapia (*Oreochromis niloticus*), native to Africa, is one of the most widely cultured fish globally due to its high nutritional value and consumer appeal (Loke *et al.*, 2021). Tilapia farming has significantly improved livelihoods by increasing household income, enhancing food security, and boosting protein intake, particularly in low- and middle-income countries (Yue *et al.*, 2016). Efficient fish production in aquaculture depends heavily on nutrition, with feed accounting for the largest portion of production costs (Craig *et al.*, 2017). As the industry grows, there is increasing interest in feed additives that promote growth and health without the environmental and health risks associated with synthetic antibiotics and hormones. Natural alternatives such as medicinal plants and probiotics have shown promise for their antimicrobial, anti-stress, appetite-stimulating, and immune-boosting properties (Ajiboye *et al.*, 2012; Dada and Olugbemi, 2013). Evaluating the health of fish fed plant-based additives often involves hematological analysis, as blood parameters offer reliable indicators of physiological and pathological conditions (Joshi *et al.*, 2002). *Adansonia digitata*, native to tropical Africa, is widely used in traditional food and medicine (De Caluwé *et al.*, 2010).

The leaves are rich in antioxidants and have demonstrated protective effects against cardiac toxicity in animal models (Olayemi *et al.*, 2021; Uhwo *et al.*, 2022). *A. digitata* seed meal has also been used successfully as a partial substitute for soybean meal in diets for *Clarias gariepinus* fingerlings (Hassan *et al.*, 2015), while its fruit pulp has been shown to enhance growth and immunity in broilers (Sulaiman *et al.*, 2011). This study was therefore designed to evaluate the effects of dietary inclusion of *A. digitata* leaf powder on the growth performance, hematological parameters, and carcass composition of *O. niloticus* fingerlings.

MATERIALS AND METHODS

Study Area

This study was carried out for 56 days at the Research Laboratory of the Department of Fisheries and Aquaculture Technology, Federal University of Technology, Akure, Ondo State, Nigeria.

Collection and Preparation of *A. digitata* Leaves

A. digitata leaves were purchased from the local plant market in Akure, Ondo State, then authenticated at the Federal University of Technology, Akure Crop, Soil and Pest Management Department. The leaves were thoroughly washed with clean water and air-dried in the shade by spreading them evenly on a mat and regularly turning them to prevent mold growth. Once dried, the leaves were ground using an electric blender (Model ES 242). Before being incorporated into the experimental diets, a sub-sample of the leaf meal was taken and

analyzed for proximate composition to aid in feed formulation.

Experimental Fish

A total of 300 apparently healthy *Oreochromis niloticus* fingerlings, with an average initial weight of 6.37 ± 0.01 g, were sourced from the fish farm at the Federal University of Technology, Akure, Ondo State, Nigeria. The fish were acclimatized for seven days and fed a commercial control diet containing 35% crude protein. Feeding was done manually to apparent satiation twice daily, between 8:00–9:00 a.m. and 4:00–5:00 p.m. (GMT).

Experimental Diets

Five isonitrogenous diets, each formulated to contain 35% crude protein, were formulated using standard feed formulation techniques. The diets incorporated varying inclusion levels of *A. digitata* leaf meal as follows: AD1 (0.0 g/kg. Control), AD2 (0.5 g/kg), AD3 (1.0 g/kg), AD4 (1.5 g/kg), and AD5 (2.0 g/kg). The diets were air-dried at room temperature for 48 hours, then packed in polyethylene bags, sealed, labeled according to their treatment group, and stored at 4°C until use.

Experimental Design and Management

The experimental design was a complete randomized design. After the acclimation period fish were weighed, out of which two hundred and twenty five (225) *O. niloticus* fingerlings with mean weight of 6.56 ± 0.16 g were randomly selected and distributed into 15 glass Tanks (70litre) each measuring (70cmx45cmx45cm) at the rate of 15 fish per tank representing five treatments and three replicates. The diets were fed to the fish twice daily between 08:00 and 09:00 and 16:00 and 17:00 hours to apparent satiation for 56 days. The fish were weighed biweekly until the experiment was completed. Water in the tank was removed partly by siphoning and replaced with fresh water every three days to avoid fouling resulting from faeces and uneaten food. Water quality parameters (temperature, dissolved oxygen and pH) were determined twice a week.

Growth Performance

Calculation of the growth performance was according to Bayon *et al.* (2016) as follows;

Weight Gain (g)

This was calculated as the difference between the initial and the final mean weight for fish in each aquarium.

