



Assessment of the growth performance of cultured African catfish (*Clarias gariepinus* Burchell, 1822)

Evaluación del rendimiento de crecimiento del bagre africano de cultivo (*Clarias gariepinus* Burchell, 1822)

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ABSTRACT

Fish morphometric studies is an important tool in the stock assessment and productivity estimation of aquaculture systems. The aim of the study was to assess the growth performance of *Clarias gariepinus* cultured in plastic tanks. Morphometric data were collected and analysed to establish the length-weight relationship (LWR) and assess the overall health condition through the condition factor (K). A total of 540 specimens were studied across nine tanks over a three-month period (September to November 2024). Results showed mean standard length of 30.03 cm and mean body weight of 334.07 g. The obtained overall growth coefficient (b) of 3.155 and mean condition coefficient (K) value of 1.102 is indicative of positive allometric growth and a healthy physiological condition of the fishes. These findings indicate that the exogenous culturing factors of feeding efficiency and water quality management practices utilized for plastic tank culturing of *C. gariepinus* is suitable for fish growth. This study has contributed to the body of knowledge on the successful culturing of *C. gariepinus* to marketable size in plastic-tanks; and has provided data for comparison with other culturing facilities.

Keywords: Body weight; Standard length; condition factor; plastic-tank culturing; *Clarias gariepinus*.

RESUMEN

Los estudios morfométricos de peces son una herramienta importante para la evaluación de poblaciones y la estimación de la productividad en sistemas acuícolas. El objetivo de este estudio fue evaluar el crecimiento de *Clarias gariepinus* cultivado en tanques de plástico. Se recopilaron y analizaron datos morfométricos para establecer la relación longitud-peso (RLP) y evaluar el estado general de salud mediante el factor de condición (K). Se estudiaron 540 ejemplares en nueve tanques durante un período de tres meses (de septiembre a noviembre de 2024). Los resultados mostraron una longitud estándar promedio de 30,03 cm y un peso corporal promedio de 334,07 g. El coeficiente de crecimiento general (b) obtenido (3,155) y el coeficiente de condición promedio (K) (1,102) indican un crecimiento alométrico positivo y un buen estado fisiológico de los peces. Estos hallazgos indican que los factores de cultivo exógenos, como la eficiencia de la alimentación y las prácticas de manejo de la calidad del agua utilizadas para el cultivo de *C. gariepinus* en tanques de plástico, son adecuados para el crecimiento de los peces. Este estudio contribuye al conocimiento sobre el cultivo exitoso de *C. gariepinus* hasta alcanzar el tamaño comercial en tanques de plástico, y ha proporcionado datos para compararlos con otras instalaciones de cultivo.

Palabras clave: Peso corporal; Longitud estándar; Factor de condición; Cultivo en tanques de plástico; *Clarias gariepinus*.

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INTRODUCTION

Growth in fishes is predominantly characterized as the increase in body size and weight over a period of time. Fish morphometry is the quantitative analysis of variability in the shape and size of fishes, which are very important for the study of biology of fishes (Yadav & Paul, 2023). The morphometric characteristics of fish are phenotypically plastic and very sensitive to environmental changes as they show variability in response to changes in their habitat and at different stages of their lives. Studies of fish morphometric characteristics have emerged as one of the important commonly used and cost-effective practical approach for understanding their biology, describing the status of fish population, predicting their potential for fisheries, and can be used effectively in stock classification and assessment of congeneric species (Gurkan & Innal, 2018; Kuebutornye et al., 2019; Flinn & Midway, 2021; Yadav & Paul, 2023).

Derived indices such as the length – weight relationship (LWR) and condition factor have been shown to be useful in providing valuable insights into fish population health, growth patterns, and ecological adaptations both in the wild and in captivity (Fagbuaoro et al., 2015; Yerima and Usman, 2020; Ainsworth et al., 2024; Amponsah, 2025; Choure et al., 2025). Understanding of LWR is beneficial for comparing fish populations across different water bodies and environmental conditions, with variations in LWR often indicative of changes in food availability, habitat quality, and fishery management practices (Khillare & Khandare, 2020; Odeyemi et al., 2025). High condition factors indicate good health and efficient nutrient utilization by fishes, while low values suggest that the fish are confronted with physiological and environmental stressors (Kamble et al., 2024; Langi et al., 2024). Species-specific variations in condition factor and LWR indices emphasizes the need for tailored management strategies in aquaculture practice, as ideal values vary across species, life stages, and environmental conditions. By integrating LWR data with other biological parameters such as condition factors, fishery managers and aqua-culturists can make informed decisions about stocking density, harvesting size, and conservation measures.

