Nwanna, L. C.; Ajani , E. K.; Omitoyin, B. O.; Magawata, I. Ayoola, S. O.; Orisasona, O.; Kareem, O. K and Abubakar, M. Y. (Eds.) (2004) ***Proceedings of the Fifth Conference of Association of Nigerian Fisheries Scientists.*** **"SUSTAINABLE FISHERIES AND AQUACULTURE PRODUCTION FOR ENHANCING LIVELIHOOD IN NIGERIAN ECONOMIC DEVELOPMENT"** 9TH – 11TH JULY, 2024 In the University of Lagos, Lagos, Nigeria

Effects of Encapsulated Phytogenes on the Growth and Health of African Catfish, *clarias gariepinus* (Burchell, 1822)

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ABSTRACT

The effects of encapsulated phytogenes on the growth performance and health of African catfish (*Clarias gariepinus*) were assessed in this study. Five (5) feeds were formulated with different phytogenes, with the control contained no phytogenes, treatment 1 contained (*Telfairia occidentalis*), treatment 2 contained (*Zingiber officinale*), treatment 3 contained (*Moringa oleifera*) and treatment 4 contained (*Ocimum gratissimum*). After the feeding trial (56 days), the proximate analysis of the feeds formulated were carried out. The growth performance and basic haematological parameters of *C.gariepinus* fed the experimental diets were assessed. Lower weight gain was recorded in treatment 3 which contain *Moringa oleifera* leaf meal (16.75g) compared to the other treatments. The best FCR was recorded in treatment 1 which contained (*Telfairia occidentalis*) with the value of 1.43±0.01. The result of the haematological parameters revealed significance differences ($P<0.05$) among treatments, particularly in the red blood cell of the fish fed with the control diet (1.21±0.12). In conclusion, Fish fed diets with encapsulated phytogenes showed improved feed conversion ratio and growth rate compared to the control. Additionally it showed enhanced immune function, and increased disease resistance, indicating improved overall health.

Keywords:
Aquafeed, African catfish, Plant materials, Growth

Introduction

Fish and fisheries are crucial for global food security, livelihoods, and economic development. With the increasing demand for seafood, fish have become a critical source of protein and essential nutrients for millions of people worldwide [1]. Fisheries involve the capture, processing, and distribution of fish and aquatic organisms, including commercial fishing, artisanal or small-scale fishing, recreational fishing, aquaculture, and fish processing and trade [1]. The African catfish, scientifically known as Clarias gariepinus, is a freshwater species native to Africa [2]. These catfish are highly adaptable species native to Africa, is highly valued in African aquaculture due to its adaptability and ability to survive in various aquatic environments including rivers, lakes, and even stagnant ponds [3]. However, successful

cultivation faces challenges such as diseases, environmental pollution, water quality issues, feed management, and market demands [4]. Diseases, in particular, can have devastating impacts on fish health and productivity, leading to economic losses and reduced sustainability of aquaculture operations [5].

Phytogenes, bioactive compounds derived from plants, have gained attention as a potential alternative to conventional additives in aquaculture. These compounds possess various beneficial properties, including antimicrobial, antioxidant, immunomodulatory, and growth-promoting effects. Incorporating phytogenes into aquafeed offers a promising approach to enhance fish health, performance, and disease resistance while reducing reliance on chemical additives [6]. Encapsulation technology can also improve feed efficiency in African catfish by optimizing the stability and targeted release of beneficial compounds, enhancing digestive health, nutrient utilization, and growth performance [7,8]. Therefore, this study aims to understand the effect of encapsulated phytogenes on the growth and health of African catfish (*Clarias gariepinus*) (Burchell 1822), a commercially important freshwater fish species.

Materials and Methods

Experimental Site

The Study was carried out at The Teaching and Research farm of the Department of Fisheries and Aquaculture Technology and Aquafeed Research Project Laboratory in the Federal University of Technology, Akure, Ondo State respectively.

