



(RESEARCH ARTICLE)



Growth performance, feed utilization and survival of African catfish (*Clarias gariepinus* Burchell, 1822) fed diets supplemented with *Detarium microcarpum* Guill. & Perr. stem bark hydroethanolic extract

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GSC Advanced Research and Reviews, 2026, 29(01), 042–048

Publication history: Received on 21 July 2026; revised on 29 September 2026; accepted on 01 October 2026

Article DOI: <https://doi.org/10.30574/gscarr.2026.29.1.0257>

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ABSTRACT

Plant extracts are increasingly investigated as natural feed additives in aquaculture because of their potential to improve growth, feed utilization, and fish health. This study was conducted to evaluate effects of dietary supplementation with *Detarium microcarpum* Guill. & Perr. stem bark hydroethanolic extract on growth and feed utilization of *Clarias gariepinus* (Burchell, 1822). Four experimental diets were formulated to contain 0 (T0, control), 200 (T1), 300 (T2), and 400 mg (T3) of extract per kg of feed. A total of 180 fish (5.58 g/fish), were randomly assigned to four dietary treatments, with three replicate per treatment (15 fish/hapa and 45 fish/treatment) and fed to apparent satiation three times daily. After the 73-day feeding trial, dietary supplementation had no significant effect on growth performance, feed utilization, or survival ($p > 0.05$). Weight gain ranged from 77 ± 34 (T0) to 88 ± 48 g (T3) and daily weight gain ranged from 1.05 ± 0.47 (T0) to 1.20 ± 0.66 g/day (T3). The specific growth rate ranged from 3.51 ± 0.56 (T0) to 3.70 ± 0.70 %/day (T2). Feed conversion ratio was 1.41 ± 0.19 in T0 and ranged from 1.29 ± 0.06 to 1.34 ± 0.11 in the supplemented groups. The survival rate was 91.12 ± 3.83 % in the control group and ranged from 84.41 ± 7.69 to 86.71 ± 6.74 % in the supplemented groups. Further studies using a broader dose range are needed to determine the potential of *D. microcarpum* bark as an aquaculture feed additive.

Keywords: *Detarium microcarpum*, Bark Extract, African Catfish, Growth Performance, Survival

1 INTRODUCTION

Fish is particularly valued for its high-quality essential amino acids, omega-3 fatty acids and micronutrients, such iron, zinc, and vitamins [1,2]. According to the Food and Agriculture Organization of the United Nations [3], the majority (62 percent) of global aquaculture production in 2030 will be composed of freshwater species. African catfish (*Clarias gariepinus* Burchell, 1822) is one the major freshwater aquaculture species. Endemic to Africa and in the Middle East, *Clarias gariepinus* is commonly farmed due to its rapid growth, good survival rates in high-density farming, strong consumer demand, and high tolerance for lower-quality water [4-6]. However, stress caused by high stocking densities can have a negative impact on the fish's growth. The use of phyto-additives as natural growth promoters is now common in the aquaculture sector because they are less harmful to the environment [7]. Therefore, several plant extracts have been studied yielding promising results regarding the feed utilization and the growth of *Clarias gariepinus*. These extracts include, in particular, African basil (*Ocimum gratissimum*) leaves at a dose of 12 g/kg of feed [8], *Moringa oleifera* leaves at 2.0g/kg [9], *Lagenaria breviflora* leaves at 1.80 g/kg [10], *Boesenbergia rotunda* rhizome at 250 mg/kg [11], clove (*Eugenia caryophyllata*) buds at 15 g/kg [4]. However, no information has yet been published regarding the effects of *Detarium microcarpum*, on the growth of *Clarias gariepinus*. Furthermore, the ethanolic extract of *D. microcarpum* stem bark contains several phytochemicals including alkaloids, saponins, glycosides, flavonoids, coumarin, benzofuran, and catechol. These compounds possess various pharmacological properties, such as anticancer, antiviral, antimicrobial, anti-diabetic, and antioxidant activities [12]. Given these properties, the *D. microcarpum* bark extract could improve fish growth, health, and immunity. Thus, the present study examined the effects of dietary supplementation with hydroethanolic extract of *Detarium microcarpum* stem bark on growth performance, feed utilization of *Clarias gariepinus* fingerlings.

2 MATERIALS AND METHODS

2.1 Harvesting and identification of plant material

Fresh stem bark from *Detarium microcarpum* was collected in January 2026 from a protected forest near Saponé, Burkina Faso (12°07'05" N, 1°33'38" W). The plant species was taxonomically identified and authenticated by a taxonomist from the Department of Environment and Forests of the Institute of Environment and Agricultural Research (INERA), Burkina Faso [13].

