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Research Article

Feeding Habit, Length–Weight Relationship and Condition Factor of *Clarias gariepinus*, *Chrysichthys nigrodigitatus* and *Oreochromis niloticus* in Aiba Reservoir, Osun State, Nigeria

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ABSTRACT
Understanding the biology and feeding ecology of freshwater fish species is essential for sustainable fisheries management and conservation of inland water ecosystems. This study investigated the feeding habits, length–weight relationships, and condition factor of *Clarias gariepinus*, *Chrysichthys nigrodigitatus*, and *Oreochromis niloticus* in Aiba Reservoir, Osun State, Nigeria. A total of 66 fish specimens were collected over six months and analysed using standard morphometric, biological, and stomach-content analytical procedures. Length–weight relationship parameters were estimated using least-squares regression analysis, while condition factor values were used to evaluate the physiological well-being of each species. Results revealed species-specific variations in morphometric characteristics, feeding habits, and reproductive conditions. All three species exhibited negative allometric growth patterns, indicating that increases in body length exceeded corresponding increases in body weight. Mean condition factor values were 0.94 ± 0.33 for *C. gariepinus*, 1.30 ± 0.23 for *C. nigrodigitatus*, and 1.01 ± 0.61 for *O. niloticus*, suggesting relatively favourable environmental conditions for growth and survival within the reservoir. Stomach-content analysis revealed active feeding across all species: *O. niloticus* exhibited omnivorous behaviour, *C. gariepinus* displayed carnivorous and opportunistic tendencies, and *C. nigrodigitatus* showed benthic and omnivorous feeding characteristics. Reproductive assessment identified immature, developing, mature, and spent gonadal stages, confirming active reproductive activity during the study period. These findings demonstrate that Aiba Reservoir supports fish growth, feeding, and reproduction, while providing baseline data for fisheries management, biodiversity conservation, and ecological monitoring in tropical freshwater ecosystems.

Keywords: Aiba Reservoir; Allometric growth; Condition factor; Feeding ecology; Freshwater fish; Length-weight relationship; Nigeria

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INTRODUCTION

Fish constitute one of the most important and affordable sources of animal protein in many developing countries, particularly in sub-Saharan Africa, where inland fisheries significantly contribute to food security, nutrition, employment, and rural livelihoods. Beyond their nutritional value, fish are key components of aquatic ecosystems, playing essential roles in nutrient cycling, energy transfer, and the regulation of trophic dynamics. Consequently, understanding fish feeding ecology is fundamental to elucidating trophic interactions, habitat utilisation, ecological adaptation, and the overall health status of freshwater ecosystems (Onimisi, 2025; Madugu *et al*., 2025). Recent studies have further demonstrated that the feeding behaviour, growth performance, and condition of freshwater fish are strongly influenced by environmental variability, water quality, and anthropogenic stressors within aquatic systems (Samira and Nafiu, 2024).

Reservoir ecosystems in Nigeria support diverse fish assemblages whose abundance, reproductive performance, and feeding strategies are shaped by seasonal fluctuations, hydrological regimes, food availability, and increasing anthropogenic disturbances. In tropical freshwater systems, seasonal rainfall patterns and fluctuations in water level often determine the availability and distribution of food resources, thereby influencing fish growth, condition factor, and feeding intensity. However, these systems are increasingly threatened by pollution, overfishing, sedimentation, and habitat modification, all of which can alter ecosystem functioning and reduce fish productivity (Yousuf *et al.*, 2023). These environmental pressures signify the importance of continuous ecological assessments of economically important fish species in Nigerian freshwater bodies.

Among the commercially important freshwater fish species widely exploited in Nigeria are *Oreochromis niloticus*, *Chrysichthys nigrodigitatus*, and *Clarias gariepinus*. These species are highly valued due to their nutritional importance, rapid growth, adaptability to varying environmental conditions, and strong market demand. Previous studies on *O. niloticus* in River Okura, Kogi State, reported a predominantly herbivorous feeding pattern, with phytoplankton and detritus forming the major dietary components, while feeding intensity varied seasonally (Onimisi, 2025). Similarly, stomach content analyses of *C. nigrodigitatus* from the Majidun River revealed a broad diet comprising sediments, crustaceans, molluscs, insects, and other benthic organisms (Ogunbanwo and Odu-Onikosi, 2024). More recent ecological studies on *O. niloticus* in tropical reservoirs have also confirmed its feeding plasticity, showing shifts between phytoplankton, detritus, and organic matter depending on environmental conditions and food availability (Madugu *et al*., 2025; Tesfahun and Alebachew, 2023). Although detailed studies on the feeding ecology of *C. gariepinus* in Nigerian inland waters remain relatively limited, available literature consistently describes the species as an opportunistic omnivore with a broad dietary spectrum and high ecological adaptability (Madugu *et al*., 2025).

Aiba Reservoir in Iwo, Osun State, Nigeria, is an important freshwater resource that supports domestic water use, fisheries production, and livelihood activities for surrounding communities. Despite its socio-economic importance, there is limited scientific information on the biology, reproductive dynamics, and feeding ecology of the dominant fish species inhabiting the Reservoir. This knowledge gap constrains effective fisheries management, stock assessment, and conservation planning within the ecosystem. Furthermore, increasing anthropogenic pressures within and around the Reservoir may be altering habitat quality, food availability, and species interactions, thereby affecting fish productivity and ecosystem stability. Similar observations have been reported in recent freshwater ecosystem studies, which highlight the ecological consequences of environmental degradation and unsustainable exploitation of fishery resources (Samira and Nafiu, 2024; Yousuf *et al*., 2023).

