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Enhancing Aquaculture Resilience with Baobab and Tamarind Pulps as Local Micronutrient Sources: Effects on Growth and Hematology Response in Catfish Fingerlings.

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ABSTRACT

This study assessed the potential of locally available baobab (*Adansonia digitata*) and tamarind (*Tamarindus indica*) pulp powders as sustainable alternatives to synthetic vitamin mineral premixes (SVMPs) in *Clarias gariepinus* fingerling diets. High costs and reliance on imported feed additives remain barriers to sustainable aquaculture, especially for smallholder systems in resource-limited regions. The aim was to enhance nutrient efficiency and build resilience in low-input aquaculture systems through the use of local, climate-smart feed sources.

A 12-week feeding trial was conducted using 300 fingerlings, allocated across five dietary treatments: 3 % SVMP (control), 5 % and 7 % baobab pulp powder, and 5 % and 7 % tamarind pulp powder (w/w). Growth performance, hematological parameters, and water quality were evaluated. All diets were formulated to be isonitrogenous and isoenergetic. Fingerlings fed baobab-based diets achieved similar weight gain (99.72 ± 0.09 g, 99.33 ± 0.27 g), and feed conversion ratios (FCR: 1.17 ± 0.53, 1.12 ± 0.14) to those fed SVMP, with survival rates above 98 %. Tamarind-based diets resulted in significantly lower growth (mean 71.5 ± 0.85) and higher FCRs (>3.24), suggesting reduced digestibility due to anti-nutritional factors. Health indicators such as red blood cell count, hemoglobin levels, and packed cell volume were maintained in baobab-fed fish, indicating effective oxygen transport and immune function. In contrast, tamarind diets led to significant reductions in these parameters, indicating possible anemia and physiological stress. Water quality also varied. Baobab and SVMP diets maintained optimal pH (7.2–7.8), high dissolved oxygen (>5.5 mg/L), and low ammonia (<0.4 mg/L). Tamarind-based diets increased total dissolved solids and lowered DO levels, reflecting poor water stability likely due to higher microbial oxygen demand. This research supports the use of baobab pulp as a climate-smart, nutrient-efficient feed ingredient that can reduce reliance on imported inputs. It contributes to SDGs 2, 12, and 13 by promoting local innovation, food system resilience, and

sustainable aquaculture practices. Future work should focus on reducing tamarind's anti-nutritional content via fermentation or enzymatic treatment to improve its usability

Keywords: Nutrient utilization; plant-based micronutrients; feed efficiency; antioxidant potential; aquaculture nutrition; environmental sustainability.

Introduction

Feed is a major cost in aquaculture, accounting for about 60–70% of production expenses. Synthetic vitamin-mineral premixes (SVMPs) are important for fish growth and health, but they are costly and sometimes unavailable in developing regions. This study examined baobab *(Adansonia digitata)* and tamarind *(Tamarindus indica*) pulp powders as sustainable, plant-based micronutrient sources to replace synthetic premixes in *Clarias gariepinus* fingerling diets. Baobab pulp is rich in vitamin C, calcium, and potassium, while tamarind pulp contains organic acids and minerals, but also tannins and phytates that may affect nutrient utilization. The study aimed to evaluate their effects on growth, survival, and hematological responses of African catfish fingerlings.

Materials and Methods

A 12-week feeding trial was carried out at the Aquaculture Research Facility, LUANAR Bunda Campus, Malawi. A total of 300 *Clarias gariepinus* fingerlings (average weight 4–5.5 g) were randomly assigned to 15 rectangular aquaria (50 L each) in a completely randomized design with five dietary treatments and three replicates per treatment.

Five isonitrogenous diets (35% crude protein) were formulated. The control diet contained 3% synthetic vitamin-mineral premix (SVMP), while test diets contained either baobab pulp powder vitamin-mineral premix (BPPVM) or tamarind pulp powder vitamin-mineral premix (TPPVM) at 5% and 7% inclusion levels. Feed ingredients used were fishmeal, soybean meal, rice bran, maize meal, and the respective plant-based premixes. All ingredients were ground, mixed thoroughly, pelleted (2.5 mm), air-dried, re-ground to uniform particle size, and stored at ambient temperature before use.

The proximate composition of feed ingredients and the vitamin C, phosphorus, and calcium contents of baobab and tamarind pulps were determined using standard AOAC (2005) methods to confirm their nutritional suitability as natural micronutrient sources.