2.2 Making a hydroethanolic plant extract

The fresh bark was dried for two weeks at room temperature. The dried bark was finely ground, and the plant powder was soaked in a mixture of distilled water and 70% ethanol (v/v). A total of 150 g of bark powder was macerated in 750 mL of solvent for 48 h. The resulting mixture was filtered through Whatman No. 5 filter paper before the solvent was removed using a rotary evaporator. The extract was dried in a ventilated oven at 45 °C for 24 h [13,14]. The dried extract was stored in a clean, sterile bottle until further use.

The extraction yield, expressed as a percentage (%) corresponds to the weight of *D. microcarpum* bark after extraction multiplied by 100, divided by weight of *D. microcarpum* bark before extraction. The weight of *D. microcarpum* bark after extraction was 14.084 g, representing a yield of 20.12%. The same procedure was applied to get more extract.

2.3 Preparation of experimental diets

A commercially available fish feed containing 40% crude protein, 7% crude lipid, 9% moisture, and 2.5% crude fiber, was used. The dry extract was dissolved in 20 ml of distilled water and sprayed on the surface of the feed according to the method described by Ashour et al. [15]. All experimental diets were prepared from the same basal feed and differed only in extract inclusion level. The control diet (T0) was sprayed with distilled water without the extract, whereas diets T1, T2, and T3 were supplemented with 200, 300, and 400 mg of extract per kilogram of feed, respectively. The same volume of distilled water (20 ml) was used for all diets. After mixing, the diets were air-dried at room temperature for 24 h, transferred to labeled airtight containers, and stored until use [13].

2.4 Fish and experimental setup

African catfish (*Clarias gariepinus*) fingerlings were obtained from the private hatchery at the Faso Fish Expertise and Production Center, located in Loumbila, Burkina Faso. The fish were transported in a plastic container to the experimental facilities of Department of Environment and Forests, where they were acclimated for 14 days in a 1m³ tank. During acclimation, the fish were fed the basal commercial diet. After this acclimation, 180 apparently healthy fish, with an initial mean body weight of 5.58 ± 0.38 g were randomly allocated to four dietary treatments. Each treatment comprised three replicates in rectangular hapas (50 cm × 40 cm × 31 cm), with 15 fish per replicate and 45 fish per treatment. Fish were fed one of four experimental diets: the unsupplemented control diet (T0) or diets containing 200

(T1), 300 (T2), or 400 mg kg⁻¹ (T3) of *D. microcarpum* stem bark extract. The 2-mm pelleted diets were manually distributed at 7% of the fish biomass per day in three equal meals at 8:00, 12:00 and 16:00 for 73 days [13]. The daily feed ration was adjusted every two weeks according to the biomass recorded in each hapa. During the experiment, the water was changed every three days with water from a borehole to maintain good water quality. Water temperature, pH and electric conductivity were measured twice daily using YINMIK multiparameter. Dissolved oxygen was measured using a DO-9100 dissolved oxygen meter.

2.5 Growth performance, feed utilization and survival parameters

At the end of the 73-day feeding trial, the fish in each hapa were fasted for 24 h. Surviving fish were counted and individually weighed. Growth performance and feed utilization indices of the fish were calculated using the following equations:

$$\text{Weight gain (WG, g)} = \text{Final body weight (FBW, g)} - \text{Initial body weight (IBW, g)}$$

$$\text{Average daily gain (ADG, g/day)} = \frac{\text{Final body weight (g)} - \text{Initial body weight (g)}}{\text{Duration of trial (day)}}$$

$$\text{Specific growth rate (SGR, \%/day)} = 100 \times \frac{\ln \text{Final body weight (g)} - \ln \text{Initial body weight (g)}}{\text{Number of days (day)}}$$

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Total feed distributed (g)}}{\text{Weight gain (g)}}$$

$$\text{Survival rate (SR, \%)} = 100 \times \frac{\text{Final fish number}}{\text{Initial fish number}}$$

2.6 Statistical analysis

The data were statistically analyzed using R software, version 4.5.0. Data distribution was assessed using the Shapiro-Wilk test and visual inspection of residual. Due to the non-normal distribution of the data, the nonparametric Kruskal-Wallis test was performed to compare each response variable among dietary treatments. The results are expressed as the mean $\pm$ SD of three replicate hapas per treatment. Treatment effects were considered significant at $p < 0.05$.