In view of these concerns, this study investigated the biology, dietary composition, and feeding ecology of *O. niloticus*, *C. nigrodigitatus*, and *C. gariepinus* inhabiting Aiba Reservoir, Nigeria. Specifically, the study examined their length–weight relationships and condition factors as indicators of growth performance and physiological wellbeing, assessed sex ratios and gonadal maturity stages to understand reproductive structure, analysed stomach contents to determine dietary composition and feeding strategies, and evaluated seasonal variations in feeding habits within the reservoir ecosystem.

MATERIALS AND METHODS

Study Area

Aiba Reservoir is located in Iwo, Osun State, southwestern Nigeria, between latitudes 7°37′N and 7°40′N and longitudes 4°10′E and 4°13′E. The reservoir was impounded in the 1950s on the Aiba River, a tributary of the Osun River system, primarily to provide a municipal water supply to Iwo and adjoining communities. It covers a surface area of approximately 1.5 km² with mean depths ranging from 3 to 8 m seasonally. It receives inflow from the Aiba River and several minor seasonal tributaries draining the surrounding catchment.

The reservoir lies within the derived savanna-forest mosaic zone of southwestern Nigeria and experiences a tropical wet-and-dry climate (Köppen Aw). The wet season spans April to October, while the dry season extends from November to March. Mean annual rainfall ranges from 1,000 to 1,400 mm, and monthly temperatures typically vary between 24°C and 33°C. The riparian landscape comprises secondary forest fragments, fringe vegetation, and cultivated farmland, which collectively contribute organic matter and nutrients to the reservoir through surface runoff, particularly during the rainy season.

The reservoir supports a range of anthropogenic activities that exert varying degrees of pressure on the aquatic environment. Artisanal fishing is the predominant activity, with local fishermen employing gill nets, cast nets, drag nets, wire traps, and hook-and-line gear to exploit commercially important fish stocks. Small-scale irrigated agriculture is practised along the drawdown zone during the dry season, with crops such as vegetables, maize, and cassava cultivated on exposed banks. Domestic water abstraction and laundry activities occur at accessible shorelines, while livestock watering by itinerant herders contributes to bank erosion and localised nutrient enrichment. Informal sand and gravel extraction has been documented near the inflow zone, and low-intensity recreational activities are also observed periodically. Cumulatively, these land-use pressures, compounded by agricultural runoff carrying fertilisers and pesticides from adjacent farmlands, introduce both organic and inorganic contaminants into the reservoir, with implications for water quality and fish physiology.

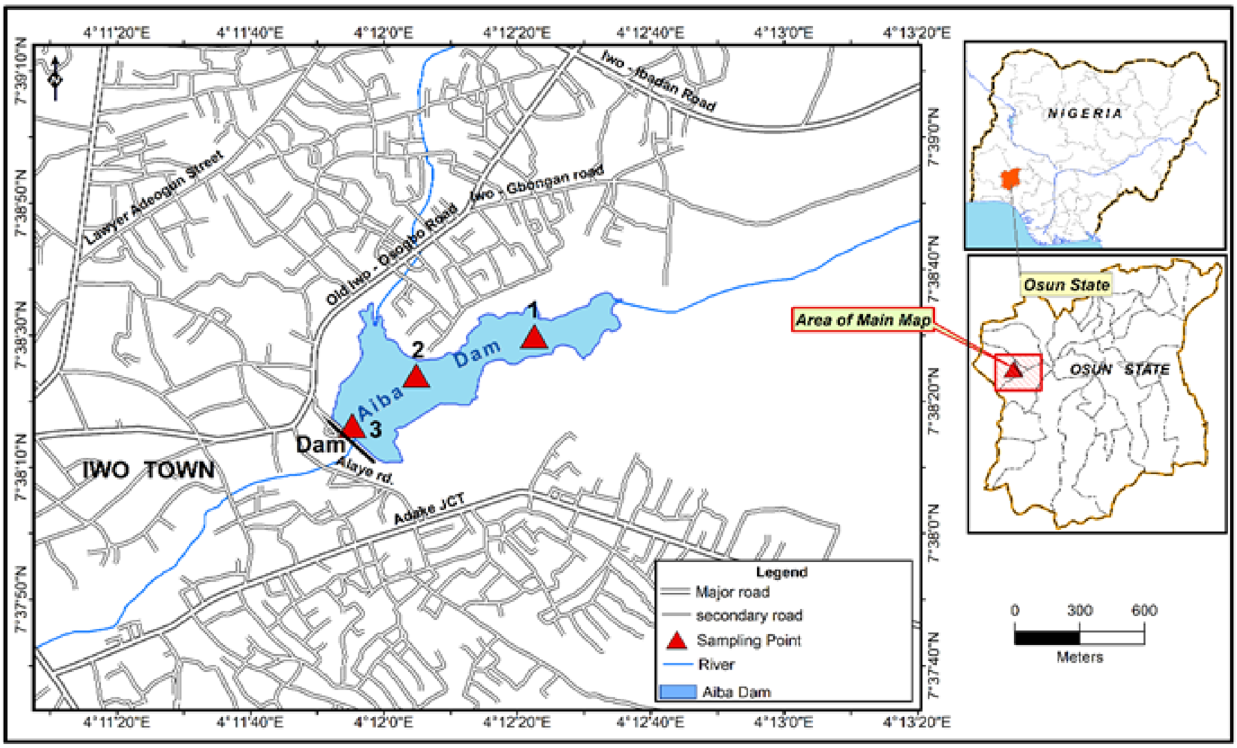

Figure 1: Map of Aiba Reservoir, Iwo, Osun State, Nigeria, showing sampling stations

