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Dietary Effects of Swizzle Stick (Rauvolfia vomitoria) Leaf Meal on Growth Performance, and Nutrient Utilisation of African Catfish (Clarias gariepinus) Fingerlings

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ABSTRACT

This study evaluated the effects of dietary supplementation with Rauvolfia vomitoria leaf meal on the growth performance, nutrient utilisation, physiological responses, and carcass composition of Clarias gariepinus fingerlings during a 70-day feeding trial. A total of 225 fingerlings (initial mean weight: 3.95 ± 0.10 g) were randomly distributed into 15 glass tanks at a stocking density of 15 fish per tank, with each treatment replicated three times. Five experimental diets containing 0.0, 0.5, 1.0, 1.5, and 2.0 g of R. vomitoria leaf meal per 100 g diet were formulated and designated as R1, R2, R3, R4, and R5, respectively. Dietary supplementation significantly influenced growth performance and nutrient utilisation. Fish fed the 1.0 g/100 g diet (R3) recorded the highest weight gain and best feed utilisation, while polynomial regression analysis identified 1.0 g/100 g diet as the optimum inclusion level for maximum growth. Higher supplementation levels resulted in reduced growth performance. Survival was high and unaffected by dietary treatment. Moderate inclusion of R. vomitoria leaf meal also improved selected haematological and serum biochemical indices, indicating enhanced physiological condition and nutrient metabolism. Carcass analysis revealed increased protein deposition and reduced lipid accumulation in fish fed the supplemented diets. These findings indicate that R. vomitoria leaf meal is an effective phytogenic feed additive for improving growth, feed efficiency, physiological status, and carcass quality in C. gariepinus fingerlings. An inclusion level of 1.0g/100 g diet is therefore recommended for optimal performance under the conditions of this study.

INTRODUCTION

Aquaculture is among the fastest-growing food production sectors worldwide and plays a vital role in improving food security, generating employment, and providing a reliable source of high-quality animal protein. As production has intensified to meet the increasing demand for fish, producers have encountered challenges such as disease outbreaks, environmental stress, poor feed efficiency, and increased dependence on antibiotics and other chemotherapeutic agents. The continuous use of these synthetic products has raised concerns about antimicrobial resistance, environmental contamination, and food safety, highlighting the need for sustainable and eco-friendly alternatives that enhance fish health and production efficiency (Marimuthu *et al.*, 2022). In recent years, phytogenic feed additives derived from medicinal plants have attracted considerable interest as natural alternatives to synthetic growth promoters in aquaculture. Rich in biologically active compounds, these plant-based additives have been reported to improve growth performance, nutrient utilisation, antioxidant capacity, immune function, and disease resistance. Their natural origin and biodegradability also make them environmentally sustainable and suitable for modern aquaculture production systems (Taştan and Salem, 2021). Rauvolfia vomitoria Afzel. (family Apocynaceae), commonly known as African snakeroot and locally referred to as Asofeyeje in southwestern Nigeria, is a medicinal plant widely distributed across tropical Africa. For many years, it has been used in traditional medicine for the treatment of hypertension, malaria, fever, gastrointestinal disorders, and microbial infections. Phytochemical investigations have shown that the leaves contain numerous bioactive constituents, including indole alkaloids such as reserpine, ajmaline, serpentine, and yohimbine, as well as flavonoids, tannins, phenolic compounds, saponins, terpenoids, and glycosides. These phytochemicals possess antioxidant, antimicrobial, anti-inflammatory, and immunomodulatory properties, indicating that the plant could serve as a valuable functional ingredient in aquafeeds (Kumar *et al.*, 2022). The African catfish, Clarias gariepinus, is one of the most commercially important freshwater fish species cultured in Africa because of its rapid growth rate, efficient feed conversion, tolerance to a wide range of environmental conditions, and strong consumer acceptance. Nevertheless, intensive farming of this species is frequently constrained by disease outbreaks, physiological stress, and rising production costs, all of which can reduce productivity and profitability. The incorporation of medicinal plants such as R. vomitoria into fish diets may offer a practical and sustainable strategy for enhancing growth, improving physiological condition, and increasing production efficiency while reducing dependence on synthetic additives. Although R. vomitoria is well recognised for its medicinal and pharmacological

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properties, information on its application as a phytogenic feed additive in aquaculture remains limited. Therefore, this study was conducted to evaluate the effects of dietary inclusion of R. vomitoria leaf meal on the growth performance, nutrient utilisation, haematological indices, serum biochemical responses, and carcass composition of Clarias gariepinus fingerlings.

MATERIALS AND METHODS

Experimental Site

This research was conducted over a 70-day period at the Research Laboratory within the Department of Fisheries and Aquaculture Technology at the Federal University of Technology, Akure, Ondo State.

