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Growth assessment of pure bred *Clarias gariepinus* (Burchell, 1822), *Heterobranchus longiflis* (Valenciennes, 1840), *Heterobranchus bidorsalis* (Geoffrey Saint Hillarie, 1809) and their Hybrids

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Abstract
This study examined the growth performance of pure bred *Clarias gariepinus*, *Heterobrachus spp* and their hybrids. The broodstocks of the species were selected and used for breeding in the Hatchery. The crosses (treatments) were pure *C. gariepinus* (T_1), *Heterobranchus longifilis* (T_2), *Heterobranchus bidorsalis* (T_3), *C. gariepinus* x *H. longifilis* (T_4), *C. gariepinus* x *H. bidorsalis* (T_5). 900 fingerlings of 32 days old were randomly selected from each of the five crosses and stocked separately in triplicate using experimental tanks. T_1 recorded the lowest significant (p<0.05) values of final weight (FW), weight gain (WG), daily growth rate (DGR) and specific growth rate (SGR). No statistical difference (p>0.05) in FW, WG, DGR and DGR among T_2, T_3, T_4 and T_5 but T5 had the highest values. The combination of female *C. gariepinus* x male *H. bidorsalis* (T_5) will be more suitable for fish farming business.

Keywords: farming, fingerlings, fish hatchery, length increment, weight gain

Introduction

The role of fish and other aquatic organisms in the food systems especially in Africa cannot be overemphasized as it provides the needed essential nutrients and minerals [1, 2, 3]. The recklessness of exploitation of fish in the natural environment coupled with the resultant degradation of habitat has led to decrease in the output obtained by artisanal and industrial fishing [4].

Main aim of fish farming is production of fish in large quantities directed to meet the demand of human population, thereby solving the issue of food insecurity and malnutrition [4]. To achieve this, there is need to carefully select fish species that are not only available but also has some qualities such as reproduction in captivity, high feed conversion rate, fast growth and hardy [5]. The biggest challenge facing aquaculture is the lack of knowledge required and poor or no skill needed in many aspects of fish rearing such as feed production, pond management, breeding of fish among others [6]. Most importantly is the use of poor or deteriorating genetic quality of broodstocks which consequently affects the quality of fish seeds (fry, fingerlings or juvenile) used by farmers [7, 8].

The most cultured fish species in Nigeria and Africa at large are *Clarias gariepinus*, *Heterobranchus spp*, and their hybrids [9] only few farmer culture Tilapia. Farmers preferred *C. gariepinus* because of its early maturity traits while the choice of *Heterobranchus spp* is due to its fast growing trait. Legendre *et al*. [10] reported that *Heterobranchus* sp. had a growth rate twice as fast as that of *Clarias gariepinus.* Their hybrids combine these desirable traits [11, 12]. Both species are known to have high disease tolerance, stocking density, possession of aerial respiratory organ, high efficiency of feed conversion, hardy, tolerate poor water condition and tasty - well accepted by many consumers in either fresh or smoked [13, 14].

This research became necessary due to the increasing interest in fish farming coupled with the determination of suitable species or combination of species to culture. Therefore, this study examined the growth of pure bred *Clarias gariepinus, Heterobranchus longiflis, Heterobranchus bidorsalis* and their crossbreeds.

Materials and Methods

Experimental Site

The experiment was carried out at the Hatchery Unit of Motherhood Farms Nigeria Enterprise, off Abeokuta-Ibadan Expressway, Obantoko, Odeda Local Government Area, Abeokuta, Ogun State, Nigeria. The farm lies between Latitudes 7°10'34.4"Nand 7°10'35.4"N and Longitudes 3°23'48.4"E and 3°23'49.3"E.

Experimental Procedure

The broodstocks of *Clarias gariepinus*, *Heterobranchus bidorsalis* and *Heterobranchus longifilis* of known breeding records were obtained from the farm. The broodstocks were selected based on their external morphological features as described by Viveen *et al.* [15]. Pure and mixed crosses of these species were carried out in the hatchery. The breeding process was carried out as described by Ataguba *et al.* [16].

