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The Effect of Different Thermo-Regulated Temperature on theGrowth Performance of *Clarias Gariepinus* (Burchell, 1822)

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Abstract

Metabolic activities of living organisms are altered by temperature. The aim of this study was to determine the best temperature, in the growth of Clarias gariepnus fingerlings at varied thermo-regulated water heaters. The temperature was varied from 28 – 38 ^{O}C at an interval of 2 ^{o}C. A total of 1,700 fingerlings with mean initial weight (1.00 ± 0.01g), total length (2.01cm) and standard length (1.80± 0.00cem) were allocated 150 each in six treatments with three replicates totaling 18 bowls of 50litres. Thermo-regulated heaters were set at specific temperature using rubbed gummed at side walls of the circular bowls at 40L water levels. A flow-through water system was constructed with water regulating knops that control the water flow. They were fed 3 times (700, 1400 and 2100hrs) per day. The data were recorded every week when the level of water was reduced, animals collected with hand net colander and data taken. Source of power was switched off and was returned after the data collection exercised. One-way ANOVA analysis, Duncan multiple test range and SPSS version 20 was used. The result revealed that the highest live weight gained was at T_6 (89.0±23.6g) and was significantly ($P<0.5$) different from other treatments. It is therefore recommended that, electricity can be connected to fish ponds for the usage of thermos-regulated water heaters to boost fast fish production

Key Words; *Temperature, Clarias gariepinus, Thermos-regulating heaters, Bowls*

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Introduction: Temperature is an important factor on the solubility of oxygen, metabolic and enzymatic activities of both plants and animals Ayanwale, Tsadu, Lami, Falusi, and Baba, (2014). It regulates the rate of photosynthesis by algae and higher plants. The metabolic rate of aquatic organisms increases with temperature increase. Parasites and diseases also act dependently on temperature (Josiah, Mwatete, and Njiru, 2014). According to Islam *et al*. (2022). *C. gariepinus* can tolerate, temperature ranging from 8-40 ^{o}C, but the optimum temperature for growth is 28-30 ^{o}C. It also plays an important role in the growth of fish. The work of Ayanwale *et al*. (2014) and Nyong,. &Nweze,(2012) on the influence of temperature on survivorship and growth performance of *Heteroclarias* fingerlings under laboratory conditions, reported that, temperature had no effect on total and standard length of fish. However, they observed that the body weight (BW) reduced significantly ($P < 0.05$) with increasing water temperature (range = 190.55 ± 31.50 g at 26.91 $^{\circ}C$ to 154.37 ± 15.25 g at 32.00 $^{\circ}C$). These authors also noted that final body weight gains and percentage weight reduced significantly ($P < 0.05$) with increased temperature. while, the mortality of the fish was not significantly different ($P > 0.05$) among the temperature treatment groups.

The report of Nyong,and Bassey,(2019)Rem et al. (2020), on water temperature affects the total metabolism of fish, and stated that at high temperature, the metabolic activities of the fish increases. Similarly, Islam et al. (2019)) noted that young *Oreochromis niloticus* preferred water temperatures between 30-36 ^{o}C while, higher temperatures of about 41 ^{o}C was lethal to the fish. Again, Ayanwale *et al*. (2014); Nyong,&Nweze,N(2012) also observed that there are many challenges that limits optimum fish production in Nigeria. The most important constraint is that, most tropical fish species welcome death when the temperature of their water drops below 10 and above 40 ^{o}C. These authors further, maintained that final body weight (FBW), weight gain (WG) and percentage weight gain (PWG) of *Heteroclarias* fish were highest and lowest when cultured at 32.00 and 26.91 ^{o}C (control) respectively. Furthermore, El-Sherif and El- Fecky (2009); Nyong,and Bassey,(2019) on the other hand reported a lower weight gain in Tilapia fingerlings at lower temperature than at higher water temperature. It is on this perspective that temperature is better manipulated for the effective temperature on growth performance *C. gariepinus* production