Collection and Preparation of Rauvolfia vomitoria Leaves

Fresh Rauvolfia vomitoria leaves were obtained from a reputable medicinal plant market in Akure, Ondo State, Nigeria. The plant material was identified and authenticated by a botanist in the Department of Crop, Soil and Pest Management, Federal University of Technology, Akure. The leaves were thoroughly washed with distilled water to remove adhering dirt and other impurities before being air-dried at room temperature to minimise the loss of heat-sensitive bioactive compounds. After drying, the leaves were milled into a fine powder using an electric blender (Model ES 242). The resulting leaf meal was stored in an airtight container at 4°C until it was incorporated into the experimental diets.

Experimental Fish

A total of 300 apparently healthy Clarias gariepinus fingerlings were obtained from the Federal University of Technology Fish Farm, Akure, Ondo State, Nigeria. Upon arrival, the fish were acclimatised to the experimental conditions for seven days before the commencement of the feeding trial. During the acclimation period, they were fed a control diet containing 40% crude protein to apparent satiation twice daily, between 08:00–09:00 h and 16:00–17:00 h, to ensure adequate adaptation to the experimental environment.

Experimental Diets

Five isonitrogenous experimental diets were formulated following standard feed formulation procedures to contain approximately 40% crude protein (Table 1). The control diet was prepared without Rauvolfia vomitoria leaf meal (0.0 g/100 g diet), while the other four diets were supplemented with graded inclusion levels of 0.5, 1.0, 1.5, and 2.0 g R. vomitoria leaf meal per 100 g diet, respectively. All diets were formulated using the same basal ingredients, including fish meal, soybean meal, groundnut cake, yellow maize, methionine, lysine, fish oil, vitamin-mineral premix, and starch. The graded levels of R. vomitoria leaf meal were incorporated by replacing equivalent quantities of yellow maize to maintain a consistent total diet weight of 100 g. The ingredients were thoroughly mixed to achieve uniform distribution of nutrients and subsequently pelleted using a Hobart A-200T mixing and pelleting machine (Hobart Manufacturing Ltd., UK) fitted with a 2-mm die. The pellets were sun-dried for four days to reduce moisture content, then crumbled into appropriate particle sizes suitable for Clarias gariepinus fingerlings. The prepared diets were packaged in airtight containers and stored at 4°C until required for feeding.

Experimental Design and Management

The experiment was conducted using a completely randomized design (CRD). After the acclimation period, all fish were weighed, and 300 healthy Clarias gariepinus fingerlings with an initial mean weight of 3.94 ± 0.01 g were randomly allocated into 15 glass tanks measuring 70 × 45 × 45 cm. The fish were stocked at a rate of 15 fish per tank, representing five dietary treatments with three replicates per treatment. The experimental diets were offered twice daily, between 08:00–09:00 h and 16:00–17:00 h, at apparent satiation throughout the 70-day feeding trial. Water quality parameters, including temperature (°C), dissolved oxygen (mg L^{-1}), and pH, were monitored twice weekly to ensure optimal rearing conditions. Water temperature was determined using a mercury-in-glass thermometer, dissolved oxygen concentration was measured with a portable dissolved

Table 1*:* Gross and proximate compositions of the experimental diets

Ingredients	**R1 (0.0)**	**R2 (0.5)**	**R3 (1.0)**	**R4 (1.5)**	**R5 (2.0)**
Fish meal	23.3	23.3	23.3	23.3	23.3
Soybean meal	25.4	25.4	25.4	25.4	25.4
Groundnut cake	28.1	28.1	28.1	28.1	28.1
Yellow maize	13.3	12.80	12.30	11.80	11.3
R. vomitoria	0.00	0.50	1.00	1.50	2.00
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20
Fish oil	5.00	5.00	5.00	5.00	5.00
Vitamin premix*	1.40	1.40	1.40	1.40	1.40
Starch	3.00	3.00	3.00	3.00	3.00
proximate composition (%)					

Ash	10.92	11.29	11.34	11.51	11.63
Fiber	3.69	3.72	3.81	3.93	4.05
Lipids	8.81	8.85	8.96	8.85	8.92
Moisture	9.89	9.14	9.09	9.16	9.02
Protein	39.72	40.02	39.89	39.75	40.01
Nitrogen Free Extract	26.97	26.98	26.91	26.80	26.37

Composition of vitamin-mineral mix (Aquamix) (quantity/kg), Vitamin A, 5,500,000 IU; Vitamin D3, 1,100,000 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, 450mg. L- Lysine, 10 g; Selenium, 50 ppm.

oxygen meter, and pH was assessed using a calibrated digital pH meter. Partial water replacement was carried out every three days to maintain favourable water quality conditions throughout the experimental period.