At four days old, hatchlings were fed ad libitum (four time daily) with dried decapsulated cysts of Artemia sp. for 14 days. After which, they were introduced gradually to commercial feed (0.2 – 1 mm) and also fed ad libitum four time daily for another 14 days.

Nine hundred (900) fingerlings of 32days old were randomly selected from each of the five crosses which represents the treatments

- T1 = female *C. gariepinus* × male *C. gariepinus*,
- T2= female *Heterobranchus longifilis* x male *Heterobranchus longifilis*
- T3 = female *Heterobranchus bidorsalis* x male *Heterobranchus bidorsalis*
- T4 = female *C. gariepinus* x male *Heterobranchus longifilis*,
- T5 = female *C. gariepinus* x male *Heterobranchus bidorsalis*

They were stocked separately in triplicate using white plastic experimental tanks (1.2 x 0.6 x 0.5m^3) at stocking rate of 300 fish per replicate.

Fish were fed to satiation two times a day with commercial feed for 90 days. And sampling carried out by batch weighing every 10 days using a weighing balance nearest to 0.001g (Model: EHA 501, specification: 0.001 to 100g). The weight and size of feed were adjusted after the sampling of the fish. The fish were not fed on the sampling days to minimize the stress impose on them.

Growth parameters

Mean weight gain

The average weight in grams was used to calculate the Mean Weight Gain as follows

$$\text{Weight gain (w)} = \text{Final weight (W2)} - \text{Initial weight of fish (W1)}$$

Specific Growth rate

Specific Growth rate which is the increase in cell mass of the fish per unit time is expressed as the percentage daily fish body weight gain throughout the culture period. The average specific growth rate for each treatment was then calculated as follows according to Ricker [17].

$$\text{Specific growth rate (SGR, \% per day)} = \frac{(\text{Loge Wi} - \text{Loge Wt}) \times 100}{\text{D}}$$

Where Wi and Wt are the initial and final mean weight respectively and 'd' represents the number of feeding days.

Daily growth rate

$$\text{Daily Growth Rate (DGR)} = \frac{\text{Final weight (g)} - \textit{Initial weight (g)}}{\text{Duration}}$$

Survival

$$\textit{Survival \%} = \frac{\textit{Initial number of fish stocked} - \textit{mortality} \times 100\%}{\textit{Initial number of fish stocked}}$$

Water parameters

Water quality parameters including temperature, Dissolved Oxygen (DO), pH and conductivity were monitored. Temperature, pH, dissolved oxygen (DO) and conductivity were measured daily at 6.30 am with mercury in-glass thermometer, pH meter model WTW pH 330 and DO meter (Model MW600), respectively.

Other water quality parameters such as Ammonia, Nitrate and Nitrite were tested with Merck test kits 2/3 days per week.

Length measurement

Total length (cm) measured from the maxilla to the end of the caudal fin, and standard length (cm) measured from the maxilla to the end of the caudal peduncle were taken every sampling days (10 days interval). Linear body measurement was carried out using a transparent ruler and digital Vernier caliper.

Statistical Analysis

The data were analysed for significant differences ($p<0.05$) by Analysis of Variance (ANOVA) using computer Statistical Package for Social Sciences (IBM SPSS version 20). The differences among the means were separated using Duncan Multiple Range Test (DMRT)

Results

The growth response of Clarias, Heterobranchus spp. and hybrids reared for 90 days was presented in Table 1. There were significant differences among the growth parameters determined except the initial weight. T1 (Clarias) recorded the lowest significant ($p<0.05$) values of final weight, weight gain, daily growth rate and specific growth rate. No statistical difference ($p>0.05$) in final weight, weight gain, daily growth rate and specific growth rate among T2, T3, T4 and T5. The highest values of FW (80.22 g), MWG (78.20 g), DGR (0.87) and SGR (4.09%) were recorded in T5. The highest significant percentage survival value (86%) was recorded in T1 while the lowest value (74.78%) was recorded in T5.