Specific Growth Rate (SGR)

This was calculated from data on changes of body weight over a given time intervals;

$$\text{SGR (\% per day)} = \frac{(\ln \text{final weight} - \ln \text{initial weight})}{\text{Time (days)}} \times 100$$

Feed Intake

This is obtained by adding daily mean feed intake (DFI) of fish under each treatment for the experiment period.

Feed Conversion Ratio (FCR)

This is calculated by dividing the total amount of feed given (feed intake) FI by the weight gain (WG). FCR is the proportion of dry feed per unit live weight gain of fish.

$$\text{FCR} = \frac{\text{feed intake (g)}}{\text{Weight gain (g)}}$$

Feed Conversion Efficiency (FCE)

This is calculated by dividing the total weight gain (WG) by the the total amount of feed given feed intake (FI).

$$\text{FCE} = \frac{\text{Weight gain (g)}}{\text{Feed intake (g)}}$$

$$\text{Survival (\%)} = \frac{\text{Number of fish survived} \times 100}{\text{Number of fish stocked}}$$

Haematological Parameters

Five fish specimens were removed from each glass aquarium tanks for blood analysis. 1ml of blood from the fish were collected from the cardiac puncture using different 5ml disposable heparinized syringes, with ethylene diamine tetra acetic acid (10ml EDTA) as anticoagulant. The blood analysis followed the method that was described by (Svobodova *et al.*, 2006).

Total White Blood Cell Count. One drop of blood was air-dried, fixed in 95% methanol, stained with Giemsa stain, and examined under an Olympus BX 50 microscope.

Red Blood Cell Count. Erythrocytes were counted using a Neubauer hemocytometer under an Olympus BX 50 microscope, with results expressed as was expressed as (10^6mm^{-3})

Hemoglobin Concentration. This was performed with the aid of Haemoglobinometer (Sigma ®) England). Standard Shilonometer N/10 HCL and 0.02ml pipette were used for the estimation Blood was mixed in a graduated tube and matched against a color standard, with results expressed as a percentage.

Packed Cell Volume (PCV). Non-clotted blood was collected in micro-hematocrit tubes, sealed, centrifuged at 10,500 rpm, and measured using a micro-hematocrit reader, expressed as a percentage.

Mean Corpuscular Hemoglobin Concentration (MCHC). This is the concentration of haemoglobin in a unit of erythrocytes. It was calculated from the haemoglobi value (HB) in G l^{-1} and from the haematocrit value (PVC)

$$\text{MCHC} = (\text{Hb} / \text{PCV}) \times 100$$

Mean Corpuscular Hemoglobin (MCH). The corpuscular hemoglobin concentration expresses the concentration of hemoglobin in unit volume of erythrocyte. It was calculated from the hemoglobin value (Hb) and from the Red Blood Cell (RBC) according to the following formula.

$$\text{MCH} = (\text{Hb} / \text{RBC}) \times 10$$



Mean Cell Volume (MCV). This was calculated from the pack cell volume (PCV) and from the Red Blood Cell (RBC) according to the following formula.

$$MCV = (PCV / RBC) \times 10$$

Carcass Composition

After the 8 weeks feeding trial, five fish were collected from each glass tank and frozen at -20°C for subsequent chemical composition analysis of the carcass. The crude lipid, ash, moisture, and crude protein contents in both the fish carcasses and experimental diets were determined according to AOAC (1990) standard procedures. Moisture content was assessed by drying samples in an electric oven at 105°C for three hours until a constant

weight was achieved. Ash content was measured by incinerating the samples in a muffle furnace at 550°C for five hours. Total lipid content was determined using ether extraction with a Soxhlet apparatus. Crude protein was analyzed via the Kjeldahl method after sulfuric acid digestion, with nitrogen values multiplied by 6.25 to calculate protein content.

Statistical Analysis

The data were expressed as mean \pm SE and analyzed using one-way analysis of variance (ANOVA) following the method of Steel and Torrie (1980). Differences among means were separated using Duncan's New Multiple Range Test (Duncan, 1955)

Table 1: Gross composition of the experimental diets (g/kg) for culturing *O. niloticus* fingerlings