Proximate Composition

The proximate composition of the plant material, experimental diets, and fish samples was determined following the standard analytical procedures of the Association of Official Analytical Chemists (AOAC, 2005). The parameters analysed included moisture content, crude protein, crude lipid, crude fibre, ash, and nitrogen-free extract (NFE). Moisture content was determined by drying samples in a hot-air oven at 105°C until a constant weight was attained. Crude protein was estimated using the Kjeldahl method by measuring total nitrogen content, and the protein value was calculated using a nitrogen conversion factor of 6.25. Crude lipid content was determined through solvent extraction, while crude fibre was analysed by sequential acid and alkaline digestion. Ash content was obtained by incinerating samples in a muffle furnace at 550°C until a constant weight was achieved. Nitrogen-free extract (NFE) was calculated by difference according to the following formula:

NFE (%) = 100 − (% moisture + % crude protein + % crude lipid + % crude fibre + % ash).

Growth Performance and Nutrient Utilisation

rowth performance and nutrient utilisation parameters were calculated according to the methods described by Adeniyi *et al.* (2023). At the end of the feeding trial, all fish were counted and individually weighed to determine the final weight. The growth performance and feed utilisation indices were subsequently calculated using the following standard formulae:

Weight Gain (g) = Final weight-initial weight

Specific Growth Rate (SGR)

This was calculated from data on changes in body weight over a given time interval:

$$\text{SGR (\%/day)} = \frac{\text{LN Final Weight} - \text{LN Initial Weight}}{\text{Number of days}} \times 100$$

Feed intake

Feed intake was determined as the cumulative amount of feed consumed by fish throughout the experimental period.

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Feed intake (g)}}{\text{Weight gain (g)}}$$

$$\text{Feed Efficiency Ratio (FER)} = \frac{\text{Weight gain (g)}}{\text{Feed intake (g)}}$$

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

Blood Collection

At the end of the 70-day feeding trial, three fish were randomly selected from each replicate tank, giving a total of nine fish per treatment, for haematological and serum biochemical analyses. Prior to blood collection, the selected fish were fasted for 24 h to reduce variations associated with recent feed intake and postprandial changes in blood metabolites. The fish were gently captured and anaesthetised with tricaine methanesulfonate (MS-222) before sampling. Blood samples were collected through caudal vein puncture using sterile disposable syringes fitted with 23-gauge needles, and approximately 0.5–1.0 mL of blood was obtained from each fish. Samples collected for haematological analysis were immediately transferred into EDTA-coated tubes to prevent coagulation, while samples intended for serum biochemical analysis were placed in plain tubes and allowed to clot at room temperature. The clotted blood samples were then centrifuged at 3,000 rpm for 10 min to separate the serum, which was carefully collected and stored for subsequent biochemical analysis.

Haematological and Serum Biochemical Analyses

Haematological parameters, including haemoglobin concentration (Hb), packed cell volume (PCV), red blood cell (RBC) count, white blood cell (WBC) count, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC), were analysed following the procedures described by Svobodova *et al.* (1991). Serum biochemical indices, including glucose, total protein, albumin, globulin, and cholesterol concentrations, were determined using commercial diagnostic kits in accordance with the manufacturers' protocols and the methods outlined by Morgan and Iwama (1997).

Data Analysis

The data obtained from the experiment were subjected to one-way analysis of variance (ANOVA) to determine the

significance of differences among the treatment means. Where significant differences existed, Tukey's Honestly Significant Difference (HSD) post-hoc test was applied to separate and compare the means among treatments. All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version 23, and differences were considered statistically significant at $P < 0.05$.

RESULTS AND DISCUSSION

Proximate Composition of R. vomitoria Leaf

The proximate composition of R. vomitoria leaf meal (Table 2) demonstrates its nutritional potential as a functional feed ingredient in aquaculture diets. The leaf meal contained 18.95% crude protein and a relatively high nitrogen-free extract (53.07%), indicating its contribution as a source of nutrients and dietary energy. The moderate levels of crude fibre (6.03%) and lipid (3.47%) suggest that the ingredient is suitable for inclusion in fish diets, while the ash content (7.12%) reflects the presence of essential mineral constituents. The recorded moisture content (11.36%) indicates good storage stability and a reduced risk of microbial deterioration during handling and storage. The crude protein content obtained in the present study (18.95%) was comparable to the 19.33% reported by Ekanem *et al.* (2025), suggesting a similarity in the nutritional composition of R. vomitoria leaves. Variations in proximate values among studies may be attributed to differences in geographical location, soil characteristics, climatic conditions, stage of plant maturity, post-harvest processing techniques, and analytical methods employed. Although the protein level of R. vomitoria leaf meal is lower than that of conventional protein sources, its nutritional importance may extend beyond its nutrient contribution due to the presence of bioactive phytochemicals that can enhance physiological functions, growth performance, and overall health status of cultured fish.