The Body Weight Gain of Clarias, Heterobranchus spp. and hybrids reared for 90 days was presented in Table 2. The results showed significant differences ($p<0.05$) from day 10 to the end of the experiment in day 90. At day 10, T_1 was not significantly different ($p>0.05$) in body weight gain when compared with T_2, T_3 and T_4 but was significantly lower than T_5. No significant difference ($p>0.05$) exists among T_2, T_3, T_4 and T_5 from day 10 to day 90 except at day 50.

Table 1: Growth response of *Clarias*, *Heterobranchus spp* and hybrids reared for 90 days

	T1	T2	T3	T4	T5
Initial weight (g)	2.03±0.02	2.01±0.03	2.00±0.01	2.00±0.02	2.02±0.01
Final weight (g)	57.40±2.35 [b]	62.94±8.45 [ab]	72.23±4.22 [ab]	77.94±4.07 [a]	80.22±4.46 [a]
MWG	55.38±2.37 [b]	60.92±8.47 [ab]	70.24±4.21 [ab]	75.94±4.06 [a]	78.20±4.46 [a]
DGR	0.61±0.03 [b]	0.68±0.09 [ab]	0.78±0.05 [ab]	0.84±0.04 [a]	0.87±0.05 [a]
SGR	3.71±0.06 [b]	3.80±0.17 [ab]	3.98±0.06 [ab]	4.06±0.05 [a]	4.09±0.06 [a]
Survival (%)	86.00±0.58 [a]	79.56±0.59 [b]	76.89±0.67 [bc]	77.22±1.09 [bc]	74.78±1.42 [c]

Means with different superscripts along same row are significantly different ($p<0.05$)

T1 = pure clarias, T2 = Heterobranchus longifilis (HL), T3 = Heterobranchus bidorsalis (HB), T4 = Clarias x HL, T5 = Clarias x HB

Table 2: Body Weight Gain of *Clarias, Heterobranchus spp* and hybrids reared for 90 days

Day	T1	T2	T3	T4	T5
10	4.02±0.05 [b]	4.21±0.11 [ab]	4.29±0.12 [ab]	4.29±0.07 [ab]	4.41±0.14 [a]
20	6.68±0.28 [b]	7.42±0.11 [a]	7.48±0.17 [a]	7.39±0.09 [a]	7.50±0.05 [a]
30	10.50±0.22 [b]	12.61±0.12 [a]	12.29±0.24 [a]	12.34±0.19 [a]	12.72±0.08 [a]
40	15.81±0.20 [b]	16.73±0.13 [a]	16.89±0.11 [a]	17.00±0.12 [a]	17.17±0.52 [a]
50	18.51±0.22 [c]	19.47±0.62 [c]	21.60±1.02[b]	24.13±0.39 [a]	23.55±0.60 [ab]
60	26.19±1.03 [b]	28.93±0.61 [a]	28.67±0.52 [a]	28.19±0.61 [ab]	28.10±0.28 [ab]
70	33.80±2.26 [c]	39.52±0.34 [b]	40.75±0.42 [b]	42.22±0.44 [b]	46.29±1.04 [a]
80	42.05±1.09 [b]	49.61±1.92 [ab]	52.30±1.58 [a]	56.15±4.33 [a]	57.13±2.15 [a]
90	57.40±2.35 [b]	62.94±8.45 [ab]	72.23±4.22 [ab]	77.94±4.07 [a]	80.22±4.46 [a]

Means with different superscripts along same row are significantly different ($p<0.05$)

The growth pattern of Clarias, Heterobranchus spp and hybrids reared for 90 days was presented in Figure 1. The fish species have almost same growth pattern from day 0 to day 20. From day 60 to day 90 there were distinct in the growth pattern with T5 having highest growth trend followed by T4, T3, T2 and T1. The length Increment of Clarias, Heterobranchus spp. and hybrids reared for 90 days was presented in Figure 2. The change in length became visible from day 20 with T1 showing the least trend. At day 60, fish in T5 has the highest length increment while fish in T1 has the least.