Aquaculture practice has emerged as an important sector in global food production and nutrition security, as it has provided consumers with all-year-round access to aquatic products that are rich in proteins and macronutrients (Belton et al., 2020; Maulu et al., 2022). Properly managed aquaculture

systems promote higher condition factor values and better disease resistance in fishes, whereas poor conditions lead to decline in condition factors signaling metabolic or health issues with the fishes (Muchlisin et al., 2010; Han et al., 2024). Tank-based aquaculture involves the cultivation of fish under controlled environments using tanks instead of traditional earthen ponds or open water systems, which provides more efficient and sustainable fish production by allowing precise control over water quality, temperature, and feeding regimes (Mota et al., 2022). In tank-based aquaculture, the condition factor serves as a measure of management effectiveness, as it is influenced by exogenous factors such as water temperature, dissolved oxygen content, feed quality and tank colour (Froese & Pauly, 2011; Ngo et al., 2024).

The African catfish (*Clarias gariepinus*, Burchell, 1822) has become an important fish species in aquaculture production and addressing protein deficiencies in human nutrition in Nigeria and many regions of Africa (Fagbuaoro et al., 2015; Onyekwelu et al., 2021; Egun and Oboh, 2022; Egun et al., 2022). The physiological attributes of *C. gariepinus* in withstanding handling stress, high growth rate, yield potential, fecundity, cultural acceptance and palatability in Nigeria, has seen the fish species become the most cultured freshwater fish in Nigeria (Ayo-Olalus, 2014; Egun et al., 2024). Earlier studies on the growth performance of *C. gariepinus* have focused largely on captured species from freshwater bodies (Davies et al., 2013; Olopade et al., 2015; Getso et al., 2017; Eze et al., 2020; Shittu and Oguntoye, 2020). However, the increasing production of *C. gariepinus* under diverse aquaculture rearing facilities and conditions (Ayo-Olalus, 2014; Fagbuaoro et al., 2015; Eneh & Okoro, 2021; Adebayo & Fashina, 2022; Abubakar & Lawal, 2023), and the readily appeal of morphometric features to fish farmers in making business decisions on return on investment, has necessitated the need for routine assessment of growth performance of fish species cultured in various media for sustainable aquaculture development and effective fishery management. Therefore, this study assesses the growth performance of tank-raised *C. gariepinus* using morphometric parameters and identified their inter-relationship trends, which aims to describe the relationship of growth characteristics based on observational design.

METHODOLOGY

Study location

This study was carried out at the Grow Out Unit facility of the TETFund Centre of Excellence in Aquaculture and Food Technology situated in the University of Benin, Benin City, Nigeria. The facility used for the study were the installed black plastic tanks, with a capacity of 6,000 L each, and stocking density of 600 fingerlings of *Clarias gariepinus* per tank (Plate 1) (Figure 1). Groundwater from a

borehole within the facility ensured the consistent availability of water supply for aquaculture.

Study setup

For the study, nine (9) units of the plastic tanks were monitored for growth parameters. Each of the tanks were stocked with 200 *C. gariepinus* fingerlings and cultured to table size (500 – 1000 g for weight and 25 – 35 cm for total length) using

commercial fish feeds from July to November 2024. No growth inducing hormone/treatment was administered to the fishes throughout the study.



Figure 1. Plate 1: Plastic Tanks at the Grow Out Unit of the TETFund Centre of Excellence in Aquaculture and Food Technology situated in the University of Benin, Benin City, Nigeria.

Collection of morphometric data

Twenty (20) fish specimens were randomly collected per tank for morphometric measurements monthly from September to November 2024. Morphometric data measurements for total length (TL), standard length (SL), head length (HL) and body weight (BD) were taken using a measuring board with attached tape to the nearest 0.1 cm. The weight of the fish was taken individually using a mechanical weighing balance to the nearest 0.1 g.

Length-weight Relationship (LWR): this was determined using the equation

$$W = aL^b \quad (1)$$

Where W: weight of fish in (g), L: total length (TL) of fish in (cm), a: constant, b: the length exponent (Bagenal, 1978).