Sample Collection and Species Identification

Fish specimens were collected monthly from Aiba Reservoir, Osun State, Nigeria, using gill nets, cast nets, drag nets, and traps with the assistance of local fishermen. Three commercially important fish species, *Clarias gariepinus*, *Chrysichthys nigrodigitatus*, and *Oreochromis niloticus*, were selected based on their abundance in the Reservoir. A total of 66 fish specimens, comprising 36 males and 30 females, were sampled during the study period.

Immediately after capture, the specimens were transported in plastic containers containing reservoir water to the Biology Laboratory, Lead City University, for identification and analysis. Fish species were identified using the diagnostic keys provided in the *Field Guide to Nigerian Freshwater Fishes* by Olaosebikan and Raji (2013). Fish handling and sampling procedures complied with institutional ethical guidelines for animal research.

Morphometric Measurements

The total length (cm) and body weight (g) of each fish specimen were measured using a measuring board and a digital weighing balance, respectively. The morphometric data obtained were used to determine the length–weight relationship and condition factor of the sampled fish species (Bagenal and Tesch, 1978).

Stomach Content Analysis

Fish specimens were dissected, and the stomachs were removed and preserved in 10% formalin solution before analysis. Stomach fullness was assessed visually and classified as empty (0/4), one-quarter full (1/4), half full (2/4), or three-quarters full (3/4) (Hynes, 1950). The stomach contents were emptied into Petri dishes and examined under a light microscope. To facilitate the separation and identification of food items, 5% formalin was added during examination. Food items were identified to the lowest possible taxonomic level based on observable morphological characteristics.

Length–Weight Relationship and Condition Factor

The length–weight relationship (LWR) of the fish species was determined using the equation:

$W = aL^b$

where:

W = body weight (g)

L = total length (cm)

a = intercept (regression constant)

b = growth exponent.

The values of *a* and *b* were estimated using least-squares linear regression following logarithmic transformation of the data (Ricker, 1975; Froese, 2006).

The condition factor (K) was calculated using the equation:

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

where:

K = condition factor

W = body weight (g)

L = total length (cm).

The condition factor was used to evaluate the general well-being and physiological condition of the fish species (Le Cren, 1951).

Sex Determination and Gonadal Maturity

Fish sex was determined through macroscopic examination of the gonads after dissection. The sex ratio was expressed as female-to-male ratio (F:M). Chi-square (χ^2) analysis was used to determine whether the observed sex ratios differed significantly from the expected 1:1 ratio.

Gonadal maturity stages were determined using the International Council for the Exploration of the Sea (ICES) maturity scale based on gonad size, colouration, vascularisation, visibility of ova in females, and the presence of milt in males. Gonads were classified into immature, developing, mature, spawning, and spent stages according to their morphological characteristics.

Statistical Analysis

Data obtained from morphometric and biological analyses were expressed as mean ± standard deviation. Least-squares regression analysis was used to estimate the parameters of the length–weight relationship. Differences among species were considered significant at $p < 0.05$.

RESULTS

Biometric Characteristics of Fish Species in Aiba Reservoir

Three fish species, *Clarias gariepinus*, *Chrysichthys nigrodigitatus*, and *O. niloticus*, were identified from Aiba Reservoir. Their mean standard length (SL) and body weight (W) are presented in Table 1. The number of individuals (N) sampled differed across species, with O. *niloticus* recording the highest number (N = 20), followed by *C. nigrodigitatus* (N = 36), and *C. gariepinus* (N = 10). These differences may reflect variations in abundance, sampling selectivity, or habitat preference among the species.

The mean standard length ranged from 15.18 ± 0.56 cm in *C. nigrodigitatus* to 22.67 ± 3.07 cm in *C. gariepinus*, while the mean body weight ranged from 66.02 ± 10.90 g (*O. niloticus*) to 229.01 ± 113.92 g (*C. gariepinus*). Mean values bearing different superscripts were significantly different ($p < 0.05$), indicating interspecific variation in growth and morphology. *C. gariepinus* exhibited the largest body dimensions, reflecting its high growth potential and adaptability to varying environmental conditions. The relatively smaller mean lengths and weights recorded in *O. niloticus* and *C. nigrodigitatus* suggest differences in ecological niches, feeding habits, and energy allocation. The higher variability in weight observed in *C. gariepinus* indicates the presence of multiple size or age classes within the sampled population. Conversely, *O. niloticus* and *C. nigrodigitatus* exhibited lower standard deviations, suggesting more uniform populations.