The Survival (mean and percenage) of Clarias, Heterobranchus spp and hybrids reared for 90 days is presented in Table 3. At day 10 there was no significant difference in survival among the treatment except T5 which recorded the lowest survival value (94.78%). At day 20, T1 recorded the highest significant survival value (96.11%) while T5 had the least value (92.00%). The survival follows the same trend from day 30 to day 90. T1 had the highest significant mean survival (86%) followed by T2 (79.56%) while the least survival value was recorded in T5 (74.78%)

The mean water quality parameter of the experimental waters during the ninety days is shown in Table 4. The results showed that the mean temperature was 28°C, pH 6.8, dissolved oxygen 5.6 mg/l and turbidity 5.45 NYU.

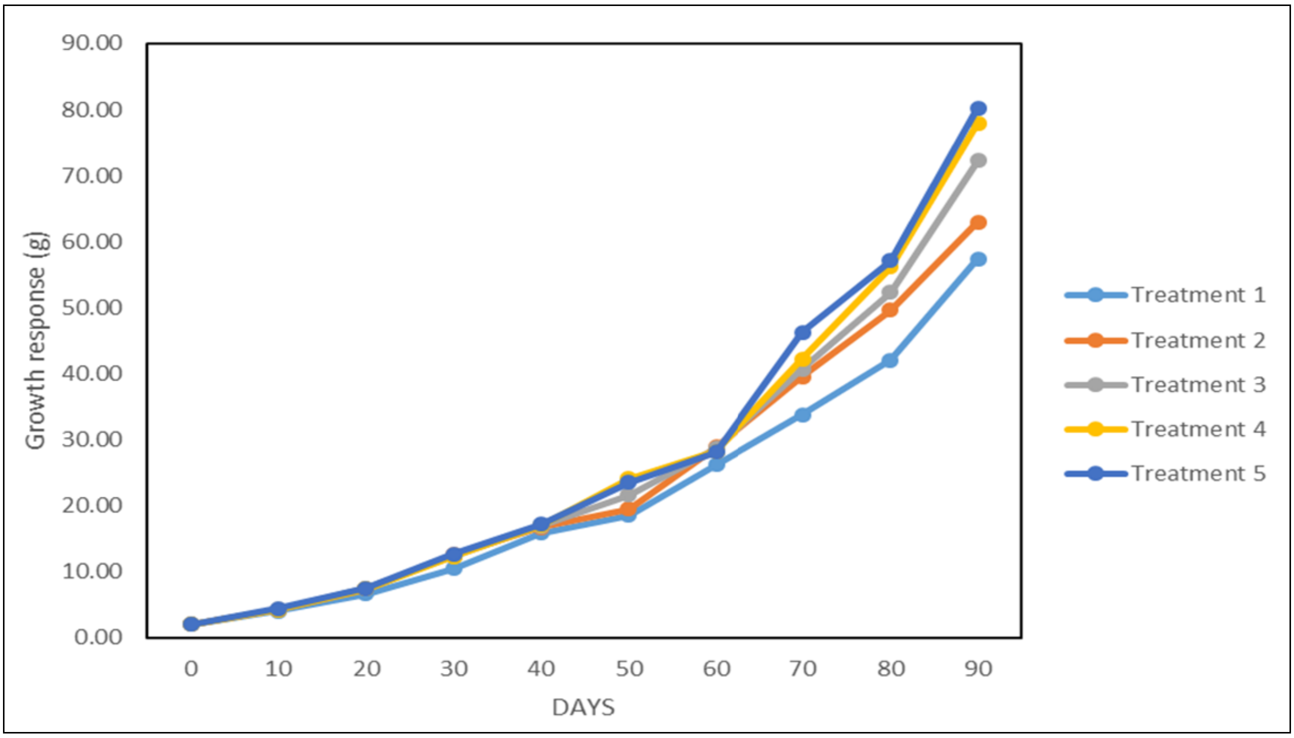

Fig 1: Growth pattern of *Clarias, Heterobranchus spp* and hybrids reared for 90 days