Fish were hand-fed twice daily (09:00 h and 16:00 h) at 3% of body weight, with feeding rates adjusted fortnightly based on weight gain. Uneaten feed and wastes were siphoned daily, and 50% of the water volume was replaced to maintain optimal quality.

Growth and survival were monitored weekly. At the end of the experiment, blood samples were collected from the caudal vein using heparinized syringes for hematological analysis. Parameters including red blood cell count (RBC), hemoglobin (Hb), packed cell volume (PCV), white blood cell count (WBC), mean cell volume (MCV), mean cell hemoglobin (MCH), and mean cell hemoglobin concentration (MCHC) were determined following the methods of Blaxhall and Daisley (1973).

All data were analyzed using one-way ANOVA in R (v4.5.1). Differences among means were compared using Tukey's Honest Significant Difference (HSD) test at a 5% significance level ($p < 0.05$).

Results and Discussion

Fish fed 5–7% baobab pulp powder (BPPVM) diets achieved growth performance comparable to those fed 3% SVMP ($p>0.05$), with higher final weights, specific growth rate (SGR), and feed conversion efficiency (FCR). In contrast, tamarind-based diets (TPPVM) resulted in significantly lower growth and feed efficiency ($p<0.05$). Survival rates were highest (100%) in SVMP and baobab groups but slightly lower in tamarind-fed fish, likely due to anti-nutritional factors affecting nutrient uptake.

Hematological parameters showed a similar pattern. Fish fed baobab diets had higher RBC, Hb, and PCV values, comparable to those on SVMP diets, indicating better oxygen transport and physiological stability. Tamarind-fed fish had lower RBC and Hb values, suggesting mild anemia and stress, possibly linked to tannin and phytate interference with iron metabolism. These results support baobab pulp as an effective natural vitamin-mineral source capable of sustaining hematological and growth performance in African catfish.

Table 1. Summary of growth and hematological responses of *Clarias gariepinus* fingerlings to dietary treatments.

Diet	Final Wt (g)	SGR (%/day)	FCR	RBC ($\times 10^{12}$/L)	Hb (g/dL)
SVMP (3%)	105.6	3.27	1.09	2.72	9.28
BPPVM (5%)	104.9	3.27	1.12	2.86	9.83
TPPVM (5%)	77.1	2.93	3.81	2.38	8.07
BPPVM (7%)	105.2	3.27	1.17	2.80	9.62
TPPVM (7%)	77.0	2.93	3.24	2.40	8.73