Sex-Specific Length–Weight Relationship Parameters

Sex-specific length–weight relationship (LWR) parameters for the three fish species from Aiba Reservoir are presented in Table 2. Males were more numerically dominant in the sex-disaggregated subsample, with 8 males and 2 females recorded for *C. gariepinus*, 17 males and 19 females for *C. nigrodigitatus*, and 11 males and 9 females for *O. niloticus*. Male *C. gariepinus* (b = 2.845, $r^2 = 0.985$) and male *C. nigrodigitatus* (b = 2.915, $r^2 = 0.941$) exhibited the strongest length–weight relationships, with b-values approaching 3, indicative of near-isometric to moderately negative allometric growth and a strong fit between body length and weight. In contrast, male *O. niloticus* recorded a markedly lower b-value (b = 0.842, $r^2 = 0.172$), reflecting pronounced negative allometric growth and weak length–weight covariation. Among female specimens, *C. gariepinus* yielded a perfect regression fit (b = 0.885, $r^2 = 1.000$, N = 2), although this result should be interpreted with caution given the very small female sample size. Female *C. nigrodigitatus* (b = 1.816, r^2 = 0.646) and female *O. niloticus* (b = 0.879, r^2 = 0.061) both displayed negative allometric growth with weak regression fits, suggesting high individual variability in weight-at-length, potentially attributable to differences in reproductive condition, nutritional status, and limited sex-specific sample sizes. In all species, males showed consistently higher b-values and r^2 coefficients than females, indicating that male growth conforms more closely to the expected allometric model. The pooled LWR parameters for all three species, combining both sexes, are presented in Table 3.

Length–Weight Relationships of Fish Species in Aiba Reservoir

Length–Weight Relationship (LWR) Parameters

The parameters of the length–weight relationship (LWR) for the fish species obtained from Aiba Reservoir are presented in Table 3. The relationship was derived from the general equation:

[W = aL^b]

where *W* = body weight (g), *L* = standard length (cm), *a* = intercept (regression constant), and *b* = slope (growth exponent). The coefficient of determination (r^2) describes the degree of association between length and weight.

Table 1: Mean Standard Length and Weight of Fish Species from Aiba Reservoir

Species	No.	SL (cm)	W (g)
Clarias gariepinus	10	22.67 ± 3.07^b	229.01 ± 113.92^b
Chrysichthys nigrodigitatus	36	15.18 ± 0.56^a	94.01 ± 9.97^a
Oreochromis niloticus	20	15.90 ± 0.92^a	66.02 ± 10.90^a

Means ± SD with different superscripts along the same column are significantly different ($p < 0.05$). No. = Number of fish; SL = Standard Length; W = Weight.

Table 2: Sex-Specific Length–Weight Relationship Parameters of Fish Species from Aiba Reservoir

Sex	Species	N	b	A	r²	95% CI
Male	*Clarias gariepinus*	8	2.845	-1.862	0.985	2.519–3.172
Male	*Chrysichthys nigrodigitatus*	17	2.915	-1.783	0.941	2.264–3.566
Male	*Oreochromis niloticus*	11	0.842	0.626	0.172	-0.552–2.235
Female	*Clarias gariepinus*	2	0.885	0.864	1.000	0.885–0.885
Female	*Chrysichthys nigrodigitatus*	19	1.816	-0.402	0.646	0.472–3.160
Female	*Oreochromis niloticus*	9	0.879	0.683	0.061	-2.554–4.311

N = Number of fish; a = intercept; b = slope (growth exponent); r^2 = coefficient of determination; CI = confidence interval. †Female Clarias gariepinus (N = 2): the r^2 = 1.000 is a mathematical artefact of fitting a line through exactly two data points and carries no biological interpretation; these values are retained for completeness only

Table 3. Length–Weight Relationship of Fishes from Aiba Reservoir

Species	N	B	A	r²	95% CI
Clarias gariepinus	10	2.602	-1.491	0.935	2.042–3.161
Chrysichthys nigrodigitatus	36	2.438	-1.176	0.812	1.793–3.082
Oreochromis niloticus	20	1.052	0.402	0.180	-0.097–2.201

N = Number of fish; a = intercept; b = slope; r^2 = coefficient of determination; CI = confidence interval.

The condition factor (K) values of the fish species from Aiba Reservoir are presented in Table 4. Mean condition factor values varied among the species, with *Chrysichthys nigrodigitatus* recording the highest mean K value (1.30 ± 0.23), followed by *Oreochromis niloticus* (1.01 ± 0.61), while *Clarias gariepinus* recorded the lowest value (0.94 ± 0.33). The condition factor values suggest relatively favourable environmental conditions that support the growth and physiological well-being of the fish species within the Reservoir ecosystem.

The stomach fullness distribution of the fish species sampled from Aiba Reservoir is presented in Table 5. Variations were observed among the species in the proportion of empty, partially filled, and full stomachs. Most stomachs examined were either one-quarter full or half full, indicating active feeding activity during the sampling period. *Clarias gariepinus* recorded the highest proportion of full stomachs, while only *Chrysichthys nigrodigitatus* recorded empty stomachs.

Sex-based variation in stomach fullness among the fish species is presented in Table 6. Differences were observed between male and female individuals in feeding intensity and stomach fullness categories. Male *Clarias gariepinus* recorded the highest proportion of full stomachs, whereas female *Chrysichthys nigrodigitatus* and *Oreochromis niloticus* showed relatively higher proportions of half-full and three-quarter-full stomachs.

The reproductive stages of the fish species sampled from Aiba Reservoir are presented in Table 7. Different gonadal maturity stages, including immature, developing, mature, spawning, and spent stages, were observed among the species. Immature individuals predominated in *Clarias gariepinus* and *Oreochromis niloticus*, whereas *Chrysichthys nigrodigitatus* exhibited a wider distribution of reproductive stages, including spawning and spent individuals, indicating active reproductive activity during the study period.

