GROWTH PERFORMANCE, HAEMATOLOGY AND SERUM BIOCHEMISTRY OF JUVENILES *Clarias gariepinus* FED POWDERED TURMERIC-BASED DIETS

A I. Khalid[1]*, S. O. E. Sadiku[2] and A. M. Orire[2]
[1]Department of Fisheries and Aquaculture, Federal University of Lafia, Nasarawa State, Nigeria.
[3]Department of Water Resources, Aquaculture and Fisheries Technology, Federal University of Technology Minna, Niger State, Nigeria.
Corresponding Author: ***akibits42@gmail.com, +2348039298297***

ABSTRACT
The increasing concern of the World Health Organisation (WHO) and that of Food and Agricultural Organisation (FAO) about the residue of antibiotic and drugs used in aquaculture is of direct health hazard on humans consuming the fish at the end. This study was therefore carried out using turmeric, a root plant as a feed additive in fish production. This experiment incorporated graded levels of turmeric in catfish diet being a widely cultured fish species in Nigeria with the purpose of producing healthy fish for human consumption. Three hundred (300) catfish juveniles were allotted into five dietary treatments of turmeric inclusion at 0, 2.5, 5.0, 7.5 and 10%levels in triplicates. Treatment 1 (T1) to treatment 5 (T5) initial blood sample was taken and mean weight of the fish were also determined by using sensitive weighing balance. Date were collected fortnightly on growth performance [Mean Weight Gain (MWG) and Specific Growth Rate (SGR)] and Nutrient Utilization [Feed Conversion Ratio (FCR) and Protein Efficiency Ratio (PER)]. The SGR falls within the range of 1.94-2.33%g/day for T5 and T1 respectively. T2 and T4 (2.25) were recorded against T3 (2.03), T5 (1.94) and that of highest value in T1 (2.33). The evaluation in SGR was in order of T5<T3<T2 and T4<T1 and FCR was in reverse order of T1>T2>T4>T3 and T5. Whereas the highest value of Haemoglobin, PCV, RBC, WBC and MCH were recorded in T2 (8.3g/dl, 25%, 2.39×1012/L, 113×10g/L and 34.72 respectively which contained 2.5% of turmeric inclusion. It is evident that turmeric can enhance growth performance and improve the immunity level in fish at 2.5% inclusion level, thereby granting successful fish production.
Keywords: Turmeric, Growth performance, Haemoglobin, and Inclusion level

INTRODUCTION

Improvement of feed and nutrition in aquaculture may give us the opportunity to further improve the nutritional quality and benefit of fish consumed (Hamed, 2022). Nutritional value, colour and appearance, smell and taste, texture and storing capacity may all be affected by the quality of nutrition and feed provided during culture. Another area of research that has received significant attention in aquaculture nutrition is the use of plant and animal by-product as fish meal substitutes in fish feed (Adesina *et al*., 2020). Unfortunately, the major emphasis of these studies is on optimizing growth, feed efficiency and general health condition (Hamed, 2022).

Recently, turmeric (Curcuma longa) which is a native plant of southern Asia and it is cultivated extensively throughout the tropical part of the world (Reyaz *et al*., 2019) has many biological activities contributed to its extract and active compound (curcumea). There are several reports indicating a variety of pharmacogical activities of turmeric, such as antioxidant (Masuda *et al*., 2001, 2002), anti-protozoal (Aghili *et al*., 2024), antimicrobial (Nduoyo *et al*., 2025), anti-venom (Fawole *et al*., 2022), anti-depressant (Yu *et al*., 2002), anti-dispetic (Deritelhoftt *et al*., 2002), anti-ulcer (Reyaz *et al*., 2019), and anti-HIV (Wei *et al*., 2023). This study aims to determine the effects of turmeric (*Curcuma longa*) on growth performance and blood chemistry of *Clarias gariepenus*.

MATERIALS AND METHODS

Research Area

The experiment was carried out at the Experimental Farm of the Department of Fisheries Technology of the Collage of Agriculture, Science and Technology Lafia. Nasarawa State. Lafia is located on latitude 8° 35'N, longitude 8°32'E, altitude 181.53m above sea level with a mean temperature of 34C, relative humidity of 40-86% and average day light of 9-12h (NIMET, 2011).