Table 2: Proximate composition of R. vomitoria leaf meal

Parameters	Values (%)
Ash	7.12
Fibre	6.03
Crude lipids	3.47
Moisture	11.36
Crude protein	18.95
Nitrogen Free Extract	53.07

Water quality parameters

The water quality parameters recorded during the experimental period are presented in Table 3. No significant differences ($P > 0.05$) were observed among dietary treatments, as indicated by the uniform superscript notation (a) across all parameters. Temperature, pH, and dissolved oxygen levels exhibited only minor variations throughout the feeding trial, demonstrating that the experimental units were maintained under stable environmental conditions suitable for *Clarias gariepinus* production. The observed consistency in water quality parameters indicates that dietary supplementation with *R. vomitoria* leaf meal did not negatively influence the aquatic environment. The maintenance of favourable water conditions throughout the study may have contributed to the satisfactory growth performance and survival of the fish. These findings suggest that appropriate husbandry practices were effectively implemented, ensuring a conducive culture environment for the experimental fish. Similar observations were reported by Abraham *et al.* (2015), who noted that maintaining optimal water quality conditions is essential for promoting growth, health, and survival of *C. gariepinus* under intensive culture systems.

Table 3: Water quality parameter measured during the experimental period

Parameters	R1 (0.0)	R2 (0.5)	R3 (1.0)	R4 (1.5)	R5 (2.0)
Temperature (oC)	25.73±1.15a	25.67±0.07a	25.86±0.03a	25.73±0.12a	25.86±0.03a
pH	7.08±0.02a	7.09±0.05a	7.06±0.01a	7.10±0.06a	7.09±0.05a
DO (mg/L)	6.72±0.09a	6.75±0.03a	6.70±0.06a	6.73±0.02a	6.75±0.03a

Means in same row with similar superscripts are not significantly different (P > 0.05)

Growth Performance and Nutrient Utilisation

The growth performance and feed utilisation responses of *Clarias gariepinus* fingerlings fed graded levels of R. vomitoria leaf meal are presented in Table 4. Dietary supplementation significantly ($P < 0.05$) affected final weight gain and other growth-related parameters, with fish fed the 1.0 g/100 g diet (R3) recording the highest growth response compared with the control and other dietary treatments. Polynomial regression analysis also identified 1.0 g/100 g diet as the optimum inclusion level for achieving maximum growth performance, indicating that moderate supplementation provided the most favourable response. Fish fed the R3 diet exhibited the highest specific growth rate and feed intake, while the control group (R1) recorded the lowest values. The improved feed conversion ratio observed in R3 suggests

enhanced nutrient utilisation and efficient conversion of feed nutrients into fish biomass. Although feed efficiency ratio and survival rate showed numerical variations among treatments, these differences were not statistically significant ($P > 0.05$). These results indicate that dietary inclusion of *R. vomitoria* leaf meal at moderate levels improved growth performance and feed utilisation without compromising fish survival. The enhanced growth observed in fish fed the R3 diet may be associated with the bioactive constituents present in *R. vomitoria* leaves, including alkaloids, flavonoids, phenolic compounds, and other secondary metabolites. These phytochemicals possess antioxidant and physiological regulatory properties that may contribute to improved digestive efficiency, metabolic activity, and overall health status of fish. Plant-based feed additives have been reported to enhance growth performance through stimulation of digestive enzyme activity, improvement of antioxidant defence systems, and better utilisation of dietary nutrients (Awad and Awaad, 2017). The higher feed intake and improved numerical feed conversion ratio (1.72) and feed efficiency ratio (0.58) recorded in R3 further suggest better diet acceptance and nutrient assimilation by the fish. Similar responses have been reported in fish fed diets containing phytogenic additives, where moderate supplementation improved feed utilisation and growth through enhanced digestion and nutrient absorption (Zhou *et al.*, 2019). The regression analysis supported the observed growth pattern by indicating an optimum dietary inclusion range of approximately 1.0–1.5 g/100 g diet. However, the decline in growth performance at higher inclusion levels (R4 and R5) suggests that excessive supplementation may reduce the beneficial effects of *R. vomitoria*. This reduction may be linked to increased concentrations of plant secondary metabolites, which could affect feed palatability, digestive processes, or nutrient availability when included beyond the optimal level. Similar dose-dependent responses have been reported for medicinal plants and phytogenic compounds, where moderate inclusion levels enhance performance, whereas excessive supplementation may negatively affect growth due to anti-nutritional effects or metabolic limitations (Van Hai, 2015). Survival rates remained high throughout the experimental period (86.67–95.56%) and were not significantly influenced by dietary treatments, indicating that *R. vomitoria* leaf meal was well tolerated by *C. gariepinus* fingerlings and did not produce adverse effects under the conditions of the study.