Materials and Methods

There were 18 thermo-regulated heaters (plate 1) bought from Lagos for 6 treatments with 2 replicates each. The experiment was from June – August, 2017. The experimental fish fingerlings were gotten from a reputable fish farm (Tetu Fish Farm Farin Gada) in Jos and were acclimatized for two weeks before the commencement of the work. A total of 2,700 fingerlings were used with 450 allocated to 6 treatments including their replicates each and were fed three times from 800, 1300 and 1600hr (interval of 5hrs) every day. Thermos-regulator heaters were rubber gummed at the bowl's (Graduated Circular Bowl Plastics of 50L) wall three quarter immersed in each treatment tank at the same water levels of 40cm and set at varied constant temperature throughout the experimental period. A flow - through system was constructed to regulate (increase or decrease) the water rate by adjusting the open and close ball cork of the knob on the PVC pipe. Each time, data was to be taken, source of power was switched off and there after the readings, was put on to continue. The water levels were reduced for easy catch and equally less stress demanded. They were weighed with weighing scale (5 kg) camry (model T1432682) and measuring board for lengths in centimeters. The readings and mean of each treatment was taken. The rate of water flow-through was determined using a small bottle of 1000ml volume held at the mouth of the inflow. 1000 ml was regulated per minute (1000 ml/min) in all the treatments was specific for each temperature at 1200, 1400, 1600, 1800 and 2000 ml/min for 28, 30, 32, 34, 36 and 38 ^{o}C respectively. It was set at specific temperature levels within which such levels were maintained by regulated water coming in and going out.

Plate 11 Thermo-regulated Heaters used in Manipulating Temperature during Growth of *C. gariepinus* Fingerling.

The following methods were used in determining the mean data values:

(a) Mean total length gain = Final total length – initial total length

(b) Mean standard length gain = final standard length – initial standard length

(c) Mean weight gain = final weight – initial weight

(d) % total length gained = a/initial length x 100

(e) % standard length gained = b/initial standard length x 100

(f) % weight gain = d/initial weight x 100

(g) RGR = log final weight – log initial weight / days x 100

(h) SR = Final number of fish - mortality/initial number of fish x 100

Results : Table 1 shows the water quality parameters of holding tanks of the fingerlings. The table shows that mean dissolved Oxygen was highest (8.5 ±0.24mg/L) in treatment 3. The next 8.4±0.95, 7.8±0.21, 7.4±0.11, 6.7±0.12 and 6.66±0.43 in a descending order were noted from T1, T2, T4, T5 and T6 respectively. The values of pH recorded revealed that the highest value of 7.4±0.44 was in treatments T_1 and T_5. It was followed by treatments 6 (7.23±1.23), 4

(6.9±0.41), 3 (6.8±0.31) and 2 (6.7±1.02) being the lowest.

The values of temperature were also observed on the same Table 1. The highest value of 29.01±2.01 in treatment 6, followed by 25.3±2.01 degrees in treatment 3 with the lowest of 24.5±0.35 degrees in treatment 1. The third highest value was recorded in T_5 with 25.2±0.22 degrees, whiles the fourth and fifth were in T_4 (25.0±0.21) and T_2 (24.8±0.14). The result of Carbon dioxide (CO_2) from the same Table revealed that treatment 3 had the highest with 21.5±1.32 followed by 1 and 2 with the same values of 21. 1±0.32 (mg/L) each. Others were T_5 with 20.5±0.31, T4(19.1±0.22) and the lowest was 19.0±1.03 from T_6. Total dissolved solids result was recorded on the same table and showed that, T_5 had the highest value of 80.0±1.32 mg/L. This was followed by T_1 with 78.37±1.67, T6 (77.04±2.12), T_2 with 73.4±1.30, T_3 with 71.4±2.00 and the lowest was T_4 with 67.9±0.32. The result of alkalinity was also presented on the same Table and it revealed that, T_1 was having the highest value of 85.24±2.13, followed by T_2 (78.0±0.11), T_5 (75.0±1.33), T_3 (70.0±3.20), T_6 (69.34±1.32) and the lowest was from T_4 with 68.0±0.11.