Ingredients	AD1 (0.0)	AD2 (0.5)	AD3 (1.0)	AD4 (1.5)	AD5 (2.0)
Fish meal	16.8	16.8	16.8	16.8	16.8
Soybean meal	30.0	30.0	30.0	30.0	30.0
Groundnut cake	22.1	22.1	22.1	22.1	22.1
Yellow maize	18.6	18.6	18.6	18.6	18.6
Methionine	1.00	1.00	1.00	1.00	1.00
Lysine	1.00	1.00	1.00	1.00	1.00
Fish oil	5.00	5.00	5.00	5.00	5.00
Vitamin-Mineral mix	3.50	3.50	3.50	3.50	3.50
Starch	2.00	2.00	2.00	2.00	2.00
<i>A. digitata</i> (g/kg)	0.0	0.5	1.0	1.5	2.0
Proximate composition (%)					
Crude protein	34.53	35.04	35.11	34.76	35.09
Ash	10.37	10.55	10.41	10.63	10.55
Lipids	4.21	4.08	4.20	4.11	4.28
Fibre	3.08	3.17	3.23	3.27	3.29
Moisture	9.16	9.26	9.12	9.33	9.26
Nitrogen free extract	38.65	37.90	37.93	37.90	37.53

Composition of vitamin-mineral mix (Aquamix) (quantity/kg), Vitamin A, 55,00,000 IU; Vitamin D3, 11,00,000 IU; Vitamin B2, 2,000 mg; Vitamin E, 750 mg; Vitamin K, 1,000 mg; Vitamin B6, 1,000 mg; Vitamin B12, 6 mcg; Calcium; Pantothenate, 2,500 mg; Nicotinamide, 10 g; Choline Chloride, 150 g; Mn, 27,000 mg; I, 1,000 mg; Fe, 7,500 mg; Zn, 5,000 mg; Cu, 2,000 mg; Co, 450. L-lysine, 10 g; Selenium, 50 ppm

RESULTS

Proximate Composition of *A. digitata*

The proximate composition analysis of *A. digitata* leaf showed that the Nitrogen-Free Extract had the highest value at 66.74%, while fiber recorded the lowest value at 2.73%, as presented in Table 2.

Parameters (%)	Values
Moisture	8.35
Ash	6.28
Protein	12.39
Fibre	2.73
Lipid	3.51
Nitrogen free extract	66.74



Growth Performance and Nutrient Utilization

The growth performance and nutrient utilization parameters of experimental fish fed *A. digitata* bark meal-based diets are presented in Table 3. Significant differences ($p < 0.05$) were observed among the treatment groups. Fish fed the diet containing 1.0 g/100g of *A. digitata* leaf powder showed a significantly ($p < 0.05$) higher final body weight compared to the control group (0.0 g/100g) and other treatment groups, suggesting that

the 1.0 g/100g inclusion level may be the most optimal for growth enhancement. The highest specific growth rate and feed intake were recorded in treatment AD3, while the lowest values were observed in AD5. In terms of feed conversion ratio (FCR), the best result was obtained in AD4, whereas AD5 had the poorest FCR. Significant differences ($p < 0.05$) were also noted in FCR and feed conversion efficiency (FCE) across the treated and control groups. Survival was 100% across all treatments.

Table 3: Result of growth performance and nutrient utilization of the fish

Parameters	AD1 (0.0)	AD2 (0.5)	AD3 (1.0)	AD4 (1.5)	AD5 (2.0)
MIW(g)	6.57±0.23 ^a	6.56±0.00 ^a	6.55±0.08 ^a	6.54±0.08 ^a	6.56±0.16 ^a
MFW(g)	10.62±0.32 ^{ab}	11.64±0.10 ^b	12.09±0.11 ^c	11.37±0.10 ^b	10.17±0.22 ^a
MWG(g)	4.05±0.09 ^{ab}	5.08±0.03 ^b	5.54±0.04 ^c	4.83±0.02 ^b	3.61±0.07 ^a
SGR(%/day)	0.86±0.02 ^a	1.02±0.0 ^b	1.09±0.01 ^b	0.99±0.01 ^a	0.78±0.02 ^a
TFI(g)	7.31±1.24 ^{ab}	8.51±0.45 ^b	9.02±0.44 ^b	8.26±0.43 ^b	7.01±0.86 ^a
FCR(g)	1.80±0.01 ^a	1.68±0.00 ^a	1.63±0.00 ^a	1.71±0.00 ^a	1.94±0.01 ^a
FCE(g)	0.55±0.09 ^a	0.60±0.04 ^a	0.61±0.03 ^a	0.58±0.03 ^a	0.51±0.07 ^a
Survival (%)	100±0.00 ^a	100±0.00 ^a	100±0.00 ^a	100±0.00 ^a	100±0.00 ^a

