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Stocking Density and Feeding Levels Impacted on Morphometric and Condition Factors of Hybrid Catfish

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ABSTRACT

Background and Objective: Stocking densities and feeding levels have an impact on the production of farmed catfish. Morphometric parameters and condition factors are tools employed in aquaculture to assess the health of a species. **Materials and Methods:** Hence, the morphometric parameters and condition factors were investigated against different stocking densities and feeding levels. The fish were reared using tarpaulin tanks measuring 1 m^3 in 250 L of water with five different densities: 100 fish/0.25 m^3 (T1), 75 fish/0.25 m^3 (T2), 38 fish/0.25 m^3 (T3), 18 fish/0.25 m^3 (T4) and 9 fish/0.25 m^3 (T5). The experiment had three replicates and lasted for 52 weeks. Feeding was administered at 1.0% feeding level (FL) and 1.5% feeding level biomass with commercial feed. The obtained data were statistically analyzed using analysis of variance and means separation with Duncan's Multiple Range Test. **Results:** Results from the statistical analysis revealed significant differences ($p<0.05$) in specific morphometric parameters among the different stocking densities, while others were insignificant. The hybrid catfish reared at T2 and 1.5% (FL) had the highest mean values for morphometric parameters. The T1 at 1.0% FL recorded the least morphometric values. The best condition factor (0.77) was obtained at T5. **Conclusion:** This study, therefore, suggested that 75 fish/m^3 stocking density is optimal for raising hybrid catfish and achieving the best growth.

KEYWORDS

Morphometric characteristics, hybrid catfish, (*Heterobranchus longifilis*×*Clarias gariepinus*), stocking densities and feeding level, factor condition

INTRODUCTION

In Nigeria, the mainstay of aquaculture is farming catfish using hypophysation, which has led to a surge in the production of farmed catfish[1]. The preferred species of catfish include *Clarias gariepinus*, *Heterobranchus bidorsalis* and their hybrid, *Heteroclarias*[2]. The crossing of *C. gariepinus* with *H. bidorsalis* led to the emergence of this hybrid catfish, which exhibits favourable characteristics such as rapid growth and high acceptability. This has resulted in the rapid expansion of catfish farming in many regions of Nigeria[2,3]. These outcomes are achieved through carefully selected species, appropriate feeding and stocking density.

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Stocking density is a well-known factor affecting growth, survival and yield in different aquaculture species and its impact on production varies[4]. To measure fish growth performance, several variables, such as adequate feeding, space availability and other environmental factors, are considered[5]. However, fish feed is a major limiting factor in commercial aquaculture due to its high cost, thereby reducing overall profitability. Feeding level, determined by fish biomass, is the amount of feed given to cultured fish daily and it plays a vital role in the overall performance of fish production[6]. Studying the biology of fish species is crucial for evaluating the possibility of their cultivation in different water bodies.

According to Oribhabor *et al*.[7] and Godwin and Jennifer[8], the aquatic ecosystem and the general well-being of fish could be evaluated through the condition factor. A critical aspect of this is the morphometric analysis of fish, which is essential in understanding their biology[9].

Morphometrics may be defined as a more or less interwoven set of largely statistical procedures for analyzing variability in the size and shape of organs and organisms[10]. Some studies have shown that stocking density has adverse effects on the welfare of farmed fish, resulting in chronic stress, reduced growth rates and changes in the physical condition and health of fish[11,12]. However, limited information exists on the influence of stocking density on the morphometrics and condition factor of hybrid catfish reared under controlled conditions. The current study aims at assessing the impact of different stocking densities and feeding levels on the morphometric parameters and condition factor of hybrid catfish.

MATERIALS AND METHODS

Study area: The site of this work was the fish farm complex of the Fisheries and Aquatic Environmental Management Department, University of Uyo. The experiment was for one year, (December, 2020 to November, 2021 using 30 tarpaulin tanks of 1 m^3 volume. The fingerlings of hybrid catfish used were obtained from a breeding exercise using two females and two male broodstock according to the methods used by Afia *et al*.[12].

Condition factor: The Condition Factor (K) was estimated using Fulton's condition equation from the relationship:

$$K = \frac{W}{TL^3} \times 100$$

where, K values of individual fish were pooled to calculate the means at the end of the experiment.

Morphometric parameters: The following morphometric characters were measured according to Wiecaszek and Krzykawski[13]. Total length (TL) was measured from the snout to the base of the caudal fin rays. Standard length (SL) was measured between the maxilla and the end of the caudal peduncle and head length (HL) from the maxilla to the posterior end of the ventral region of the opercular. The dorsal fin length (DFL) was taken from the inception of the dorsal fin to its extreme and the anal fin length (AFL) from the start of the caudal fin to the end. All measurements were taken with a measuring board to the nearest 0.1 cm at the end of the experiment.

Statistical analysis: Morphometric parameters and condition factor were analyzed with Analysis of Variance (ANOVA) and mean compared with Duncan's Multiple Range Test at p = 0.05 significant level with IBM SPSS version 25.