Experimental Set Up

Three hundred (300) juvenile catfish (*Clarias gariepinus*) were purchased from Keffi supreme fish farm, keffi; Nasarawa State. The stocks were acclimatized and weighed and then allocated into five dietary treatments; each treatment containing 20 fish in triplicate. Similar weight was maintained in all replicates with different of ± 3g in a completely randomized design. The experiment had five (5) treatments replicated thrice. Each experimental treatment contained graded quantities of turmeric. Treatment 1(T1) was controlled with no inclusion of turmeric,

Treatment 2(T2) with 2.5% of turmeric, Treatment 3(T3) with 5% turmeric, Treatment 4(T4)with 7.5% turmeric and Treatment 5(T5) with 10% turmeric inclusion (Saleem *et al*., 2024).

Experimental Procedure
The period of the feeding lasted for 10 weeks. All feed ingredients (fish meal, Groundnut cake (GNC), Brewers dry grain (BDG), indomie waste, oil, bone meal, salt, vitamin premix, lysine, Methionine and turmeric milk powder) of the feed were milled into powdery form separately, weighed, mixed properly and then pelleted into 2mm pellet size and dried before feeding the experimental fish. The experimental fishes were fed with the experimental diet of 40% crude protein (CP) at a rate of 4% of their body weight per day in two feeding regimes (morning and evening) (Gherescu *et al*., 2023; Hamed *et al*., 2022).

Data Collection
Initial mean weight of the fish was determined by weighing using sensitive weighing balance after which regular sampling for mean weight changes were taken at two weeks intervals for 8 weeks. The data was collected and was processed for growth assessment and nutrient utilization. The following formulae were used to determine feed utilization and growth performance of the experimental fish according to methods described by Jobling (1983).

Percentage mean weight gain (PMWG)
This is calculated using the formula:

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

Where, Wf is final mean weight and Wi is initial mean weight

Specific growth rate (SGR)
The SGR was calculated using the formula below:

$$SGR = \frac{(\ln Wf - \ln Wi)}{T} \times 100$$

Where, Wf= final mean weight, Wi= initial mean weight and T = culture period (days)

Feed intake
FI=Total amount of feed consumed or FI = feed offered – feed leftover (Jobling, 1983; Cho *et al*., 1982).

Feed Conversion Ratio (FCR)
FCR=Total feed consumed / Weight gain. (Cho *et al*., 1982).

Protein Efficiency Ratio (PER)
PER= Mean weight gain (g) / Protein intake (g). Where: Protein intake (g) = feed consumed (g) X protein content (%). Where: Feed consumed (g) is the total amount of feed eaten by the fish. Protein content (%) is the percentage of the protein in the feed. (NRC, 2011; Jauncey, 1982)

Survival Rate

$$\text{Survival rate \%} = \frac{\text{No of fish survived at the end of experiment}}{\text{Initial number of fish stocked}} \times 100$$

Blood Sampling and Analytical Method
Sample of 2ml of blood per treatment was collected from the caudal peduncle of the juvenile using 2ml disposable syringe and needle and then transferred into ethylene daiminetetracetic acid (EDTA) bottle for haematology (Sodomola *et al*., 2016; Ihenacho *et al*., 2017; Eissa *et al*., 2023) and serum into non anti-coagulant bottle. Initial blood was collected before the start of the feeding trial and final collection was done by collecting from each treatment on the last day of the feeding trial. The blood samples collected for haematology and serum analysis was analysed at Bafawat Biomedical Diagnostic Laboratory Center, No 3 Almakura Street, Lafia. Nasarawa state.

Statistical Analysis
The result of the data was subjected to analysis of variance (ANOVA) and Means were separated using least significant difference (LSD) at 5% probability. All statistical analyses were carried out using Statistical Analysis System (SAS 2008).

RESULTS AND DISCUSSION
The present study was conducted to evaluate the effect of turmeric on growth performance and blood chemistry of *Clarias gariepinus*. Medicinal plants, have received increasing attention as spices for human and additive in diet for animals. However, only few studies have been done on it use as feed additives in fish nutrition (El-Bahr

and Saad, 2008; Lawhavinit *et al*., 2011; Iheanacho *et al*., 2017; Fawole *et al*., 2022). The result of the proximate composition of the experimental feeds (Table1) showed that the percentage crude protein and other nutrients meets the recommended nutrient required for juvenile catfish as it is in line with the report of Saleem *et al*., (2024)

Table 1: Proximate composition of the experimental diets

Treatment	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
Inclusion level (%)	**0%**	**25%**	**50%**	**75%**	**100%**
Crude protein	41.78	39.85	44.25	43.67	43.29
Fat	3.86	3.87	3.97	3.67	3.72
Crude fiber	2.57	2.38	2.45	2.33	2.26
Ash	8.39	6.79	9.75	7.08	7.21
Moisture	5.34	8.21	6.96	8.29	8.37
NFE	38.06	38.90	32.62	34.96	34.82