Table 2 results revealed that, total body length gain (cm) of fingerlings subjected to temperature was highest in T_6 with 25.4±10.40 cm, followed by T_5 (22.7±7.3). The next was T_4 (21.5±9.3), followed by T_3 (20.9±12.1), then T_2 (17.91±7.0) and the lowest was in T_1 with 15.9±6.6 cm. The highest increased in standard body length was seen in T6 of the same Table with 21.7±12.4 cm, followed by T_5, T_4, T_3, T_2, T_1 with 20.9±11.0, 19.7±9.6, 18.2±,7.12 13,5±5.24 and 11.4±2.40 cm respectively. The result of the live weight gained in the same Table followed the same pattern from highest to the lowest with 89.0±23.6, 80.0±24.3, 62.45±31.0, 54.25±,16.7 49.31±14.1 and 47.23±112.0 g respectively. Relative growth rate was also observed in the same Table and it followed the same pattern of highest from T_6 chronologically to T_1 with 1.98±0.45, 1.78±0.40, 1.39±0.30, 1.21±0.45, 1.10±0.30 and 1.05±0.20 in that order. However, the result of final number of the animals that survived did not follow the same pattern with the other indices. The highest number of survived fish was in T_2 (125±64.6) followed by T_1 (122±24.6). The next was in T_4 (120±24.70), then T_3 (105±34.10), T_5 (81±30.10). The lowest was 72±26.30 fish in T_6. This could be because, most fingerlings did not withstand that high temperature. The results were significantly different ($P<0.05$) from each other

Discussion: Temperature is the degree or intensity of heat present in a substance or object, especially as expressed according to a comparative scale and shown by a thermometer or perceived by touch. When its value is beyond the required level, then the organism is affected negatively even to a point of death. However, when within the required range value, the metabolic enzymatic activities are maintained. Furthermore, when high, the metabolic activities increase and vice versa. Once the values are beyond the required levels, the organism is at risk of survival. We have ambient and body or water temperature which the former control the later (Islam et al., 2019). Temperature being the factor that alters the metabolic activities in living things performance or development is critical. But at which temperature is the most required? It was because of this that temperature were varied using thermos-regulated water heaters at an interval of 2 ^oC ranging from 28 - 38, to determine the most effective. The effective temperature for weight gained was at 38 degrees and the one for best survival rate was at 30 degrees Celsius. From this result, it was noted that increase in temperature was proportional to the increase in length, relative growth rate and weight gained but fish survival was inversely proportional to increase in temperature. The effective temperatures for growth of *C. gariepinus* in this work was not consistent to the work of Ukwe & Abu (2016); Dansuki et al. (2013), Ayanwale et al. (2014); and Khan et al. *(*2015) who reported on temperature of 32 ^0C. This could be because the manipulation in this work was carried out under thermo-regulated temperature heaters.

Andrews and Stickney (1972) also reported that channel catfish, *Ictalurus Punctatus*, fingerlings reared at a temperature range of 18-34 ^oC registered improvement in FCR, with the best values obtained at 30 ^oC. Snyder (2017) reported that optimum temperatures for aquatic flora and fauna can be as high as 40 ^oC which was even

beyond the various temperature manipulated in this study. More so this study had equivalent reciprocal water exchange through flow-through system that made the fish responded accordingly. In conclusion, this temperature manipulation that was varied from 28 - 38ºC, had the best being observed in 38ºC where the highest weight gain (89.0g) was recorded while the lowest was in 28ºC (47.23g). Ironically most researchers recommended this 28ºC when their works were under the control of ambient temperature.

Table 1
Mean Values of Water Quality Parameters of Holding tanks of *Clarias gariepinus* fingerlings