RESULTS

Morphometric parameters of hybrid catfish at different feeding levels: The morphometric parameters of hybrid catfish at feeding level 1.0% as shown in Table 1. There was no significant difference ($p>0.05$) among the stocking densities in standard length and anal fin length. The values for standard length were:

Table 1: Morphometric characteristics of hybrid catfish at feeding level 1.0%

Parameter	100 fish/m^3 Higher density	75 fish/m^3 High density	38 fish/m^3 Medium density	18 fish/m^3 Low density	9 fish/m^3 Lower density
BW (g)	925.15±74.01^{ab}	967.88±47.70^{ab}	878.86±55.00^{ab}	733.82±37.00^{b}	815.46±93.04^{ab}
TL (cm)	49.82±1.18^{bc}	50.75±0.74^{c}	49.83±0.77^{bc}	47.60±0.78^{ab}	46.72±0.97^{c}
SL (cm)	43.14±1.00^{a}	41.97±1.45^{a}	42.80±0.69^{a}	41.62±0.70^{a}	40.81±0.90^{a}
HL (cm)	12.95±0.30^{bc}	13.30±0.19^{a}	13.19±0.22^{bc}	12.48±0.28^{ab}	12.12±0.29^{c}
DFL (cm)	23.19±0.83^{ab}	24.96±0.42^{a}	23.62±0.62^{ab}	22.96±0.57^{a}	21.82±0.62^{a}
AFL (cm)	6.42±0.16^{a}	6.81±0.12^{a}	6.40±0.21^{a}	6.76±0.46^{a}	6.46±0.16^{a}

^{abc}Means with the same superscript alphabets within the same row are not significantly different (p>0.05), ±(standard error of the mean), BW: Body weight, TL: Total length, SL: Standard length, HL: Head length, DFL: Dorsal fin length and AFL: Anal fin length

Table 2: Morphometric characteristics of hybrid catfish at feeding level 1.5%

Parameter	100 fish/m^3 Higher density	75 fish/m^3 High density	38 fish/m^3 Medium density	18 fish/m^3 Low density	9 fish/m^3 Lower density
Body weight (g)	794.91±88.48^{ab}	913.23±95.49^{ab}	744.31±76.04^{ab}	627.27±56.10^{b}	706.75±82.51^{ab}
Total length (cm)	48.71±1.87^{ab}	52.50±1.28^{ab}	47.75±1.53^{ab}	44.83±1.36^{b}	44.01±1.89^{b}
Standard length (cm)	42.03±1.57^{ab}	45.13±1.09^{ab}	41.51±1.37^{ab}	39.13±1.18^{b}	38.67±1.57^{b}
Head length (cm)	13.10±0.54^{ab}	13.96±0.31^{ab}	12.48±0.40^{ab}	12.09±0.39^{b}	12.20±0.62^{b}
Dorsal fin length (cm)	23.42±1.19^{ab}	25.85±0.83^{a}	21.48±1.57^{b}	21.83±0.83^{b}	21.31±1.08^{b}
Anal fin length (cm)	6.53±0.22^{ab}	7.17±0.23^{a}	5.84±0.47^{b}	6.19±0.27^{b}	6.19±0.25^{b}

^{ab}Means with the same superscript alphabets within the same row are not significantly different (p>0.05)

Table 3: Condition factor of hybrid catfish at different feeding levels and stocking densities

Stocking densities	Feeding level 1.0%	Feeding level 1.5%
100 fish/0.25 m^3	0.61±0.01^{b}	0.65±0.01^{b}
75 fish/0.25 m^3	0.60±0.01^{b}	0.72±0.04^{a}
38 fish/0.25 m^3	0.63±0.01^{b}	0.65±0.02^{b}
18 fish/0.25 m^3	0.66±0.03^{b}	0.71±0.02^{a}
9 fish/0.25 m^3	0.60±0.02^{b}	0.77±0.02^{a}

^{ab}Means with the same superscript alphabets within the same row are not significantly different (p>0.05) from each other and ±(standard error of the mean)

(43.14, 41.97, 42.80, 41.62 and 40.81) and anal fin length was: (6.42, 6.81, 6.40, 6.76 and 6.46). Significant differences (p<0.05) were observed in all other morphometric parameters among the stocking densities.

Morphometrics of hybrid catfish at feeding level 1.5%. Body weight values were significantly different (p<0.05) among the stocking densities. Values of: 794.91, 913.23, 744.31, 627.27 and 706.75 were recorded at SD1, SD2, SD3, SD4 and SD5, respectively. Total length showed significant differences (p<0.05) among stocking densities with values of: 48.71, 52.50, 47.75, 44.83 and 44.01 for SD1, SD2, SD3, SD4 and SD5 as shown in Table 2. Standard length showed significant differences (p<0.05) among stocking densities. The values obtained were: 42.03, 45.13, 41.51, 39.13 and 38.67 for SD1, SD2, SD3, SD4 and SD5.

Condition factor of hybrid fish reared at different stocking densities: At SD1, hybrid catfish fed at 1.5% (0.65) was significantly different (p<0.05) from 1.0% (0.61). At SD2, 1.5% (0.72) also had significantly (p<0.05) different values from 1.0% (0.60). The SD3 and SD4 recorded significant (p<0.05) differences (0.63, 0.65), (0.66 and 0.71), respectively. At SD5 and FL 1.5%, a significant difference (p<0.05) was recorded (0.77) as shown in Table 3.