Table 1

Summary of the physico-chemical characteristics of borehole water in the samples and its suitability for aquaculture

Parameters	Mean ± SD	Standard Water Quality Criteria for fisheries (NESRA, 2011)	Remarks
pH	5.84 ± 0.69	6.5 – 8.5	Satisfactory
E. Conductivity (µS/cm)	57.50 ± 40.87	400	Satisfactory
Turbidity (NTU)	1.75 ± 2.49	< 20	Satisfactory
Total Suspended solid (mg/L)	1.25 ± 1.30	0.25	Not Satisfactory
Dissolved Oxygen (mg/L)	5.15 ± 0.80	≥ 6.0	Not Satisfactory
BOD (mg/L)	1.65 ± 0.57	≤ 3.0	Satisfactory
Nitrate (mg/L)	0.34 ± 0.24	≤ 9.1	Satisfactory
Chloride (mg/L)	14.12 ± 0.50	300	Satisfactory
Calcium (mg/L)	5.71 ± 4.15	180	Satisfactory
Magnesium (mg/L)	3.04 ± 1.59	40	Satisfactory
Phosphate (mg/L)	0.16 ± 0.20	3.50	Satisfactory

RESULTS AND DISCUSSION

The evaluation of growth performance of fishes is essential for efficient fish-stock management, feed formulation, and aquaculture sustainability. Morphometric assessment using length and weight data provide statistics that are cornerstones in the foundation of fishery research and management (Merino et al., 2006; Reis Neto et al., 2012). The

The logarithmic transformation of the equation gives a straight line relationship

$$\text{Log } W = \text{Log } a + b \text{ Log } L \quad (2)$$

Where $\text{Log}_{10}W$: Against plotted $\text{Log}_{10}L$, b: Regression coefficient, and $\text{Log } a$: Intercept on the Y axis.

Condition Factor (K): This shows the degree of wellbeing of the fish in their habitat, and this was determined using (Le Cren, 1951).

$$K = \frac{100 W}{L^3} \quad (3)$$

Where W: weight of fish in (g), L: total length (TL) of fish in (cm).

According to Le-Cren (1951) the mathematical framework for calculating length-weight relationships remains standardized regardless of environment, allowing for statistically robust comparisons

Water quality analysis

Physico-chemical parameters of borehole water samples were analyzed using standard methods (APHA, 2023) to ensure suitability for aquaculture. Table 1 shows the results of the water physico-chemical analysis and its suitability for aquaculture. Water was pumped into the tanks through a fitted water sieve to reduce suspended solids in the water. Dissolved oxygen content in the water was increased (> 6.0 mg/L) by releasing the water into the various tanks from an elevated height.

Data analysis

All statistical analysis was computed Statistical Package for Social Sciences (SPSS) version 21 and Microsoft Excel (2016) for analysis of variance (ANOVA), regression and descriptive statistics.

result of the morphometric measurements taken in this study is presented in Table 2. A total of 540 specimen of *C. gariepinus* were collected from the plastic tanks and examined. The total length of the specimen ranged from 21.50 – 50.50 cm, standard length ranged from 19.00 – 45.00 cm and the body weight range from 100 – 1000 g.

Table 2
Morphometric Parameters of cultured *Clarias gariepinus*

	Standard length (Mean \pm SD)	Body weight (Mean \pm SD)	b	R	Mean Condition Factor (K)	p-value
Tanks 1 - 9	30.03 \pm 5.62 ^a	334.07 \pm 206.66 ^b	3.16	0.84	1.10	p < 0.05

Note: Across each row, similar superscript indicates no significant difference ($p > 0.05$), while dissimilar superscript indicates significant difference ($p < 0.05$).

The recorded overall mean standard length of cultured *C. gariepinus* (30.03 cm) was within the range of values reported in similar studies on cultured *C. gariepinus* (Fagbuaro et al., 2015; Shittu and Oguntoye, 2020). The overall mean body weight (334.07g) was comparable to mean body weight reported by Ayo-Olalus (2014) for *C. gariepinus* reared in flow-through tank system.