Table 4: Growth and nutrient utilization of experimental fish

Parameters	**R1 (0.0)**	**R2 (0.5)**	**R3 (1.0)**	**R4 (1.5)**	**R5 (2.0)**
IW (g)	3.95±0.01a	3.96±0.01a	3.94±0.01a	3.94±0.00a	3.96±0.00a
FW (g)	31.89±0.30a	39.87±2.35cd	44.55±1.06d	37.18±2.78c	33.78±3.41b
WG (g)	27.94±0.30a	35.91±2.33cd	40.61±1.06d	33.24±2.78c	29.82±3.41b
SGR (%/day)	2.98±0.01a	3.30±0.08a	3.46±0.03a	3.21±0.11a	3.06±0.14a
TFI (g/fish)	52.70±0.59a	64.62±3.62cd	69.78±2.08d	61.32±5.47c	56.53±6.70b
FCR	1.92±0.00a	1.79±0.02a	1.72±0.00a	1.84±0.01a	1.90±0.01a
FER	0.53±0.01a	0.56±0.01a	0.58±0.03a	0.54±0.10a	0.53±0.00a
Survival (%)	93.33±3.85a	88.89±4.54a	93.33±5.89a	95.56±4.44a	86.67±3.85a

Mean in the same row with different letter are significantly different (P<0.05)
KEY; IW = Initial weight, FW = Final weight, WG = Weight gain, ADG = Average daily weight gain, SGR = Specific growth rate, TFI = Total feed intake, FCR = Feed conversion ratio, FER = Feed efficiency ratio

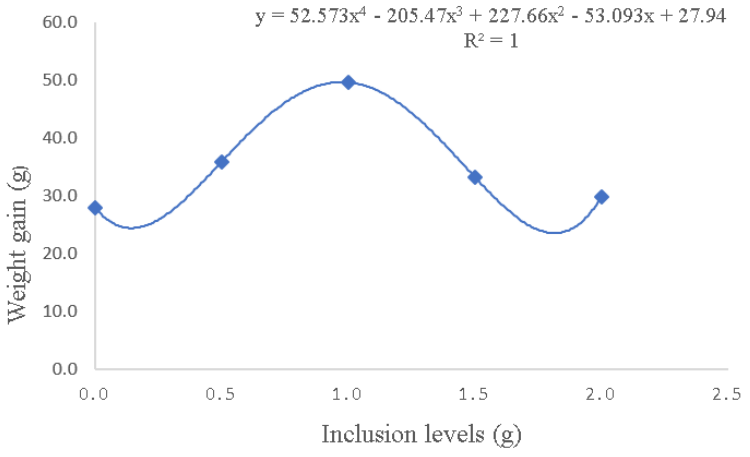

Figure 1: Polynomial regression analysis illustrating the relationship between R. vomitoria inclusion and weight gain in C. gariepinus.

Haematological Parameters

The haematological responses of Clarias gariepinus fingerlings fed graded levels of *R. vomitoria* leaf meal are presented in Table 5. Dietary supplementation significantly ($P < 0.05$) influenced white blood cell (WBC) count, haemoglobin concentration (Hb), packed cell volume (PCV), and mean corpuscular haemoglobin concentration (MCHC), whereas red blood cell (RBC) count, mean corpuscular volume (MCV), and mean corpuscular haemoglobin (MCH) were not significantly affected by the dietary treatments. White blood cell count varied significantly among the treatments, with the lowest value observed in fish fed the R3 diet and the highest value recorded in R5. This variation suggests that dietary inclusion of *R. vomitoria* leaf meal influenced leucocyte response, possibly through modulation of immune activity. Haemoglobin concentration and packed cell volume followed a similar pattern, with fish fed the R3 diet exhibiting the highest values, while the lowest values were observed at the highest inclusion level (R5). The improved Hb and PCV values at moderate supplementation indicate enhanced oxygen transport capacity and improved physiological condition of the fish. The non-significant differences observed in RBC, MCV, and MCH indicate that inclusion of *R. vomitoria* leaf meal did not negatively affect erythrocyte production, size, or haemoglobin content. This suggests that the dietary treatments supported normal blood cell formation and maintained erythrocyte integrity. However, the progressive increase in MCHC with increasing dietary inclusion, with the highest value recorded in R5, indicates that higher levels of *R. vomitoria* supplementation influenced haemoglobin concentration within red blood cells. The observed improvements in selected haematological indices, particularly at moderate inclusion levels, may be associated with the bioactive constituents of *R. vomitoria* leaves. The presence of indole alkaloids, phenolic compounds, flavonoids, and other antioxidant components may contribute to improved cellular protection by reducing oxidative stress and supporting normal physiological functions (Bhat *et al.,* 2015). Similar observations have been reported in fish fed medicinal plant-based diets, where phytogenic additives enhanced haematological status, immune responses, and resistance to physiological stress through the activity of bioactive plant compounds (Awad and Awaad, 2017). The increase in MCHC with increasing dietary inclusion suggests improved haemoglobin concentration within erythrocytes, which could potentially enhance oxygen transport and metabolic efficiency. However, because other erythrocyte indices did not show consistent significant changes, the physiological significance of this response should be interpreted with caution. The findings indicate that *R. vomitoria* leaf meal can positively influence selected haematological parameters without causing adverse effects on blood cell characteristics of *C. gariepinus* fingerlings.