NFE = Nitrogen free extract

The result of the weight (Table 2) is in contrast with the result reported by Sodamola *et al*. (2016) that turmeric can best improve the growth performance and immunity of the fish at rate of 7.5% inclusion in the diet. Also in contrast with the result reported by Lawhavinit *et al*. (2011), that ethanolic turmeric extracts could improve weight gain when supplemented in white shrimp diets at 15g/kg. The enhanced growth response indicated by turmeric supplementation in this experiment may be due to improved feed intake and protein efficiency ratio which is an indication of increased nutrient digestibility and antioxidant activity of turmeric (Olusola *et al*., 2024).

The result of the FCR is in line with the result of Lawhavinit *et al*. (2011) who reported that there was significant difference ($P<0.05$) in the feed conversion ratio in shrimp fed ethanolic extract of turmeric. The result of the survival rate is in line with the result of Sodamola *et al*. (2016) who reported that there was significant difference ($P<0.05$) in the survival rate, and contrast with the findings of Lawhavinit *et al*. (2011) which says that there was no significant difference in the survival rate in the white shrimp fed ethanolic extract of turmeric.

Table 2: Growth performance and nutrient utilization of *Clarias gariepinus* juvenile fed powdered turmeric-based feeds

Treatments	**T1**	**T2**	**T3**	**T4**	**T5**
			Inclusion Level		
	0%	25%	50%	75%	100%
Initial weight (g)	5±0.00a	5±0.00a	5±0.00a	5±0.00a	5±0.00a
Final weight (g)	212.37±2.54[a]	187.40±32.82[b]	131.70+7.04[c]	186.77±6.96[b]	113.20±5.5
MWG (g)	207.37±0.25a	182.40±3.28b	126.70±0.55°	181.00±0.70b	108.00±0.7
SGR (%/%/day)	2.33±0.01b	2.25+0.05a	2.03±0.01°	2.25±0.01a	1.94±0.01d
Feed intake (g)	752.33±2.52a	736.00±7.94b	633.67±6.03°	726.67±11.72b	607.67±7.0
FCR	3.63±0.07d	4.04+1.37°	5.00±1.04b	4.02±0.29°	5.63±0.83a
PER	0.51±3.66a	0.46±3.70b	0.22±20.82°	0.43+13.67°	0.31+16.39
Survival rate (%)	90.00±1.00a	86.67+1.12b	66.67±0.58d	83.33+ 1.53°	60.00±1.00

Mean with same superscript along the row are not significantly different ($P>0.05$)
MWG = Mean Weight Gain **FCR** = Feed Conversion Ratio
SGR = Specific Growth Rate **PER** = Protein Efficiency Ration

The result of the blood chemistry (Table 3) shows that their packed cell volume (PCV) value obtained were not significantly different which is in line with Sodamola *et al*. (2006) findings and the values (22 to 25) fell within the normal range 20 to 35% (Wei *et al*., 2023). The highest white Blood cell (WBC) (113x10°/L) was recorded in the blood of catfish on T2. This is an index of high immunity pursed by the fish and resistance to diseases (El-Bahr and Saad, 2008). Aghili *et al*. (2024) reported that a measurable increase in WBC of fish and any other animal is a function of immunity and resistance to vulnerable diseases.

Table 3: Haematology of *Clarias gariepinus* juvenile fed powdered turmeric-based feeds

Parameters	Initial inclusion level (%)	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)
Hmgbn (g/dl)	9.80	7.30°	8.30a	8.00b	8.00b	7.30°
PCV (%)	30.00	22.00°	25.00a	24.00b	24.00b	22.00c
RBC ($X10^{12}$/L)	2.99	2.11d	2.39a	2.33b	2.32b	2.19c
WBC ($X10^{9}$/L)	139.00	89.00c	113.00a	100.00b	75.00e	86.00d
MCH (pp)	32.70	34.59a	34.72a	34.33a	34.48a	33.33b
MCHC (%)	32.60	0.33a	0.33a	0.33a	0.33a	0.33a

Mean with same superscript along the row are not significantly different (P>0.05)

PCV=Packed cell volume, **RBC** = Red blood cell, **WBC** = White blood cell, **MCH** = Mean corpuscular haemoglobin, **MCHC**=Mean corpuscular haemoglobin count.

