

Comparative Study of Gonadosomatic Index and Hepatosomatic Index Between Wild and Cultured *Clarias Gariepinus*

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ABSTRACT

This study was conducted to examine the Gonadosomatic and liversomatic index of *Clarias gariepinus* in the wild and cultured environment was carried out for a period of two months (October and December, 2021). A total of 40 adult *Clarias gariepinus* were used in this study, comprising 20 cultured (from a private farm in Makurdi) and 20 wild fish (from the Lower River Benue). The GSI and HSI of the female sex in the cultured ($GSI = 8.25 \pm 1.02$; $HSI = 1.70 \pm 0.52$) varied significantly ($p < 0.05$) from the wild ($GSI = 1.40 \pm 0.38$; $HSI = 1.49 \pm 0.09$) in the month of October. The male sex variation: cultured ($GSI = 2.10 \pm 0.00$; $LSI = 2.45 \pm 0.00$); wild ($GSI = 0.49 \pm 0.14$; $HSI = 1.59 \pm 0.15$). Variations in December for the female sex as: cultured ($GSI = 4.85 \pm 1.00$; $HSI = 0.97 \pm 0.10$) and wild ($GSI = 0.38 \pm 0.06$; $HSI = 1.07 \pm 0.17$). All comparisons were statistically significant ($p < 0.05$). It was concluded that the GSI and HSI of *Clarias gariepinus* are higher in the cultured than in the wild I therefore recommend that indiscriminate dumping of toxicants into the water bodies should be controlled.

Keywords: *Clarias gariepinus*, Gonadosomatic Index (GSI), Hepatosomatic Index (HSI), Reproductive biology and Aquaculture.

1.0 Introduction

Providing sufficient food for Nigeria's growing population remains a major challenge. A healthy diet rich in protein is essential to prevent malnutrition and reduce the risk of disease in a rapidly expanding population [1]. Fish represents an important and accessible source of high-quality protein, being easily digestible and rich in essential nutrients. Understanding the reproductive biology and health of fish is critical for managing populations and maximizing yield, as it provides insights into breeding cycles, fecundity, and stock sustainability [2]. The commercial potential of a fish species is closely linked to its life history, population dynamics, culture practices, and overall management strategies [3]. Among cultured species in Nigeria, African catfish (*Clarias gariepinus*) is the most widely farmed, owing to its adaptability to varied environmental conditions, high stocking density tolerance, rapid growth, disease resistance, acceptance of formulated feeds, high fecundity, quality meat, and ease of artificial breeding [4]. Globally, fish contributes significantly to human nutrition, providing over 1.5 billion people with nearly 20% of their animal protein intake and 3 billion people with at least 15% [5]. Detailed knowledge of reproductive biology is fundamental for assessing the commercial potential of fish stocks, guiding culture practices, and managing fisheries effectively [6]. The reproductive capacity of a population, particularly gonadal development, is a key factor in evaluating the breeding potential of individual fish [7]. However, studies have shown that egg production varies not only among species but also with the size and weight of the gonads, highlighting the importance of species-specific reproductive assessments [8,9].

Gonadosomatic index (GSI) and gonad volume are widely used as indicators of gonadal development and reproductive status in fish [10]. The liver, being the primary organ for detoxification, often exhibits morphological and enzymatic changes following exposure to environmental toxicants [11].

For instance, a decrease in hepatosomatic index (HSI) was observed in rainbow trout (*Oncorhynchus mykiss*) after nine weeks of paraquat exposure [12], whereas an increase in HSI was reported in both male and female tilapia (*Oreochromis niloticus*) under similar conditions, reflecting essential physiological functions [13]. Histopathological biomarkers, including changes in liver and gonad tissues, are generally considered reliable indicators of fish health and serve as mirrors of exposure to various anthropogenic pollutants [14]. GSI has long been used to estimate relative gonadal development, often assuming a constant arithmetic relationship between gonad weight and fish body weight [15,16]. Gonadal recrudescence in female fish involves the accumulation of lipids and proteins within developing oocytes, which contributes to reproductive readiness [17]. HSI is calculated as the ratio of liver weight to body weight, providing insights into metabolic and physiological status. Studies have shown that ovary weight increases significantly with body weight in goldfish (*Carassius auratus*) [16], and similar reproductive investigations have been conducted on freshwater eels in the Mymensingh region [17,18]. Despite these efforts, scientific information on the reproductive indices, particularly GSI and HSI, of cultured and wild *Clarias gariepinus* remains limited. Therefore, this study aimed to provide comprehensive data on the GSI and HSI of both cultured and wild *C. gariepinus* in the Makurdi Local Government Area of Benue State, Nigeria.