Sex-based reproductive stage distribution of the fish species is presented in Table 8. Variations in gonadal maturity stages were observed between male and female individuals across the species studied. Spawning and spent stages were more pronounced in *Chrysichthys nigrodigitatus*, while most male and female individuals of *Clarias gariepinus* and *Oreochromis niloticus* were predominantly immature or developing.

Table 4: Condition Factor Coefficient of Fish from Aiba Reservoir

Species	Mean±SD	Range	95% CI
Clarias gariepinus	0.94±0.33	0.73 – 1.83	0.71 – 1.18
Chrysichthys nigrodigitatus	1.30±0.23	0.65 – 1.70	1.18 – 1.42
Oreochromis niloticus	1.01±0.61	0.18 – 2.18	0.71 – 1.30

SD= Standard deviation; Cl= confidence interval

Table 5: Stomach Fullness of Fish Species in Aiba Reservoir

Species	N	Stomach fullness				
		Empty	One quarter	Half	Three quarter	Full
Clarias gariepinus	10	0 (0.0)	4 (40.0)	2 (20.0)	1 (10.0)	3 (30.0)
Chrysichthys nigrodigitatus	36	4 (11.11)	8 (22.22)	10 (27.78)	8 (22.22)	6 (16.67)
Oreochromis niloticus	20	0 (0.0)	7 (35)	6 (30.0)	5 (25.0)	2 (10.0)

N = Number of fish

Table 6: Stomach Fullness of Fish Species in Aiba Reservoir by Sex

Sex	Species	N	Stomach fullness				
			Empty	One quarter	Half	Three quarter	Full
Male	*Clarias gariepinus*	8	0 (0.0)	3 (37.5)	1 (12.5)	1 (12.5)	3 (37.5)
	Chrysichthys nigrodigitatus	17	4 (23.53)	2 (11.76)	6 (35.30)	3 (17.65)	2 (11.76)
	Oreochromis niloticus	11	0 (0.0)	4 (36.4)	4 (36.4)	2 (18.2)	1 (9.1)
Female	*Clarias gariepinus*	2	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)
	Chrysichthys nigrodigitatus	19	0 (0.0)	6 (31.58)	4 (21.05)	5 (26.32)	4 (21.05)
	Oreochromis niloticus	9	0 (0.0)	3 (33.33)	2 (22.22)	4 (44.44)	0 (0.0)

N = Number of fish

Table 7: Reproductive Stages of Fish Species in Aiba Reservoir

Species	N	Reproduction stage				
		Immature	Developing	Mature	Spawning	Spent
Clarias gariepinus	10	6 (60.0)	3 (30.0)	1 (10.0)	0 (0.0)	0 (0.0)
Chrysichthys nigrodigitatus	36	5 (13.89)	3 (8.33)	5 (13.89)	20 (55.56)	3 (8.33)
Oreochromis niloticus	20	12 (60.00)	6 (30.00)	1 (5.00)	1 (5.00)	0 (0.0)

Table 8: Reproductive Stages of Fish Species in Aiba Reservoir by Sex

Sex	Species	N	Reproduction Stage				
			Immature	**Developing**	**Mature**	**Spawning**	**Spent**
Male	*Clarias gariepinus*	8	5 (62.5)	3 (37.5)	0 (0.0)	0 (0.0)	0 (0.0)
	Chrysichthys nigrodigitatus	17	3 (17.65)	1 (5.88)	1 (5.88)	11 (64.71)	1 (5.88)
	Oreochromis niloticus	11	7 (63.6)	3 (27.3)	1 (9.1)	0 (0.0)	0 (0.0)
Female	*Clarias gariepinus*	2	1 (50.0)	1 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Chrysichthys nigrodigitatus	19	2 (10.53)	2 (10.53)	4 (21.05)	9 (47.37)	2 (10.53)
	Oreochromis niloticus	9	5 (62.5)	3 (37.5)	0 (0.0)	0 (0.0)	0 (0.0)

N = Number of fish

DISCUSSION

The biometric analysis of fish species from Aiba Reservoir revealed distinct interspecific differences in mean standard length (SL) and body weight (W). *Clarias gariepinus* exhibited the largest body dimensions (22.67 ± 3.07 cm; 229.01 ± 113.92 g), consistent with its high growth potential and trophic role as a top predator. Similar observations have been reported in *C. gariepinus* and *Oreochromis niloticus* populations from Sabke Reservoir, where both species showed relatively large size ranges but exhibited negative allometric growth ($b < 3$) (Auta *et al.,* 2025).

The comparatively smaller sizes recorded for *Oreochromis niloticus* and *Chrysichthys nigrodigitatus* in Aiba Reservoir may reflect differences in habitat utilisation, food availability, and energy allocation, factors identified as key drivers of morphometric variability in tropical freshwater ecosystems. Auta *et al*. (2025) similarly reported that environmental heterogeneity in Nigerian reservoirs contributes to size dispersion in catfish populations, emphasising the adaptive flexibility of *C. gariepinus* under variable ecological conditions.