3 RESULTS

3.1 Water quality parameters

The water quality parameters measured twice daily throughout the experiment mean water temperature across treatments varied from 27.58 ± 1.11 to 27.93 ± 1.20 °C, mean dissolved oxygen concentration varied from 4.43 ± 0.85 to 4.65 ± 0.83 mg L⁻¹, mean pH values varied from 6.33 ± 0.29 to 6.38 ± 0.33 , and mean electric conductivity varied from 186 ± 52 to 191 ± 54 uS/cm (Table 1).

Table 1: Water quality parameters measured during the 73-days feeding trials

Parameters	Treatments				P-value
	T0	T1	T2	T3	
pH	6.34 ± 0.29	6.38 ± 0.33	6.33 ± 0.29	6.33 ± 0.30	0.5
Temperature (°C)	27.62 ± 1.19	27.93 ± 1.20	27.58 ± 1.11	27.65 ± 1.08	0.3
Dissolved oxygen (mg/L)	4.43 ± 0.85	4.65 ± 0.83	4.50 ± 0.90	4.55 ± 0.88	0.3
Electric conductivity (uS/cm)	189 ± 52	191 ± 54	190 ± 52	186 ± 52	0.9

Note: Values are presented as mean $\pm$ standard deviation. T0 = control; T1 = group of fish fed with 200 mg/kg *D. microcarpum*; T2 = group of fish fed with 300 mg/kg *D. microcarpum*; T3 = group of fish fed with 400 mg/kg *D. microcarpum*

3.2 Growth performance, feed utilization and survival

All experimental diets were readily accepted by the fish. No significant differences were observed among the dietary treatments in weight gain, specific growth rate, feed conversion ratio, or survival ($P > 0.05$; Table 2). Nevertheless, some numerical differences were observed. Weight gain ranges from 77 ± 34 g in control group (T0) to 88 ± 48 g in T3, while

daily weight gain ranged from 1.05 ± 0.47 (T0) to 1.20 ± 0.66 g day⁻¹ (T3), respectively. Specific growth rate ranged from 3.51 ± 0.56 (T0) to 3.70 ± 0.70 % day⁻¹ (T2). Feed conversion ratio was numerically lower in T3 (1.29 ± 0.06) than in T0 (1.41 ± 0.19), although the difference was not statistically significant. Survival ranged from 84.41 ± 7.69 % to 86.71 ± 6.74 % in the supplemented groups, compared with 91.12 ± 3.83 % in the control group. Thus, survival was numerically lower in the supplemented groups, but this difference was not statistically significant.

Table 2: Growth Performance, feed utilization, and survival of *Clarias gariepinus* fingerlings after the 73-day finding trial.

Parameters	Treatments				P-value
	T0	T1	T2	T3	
IBW (g)	5.91 ± 0.44	5.48 ± 0.24	5.35 ± 0.20	5.56 ± 0.33	0.1
FBW (g)	81.16 ± 4.0	88.34 ± 8.84	91.59 ± 12.18	93.69 ± 10.37	0.8
WG (g)	77 ± 34	83 ± 39	85 ± 45	88 ± 48	0.7
ADG (g/day)	1.05 ± 0.47	1.14 ± 0.53	1.16 ± 0.61	1.20 ± 0.66	0.7
SGR (%/day)	3.51 ± 0.56	3.65 ± 0.70	3.70 ± 0.70	3.68 ± 0.77	0.3
SR (%)	91.12 ± 3.83	86.71 ± 6.74	84.41 ± 15.40	84.41 ± 7.69	0.7
FCR	1.41 ± 0.19	1.34 ± 0.18	1.34 ± 0.11	1.29 ± 0.06	0.7

Note: Values are mean $\pm$ standard deviation of three replicates of 15 fish each. T0, T1, T2, and T3: groups of fish fed, respectively, commercial feed and diets containing 200, 300, and 400 mg/kg of *D. microcarpum* extract. Initial body weight (IBW); Final body weight (FBW); Weight gain (WG); Average daily gain (ADG); Specific growth rate (SGR); Feed conversion ratio (FCR); Survival rate (SR).

4 DISCUSSION

Phytogenic feed additives, including plant materials, extracts, essential oils, and purified phytochemicals, are incorporated into animal feed to improve digestibility, nutrient absorption, growth, and help control pathogenic microorganisms [16]. In addition, these plant extracts enhance fishes' ability to adapt to poor water quality [17]. Their use in aquaculture to improve fish growth and health is a major area of research.