Table 5: Haematological parameters of experimental fish

Parameters	R1 (0.0)	R2 (0.5)	R3 (1.0)	R4 (1.5)	R5 (2.0)
WBC (x103/mm3)	5.55±0.35b	5.35±0.05b	4.73±0.10a	6.35±0.15c	6.84±0.10c
Hb (g/100ml)	11.3±0.30b	11.5±0.15b	12.7±0.30c	10.4±0.05ab	9.55±0.05a
PCV (%)	34.1±1.00b	35.8±4.00b	38.3±1.00c	31.5±1.00ab	29.6±1.00a
RBC (x106/mm3)	3.80±0.10a	3.84±0.02a	4.30±0.10a	3.43±0.10a	3.29±0.20a
MCV (fl)	89.74±0.21a	93.23±10.12a	89.07±4.33a	91.84±5.98a	89.97±2.26a
MCH (pg)	29.74±0.02a	29.95±0.28a	29.53±1.37a	30.32±1.11a	29.03±1.81a
MCHC (%)	33.14±0.09a	46.52±3.46b	37.24±0.10a	61.06±0.86c	71.62±1.23d

Means in same row with different superscript are significantly different (P<005)

Key: PCV = Packed Cell Volume, Hb = Haemoglobin Content, WBC = White Blood Cell, RBC = Red Blood Cell, MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration, MCV = Mean Corpuscular Volume

Biochemical Profile

The serum biochemical responses of *Clarias gariepinus* fingerlings fed graded levels of *R. vomitoria* leaf meal are presented in Table 6. Dietary supplementation significantly ($P < 0.05$) affected serum glucose, cholesterol, total protein, albumin, and globulin concentrations, indicating that inclusion of *R. vomitoria* leaf meal influenced metabolic processes and physiological responses of the fish. Serum glucose concentration varied significantly among dietary treatments, with the highest value recorded in R2 and the lowest in R5. Glucose is an important indicator of energy metabolism and physiological adjustment in fish, and variations in its concentration may reflect differences in nutrient utilisation, energy availability, and metabolic regulation resulting from dietary supplementation. The reduced glucose level observed at higher inclusion levels may indicate increased glucose utilisation or altered energy allocation towards growth, maintenance, and other physiological functions. Similar dose-dependent responses have been reported in fish fed medicinal plant-based diets, where moderate inclusion enhances metabolic efficiency, whereas excessive supplementation may modify nutrient metabolism due to increased levels of bioactive compounds or secondary metabolites (Van Hai, 2015). Serum cholesterol concentration was also significantly influenced by dietary treatments, with the

highest value observed in R2, followed by a gradual reduction as the inclusion level of *R. vomitoria* increased. The decline in cholesterol concentration at higher supplementation levels may be associated with the lipid-modulating properties of phytochemicals present in *R. vomitoria,* including alkaloids, flavonoids, and phenolic compounds. These compounds have been reported to regulate lipid metabolism through mechanisms such as modulation of cholesterol synthesis, enhancement of antioxidant activity, and maintenance of cellular lipid balance (Gholami-Ahangaran *et al.*, 2022). Similar reductions in serum cholesterol have been observed in fish fed medicinal plant supplements, suggesting improved lipid utilisation and metabolic regulation. Total protein concentration was highest in fish fed R2, while reduced values were observed at higher inclusion levels (R4 and R5). Similarly, albumin concentration increased up to R3 before declining at higher inclusion levels. Serum total protein and albumin are important indicators of nutritional status, hepatic function, and protein synthesis efficiency in fish. The elevated values observed at moderate inclusion levels suggest improved nutrient assimilation and enhanced protein metabolism, whereas the reduction at higher supplementation levels may indicate possible limitations in nutrient utilisation or metabolic adjustment associated with excessive phytochemical intake. Globulin concentration was higher in the control and R2 groups but decreased progressively in fish fed R3, R4, and R5. Since globulins are associated with immune-related functions, the observed variation suggests that dietary inclusion of *R. vomitoria* may have influenced immune protein synthesis in a dose-dependent manner. However, the reduction at higher inclusion levels indicates that excessive supplementation may not necessarily provide additional physiological benefits. The observed changes in serum biochemical parameters may be linked to the phytochemical composition of *R. vomitoria* leaves, particularly indole alkaloids, flavonoids, and phenolic compounds, which possess antioxidant and metabolic regulatory properties. These bioactive compounds may influence enzymatic activities, oxidative balance, and nutrient metabolism, thereby affecting biochemical responses in fish. Previous studies on *Rauvolfia* species have demonstrated the role of their phytoconstituents in regulating oxidative stress, lipid metabolism, and cellular physiological functions (Kumar *et al.*, 2022).