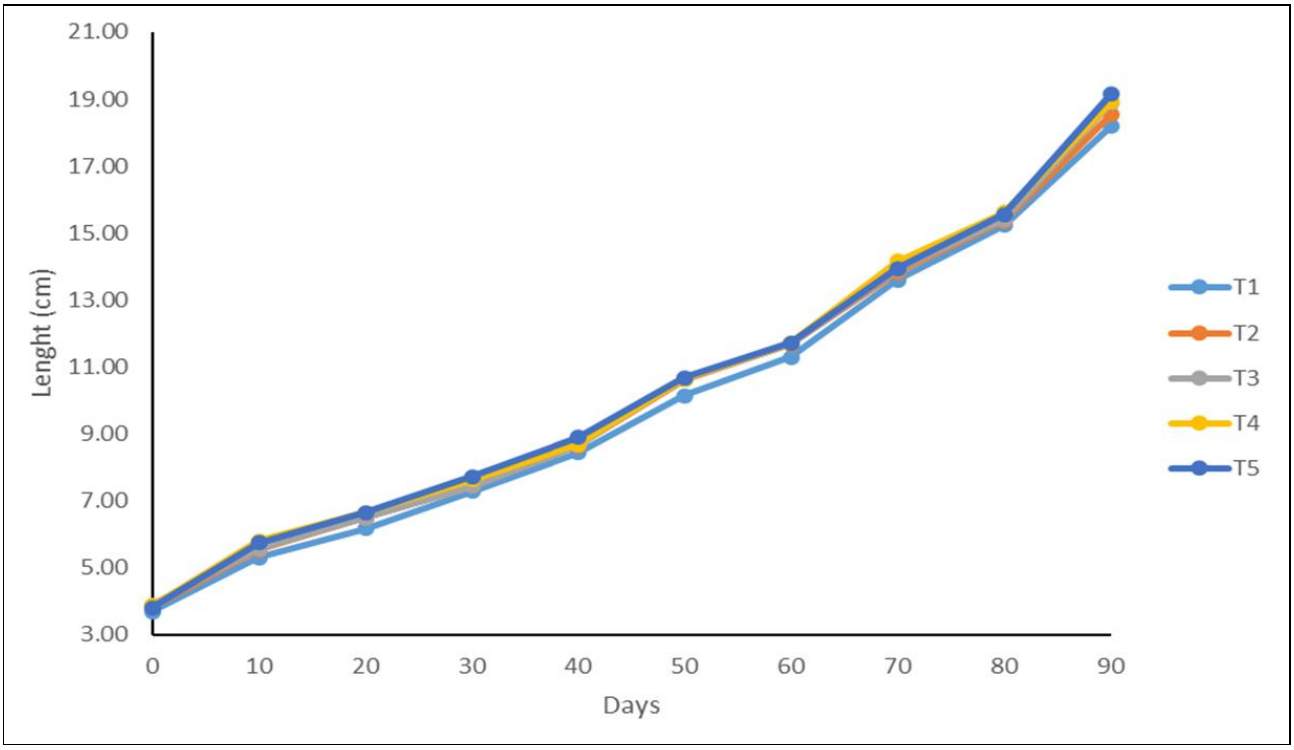

Fig 2: Length Increment of *Clarias, Heterobranchus spp* and hybrids reared for 90 days