DISCUSSION

Results of this study revealed that hybrid fish reared at stocking density 100 fish/m^3 recorded significantly (p<0.05) the highest mean body weight, total length and standard length (p<0.05). Morphometrics is a measure related to the size of the length, width and height of the body or parts of the fish's body and is used in fisheries biology as a vigorous tool for measuring the discreteness and relationships among various taxonomic categories[14].

Previous studies observed significant differences in morphometric traits amongst fish species. Kuebutornye *et al*.[9] reported significant differences in *Auchenoglanis occidentalis, Brycinusimberi, Sarotherodon galilaeus* and *Oreochromis niloticus* of the Libga reservoir, Ghana. Oguguah *et al*.[15] and Solomon *et al*.[16] observed a significant difference in morphometric traits of hybrid catfish from fish farms. These reports corroborate the results of this present study.

Hybrid catfish reared at stocking density 75 fish/0.25 m^3 and fed at 1.5% biomass, recorded the highest mean morphometric characteristics over those fed at 1.0%. This superior body trait may be attributed to feeding level and favorable environmental factors. The assumption that low stocking density, more space and less competition for feed result in enhanced morphometric traits were not evident in this study as hybrid fish at the lowest stocking density 9 fish/0.25 m^3 failed to produce the best morphometric traits. This, however, contradicts the earlier findings of Ayanwale *et al*.[17] who reported the highest morphometric traits at the lowest stocking density (5 m^{-2}) against those with 10, 15 and 20 stocking densities in heteroclarias fingerlings. Similarly Oguguah *et al*.[15] recorded the best morphometric traits at the stocking density of 7 catfish m^{-2} in relation to 14 and 21 m^{-2}, stocking densities. Hossain *et al*.[18] reported that suitable stocking density varies with species and feeding regimes and is important for sustainable aquaculture.

Condition factor being an estimation of the general well-being of fish is based on the hypothesis that heavier fish are in better condition than lighter ones[7]. In this study, the condition factor values obtained were mostly <1. This implies that they were not in good physiological condition in the cultural environment. Many factors such as sex, age, state of maturity, size, sample size and environmental conditions affect conditions which reflect in the K values[1].

The K values for the hybrid fish in this study compare favorably with authors: Ibim *et al*.[19], who reported K values for *Elops lacerta* (0.3), *Eleotris senegalensis* (0.9) and *Pomadasys peroteti* (0.7) in the Amadi Creek, Rivers State, Jisr *et al*.[20] recorded K>1 and <1 for *C. gariepinus*. However, the K values from this work are deviant from the reports of Arame *et al*.[21], who obtained K = 7.276 for *Synodontis sorex* from the Niger River, Ao *et al*.[22] reported (K) of 1.22 and 1.120 for *Mugil cephalus* and *Liza falcipinnis*, respectively from the Lagos Lagoon. Odedeyi *et al*.[23] attributed the difference in condition factor to the deposition of materials for gonad formation which led to an increase in body weight and spawning led to a reduction in fish weight.

Anibeze[24] attributed increased values of the monthly condition factor of *H. longifilis* to the availability of food and gonad development. The K values obtained from this study were better at low stocking density and a higher feeding level. This implies that adequate space and availability of feed, aid in the general well-being of a fish. This is in conformity with earlier findings of authors such as Abdel-Tawwab[25], Huang and Chiu[26], who had the same report on Nile tilapia when stocked at different densities. The implication of this study is that better morphometrics and condition factor are indicative of a healthy fish. These were obtained in fish on 75 stocking density and 1.5% feeding level further revealing that the stocking density could be stepped up given adequate feed in a conducive rearing environment. Thus, to achieve good health and superior growth, the stocking density of 75 stocking density and feeding level of 1.5 are applicable to improve the economy of catfish culture. The range of treatments in this study was limited by the available resources therefore, further investigations on these parameters should consider higher upper limits to compare the results.

CONCLUSION

Morphometric parameters of cultured fish species are essential for assessing their distinctness. The morphometric characteristics for stocking density 75 fish/0.25 m^3 and 1.5% FL had the best performance for BW, TL, SL, HL, DL and AL. Hence, this study recommends that hybrid catfish for intensive culture can be carried out using collapsible tanks at a high stocking density of 75 fish/0.25 m^3 and feeding level of 1.5% for maximum performances in growth and profitability.

SIGNIFICANCE STATEMENT

Morphometric characteristics and condition factors differ among fish species. This study aims at identifying the morphometric characteristics of hybrid catfish reared in tanks and to assess the condition factor of the species under culture using different stocking densities and feeding levels. Best morphometric parameters were obtained at stocking density 75 fish/m^3 and feeding level 1.5%. The values obtained for the condition factor were all less than 1. Stocking fish at 75 fish/m^3 and feeding at 1.5% body weight is recommended. Results will give baseline information for further research work. The information will guide aquaculturists on favourable stocking density and feeding levels to use for maximum profitability.

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