Experimental Fish

Apparently Three hundred (300) *C. gariepinus* post fingerlings with weight of 26 ± 0.05g each was procured from the teaching and research farm of the Department of Fisheries and Aquaculture, Federal University of Technology, Akure, Ondo State.

Collection and Identification of Plant materials

Ugwu leaf (*Telfairia occidentalis*), Ginger (*Zingiber officinale*) Moringa leaf (*Moringa oleifera*) and Scent leaf (*Ocimum gratissimum*) was procured from the markets within Akure metropolis and taken to the Crop, Soil and Pest Department for proper Identification.

Preparation of Plant Materials

Leaves from the stems of this plants was picked out and air-dried at room temperature after which it was blended into a fine powder. It was stored in a Ziploc bag and stored at room temperature.

Feed ingredients and Formulation of Experimental Diets

Fish meal, soya beans, groundnut cake (GNC), yellow maize, baker's yeast, cassava flour (serves as binder), dicalcium phosphate, vitamin C, vitamin-mineral premix, groundnut oil and phytogenes (ugwu leaf, ginger, moringa leaf and scent leaf) was used in formulating the experimental diets. Different Phytogenic feed additives was included at the level of 0g/100g (Control) and 0.5/100g incorporated into the remaining four diets.

The ingredients composition is shown in Table 1 below.

In Table 1, Treatment 1 represent Ugwu leaf (*Telfairia occidentalis*)
Treatment 2 represent Ginger (*Zingiber officinale*)
Treatment 3 represent Moringa leaf (*Moringa oleifera*)
Treatment 4 represent Scent leaf (*Ocimum gratissimum*)
Control has no phytogenic additives
CP represent Crude Protein

Table 1: Ingredients composition of the Experimental Diets (g/100g) for *C. gariepinus*

Ingredients	Control	T1	T2	T3	T4
Fish meal (65% CP)	34	30	30	30	30
Soya beans (45% CP)	17	23	23	23	23
Groundnut cake (43.5 %)	20	20	20	20	20
Yellow maize (10% CP)	11	11	11	11	11
Alginate	5	5	5	5	5
Yeast	3	3	3	3	3
Dicalcium phosphate	1	0.5	0.5	0.5	0.5
Vitamin C	1.5	0.5	0.5	0.5	0.5
Vitamin-mineral premix	1.5	0.5	0.5	0.5	0.5
Groundnut oil	6	6	6	6	6
Phytogenes	0	0.5	0.5	0.5	0.5
Moisture	8.51	8.66	9.66	8.64	7.28
Ash	12.33	12.28	11.43	12.26	11.11
Protein	45.19	44.94	44.99	44.55	44.86
Fibre	0.33	1.42	3.59	2.18	3.93
Fat	18.27	17.43	19.42	16.67	23.81
Nitrogen Free Extract	15.37	15.27	10.91	15.70	9.01

Vitamin-mineral premix constituents: Vitamin A: 8,000,000 IU, Vitamin D3: 1,600,000IU, Vitamin E: 6,000 IU, Vitamin K: 2,000mg, Thiamine B1: 1,500mg, Riboflavin B2: 4,000mg, Pyridoxine B6: 15,000mg, Niacin: 15,000mg, Vitamin B12: 10mg, Pantothenic acid: 5,000mg, Folic acid: 500mg, Biotin: 20mg, Choline chloride: 200g, Antioxidant: 125g, Manganese: 80g, Zinc: 50g, Iron: 20g, Copper: 5g, copper: 5g, Iodine: 1.2g, Selenium: 200mg, Cobalt: 200mg (Hi-Nutrient International Limited, 2017).

Keys: T1- Treatment 1, T2 – Treatment 2, T3 – Treatment 3 and T4 – Treatment 4

2.6 Preparation of Plant Extracts and Encapsulated Phytogenes

The leaves powder was extracted using ethanol 96% and concentrated using evaporation. The crude extract was then dissolved in methanol 20% and shaken with solvents like petroleum ether, chloroform,

and ethyl acetate (EA). The EA crude fraction extract was obtained and stored in a refrigerator. The extract was then encapsulated using a spray-drying method, combining phytogenes with a specific formulation.