Table 4: The mean water quality parameter in the Experimental Tanks

Parameters	Mean value
Temperature (^oC)	28±1.2
pH value	6.8±0.5
Dissolved Oxygen(mg/l)	5.6±0.78
Ammonia NH_4(mg/l)	0.4±0.06
Nitrate, NO_2(mg/l)	0.02±0.00
Turbidity (NYU)	5.45±0.21
Total solids (mg/l)	290±15.4
Nitrite, NO_3	0.01±0.00
Ammonium, NH_3	0.02±0.00

Table 3: Survival (mean and percentage) of *Clarias, Heterobranchus spp* and hybrids reared for 90 days

	T1		T2		T3		T4		T5	
Day	**Mean**	**%**	**Mean**	**%**	**Mean**	**%**	**Mean**	**%**	**Mean**	**%**
0	300	100	300	100	300	100	300	100	300	100
10	292.67±1.20 ^{a}	97.56	290.33±0.33 ^{ab}	96.78	288.33±2.33 ^{ab}	96.11	287.00±2.08 ^{ab}	95.67	284.33±3.38 ^{b}	94.78
20	288.33±1.45 ^{a}	96.11	282.00±1.15 ^{b}	94.00	280.33±0.88 ^{bc}	93.44	277.67±1.86 ^{bc}	92.56	276.00±2.00 ^{c}	92.00
30	284.00±2.31 ^{a}	94.67	274.33±2.03 ^{b}	91.44	273.33±2.40 ^{bc}	91.11	269.33±1.20 ^{bc}	89.78	267.00±1.53 ^{c}	89.00
40	278.00±2.65 ^{a}	92.67	269.00±0.58 ^{b}	89.67	266.00±1.53 ^{b}	88.67	264.00±2.31 ^{bc}	88.00	257.67±2.85 ^{c}	85.89
50	273.00±2.52 ^{a}	91.00	262.67±1.45 ^{b}	87.56	260.33±1.45 ^{bc}	86.78	257.67±2.03 ^{bc}	85.89	253.67±2.96 ^{c}	84.56
60	270.00±2.00 ^{a}	90.00	256.67±1.76 ^{b}	85.56	254.00±2.31 ^{bc}	84.67	248.67±1.76 ^{cd}	82.89	245.67±3.38 ^{d}	81.89
70	266.67±1.76 ^{a}	88.89	250.33±1.86 ^{b}	83.44	246.00±1.15 ^{bc}	82.00	246.33±3.18 ^{bc}	82.11	239.33±3.84 ^{c}	79.78
80	263.67±2.33 ^{a}	87.89	245.00±2.52 ^{b}	81.67	239.67±2.96 ^{bc}	79.89	238.00±3.46 ^{bc}	79.33	232.67±5.46 ^{c}	77.56
90	258.00±1.73 ^{a}	86.00	238.67±1.76 ^{b}	79.56	230.67±2.03 ^{bc}	76.89	231.67±3.28 ^{bc}	77.22	224.33±4.26 ^{c}	74.78

Means with different superscripts along same row are significantly different (p<0.05)

Discussion

The values for the water quality observed in this study were within the range recommended for aquaculture practice [18, 19]. The water temperature, dissolved oxygen and nitrite observed in this study is similar to the report of Anifowose *et al.* [18] who recorded a temperature range of 27.5 ^oC to 27.63 ^oC, dissolved oxygen range of 6.5 to 7.0 mg/l and nitrite value of 0.01mg/l for *Clarias gariepinus* fed on live and artificial diets. Meanwhile, the values of pH and ammonia recorded in this study was lower than the values observed in Anifowose *et al.* [18].