Sex-related differences were evident across the three species, with males generally exhibiting higher mean lengths and body weights than females. Male *C. gariepinus* recorded higher mean SL (23.71 ± 3.75 cm) and W (259.84 ± 142.02 g) than females (18.50 ± 3.00 cm; 105.70 ± 16.00 g), indicating pronounced sexual dimorphism. Similar findings were documented for *C. gariepinus* in Zuru Reservoir, where males were significantly larger and heavier than females due to metabolic and hormonal differences favouring faster growth (Muhammad *et al.,* 2025).

The predominance of males in the Aiba Reservoir samples may be attributed to behavioural or reproductive differences, such as male territoriality during spawning, which increases their susceptibility to capture. For *O. niloticus*, male dominance mirrors the trend reported in the Ogun River, where *O. niloticus* populations exhibited male-biased sex ratios during active breeding periods (Umoren *et al.*, 2025). The length–weight relationship analysis revealed negative allometric growth for all three species, with b-values below 3: *C. gariepinus* (2.602), *C. nigrodigitatus* (2.438), and *O. niloticus* (1.052).

All three species exhibited b-values below 3, indicative of negative allometric growth, consistent with the expected biological range for teleost fishes (Froese, 2006). These b-values fall within the range documented for the respective species in global fisheries databases (Froese and Pauly, 2024). This indicates that fish tend to grow more in length than in weight as they increase in size, a trend also reported in Nigerian freshwater systems. Such growth patterns are typical of populations influenced by fluctuating food supply, temperature changes, or energy constraints (Pauly, 1984; Atawodi *et al*., 2025)

The exceptionally low b and r^2 values for *O. niloticus* ($b = 1.052$; $r^2 = 0.180$) suggest irregular growth, likely resulting from environmental stress or restricted food resources. In contrast, a controlled aquaculture study reported a strong correlation ($r^2 = 0.899–0.994$) and near-isometric growth ($b = 2.8469$) for *O. niloticus*. This contrast highlights the significant influence of environmental factors on growth patterns and suggests that tilapia populations in Aiba Reservoir may be experiencing ecological limitations.

Sex-specific LWR analysis showed that male *C. gariepinus* and *C. nigrodigitatus* exhibited higher b-values (2.845 and 2.915, respectively) and stronger correlations ($r^2 = 0.985$ and 0.941, respectively) than their female counterparts. These findings are consistent with those from Zuru Reservoir, where males demonstrated superior growth performance linked to hormonal and metabolic advantages. The weak correlation in *O. niloticus* males ($b = 0.842$; $r^2 = 0.172$) supports the conclusion that environmental factors within Aiba Reservoir may limit tilapia growth relative to the more stable conditions of cultured systems (La Rosa *et al.,* 2025).

In the present study, three fish species, *Clarias gariepinus*, *Chrysichthys nigrodigitatus*, and *Oreochromis niloticus* from Aiba Reservoir exhibited mean condition factors (K) of 0.94±0.33, 1.30±0.23, and 1.01±0.61, respectively. These condition factors indicate differences in the well-being and environmental adaptability of each species within the Reservoir ecosystem.

Stomach fullness data (Tables 5 and 6) provided important insight into the feeding activity and nutritional status of the three fish species in Aiba Reservoir. None of the *C. gariepinus* or *O. niloticus* specimens recorded empty stomachs, indicating consistent and active feeding throughout the sampling period. In contrast, four specimens of *C. nigrodigitatus* (11.11%) presented empty stomachs, suggesting occasional interruptions in foraging, possibly linked to diurnal feeding rhythms or benthic microhabitat disturbance. Among the three species, one-quarter stomach fullness was the most frequently observed category in *C. gariepinus* (40.0%) and *O. niloticus* (35.0%), whereas half-full stomachs predominated in *C. nigrodigitatus* (27.78%), suggesting active feeding activity within the Reservoir. Full stomachs were recorded in 30.0% of *C. gariepinus* specimens, the highest among the three species, which is consistent with the species' known opportunistic and carnivorous feeding strategy that enables rapid prey consumption when food resources are encountered (Madugu *et al.,* 2025). The lower proportion of full stomachs observed in *C. nigrodigitatus* (16.67%) and *O. niloticus* (10.0%) may reflect their more selective feeding behaviour and reliance on dispersed benthic and phytoplanktonic food resources, respectively. Sex-based analysis (Table 6) revealed that male *C. gariepinus* recorded a higher proportion of full stomachs (37.5%) compared to females (0.0%), which may reflect the higher metabolic demands associated with male growth and territorial behaviour. Similarly, female *C. nigrodigitatus* showed a higher proportion of half-full and three-quarter-full stomachs than males, suggesting that females may engage in more sustained, moderate-intensity foraging rather than episodic high-intake feeding. These sex-based differences in feeding intensity are broadly consistent with patterns reported in Nigerian freshwater catfishes, where males tend to exhibit more aggressive and opportunistic feeding behaviour (Muhammad et al., 2025).