Table 4 depicts the data pertaining to serum Biochemistry. The result shows the creatinine was significantly ($p<0.05$) influenced by the varying inclusion of turmeric root powder. The stocks in T2 recorded the highest creatinine level (44Nmol/L) when compared with T1 (control)(39Nmol/L) and other cholesterol level was significantly lower with increasing turmeric concentration in the experimental diets/feeds. T5 recorded the lowest cholesterol level (1.9mmol/L) as compared to T1 (control) (2.3mmol/L) and initial (3.2 mm/L) whereas total calcium reduces with increasing creatinine level.

Table 4: Serum biochemistry of *Clarias gariepinus* juvenile fed powdered turmeric-based feeds

Parameters	Initial inclusion level (%)	T1 0%	T2 25%	T3 50%	T4 75%	T5 100%
Albumin	39.00	24.00^{b}	19.00^{d}	20.00^{c}	27.00^{a}	24.00^{b}
Cholesterol	3.20	2.30^{b}	2.60^{a}	1.90^{c}	2.20^{b}	1.90^{c}
Creatinine	57.00	39.00^{c}	44.00^{a}	40.00^{b}	36.00^{d}	35.00^{e}
Total calcium	2.00	1.10^{a}	0.90^{b}	1.30^{a}	1.10^{a}	1.10^{a}

Mean with same superscript along the row are not significantly different (P>0.05)

CONCLUSION

Turmeric supplementation in this research can be said to be to optimally improve the measured growth performance and nutrient utilization at 2.5% turmeric inclusion. There is wider decrease at the peak of turmeric concentration against the higher recorded in control. Hence, at 2.5% turmeric supplementation improve the immunity and disease resistance of catfish.

REFERENCES

Adesina, O. S., Ajibare, A. O., & Abubakar, R. (2020). Effect of Graded Dietary Levels of Boiled Fenugreek (Trigonellafoenumgraceum) Seed Meal on Haematological and Serum Biochemical Profile of *Clarias gariepinus* Fingerlings. *Nigerian Journal of Agriculture, Food and Environment*, 16(3), 64-79.

Aghili, S. M., Firouzbakhsh, F., Haghparast, S. & Farhadi, A. (2024). Growth parameters, hematology, immunity, and relative expressions of TNF-α and IL-8 genes in rainbow trout (*Oncorhynchus mykiss*) fed a combination of turmeric (*Curcuma langa*) powder and black pepper (*Piper nigrum*). *Aquaculture International*, 32(3), 2353-2372.

Cho, C. Y., Slinger, S. J., & Bayley, H. S. (1982). Bioenergetics of salmonid fishes: Energy intake, expenditure and productivity. Comparative Biochemistry and Physiology Part B: *Comparative Biochemistry*, 73(1), 25-41.

Deitelhoft, P., Peterowicz, O. & Muller, B. (2002). Anti-dyspeptic properties of turmeric rootextract (TRE). Phytomedicine 7:92.

Eissa, E. S. H., Alaidaroos, B. A., Jastaniah, S. D., Munir, M. B., Shafi, M. E., Abd El-Aziz, Y. M. & Saadony, S. (2023). Dietary effects of nano curcumin on growth performances, body composition, blood parameters and histopathological alternation in red tilapia (*Oreochromis sp*.) challenged with *Aspergillus flavus*. *Fishes*, 8(4), 208.

El-bahr, S. M. & Saad, T. T. (2008). Effect of black curcumin seeds (*Nigella sativa*) and Turmeric on haematological, biochemistry and immunological parameters of Mugilcephalus fish vaccinated with Aeromonus hydrophila bacterial. In the 13th scientific congress, faculty of veterinary medicine Assiut University, Pp: 365-388.

Fawole, F. J., Yisa, R. O., Jayeoba, O. O., Adeshina, I., Ahmed, A. O., & Emikpe, B. O. (2022). Effect of Dietary Polyherbal Mixture on Growth Performance, Haemato-Immunological Indices, Antioxidant Responses, and Intestinal Morphometry of African Catfish, Clarias gariepinus. *Aquaculture Nutrition,* 2022(1), 5502796.

Gherescu, P., Mihailov, S., & Grozea, A. (2023). The Influence of Some Phyto-Additives on Bio-Productive Performances and the Health of the Farmed Fish–Review. *Scientific Papers Animal Science and Biotechnologies*, 56(1), 128-128.