The daily growth rate (0.87 g/day) observed in this study for hybrid (*Clarias gariepinus x Heterobranchus bidosalis*) is higher than -0.5 g/day after 24 weeks but lower than 4.14 g/day for 30 days reported by Owodehinde *et al.* [20] for same fish species reared in earthen ponds for 24 weeks. The highest significant (p<0.05) weight gain and specific growth rate were recorded in T5 while the least value was recorded in T1. This is in agreement with the report of Owodeinde *et al.* [21] who reported a high significant values of weight gain for pure cross of *Heterobranchus bidorsalis* when compared with cross between *H. bidorsalis* and *C. gariepinus* using ovaprim hormones. Ataguba *et al.* [16] and Owodeinde and Ndimele [21] reported that pure breeds gave a better performance than their hybrids. Abanikannda *et al.* [4] concluded that the hybrids (*C. gariepinus x H. bidorsalis*) showed superiority over the pure breeds in all growth parameters when fed commercial feed for four (4) months. Sobczak *et al.*, [22] also reported a significantly higher carcass and fillet yield was shown for heteroclarias (68.3 and 53.9%, respectively) compared to C. gariepinus (60.4 and 49.1%) reared for 7 months with a commercial feed.

The value of specific growth rate for cross between C X HL was higher compare to the values recorded for pure HL and pure Clarias in this study. A similar observation was observed by Ndome *et al*., [12] and Adewolu *et al*., [9] who reported a better specific growth rate for CG x HL than pure CLxCL. In this study, the values of SGR for hybrids were higher than those recorded for the pure breeds. This is in contrast to the findings of Solomon *et al.* [14] who reported higher SGR values for pure *C. gariepinus* and pure *H. bidorsalis* than their hybrid when fed with same commercial feed. However, Solomon *et al.* [14] recorded a lower percentage survival compared to the values obtained in this study. The differences in the values may be due to nutrition, culture medium, environmental conditions, stocking densities and the duration of culture. The SGR recorded for *H. longifilis* is similar to 3.52 – 3.54%/day reported by Wilfred-Ekprikpo [23] for the same species of fish reared with organic fertilizers in earthen ponds. Meanwhile, the values (1.54 – 2.90%/day) obtained by Ibiyo *et al.* [24] for *H. longifilis* fed graded levels of moringa leave meal were lower than the values reported in this study. This may be as a result of the differences in experimental duration and the initial weight of fish used. The mean weight gain recorded in this study for hybrid (HB x CL) was higher than the values (6.91 – 17.06 g) observed by Oguguah *et al.* [25] for same hybrid fish reared in different culture receptacle and at different stocking densities for 120 days. The difference may be due to differences in water quality. The author reported a lower dissolved oxygen (3.79 -4.27 mg/l) compared to our observation. Also, the mean weight gain (0.37 – 1.25 g) and specific growth rate (0.33 – 1.33%/day) reported by Aliu *et al.* [26] for hybrid (CL x Hb) fed Lablab bean meal diets for 70 days were lower compared to the results of this study. This suggest that the crosses of *H. bidorsalis* male with *C. gariepinus* female provide a better growth performance (Used in this study) than *H. bisorsalis* female crossed with *C. gariepinus* female. The mean weight gain observed in this study for *C. gariepinus* was better than the values (3.99 – 7.59 g) reported by Shrestha and Niraula [27] when the fish was fed diets containing different levels of crude protein for 56 days. This may be attributed to lower values of dissolved oxygen (3.34-3.65 mg/l) and temperature (21.07-22.40 ^{o}C) recorded by the authors when compared to the values in the present study.

The body weight gains showed significant differences from day 10 to day 90 among the fish species used in this study. This is in agreement with the report of Ekelemu [28] who reported significant differences in the body weight gain among C. gariepinus, Heteroclarias and H. bidorsalis fed commercial diets from day 7 to day 49. No significant difference was observed in final body weights of the two heterobranchus species and their crosses with C. gariepinus from day 80 to the end of the experiment. This suggest that any of these fish species performed better than pure C. gariepinus and can be successfully culture in fish pond. The value final body weight CLxHL observed in this study was higher than the value (21.4 – 30.41 g) obtained by Ndome *et al*. [29] for same hybrid fish reared for 84 days.

Conclusion

This study revealed that any of these fish species performed better than pure C. gariepinus and can be successfully culture in fish pond. But The combination of female *C. gariepinus* x male *H. bidorsalis* (T5) will be more suitable for fish farming business.

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