2.7 Experimental System

C. gariepinus post fingerlings (26.00 ± 0.05g) was stocked into 15 glass tanks at 15 fish per tank. Each treatment group was in triplicate. There were four treatments group and a control group. The fish were kept in a glass tank of 60cm x 45cm x 45cm dimension on the farm and was acclimated and fed with commercial diet for two weeks. The fish were acclimated and fed a commercial diet for two weeks. Prior to the experiment, the fish were starved for 24 hours to eliminate weight variation and prepare the gastrointestinal tract for the diets. The feeding trial lasted for 56 days and the fish were fed to satiation with their respective diet twice daily. The weight of the fish in each glass tank was taken and recorded every week. At the beginning and the end of the feeding trial, samples from each treatment were taken for carcass analysis. Growth responses and nutrient utilization parameters were calculated as follows:

Weight gain (WG) = Final body weight – Initial body weight

$$\text{Specific Growth Rate (SGR)} = \frac{\text{Ln (Final body weight} - \text{Initial body weight)}}{\text{Duration of feeding}} \times 100$$

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

Water quality parameters such as temperature, PH, dissolved oxygen and conductivity were measured weekly, using HANNA instruments to measure temperature and PH while dissolved oxygen concentration was measured using D.O meter. The composition (crude protein, lipid, fiber and ash) of the experimental diets was carried out according to [9]. At the end of the experiment, two fish from each basket was randomly hand-picked and blood samples was collected for haematological analysis as described in [10].

2.8 Statistical Analysis

Data collected from the experiment was subjected to One – way Analysis of Variance (ANOVA) using the SPSS version 22.0 (Statistical Package Computer Software). Duncan's multiple range test was used to compare significant differences among individual means at P-levels (< 0.05).

Results and Discussion

The proximate composition of experimental diets (control, treatment 1, treatment 2, treatment 3 and treatment 4) is shown in Table 2. Water quality during the study showed PH ranged between the levels of 6.28 to 6.63, dissolved oxygen (6.66 to 6.97 mg/L), temperature (25.8°C to 27.47°C) and conductivity (0.69 to 0.82). The dataset indicated stable conditions, which is favorable for catfish aquaculture [11]. The study found that moisture content, ash content, protein content, fiber content, lipid content, and Nitrogen Free Extract (NFE) content varied among the diets. The control diet had the highest ash content, suggesting a higher mineral concentration [12]. The addition of phytogenes, such as Scent leaf, did not significantly impact the moisture content of the feed. The control diet had the highest protein content, aligning with the observations of [13]. on the importance of protein-rich diets in supporting optimal animal performance. The study also found that the addition of Scent leaf may contribute to improved digestive well-being in catfish. The Nitrogen Free Extract (NFE) content varied, emphasizing the importance of considering carbohydrate balance in feed formulation [14].

Growth performance of *C. gariepinus* fed experimental diets are presented in Table 2. Initial weight (MIW) and final weight (MFW) were similar across the treatments, suggesting similar initial conditions. Treatment 1 (with ugwu leaf) showed promising results, with a higher SGR indicating better growth rates. Feed intake (MFI) showed variability among the treatments, with higher intake in Treatment 1 and Treatment 2 (with ginger) possibly due to the sensory properties of the additives [15]. Lower FCR values in certain treatments suggest potential improvements in feed utilization efficiency.