Length-weight Relationship

A length-weight relationship (LWR) provides information on growth patterns of animals. In aquaculture factors such as stocking density, feed availability and water quality management are critical determinants of fish growth patterns. Water quality parameters such as dissolved oxygen, pH, ammonia, nitrite, alkalinity, and hardness influences the metabolism, feed utilization and disease resistance of fishes. The LWR relationships for cultured *C. gariepinus* in this study had an a-value of 2.20 and b-value of 3.16 which is indicative of positive allometric growth, with an equation:

$$\text{Log WT} = 3.155 \text{ Log LT} + 2.200 \text{ (Figure 2) (4)}$$

This indicates that the fishes exhibited more rapid gain in weight relative to increase in length, and the overall condition of the fish in terms of appetite and gonad content (Hamid et al., 2015). Also, the positive allometry ($b > 3$) observed in this study a reflection of good feeding regimes and water quality management. Similar growth pattern with b-values greater than 3 have been reported for cultured *C. gariepinus* (Fagbuaro et al., 2015; Joseph et al., 2019; Olatunji et al., 2022). However, studies have reported negative allometric growth (b -values < 3) in cultured *C. gariepinus* (Shittu & Oguntoye, 2020; Adeboye & Fashina, 2022), which is often associated with crowding, sub-optimal diets and poor water quality.

Condition Factor

The condition coefficient "K" provides information on the physiological condition of fishes in relation to their welfare, which is greatly influenced by abiotic factors such as water quality, feeding efficiency and stocking densities (Fagbuaro et al., 2019). Condition coefficient "K" values greater than 1.0 indicates that fishes are in good physiological condition, while a values lesser than 1.0 is an indication of adverse physical environment or insufficient nutrition. Also, a K value of 1.0 is the recommended minimum K values for mature freshwater fishes in the tropics (Getso et al., 2017; Omotayo et al., 2019). In this study, the estimated mean condition factor (K) value for cultured *C. gariepinus* was 1.10, which indicates that the fishes are in good physiological condition, and the abiotic influences of water quality and feeding efficiency was favourable for their growth. The K value (1.10) in this study aligns with reported values for *C. gariepinus* and other fresh water fishes from the wild (Dan-Kishiya, 2013; Ibrahim et al., 2012; Oso and Iwalaye, 2016; Olowo et al., 2022). This indicates that the culturing conditions provided is suitable for fish growth. Differences in growth patterns between wild and cultured populations divulge vital ecological insights about environmental impacts on fish physiology as wild fish naturally face resource limitations, predation pressure, and seasonal variations that may result in different allometric relationships compared to cultured fish with consistent feeding and optimized conditions (Jobling, 2002). Also, comparing cultured fish growth to wild conspecifics helps evaluate the effectiveness of culture practices. Positive allometry in cultured fish ($b > 3$) often indicates successful husbandry, while negative allometry may suggest suboptimal conditions that require adjustment.

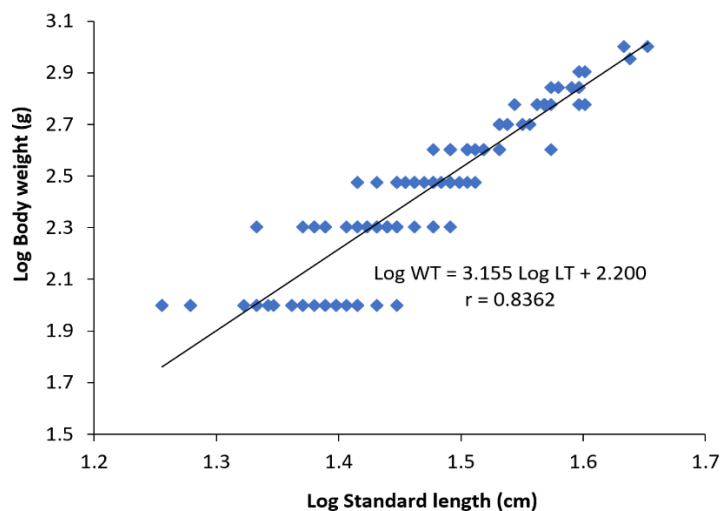


Figure 2. Log transformed graph for Length-weight relationship for Cultured *C. gariepinus*.

CONCLUSIONS

Morphometric assessment provides critical data for evaluating growth performance, informing profit and business decisions in aquaculture. The significance of the study in assessing the growth performance of plastic tank cultured *C. gariepinus* in the first cycle of fish production at the TETFund Centre of Aquaculture and Food Technology facility, has provided information that will assist in the efficient management of subsequent aquaculture activities. Results of length-weight relationship and condition factor showed a positive

allometric growth and good physiological state of health of the fishes. This indicates that exogenous culturing factors of feeding efficiency and water quality management practices utilized for aquaculture provided a suitable environment for fish growth. Also, it has contributed to the body of knowledge on the successful culturing of *C. gariepinus* to marketable size in plastic-tanks; and has provided data for comparison with other culturing facilities.

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