Hamed, H. S., Ismal, S. M., & Abdel-Tawwab, M. (2022). Modulatory effects of dietary cinnamon (Cinnamomum zeylanicum) against waterborne lead toxicity in Nile tilapia fingerlings: Growth performance, haemato-biochemical, innate immunity, and hepatic antioxidant indices. *Aquaculture Reports*, 25, 101190.

Iheanacho, S. C., Ogunji, J. O., Ogueji, E. O., Nwuba, L. A., Nnatuanya, I. O., Ochang, S. N. & Haruna, M. (2017). Comparative assessment of ampicillin antibiotic and ginger (*Zingiber officinale*) effects on growth, haematology and biochemical enzymes of *Clarias gariepinus* Juvenile. *Journal of Pharmacognosy and Phytochemistry*, 6(3), 761-767.

Jauncey, K. (1982). The effects of varying dietary protein level on the growth, food conversion, protein utilization and body composition of juvenile tilapias (*Sarotherodon mossambicus*). *Aquaculture*, 27(1), 43-54.

Jobling, M. (1983). A short review and critique of methodology used in fish growth and nutrition studies. *Journal of Fish Biology.* 23: 686-703.

Lawhavinit, O.P., Charoepokai, S. & Sunthornadh, P. (2011). Effects of ethanol turmeric (*Curcuma longa* linn) extract on shrimp (litopeanaesvannamei). Kasetsalrt. *J. Nat. Sci*.45:70-77.

Masuda, T., Maekawa-Hidaka, T.K., Bando, H., Takeda, Y. & Yamaguchi, H. (2001).Chemical studies on antioxidant mechanism of Curcumin: Analysis of oxidativecoupling products from Curcumin and Linoleate. *J. Agric. Food. Chem*. 49:2539-2547.

Masuda, T., Toi, Y., Bando, H., Maekawa, T., Takeda, Y. & Yamaguchi, H. (2002).Structuralidentification of new curcumin dimers and their contribution to the antioxidantmechanism of curcumin. *J. Agric. Food.Chem*.50:2524-2530

National Research Council. (2011). Nutrient requirements of fish and shrimp. National Academies Press.

Nduoyo, J. E., Ekwu, A. O., Umanah, S. I., Udo, I. U. & Akpan, I. I. (2025). Evaluation of Dietary Turmeric (*Curcuma longa*) As a Reproductive Modulator in Nile Tilapia (*Oreochromis niloticus*): An Exploratory Study on Its Contraceptive Properties. *Aceh Journal of Animal Science*, 10(1), 11-21.

NIMET (2011). Nigerian Metrological Agency. Synoptic Office, Lafia, Nasarawa State, Nigeria.

Olusola, S. E., Agbebi, F. O., Amulejoye, F. D., Adejumo, F. A., & Salimon, Y. A. (2024). Immunoprotective efficacy of aqueous monovalent vaccine, turmeric (*Curcuma longa*) rhizome and soursop (*Annona muricata*) leaves against Pseudomonas aeruginosa infection in African sharptooth catfish (*Clarias gariepinus*) fingerlings. *Journal of Applied Aquaculture*, 1-18.

Reyaz, M. A., Jehan, S. Q., & Sanjay, T. (2019). Formulation of Fish feed using Medicinal Herb Curcuma amada and Its Biochemical and Haemotological Changes in Labeo rohita. *Journal of Drug Deliery and Therapeutics*, 9, 96-99.

Saleem, M., Hussain, S. M., Ali, S., Sarker, P. K., Shahid, M., & Naeem, A. (2024). New insights into the effect of *Solanum nigrum* extract supplementation on growth, digestibility, carcass, hematological indices, and antioxidant status in *Oreochromis niloticus*. *Aquaculture Reports*, 39, 102454.

Sodamola, M. O., Jimoh, W. A., Adejola, Y. A., Akinbola, D. D., Olanrewaju, A., & Apiakason, E. (2016). Effect of turmeric (*Curcuma longa*) root powder (TRP) on the growth performance, hematology and serum biochemistry of African catfish (*Clarias gariepinus*).

Wei, L. S., Kari, Z. A., Kabir, M. A., Khoo, M. I., Azra, M. N., & Wee, W. (2023). Promoting growth and health of african catfish, *Clarias gariepinus*, through dietary novel supplement, ginger, *zingiber officinale* rosc, leaf powder. *Aquaculture Studies*, 24(4).

Yu, Z. F., Kong, L. D. & Chen, Y. (2002). Antidepressant activity of aqueous extracts of *Curcuma longa* in mice. *J. Ethnophamacol.* 83: 161-165.