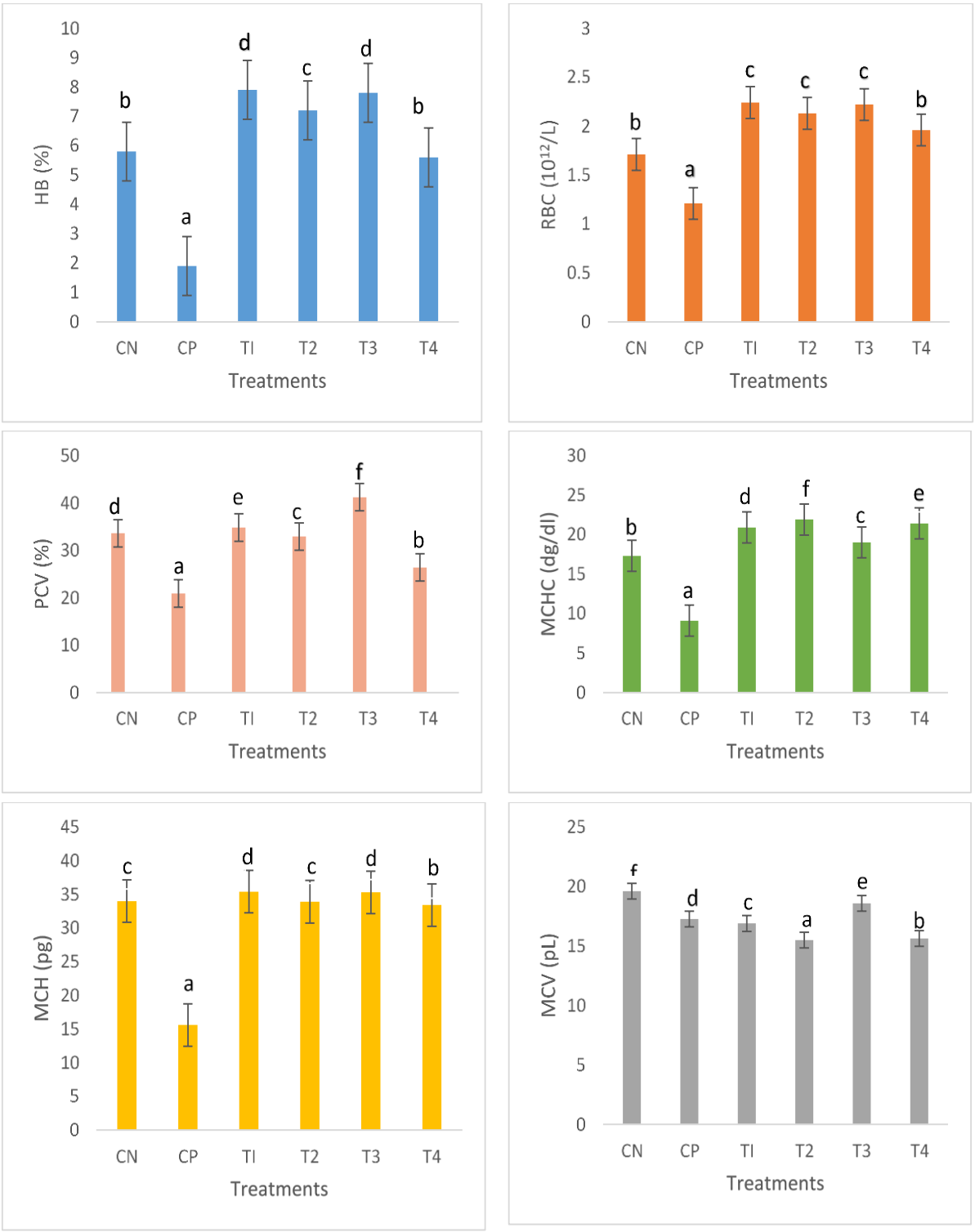
Table 2: Growth performance and Nutrient Utilization of *C. gariepinus* fed with experimental diets containing different phytogenes each

Parameters	Control	Treatment 1	Treatment 2	Treatment 3	Treatment 4
MIW (g)	8.76±0.39[a]	8.67±0.31[a]	8.77±0.38[a]	8.53±0.16[a]	8.11±0.32[a]
MFW (g)	34.79±3.49[a]	35.44±5.38[a]	31.15±4.02[a]	25.29±0.16[a]	29.16±0.32[a]
MWG (g)	26.03±3.11[a]	26.78±5.12[a]	22.39±3.76[a]	16.75±0.55[a]	21.09±0.36[a]
SGR (%)	1.97±0.33[a]	2.07±0.23[a]	1.93±0.18[a]	1.72±0.16[a]	1.78±0.10[a]
FCR	1.31±0.13[a]	1.25±0.26[a]	1.30±0.07[a]	1.43±0.01[a]	1.31±0.04[a]