During the trial, the average water temperature was 27.58–27.93 °C, dissolved oxygen was 4.43–4.65 mg L⁻¹, pH was 6.33–6.38 and electric conductivity 186–191 uS/cm. Recommended ranges for African catfish farming, the pH, temperature, electric conductivity, and dissolved oxygen concentration recorded in this study fell within acceptable limits for the farming of *Clarias gariepinus*, indicating that the physicochemical parameters of the farming environments did not influence the results obtained [18,19]. Studies showed that *C. gariepinus* can handle temperatures about 18–32 °C, grows best around 27–29 °C, prefers pH around 5.0–9.0, desirable electric conductivity around 100–2,000 μ S cm⁻¹ and needs 3–6 mg L⁻¹ of dissolved oxygen [18, 20]. Because the numbers did not differ much between treatments it is unlikely that changes in temperature, dissolved oxygen or pH caused the growth differences. Still, we cannot rule out their effect completely, especially because we did not record ammonia, nitrite, alkalinity or other water quality factors.

Adding 200–400 mg kg⁻¹ of *D. microcarpum* stem bark extract to the diet did not change weight gain, daily weight gain, specific growth rate, feed conversion ratio or survival of *C. gariepinus* fingerlings. So, in this study we did not find any statistical evidence that the extract helped fish grow or use feed better. Still a few supplemented groups showed higher weight gain and a lower feed conversion ratio. These numbers might hint at a biological effect, but we cannot confirm it because the experiment had only three hapas per treatment giving low statistical power. We should keep this interpretation cautious. Consistent with our results, Soara et al. [13] reported that the inclusion of a hydroethanolic extract of *D. microcarpum* bark in the diet of Nile tilapia had no significant effect on their body weight, survival rate, or feed utilization. Our results match also those of Aderolu et al. [6]. They observed no changes in final weight, weight gain or specific growth rate in *C. gariepinus* that at 0.25–1.0 g kg⁻¹ of *Dictyota ciliolata* extract. They did find a better feed conversion ratio and protein efficiency ratio. This shows that a plant extract can improve feed use without boosting growth.

Other plant extracts, however, have been reported to boost the growth of *C. gariepinus*. For example, an aqueous extract of *Carica papaya* leaves increased the weight gain of *C. gariepinus* juveniles [21]. Similarly, *C. gariepinus* fed a diet supplemented with 2.0 g kg⁻¹ of *Moringa oleifera* leaf extract exhibited significantly higher weight gain and specific growth rate and a lower feed conversion ratio than fish fed the control diets [9]. Furthermore, the feed conversion ratio decreased as the incorporation rate of *Moringa oleifera* leaf increased [9]. Munglue [22] also reported a significant

increase in weight gain, specific growth rate, and a decrease feed conversion ratio in *Clarias gariepinus* fed with ethanolic extract of *Nelumbo nucifera* stamens at concentrations of 0.1%, 0.5%, and 1%.

Plant-derived bioactive compounds can help fish grow by making them eat more changing the gut bacteria boosting enzymes using nutrients better or lowering the energy fish use, for fighting oxidation and stress [23,24]. Several studies have shown that incorporating plants into fish feed promotes growth and improves health. However, the effects of extracts from different plants on growth depend on factors such as the plant species, the part of the plant used, the extraction method, and the animal species in question [25]. Future research should try a range of doses and look at the phytochemicals and how well they digest food, enzyme levels, gut tissue, antioxidant markers, immune markers and use more tanks for better data.

5 CONCLUSION

The present study therefore aimed to evaluate the effects of *Detarium microcarpum* stem bark extract on the growth performance of *Clarias gariepinus*. Dietary supplementation at a rate of 200 to 400 mg per kg, had no significant effect on growth performance, feed utilization or survival of *C. gariepinus* fingerlings during the 73-day feeding trial. Although fish fed, a diet enriched to 400 mg kg⁻¹ showed the highest weight gain in absolute terms and the lowest feed conversion ratio. These differences were not statistically significant. Further studies should evaluate a wider range of inclusion rates, use a larger number of tanks, and include quantitative phytochemical characterization, feed digestibility, physiological responses and safety indicators. Such research is necessary to determine the effective and safe inclusion rate of *D. microcarpum* stem bark extract in the diet of the African catfish.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Acknowledgments

The authors are extremely grateful to General Directorate for Fish Resources, Ouagadougou, Burkina Faso for providing the necessary facilities for conducting the research work.

Disclosure of conflict of interest

The authors declare no conflicts of interest.

Statement of ethical approval

The Health Research Ethics Committee (CERS No. 2026-03-145) gave its approval for the use of *Clarias gariepinus*, and all guidelines for using animals in research were followed during the study period. The animals were handled in compliance with the Canadian Council on Animal Care (CCAC) guidelines on the care and use of laboratory animals in research, teaching and testing [26].

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