Parameters	Treatments						
	T1	T2	T3	T4	T5	T6	Desirable values (WHO, 2015)
DO(mg/L)	8.4±0.95	7.8±0.21	8.5±0.24	7.4±0.11	6.7±0.12	6.66±0.43	3 - 10
pH	7.4±0.44	6.7±1.02	6.8±0.31	6.9±0.41	7.4±0.44	7.23±1.23	6 - 8
Tempt(^{O}C)	24.5±0.35	24.8±0.14	25.3±2.01	25.0±0.21	25.2±0.22	29.01±2.01	18 - 30
CO2(mg/L)	21.2±0.32	21.1±0.32	21.5±1.32	19.1±0.22	20.5±0.31	19.0±1.03	0 - 60
TDS(mg/L)	78.37±1.67	73.4±1.30	71.40±2.00	67.9±0.32	80.0±1.32	77.04±2.12	50 - 250
Alkalinity(mg/L)	85.24±21.13	78.00±0.11	70.00±3.20	68.0±0.11	75.0±1.33	69.34±1.32	50 - 150
Conductivity(µS/cm)	230±0.01	250±0.00	240±0.03	430±4.05	680±6.34	980±3.56	30 – 1,500

Key: TDS = Total dissolved solids, Trt = treatment, ± = SE

Table 2
Mean Effect of Varied Temperature on the Growth performance of *Clarias gariepinus* Fingerlings

Parameter	Treatment					
	T1	T2	T3	T4	T5	T6
FTBL(cm)	18.00±9.00	20.01±8.12	22.50±10.01	23.50±10.02	24.50±11.02	27.50±13.12
ITBL(cm)	2.10±9.00	2.00±8.12	2.00±10,01	2.00±10.02	1.80±11.02	2.10±13.12
TBLG(cm)	15.90±6.6	17.91±7.0	20.50±12.1	21.50±9.3	22.70±7.3	25.40±10.4
%TBLG	757.10±0.00	895.50±0.00	1025.00±0.00	1075.00±0.00	1261.10±0.00	1209.50±0.00
FSBL(cm)	13.20±6.01	15.30±7.10	20.0±9.03	21.50±9.20	22.50±10.30	23.50±11.10
ISL(cm)	1.80±0.00	1.80±0.00	1.80±0.00	1.80±0.00	1.60±0.00	1.80±0.00
SBLG(cm)	11.40±2.4	13.5±5.24	18.2±7.12	19.7±9.6	20.9±11.0	21.70±12.4
%SBLG	633.3±0.00	750.0±0.00	1011.1±0.00	1094.4±0.00	1306.3±0.00	1205.6±0.00
FBW(g)	48.23±22.20	50.31±24.10	55.25±24.20	63.45±26.20	81.0±40.01	90.00±44.10
IBW(g)	1.00±0.00	1.00±0.00	1.00±0.00	1.00±0.00	1.00±0.00	1.00±0.00

BWG(g)	47.23±12.0	49.31±14.1	54.25±16.7	62.45±31.0	80.00±24.3	89.00±23.6
RGR	1.05±0.20	1.10±0.30	1.21±0.45	1.39±0.30	1.78±0.40	1.98±0.45
%BWG	4723±0.00	4931±0.00	5425±0.00	6245±0.00	8000±0.00	8900±0.00
INF	150±0.00	150±0.00	150±0-00	150±0.00	150±0.00	150±0.00
FNFS	122.00±24.6	125.00±64.6	105.00±34.10	120.00±24.70	81.00±30.10	72.00±26.30
SR (%)	81.00±0.00	83.00±0.00	70.00±0.00	80.00±0.00	54.00±0.00	48.00±0.00

Key: T1 = 28, T2 = 30, T3 = 32, T4 = 34, T5 = 36 and T6 =38 ^{o}C

FTBL = Final total body length, ITBL = Initial total body length, TBLG = Total body length gain, FSBL = Final standard body length, ISBL = Initial standard body length, SBLG = Standard body length gain, FBW = Final body weight, IBW = Initial body weight, BWG = body Weight gain, RG = Relatie gain, FNFS = Final number of fish survived, INF = Initial number of fish, SR = Survival rate, SGR = Specific growth rate

Note: ONE WAY ANOVA Analysis; F 38.4.21>P 0.0027, The results were significantly different (P<0.05) from each other.

Conclusion: Temperature is the main factor that affect the growth and development in all livings. The best temperature observed at the end of this work was 38^{o}C, where the highest weight and total length gain were obtained.

Recommendation: It is therefore, recommended that, the temperature in the fish ponds water be increased to 38 degrees Celsius and even beyond for high production of *Clarias gariepinus*

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