Values are expressed as mean ± SE (Standard Error). The mean values with different superscript within the same row are significantly different ($P<0.05$)

The study also analyzed the haematological parameters of experimental fish fed with encapsulated phytogenes. The results showed significant variations in key parameters, including haemaglobin estimation (HB), red blood cell count (RBC), packed cell volume (PCV), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV), and white blood cell count (WBC). Haemoglobin estimation (HB) showed significant differences, with TI and T3 showing higher values. This suggests the potential hematopoietic effects of uwgu and Moringa leaf, contributing to increased HB levels in fish [16]. Red blood cell count (RBC) showed notable variations among treatments, with TI and T3 showing higher RBC values. This suggests a potential enhancement in oxygen-carrying capacity in fish supplemented with Moringa leaf, aligning with findings associating higher RBC counts with improved oxygen transport (Panda *et al*., 2007). Packed cell volume (PCV) values were significantly elevated in TI and T3, supporting the observations related to HB and RBC. Mean corpuscular hemoglobin concentration (MCHC) showed significant differences, with T2 and T4 showing higher values. Mean corpuscular volume (MCV) values differed significantly among treatments, with control negative (CN) having higher values. White blood cell count (WBC) values were significantly elevated in T3, suggesting potential immunomodulatory effects of Moringa

leaf. The increase in WBC count may indicate enhanced immune response and supplemented with Moringa leaf, supporting its known immunostimulatory properties [17].



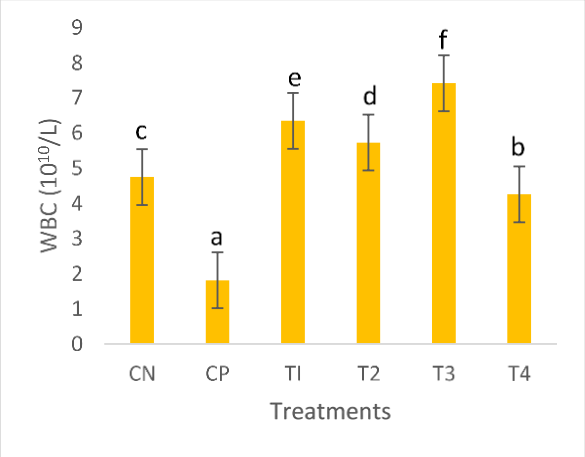


Figure 3.1: Haematological analysis of the experimental fish. The bar chart indicated the result for the haemoglobin estimation (HB), red blood cell (RBC), packed cell volume (PCV), mean cell haemoglobin concentration (MCHC), mean cell haemoglobin (MCH), mean corpuscular volume (MCV), white blood cell (WBC) respectively.
Values are expressed as mean ± SE (Standard Error). The mean values with different superscript within the same row are significantly different ($P<0.05$).

Conclusions

The study investigated the effects of encapsulated phytogenes on zootechnical performance of African catfish (*Clarias gariepinus*) has provided valuable insights into the potential benefits of incorporating these encapsulated additives in aquafeed formulations. The results of the study revealed significant differences in various parameters among different treatment groups. Hematological analysis revealed positive changes in hematological parameters, indicating enhanced immune function and overall health. The inclusion of encapsulated phytogenes influenced growth performance and nutrient utilization of *C. gariepinus*. However, further research is recommended to optimize the formulation of encapsulated phytogenes in aquafeeds.

Acknowledgement

The research group wish to acknowledge the NRF TETFUND Research with Grant Number: TETF/ES/DR&D-CE/NRF2021/SETI/AFS/00404/VOL.1] for sponsoring the research.

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