The stomach content analysis revealed distinct interspecific differences in dietary composition that reflect the ecological roles and feeding guilds of the three species within Aiba Reservoir. *Oreochromis niloticus* exhibited predominantly omnivorous feeding behaviour, with stomach contents comprising phytoplankton, algal filaments, detritus, and organic particulate matter. This dietary profile aligns closely with findings from River Okura, where *O. niloticus* fed primarily on phytoplankton and detritus, with feeding intensity varying seasonally in response to fluctuations in primary productivity (Onimisi, 2025). The omnivorous strategy of *O. niloticus* confers significant ecological flexibility, enabling the species to exploit a broad spectrum of food resources and maintain adequate nutritional intake even under conditions of reduced food availability, a trait particularly advantageous in tropical reservoir environments subject to seasonal hydrological variability (Tesfahun and Alebachew, 2023; Madugu *et al.*, 2025). *Clarias gariepinus* displayed predominantly carnivorous feeding tendencies with opportunistic characteristics. Stomach contents included invertebrate fragments, crustacean remains, insect larvae, and organic debris, consistent with its recognised status as an apex predator and benthic scavenger in West African freshwater systems. This dietary profile is supported by Madugu *et al.* (2025), who described *C. gariepinus* as an opportunistic omnivore with a broad dietary spectrum, capable of exploiting both planktonic and benthic food chains depending on prey availability. The absence of empty stomachs in *C. gariepinus* further reveals its active and persistent foraging behaviour within the Reservoir. *Chrysichthys nigrodigitatus* demonstrated benthic and omnivorous feeding characteristics, with stomach contents comprising sediment particles, benthic invertebrates, mollusc fragments, and plant material. These findings are consistent with the broad benthic diet reported for the species in the Majidun River, which included crustaceans, molluscs, insects, and detrital matter (Ogunbanwo and Odu-Onikosi, 2024). The predominance of benthic food items in the diet of *C. nigrodigitatus* reflects its morphological and behavioural adaptations for bottom-feeding, including a flattened ventral surface and barbels suited for substrate exploration.

The interspecific dietary differences observed among the three fish species in Aiba Reservoir suggest a degree of ecological resource partitioning that is likely to reduce direct competition and facilitate coexistence within shared habitat. *O. niloticus* occupies a predominantly planktivorous and detritivorous trophic niche in the water column, while *C. gariepinus* operates as an active carnivore and opportunistic feeder across both pelagic and benthic zones. *C. nigrodigitatus* functions primarily as a benthic omnivore, exploiting sediment-associated invertebrates and organic matter at the substrate level. This trophic stratification, spanning the pelagic, midwater, and benthic zones, indicates that the three species partition food resources both horizontally and vertically within the reservoir ecosystem, a pattern well-documented in multi-species assemblages of tropical freshwater systems (Tesfahun and Alebachew, 2023; Onimisi, 2025). The ecological significance of this resource partitioning extends beyond competition reduction: the distinct trophic roles fulfilled by these three species collectively contribute to nutrient cycling, energy transfer across trophic levels, and the regulation of invertebrate and phytoplankton populations within the Reservoir. Their coexistence therefore reflects a functionally diverse fish community that supports ecosystem stability and productivity.

Sex ratio analysis revealed that males outnumbered females in the overall sample, with a total of 36 males and 30 females recorded across all three species. For *C. gariepinus*, the observed sex ratio was 8 males to 2 females (4:1 F:M). Chi-square analysis indicated that this ratio deviated significantly from the expected 1:1 ratio ($\chi^2 = 3.60$, df = 1, $p < 0.05$), suggesting a male-biased sex ratio in the sampled population, possibly attributable to gear selectivity, male territorial behaviour during the sampling period, or differential spatial distribution between sexes. For *C. nigrodigitatus*, both sexes were represented in the sample, with 17 males and 19 females recorded. The observed sex ratio (0.89:1 M:F) did not deviate significantly from the expected 1:1 ratio ($\chi^2 = 0.11$, df = 1, $p > 0.05$), suggesting a relatively balanced sex structure in the population during the study period. For *O. niloticus*, the sex ratio was 11 males to 9 females (approximately 1.4:1 M:F), and chi-square analysis indicated no significant departure from the expected 1:1 ratio ($\chi^2 = 0.58$, df = 1, $p > 0.05$), suggesting a relatively balanced sex structure in the tilapia population. Male-biased sex ratios in *O. niloticus* have nonetheless been reported elsewhere during active breeding seasons, when males occupy and guard nest sites that increase their exposure to fishing gear (Umoren *et al.*, 2025). The generally male-dominated samples across species are therefore most plausibly interpreted as a seasonal and behavioural artefact rather than a true population-level sex imbalance.

The reproductive stage data (Tables 7 and 8) provided important insights into the gonadal maturity structure and reproductive activity of the three fish species during the study period. For *Clarias gariepinus*, the majority of specimens were in the immature stage (60.0%), with 30.0% in the developing stage and only one specimen (10.0%) classified as mature. No spawning or spent individuals were recorded, suggesting that the majority of the sampled *C. gariepinus* population had not yet entered active spawning during the study period. This pattern may reflect the timing of sampling relative to the species' reproductive cycle; *C. gariepinus* typically spawns during the peak of the rainy season in West African freshwater systems, and the absence of spawning individuals may indicate that sampling coincided with a pre-spawning phase (Auta *et al.*, 2025). In contrast, *Chrysichthys nigrodigitatus* exhibited the most diverse reproductive stage distribution, with 35.3% of individuals classified as immature, 35.3% as spawning, and 17.6% as spent, alongside small proportions in the developing (5.9%) and mature (5.9%) stages (Table 8).