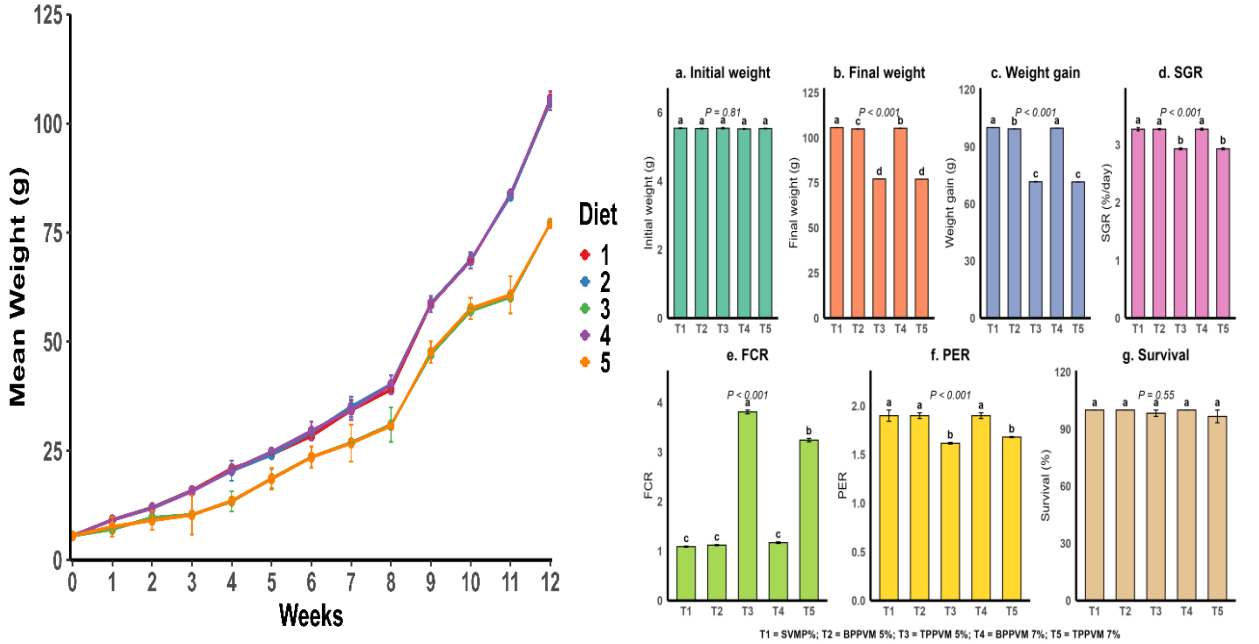

Figure 1. The growth curve and growth response of Clarias gariepinus fingerlings fed different diets over 12-week period (Bars represent mean + SE) Different letters indicate significant difference (Tukey's HSD, P< 0.05).

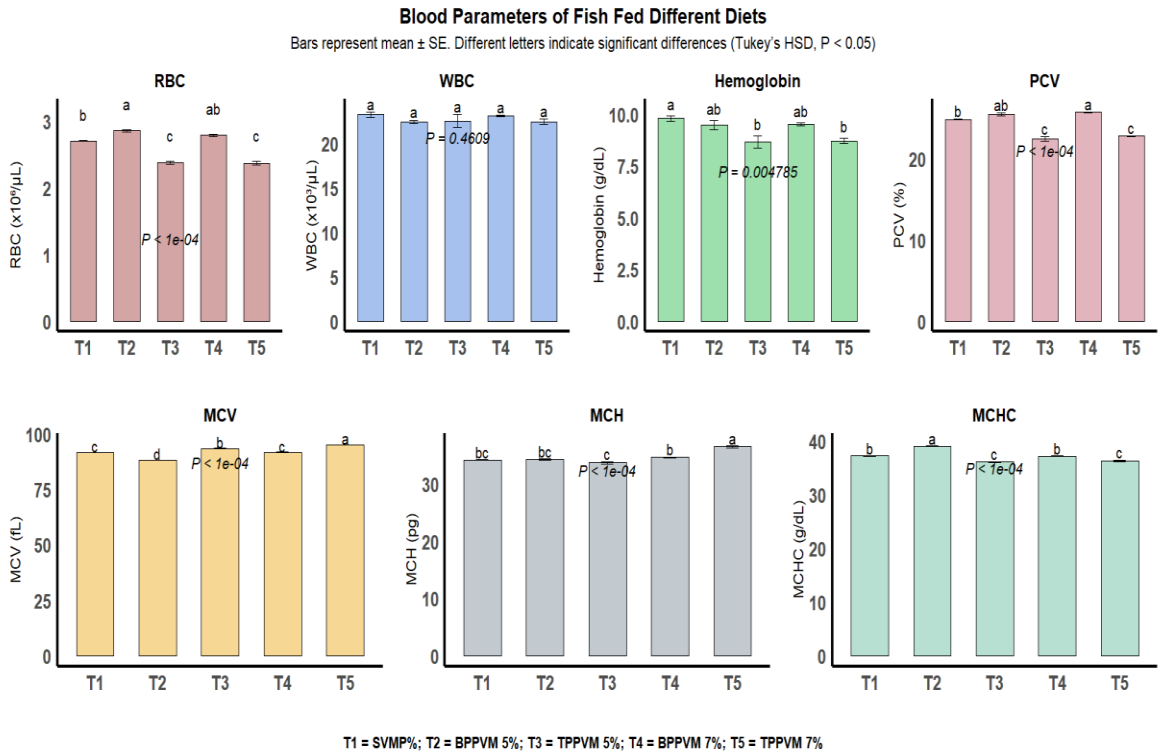

Figure 3: Hematological response of fish fed different diets (Bars represent mean + SE) Different letters indicate significant difference (Tukey's HSD, P< 0.05).

Conclusions and Outlook

Baobab pulp powder at 5–7% inclusion supported growth and hematological performance comparable to synthetic premix diets. Tamarind pulp diets reduced both parameters, likely due to residual anti-nutritional factors. Baobab pulp shows promise as a sustainable alternative for micronutrient supplementation in aquaculture. Future work should optimize tamarind processing to reduce anti-nutritional compounds and assess immune responses.

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