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

Haematological Parameters

Table 4 presents the haematological parameters of experimental fish fed diets containing varying inclusion levels of *A. digitata* leaf meal. Significant differences ($p < 0.05$) were observed in all haematological parameters measured at the end of the experiment. White blood cell (WBC) counts increased with higher inclusion levels of *A. digitata* leaf meal. The highest packed cell volume (PCV) values were recorded in treatments AD3 and AD4 (30.50%), while the lowest was observed in AD1. Red

blood cell (RBC) count and haemoglobin (Hb) concentration were highest in AD5 and lowest in AD1. A general decreasing trend was observed in certain parameters as the inclusion level of *A. digitata* leaf meal increased. Moreover, significant differences ($p < 0.05$) were noted in mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH), and mean corpuscular volume (MCV) across the treated and control groups.

Table 4: Haematology parameters of *O. niloticus* fed *A. digitata* leaf meal

Parameters	AD1 (0.0)	AD2 (0.5)	AD3 (1.0)	AD4 (1.5)	AD5 (2.0)
PCV (%)	26.50±0.71 ^a	28.00±1.41 ^{ab}	30.50±2.12 ^b	30.50±0.71 ^b	32.00±2.83 ^c
RBC ($\times 10^3$ /mm ³)	2.90±0.17 ^a	3.04±0.08 ^{ab}	3.43±0.26 ^b	3.34±0.07 ^b	3.66±0.18 ^c
Hb (g/100ml)	8.21±0.82 ^a	8.73±0.26 ^a	8.52±0.76 ^a	8.40±0.71 ^a	9.53±0.59 ^a
WBC ($\times 10^3$ /mm ³)	5.65±3.53 ^a	6.15±4.94 ^{ab}	6.35±4.94 ^{ab}	6.90±4.24 ^b	7.50±2.82 ^c
MCV (fl)	91.38±2.91 ^a	92.08±2.09 ^a	89.08±0.62 ^a	91.32±0.18 ^a	87.47±3.51 ^a
MCH (pg)	28.28±1.17 ^b	28.70±0.06 ^b	24.87±0.33 ^a	25.11±1.61 ^a	26.07±0.36 ^a
MCHC (%)	30.96±2.27 ^b	31.18±0.64 ^b	27.92±0.56 ^a	27.51±1.70 ^a	29.82±0.78 ^b

Means in same row with different superscript are significantly different ($P < 0.05$)

Key: PCV - Pack Cell Volume, RBC- Red Blood Cell, Hb- Haemoglobin, WBC- White Blood Cell, MCV- Mean cell Volume, MCH- Mean Cell Haemoglobin, MCHC- mean cell haemoglobin concentration,

Carcass Composition

Table 5 presents the carcass composition of fish before and after being fed diets with varying inclusion levels of *A. digitata* leaf meal. The results showed that moisture content ranged from 7.95% in AD1 to 8.70% in AD5. Ash content was significantly higher in the control group (AD1) and the low inclusion group (AD2) compared to

higher inclusion levels (AD4 and AD5). Lipid content decreased progressively as the level of *A. digitata* increased, with the highest lipid level observed in the control and the lowest in the 2.0 g/kg group (AD5). Protein content significantly increased with higher inclusion levels, particularly in AD5, indicating enhanced protein deposition in fish muscle due to *A. digitata* supplementation. Nitrogen-Free Extract (NFE), which includes carbohydrates and other soluble components, showed no significant differences among the treatments.

Table 5: Proximate Composition of experimental fish

Parameters (%)	AD1 (0.0)	AD2 (0.5)	AD3 (1.0)	AD4 (1.5)	AD5 (2.0)
Moisture	7.95±0.80 ^a	8.15±1.54 ^a	8.55±0.89 ^a	8.70±1.35 ^a	8.30±1.50 ^a
Ash	18.77±0.70 ^b	18.69±0.73 ^b	17.17±0.21 ^{ab}	15.63±0.15 ^a	15.86±1.87 ^a
Lipids	16.33±0.70 ^c	16.04±0.23 ^c	13.36±2.44 ^b	13.23±0.33 ^b	11.70±1.24 ^a
Protein	50.12±0.58 ^a	50.32±2.39 ^a	54.55±4.06 ^{ab}	56.53±1.97 ^b	58.50±1.94 ^c
NFE	6.83±0.21 ^a	6.81±0.11 ^a	6.37±0.93 ^a	5.91±0.15 ^a	5.65±0.35 ^a

Mean in the same row with different superscripts are significantly different at P<0.05

Key: NFE – Nitrogen Free Extract

Water Quality Parameters

Throughout the experimental period, dissolved oxygen, temperature, and pH levels remained stable across all treatments (AD1 to AD5) with different inclusion levels.