Materials and Methods

This experiment was carried out in two areas within the Makurdi Local Government Area. Makurdi the capital of Benue State lies between latitude 7° 41'N and longitude 08° 35'E. The locations were Owner Occupier quarter Makurdi for the cultured and Wadata landing site for collection of wild fish. A total of 40 adult *Clarias gariepinus* were used in this experiment, it comprised of 20 cultured and 20 wild fish.

The fish were obtained from Wadata landing site and Ogalahi's farm wild and cultured strains respectively both in Makurdi, Benue state. Two plastic bowls were used to hold the fish during sample collection, a little water was poured in the bowl so that the fish will not die before been properly killed. They were then taken to the general-Purpose Laboratory at the Department of Fisheries and Aquaculture, University of agriculture Makurdi for further work, where the fish were sacrificed and dissected the liver and gonad were removed and weighed and the GSI and HSI were calculated and compared. The liver and testis were weighed on a sensitive weighing balance individually for all the samples and were recorded.

The GSI was calculated by following formula given by [19] for both male and female fish. Same applies to the hepatosomatic index

$$\text{Gonado somatic index} = \frac{\text{weight of gonad}}{\text{weight of fish}} \times 100$$

$$\text{Hepato somatic index} = \frac{\text{weight of the liver}}{\text{weight of the fish}} \times 100$$

Results

Table 1 shows the comparison between the body parameters of cultured and wild *Clarias gariepinus* for both sexes in the month of October. The result indicates significant differences except for the total length of the female.

Table 1: Comparison of Body Parameters between Cultured and Wild fish (October)

Sex	Parameters	Source of Fish Sample		P-value
		Cultured	Wild	
Female	Total Length (cm)	41.67±0.45	41.33±0.98	0.514
	Body Weight (g)	509.50±22.90	485.10±29.30	0.035*
Male	Total Length (cm)	43.13±1.46	40.00±0.00	0.028*
	Body Weight (g)	486.60±69.10	428.40±0.00	0.046*

*indicates statistical difference at 0.05%

Table 2 presents the comparison of body parameters between cultured and wild *Clarias gariepinus* for both sexes in December both indicated significant differences with higher values occurring in the cultured than in the wild.

Table 2: Comparison of body parameters between cultured and wild (December)

Sex	Parameters	Source of Fish Sample		P-value
		Cultured	Wild	
Female	Total Length (cm)	40.67±0.67	38.66±1.57	0.023*
	Body Weight (g)	491.20±28.8	380.64±0.79	0.039*
Male	Total Length (cm)	40.62±0.59	39.64±0.79	0.030*
	Body Weight (g)	445.70±23.00	390.20±16.80	0.034*

*indicates statistical difference at 0.05%

Table 3 presents the comparison between the GSI and LSI for both sexes in cultured and wild *Clarias gariepinus* the comparison depicts significance differences with higher values occurring in the cultured than the wild.

Table 3: Comparison between GSI and LSI of cultured and wild fish (October)

Sex	Parameters	Source of Fish Sample		P-value
		Cultured	Wild	
Female	Gonad Weight (g)	41.76±5.33	6.48±1.40	0.014*
	Liver Weight (g)	8.18±0.96	7.64±0.62	0.036*
	GSI	8.25±1.02	1.40±0.38	0.027*
	HIS	1.70±0.52	1.49±0.09	0.039*
Male	Gonad Weight (g)	9.00±0.00	2.18±0.38	0.036*
	Liver Weight (g)	10.50±0.00	7.55±0.74	0.029*
	GSI	2.10±0.00	0.49±0.14	0.027*
	HIS	2.45±0.00	1.59±0.15	0.019*

*indicates statistical difference at 0.05%

Table 4 presents the comparison between the GSI and LSI of cultured and wild *Clarias gariepinus* all showed significant differences with higher values occurring in the cultured than in the wild except for the GSI and LSI of cultured and wild female.