Table 6: Biochemical profile of experimental fish

Parameters	**R1 (0.0)**	**R2 (0.5)**	**R3 (1.0)**	**R4 (1.5)**	**R5 (2.0)**
Glucose (mg/dl)	44.0±0.58b	62.3±0.88d	52.7±0.25c	41.6±0.29ab	38.3±0.82a
Cholesterol (mg/dl)	63.4±0.23c	77.1±1.53d	58.7±0.88b	54.6±0.62ab	47.5±0.43a
Protein (g/dl)	5.71±0.06b	6.35±0.33c	5.60±0.12b	4.65±0.08a	4.29±0.15a
Albumin (g/dl)	2.33±0.02b	2.59±0.06bc	2.86±0.10c	2.23±0.02b	2.00±0.00a
Globulin (g/dl)	3.38±0.06b	3.76±0.08b	2.74±0.03a	2.42±0.80a	2.29±0.07a

Mean in the same row with different letters are significantly different (P<0.05)

Carcass Composition

The carcass composition of *Clarias gariepinus* fingerlings fed graded levels of *R. vomitoria* leaf meal is presented in Table 7. Dietary supplementation significantly ($P < 0.05$) influenced carcass lipid, moisture, and protein contents, whereas ash and nitrogen-free extract (NFE) values were not significantly affected by the treatments. Fish fed the control diet recorded the highest carcass lipid and moisture contents, while those fed diets supplemented with *R. vomitoria* leaf meal exhibited reduced lipid accumulation and lower moisture levels, indicating alterations in nutrient deposition and body composition as a result of dietary supplementation. Carcass protein content was significantly higher in fish fed *R. vomitoria*-supplemented diets compared with the control, suggesting improved protein retention and enhanced deposition of tissue protein. Although variations existed among the supplemented groups, no significant differences were observed between them. The absence of significant differences in ash and NFE contents indicates that mineral deposition and carbohydrate reserves were relatively unaffected by dietary inclusion of *R. vomitoria* leaf meal. The reduction in carcass lipid content observed in supplemented fish suggests that *R. vomitoria* leaf meal may have influenced lipid metabolism by promoting more efficient utilisation of dietary energy and reducing excessive fat deposition. The phytochemicals present in *R. vomitoria,* including alkaloids, flavonoids, and phenolic compounds, possess biological activities that may regulate lipid metabolism through antioxidant mechanisms and modulation of metabolic pathways. Therefore, the reduced lipid accumulation in treated fish may reflect improved nutrient partitioning and enhanced carcass quality. Similar responses have been reported in fish fed plant-based functional additives, where phytogenic compounds influenced nutrient utilisation and reduced lipid deposition in tissues (Van Hai, 2015; Dawood *et al.*, 2020). The lower moisture content observed in supplemented groups, coupled with increased carcass protein deposition, suggests improved dry matter retention and more efficient nutrient utilisation. Fish fed the *R. vomitoria* diets recorded higher carcass protein values than the control group, with the highest value observed in fish receiving the 1.0 g/100 g diet (R3). Increased protein deposition reflects enhanced utilisation of dietary amino acids for muscle growth and tissue development, which

is an important indicator of feed quality and production efficiency in cultured fish. The improved carcass protein content observed in the present study may be associated with the ability of phytogenic feed additives to enhance digestive efficiency, nutrient absorption, and metabolic processes involved in protein synthesis. Medicinal plant-derived additives have been reported to improve nutrient retention by stimulating digestive enzyme activity and promoting efficient utilisation of dietary nutrients (Oliva-Teles *et al.,* 2015). Thus, the findings suggest that moderate inclusion of *R. vomitoria* leaf meal, particularly at 1.0 g/100 g diet, enhanced carcass quality by promoting protein deposition while limiting excessive lipid accumulation in *C. gariepinus* fingerlings.

Table 7: Body composition of the experimental fish

Parameters (%)	R1 (0.0)	R2 (0.5)	R3 (1.0)	R4 (1.5)	R5 (2.0)
Ash	9.22±0.02a	8.30±0.02a	8.44±0.01a	8.50±0.04a	8.47±0.03a
Lipid	11.05±0.01b	10.49±0.04a	10.64±0.02a	10.61±0.02a	10.59±0.01a
Moisture	13.10±0.01b	11.28±0.02a	11.19±0.01a	11.34±0.01a	11.22±0.02a
Protein	59.66±0.02a	63.01±0.01b	63.12±0.02b	62.95±0.03b	63.05±0.02b
NFE	6.97±0.04a	6.92±0.01a	6.61±0.02a	6.60±0.01a	6.67±0.02a

Values in the same row with different superscripts differ significantly at $P < 0.05$.
Key: NFE = Nitrogen free extract