Dissolved oxygen ranged from 5.03 to 5.93 mg/L, temperature ranged from 26.47°C to 26.69°C, and pH levels ranged from 6.07 to 6.47, as showed in Table 6.

Table 6: Water quality parameters for culture of *O. niloticus* fingerlings

Parameters	AD1 (0.0)	AD2 (0.5)	AD3 (1.0)	AD4 (1.5)	AD5 (2.0)
DO (ml/l)	5.38±0.05 ^a	5.45±0.02 ^a	5.27±0.03 ^a	5.23±0.01 ^a	5.42±0.05 ^a
Temperature (°C)	26.51±0.02 ^a	26.65±0.05 ^a	26.59±0.01 ^a	26.63±0.24 ^a	26.60±0.39 ^a
pH	6.37±0.05 ^a	6.43±0.12 ^a	6.40±0.01 ^a	6.44±0.02 ^a	6.29±0.02 ^a

Means in same row with different superscripts are significantly different (P<0.05)

Key: DO = Dissolved Oxygen, pH = Hydrogen ion concentration

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DISCUSSION

Proximate Composition of *A. digitata* leaf powder

The proximate composition of *A. digitata* leaves in this study aligns closely with the findings of Ocholi *et al.* (2021), who reported similar values for moisture, protein, and lipid contents. Slight variations such as the 8.35% moisture and 12.39% protein recorded in this study compared to 10.80% and 12.42% reported by these authors may be attributed to differences in geographic origin and harvesting time.

Water Quality Parameters

The growth and survival percentage of *O. niloticus* fingerlings observed in this study were likely due to the consistent maintenance of good water quality throughout the experimental period. The water quality parameters remained within the recommended ranges for most freshwater species, including *O. niloticus*. These findings align with previous reports by (El-Sayed, 2006; Boyd and Tucker, 2014), who reported similar results for *O. niloticus* cultured under controlled aquaculture conditions.

Growth Performance and Nutrient Utilization

Incorporating *A. digitata* leaf meal into the diet of *O. niloticus* fingerlings at an inclusion level of 1.0 g/kg (AD3) significantly enhanced growth performance and feed efficiency compared to the control and other inclusion levels. Inclusion rates of 0.5 and 1.0 g/kg improved growth and feed utilization without negatively affecting feed intake or survival (%), while a higher inclusion level of 2.0 g/kg negatively impacted both growth and feed efficiency. These findings align with Okomoda *et al.* (2020), who reported improved growth in *O. niloticus* to fed diets supplemented with plant-based

additives. Supporting studies include Olaniyi and Salau (2013), who reported improved weight gain and feed efficiency in *C. gariepinus* fed *A. digitata* leaf meal at 5–10% inclusion, attributing benefits to its high protein and micronutrient content. Similarly, The SGR was highest in the AD3 group, indicating improved feed efficiency at moderate inclusion levels. This agrees with Gabriel *et al.* (2019), who found that phytochemical-rich plant ingredients positively influenced SGR in *O. niloticus*. Total feed intake was also highest in the AD3 group, suggesting good diet palatability. The lowest feed conversion ratio (FCR) of 1.63 was recorded at this level, demonstrating efficient feed utilization. These results support El-Naggar *et al.* (2022), who noted that functional feed ingredients can significantly reduce FCR when included optimally. Umar *et al.* (2020) observed enhanced SGR and improved FCR in *C. gariepinus* fed diets containing 2–4% *A. digitata* fruit pulp. These findings align with the current study, where 1.0 g/kg of the plant leaf meal led to optimal FCR and SGR in *O. niloticus*. Aderinboye *et al.* (2016) also reported that broiler chickens fed up to 5% *A. digitata* leaf meal showed better weight gain, FCR, and survivability, largely due to the fiber and antioxidant content supporting gut health. Conversely, feed conversion efficiency (FCE) was significantly improved in both AD2 and AD3 (ranging from 0.60 to 0.61), further confirming the beneficial effects of moderate *A. digitata* inclusion, consistent with Ovie *et al.* (2018), who linked plant-based additives to enhanced nutrient utilization in aquaculture. Survival was 100% across all treatments, indicating that *A. digitata* leaf meal, even at the highest tested inclusion level, had no adverse effects on fish health corroborating Ibrahim *et al.* (2020), who confirmed the safety of *A. digitata* based diets in aquaculture.