The relatively high proportion of spawning and spent individuals in *C. nigrodigitatus* strongly suggests that active reproduction was occurring in or shortly before the sampling period, indicating that the Reservoir provides suitable spawning conditions for this species. These findings are noteworthy given that *C. nigrodigitatus* is a commercially important benthic species whose reproductive success is closely tied to sediment quality and benthic habitat integrity (Ogunbanwo and Odu-Onikosi, 2024). For *Oreochromis niloticus*, the reproductive stage distribution was dominated by immature individuals (63.2%), with 31.6% in the developing stage and only one mature specimen (5.3%). No spawning or spent individuals were recorded, consistent with the observation that tilapia reproductive activity in Nigerian reservoirs tends to be tightly regulated by seasonal cues such as rising water temperatures and increased primary productivity (Onimisi, 2025; Madugu *et al.*, 2025). Sex-disaggregated reproductive data (Table 8) further revealed that spawning activity in *C. nigrodigitatus* was distributed between males (64.71%) and females (47.37%), with spent females (10.53%) outnumbering spent males (5.88%), indicating that females may have completed their reproductive cycles slightly ahead of males. For *C. gariepinus*, all developing individuals were male (37.5%), and no males reached the mature or spawning stages. At the same time, the single female recorded was either immature or developing, consistent with the early-stage reproductive profile observed for the species during the sampling period. Collectively, these reproductive observations confirm that Aiba Reservoir supports active and stage-diverse reproductive populations, underlining its ecological value as a breeding and nursery habitat for commercially important freshwater fishes.

The mean condition factor (K) values recorded for the three species, 0.94 ± 0.33 for *C. gariepinus*, 1.30 ± 0.23 for *C. nigrodigitatus*, and 1.01 ± 0.61 for *O. niloticus*, provide ecologically meaningful indicators of species-specific physiological condition and habitat quality within the Reservoir. The condition factor of *C. nigrodigitatus* (K = 1.30±0.23) exceeded the widely accepted threshold of K = 1.0, above which fish are generally considered to be in good physiological condition (Le Cren, 1951), suggesting that this species is well-nourished and operating in a habitat that adequately supports its metabolic requirements (Auta *et al.*, 2025; Yousuf *et al.*, 2023). *O. niloticus* also attained a mean K value at or marginally above 1.0, indicating acceptable nutritional status, despite exhibiting the weakest length–weight relationship among the three species. The K value of *C. gariepinus* (0.94±0.33) fell marginally below 1.0, suggesting a slightly sub-optimal physiological condition that may be partly attributable to the lower sample size for this species (N = 10) and the predominantly immature reproductive stage of the sampled individuals, which may reflect sub-adults not yet allocating resources to somatic mass accumulation. Similar marginal K values below 1.0 for *C. gariepinus* have been reported in other Nigerian freshwater ecosystems experiencing moderate food limitation or anthropogenic disturbance (Atawodi *et al.*, 2025). Overall, the condition factor values across species indicate that Aiba Reservoir maintains relatively adequate ecological conditions for fish growth and survival, though the marginal condition of *C. gariepinus* warrants attention in future long-term monitoring programmes.

CONCLUSION

This study evaluated the feeding ecology, length–weight relationship, condition factor, and reproductive characteristics of *Clarias gariepinus*, *Chrysichthys nigrodigitatus*, and *Oreochromis niloticus* inhabiting Aiba Reservoir, Iwo, Osun State, Nigeria. The findings revealed species-specific variations in morphometric and biological parameters, reflecting differences in feeding strategies, ecological adaptation, and growth performance within the Reservoir ecosystem.

The length–weight relationship analysis indicated negative allometric growth patterns in the three fish species, suggesting that increases in body length occurred at a faster rate than body weight. Nevertheless, the condition factor values obtained for the species were within acceptable ranges for tropical freshwater fishes, indicating that the Reservoir provides relatively favourable environmental conditions for growth, feeding, and survival.

Stomach content analysis showed that the fish species exploited diverse food resources available within the Reservoir. *Oreochromis niloticus* exhibited predominantly omnivorous feeding behaviour, *Clarias gariepinus* displayed carnivorous tendencies with opportunistic feeding characteristics, while *Chrysichthys nigrodigitatus* demonstrated benthic and omnivorous feeding patterns. These dietary variations suggest ecological resource partitioning among the species, thereby reducing interspecific competition and supporting coexistence within the aquatic ecosystem (Nikolsky, 1963).

The presence of developing and mature gonadal stages among the sampled fish further indicates active reproductive activity during the study period and suggests that Aiba Reservoir serves as a suitable habitat for fish breeding and population maintenance. Collectively, the observed growth patterns, feeding ecology, and reproductive characteristics reflect a relatively stable trophic structure and ecological functionality of the Reservoir.

This study therefore provides important baseline information for fisheries management, ecological monitoring, and biodiversity conservation in Aiba Reservoir. To ensure sustainable utilisation of the fishery resources, there is a need for continuous monitoring of fish populations, habitat quality, and anthropogenic activities within the Reservoir. Fishing activities should be regulated through appropriate management measures such as mesh-size control, seasonal restrictions, and protection of breeding grounds to prevent overexploitation of economically important species. In addition, regular water-quality assessment and community-based awareness programmes should be encouraged to promote sustainable fishing practices and long-term ecosystem health. Given the commercial importance and adaptability of *O. niloticus* and *C. gariepinus*, the promotion of responsible aquaculture and restocking programmes may further enhance fish production and local food security. Future studies should also investigate seasonal variations in feeding ecology, reproductive dynamics, and environmental parameters to provide more comprehensive insights into the ecological sustainability of the Reservoir ecosystem.

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