Table 4: Comparison between Fish in Cultured and Wild (December)

Sex	Indices	Source of Fish Sample		P-value
		Cultured	Wild	
Female	Gonad Weight (g)	21.67±5.91	18.82±4.04	0.028*
	Liver Weight (g)	4.37±0.92	3.64±0.36	0.047*
	GSI	4.85±1.00	4.46±1.00	0.058
	HIS	0.97±0.10	0.91±0.23	0.051
Male	Gonad Weight (g)	1.67±0.26	1.84±0.57	0.047*
	Liver Weight (g)	5.67±0.44	4.20±0.72	0.039*
	GSI	0.47±0.15	0.38±0.06	0.028*
	HIS	1.29±0.10	1.07±0.17	0.037*

*indicates statistical difference at 0.05%

Discussions

The findings of this work showed that the GSI was higher in the cultured than in the wild, the highest GSI for females occurred in the cultured female in October and the least in the wild strain in October. Highest GSI in the Males occurred in October and least in December in the wild strain this may be as a result of better environmental conditions such as food availability, water temperature and salinity which are under control in the cultured and as a result of that better gonadal state these agrees with the work of [20] who identified the use of gonadosomatic index and volume of gonad as indicators of gonadal state.

The highest HSI in females occurred in the cultured strain and least in wild strain in December. Highest HSI in males occurred in the cultured strain in October and least in December in the wild strain the high HSI in the cultured fish may be as a result of higher quality feeding levels. This result disagrees to that of [12] found an increase of HSI in male and female tilapia, related to essential physiological functions, like *O. niloticus*, exposed to paraquat. The least in December in the wild strain may be as a result of high pollution this agrees with the findings of [10] who found a decrease in HSI values after 9 weeks in rainbow trout, *Oncorhynchus mykiss*, injected with paraquat. Higher LSI in the cultured fish may also be as a result of higher inclusion of carbohydrate in the diet of the cultured fish with low activity which may result to deposition of the excess carbohydrate in the liver. These also agrees with the work of [16] who reported that Gonadal recurrence in female fish involves accumulation of lipids and protein stores within the developing oocytes. It has been generally reported that histopathological biomarkers serve as reliable indicators of overall fish health, reflecting exposure to various anthropogenic pollutants [13]. This suggests that the hepatosomatic index (HSI) can be used as a rapid and practical indicator for detecting environmental pollution in aquatic ecosystems. Accordingly, HSI may be considered a valid and efficient measure for monitoring the impact of such pollutants on fish populations. When GSI and HSI of both cultured and wild strains were compared, we came to know that have maximum values of GSI and HSI occurred in culture than in the wild except for females in December.

This work has shown that the GSI and HSI of *Clarias gariepinus* in the cultured and the wild are not similar, with higher levels occurring in the cultured than in the wild except for females in December. The data from this work can serve as a baseline data for comparison between the GSI and HSI in cultured and wild *Clarias gariepinus* found in Western African which in turn can be

used in the assessment of the effects of toxins and indication of wellbeing in the *Clarias gariepinus* of West African.

Conclusion and Recommendation

The present study revealed that the gonadosomatic index (GSI) and hepatosomatic index (HSI) of *Clarias gariepinus* were generally higher in cultured populations compared to their wild counterparts, suggesting better reproductive and physiological conditions under controlled aquaculture systems. These findings indicate that aquaculture practices, including proper feeding, management, and reduced exposure to environmental stressors, positively influence gonadal development and liver function in this species, wild populations may experience reduced GSI and HSI due to natural environmental variability, exposure to pollutants, and limited food availability. Based on these results, it is recommended that indiscriminate disposal of toxicants and industrial effluents into water bodies be strictly controlled to prevent adverse impacts on fish health and reproduction, regular monitoring of GSI and HSI in both cultured and wild populations should be conducted as a part of sustainable fisheries management and environmental assessment programs to ensure the long-term viability of *C. gariepinus* stocks.

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