CONCLUSION

Dietary supplementation with *R. vomitoria* leaf meal positively influenced growth performance, nutrient utilisation, physiological responses, and carcass characteristics of *Clarias gariepinus* fingerlings. Among the dietary treatments, the inclusion level of 1.0 g/100 g diet produced the most favourable growth performance and feed utilisation, while further increases in supplementation resulted in reduced performance. Polynomial regression analysis confirmed 1.0 g/100 g diet as the optimum inclusion level for enhancing growth response. Moderate dietary supplementation also improved selected haematological and serum biochemical indices without negatively affecting fish survival. Furthermore, *R. vomitoria* leaf meal enhanced carcass quality by promoting protein deposition and reducing lipid accumulation. Therefore, the inclusion of *R. vomitoria* leaf meal at 1.0 g/100 g diet is recommended as a functional phytogenic feed additive for improving growth performance, physiological condition, and carcass quality of *C. gariepinus* fingerlings under the conditions of this study.

REFERENCES

Abraham, S., Singh, A., & Singh, R. (2015). Growth performance and feed utilization of African catfish (*Clarias gariepinus*) under different stocking densities. *Aquaculture International, 23*(6), 1659–1673.

Adeniyi, O. V., Norman, A. S., & Onojobi, S. (2023). Effects of dietary supplementation of *Parkia biglobosa* pulp on growth performance and physiological status of *Clarias gariepinus* fingerlings. *Journal of Basic and Applied Zoology, 84*, 19.

Association of Official Analytical Chemists. (2005). *Official methods of analysis* (18th ed.).

Awad, E., & Awaad, A. (2017). Role of medicinal plants on growth performance and immune status in fish. *Fish & Shellfish Immunology, 67*, 40–54.

Bhat, A. A., Wani, M. Y., & Kirmani, D. (2015). Phytochemistry and pharmacological activities of *Rauvolfia* species: a review. *Journal of Pharmacognosy and Phytochemistry, 4(*3), 25–32.

Dawood, M. A. O., El Basuini, M. F., & Zaineldin, A. I. (2020). Antioxidant and immune responses of fish fed plant-derived functional ingredients. *Fish & Shellfish Immunology, 98*, 694–705.

Ekanem, N. J., Afolabi, K. D., Inyang, U. A., Enyenihi, G. E., Mbaba, E. N., Unah, U. L., Solomon, I. P., Ebenso, I. E., Udoh, J. E., Isaac, L. J., Eko, P. M., Assam, E. D., Jack, A. A., Okon, I. E., Etteh, U. D., Agwu, A. E., Okon, U. E., & Udo, A. L. (2025). Chemical composition of *Rauvolfia vomitoria* leaves as a feed resource for ruminant species. *African Journal of Agricultural Science and Food Research, 17*(1), 232–240.

Gholami-Ahangaran, M., Ziaei, M., & Mohammadi, S. (2022). Medicinal plants and their bioactive compounds: effects on lipid metabolism and biochemical responses in animals. *Veterinary Medicine and Science, 8*(4), 1545–1558.

Kumar, S., Kumari, D., & Singh, B. (2022). *Genus Rauvolfia:* a review of its ethnopharmacology, phytochemistry, quality control/quality assurance, pharmacological activities and clinical evidence. *Journal of Ethnopharmacology, 295*, 115327.

Marimuthu, V., Shanmugam, S., Sarawagi, A. D., Kumar, A., Kim, I. H., & Balasubramanian, B. (2022). A glimpse on influences of feed additives in aquaculture. *eFood, 3, e6*.

Morgan, J. D., & Iwama, G. K. (1997). Measurement of stressed states in the field. In G. K. Iwama, A. D. Pickering, J. P. Sumpter, & C. B. Schreck (Eds.), *Fish stress and health in aquaculture* (pp. 247–268). Society for Experimental Biology.

Oliva-Teles, A., Enes, P., & Peres, H. (2015). Replacing fishmeal and fish oil in industrial aquafeeds for carnivorous fish. In D. A. Davis (Ed.), *Feed and feeding practices in aquaculture* (pp. 203–233). Woodhead Publishing.

Svobodová, Z., Pravda, D., & Paláčková, J. (1991). *Unified*

methods of haematological examination of fish. Research Institute of Fish Culture and Hydrobiology.

Taştan, Y., & Salem, M. O. A. (2021). Use of phytochemicals as feed supplements in aquaculture:a review on their effects on growth, immune response and antioxidant status of finfish. *Journal of Agricultural Production, 2(*1), 1–12.

Van Hai, N. (2015). The use of medicinal plants as immunostimulants for aquaculture: a review. *Aquaculture, 446*, 77–89.

Zhou, Q. C., Buentello, A., & Gatlin, D. M. (2019). Cottonseed meal and phytogenic feed additives in aquaculture nutrition: effects on growth performance and physiological responses. *Aquaculture Nutrition, 25*, 1–12