Haematological Parameters

The haematological parameters assessed in this study showed significant variations across different inclusion levels of *A. digitata* leaf meal in the diets of *O. niloticus*. These variations reflect the influence of plant-based additives on fish blood health. Packed Cell Volume (PCV) increased from 26.50% in the control group to 32.00% at the highest inclusion level (2.0 g/kg), indicating an enhanced oxygen-carrying capacity of the blood. This finding is consistent with Olurin *et al.* (2015), who reported elevated PCV values in tilapia fed diets containing natural plant-based supplements. Red Blood Cell (RBC) counts ranged from 2.90 to $3.66 \times 10^3/\text{mm}^3$, which falls within the range reported by Rad *et al.* (2016), who observed RBC counts between 2.8 and $3.8 \times 10^3/\text{mm}^3$ in tilapia fed herbal extracts. This suggests that *A. digitata* leaf meal supports red blood cell production and hematopoiesis without adverse effects. Hemoglobin (Hb) levels ranged from 8.21 to 9.53 g/100 ml across treatments, with no significant differences, indicating a stable oxygen transport function. These results are in line with Abdel-Tawwab *et al.* (2010), who found that moderate inclusion of plant-based ingredients in tilapia diets did not negatively affect haemoglobin concentration. White Blood Cell (WBC) counts showed an increasing trend with higher inclusion levels of *A. digitata*, suggesting potential immunostimulatory effects. This observation supports findings by Ibrahim *et al.* (2019), who linked dietary plant additives to enhanced immune responses in tilapia. Erythrocyte Indices including Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean Corpuscular Hemoglobin Concentration (MCHC) remained within acceptable limits, consistent with Okomoda *et al.* (2020). Evidence from other animal studies supports the beneficial effects of *A. digitata*. Ogbe and Affiku (2012) reported improved immune function and nutrient digestibility in poultry supplemented with baobab fruit pulp. Similarly, Abiona *et al.* (2015) found significant improvements in haematological parameters in rabbits fed *A. digitata* seed meal, attributing these effects to the plant's rich bioactive compound profile.

Carcass Composition

The inclusion of *A. digitata* leaf meal in *Oreochromis niloticus* diets, particularly at higher levels (1.0–2.0 g/kg), significantly enhanced muscle protein content while reducing ash and lipid levels. This indicates a positive effect on protein accumulation and a potential influence on fat metabolism, highlighting *A. digitata* as a promising feed additive for improving the nutritional quality of cultured tilapia. Specifically, muscle protein content increased markedly with higher inclusion levels, reaching up to 58.50% at 2.0 g/kg. This result aligns with Eze *et al.* (2022), who reported enhanced protein deposition in *O. niloticus* fed diets supplemented with *A. digitata* leaf meal, likely due to improved nutrient absorption and utilization. Similarly, Khalil *et al.* (2021) observed increased muscle protein levels in Nile tilapia fed medicinal plant extracts, attributing these effects to the stimulation of anabolic pathways by plant bioactive compounds. The observed decline in lipid content with

increasing *A. digitata* inclusion supports previous findings by Adeyemo *et al.* (2023), who noted that herbal additives can modulate lipid metabolism, reduce fat accumulation, and enhance fillet quality in fish. This lipid-lowering effect is further corroborated by Jiang *et al.* (2020), who documented decreased lipid deposition in tilapia fed diets enriched with plant-derived bioactive compounds, possibly through increased lipid catabolism or enhanced energy utilization. Regarding ash content, the reduction seen at higher inclusion levels parallels the observations of Mohammed *et al.* (2019), who suggested that plant meal supplementation can influence the mineral composition of fish muscle. This effect may be linked to interactions between plant secondary metabolites and the absorption or retention of specific minerals. The relatively stable moisture and nitrogen-free extract (NFE) values across treatments agree with reports by (Gomes *et al.*, 2021; Olufayo *et al.*, 2022), indicating that while plant-based additives significantly affect protein and lipid fractions in fish muscle, their impact on water content and carbohydrate levels is minimal.

CONCLUSION

In conclusion, incorporating *Adansonia digitata* leaf meal at 1.0 g/kg in *Oreochromis niloticus* diets significantly improves growth performance and nutrient utilization without affecting survival. It enhances haematological parameters and carcass protein content while reducing fat and ash levels. This makes *A. digitata* leaf meal a promising, eco-friendly feed additive for sustainable tilapia farming.

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