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Assesment of Growth Pattern and Well-Being of Nile Tilapia (*Oreochromis niloticus)* in Semi-Arid Zone, Nigeria

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Abstract: Biological and ecological study is an important field in aquaculture. Ninety-six (96) samples of *Oreochromis niloticus* were collected from three dams (Bagwai dam (BG), (DG), Tiga dam (TG) and Thomas dam (TD)) and a river (river Dundurun Gaya) to assess Nlie tilapia *Oreochromis niloticus* growth pattern and well-being in semi-arid as a guide for tilapia production. The Nlie tilapia (*Oreochromis niloticus)* samples were purchase from fishermen landings on each water body. The growth pattern was evaluated using Length-weight relationship derived from the equation: W=aLb, while the well-being using condition factor as ponderal index (K) = 100(W/L^3). The results revealed that, the b and r^2 values of Nlie tilapia (*Oreochromis niloticus)* from the four water bodies ranges from 2.0940 to 3.0196 and from 0.7439 to 0.9336 respectively, in which Nlie tilapia (*Oreochromis niloticus)*of River Dundurun Gaya (DG) had the highest values of b and r^2. Nlie tilapia (*Oreochromis niloticus)* from the four water bodies exhibited negative allometrics growth pattern in BG, TD and TG, while isometrics growth pattern DG. The ponderal index (K) of Nlie tilapia (*Oreochromis niloticus)*from the water bodies assessed range from 1.61-1.80, in which that of Tiga dam had the highest value. Thomas dam (TD) had the highest availability of feed than others, and river Dundurun Gaya (DG) had the most suitable environmental factors (ecological status) than others. Nlie tilapia (*Oreochromis niloticus)* of River Dundurun Gaya (DG) had the strongest length-weight relationship and highest better body condition. Conclusively, Bagwai dam (BG), Thomas dam (TD) and river Dundurun Gaya (DG) had poor nutritional and environmental conditions, while Tiga dam (TG) has good nourishment from abundant food supply and favourable environmental factors. Nile tilapia (*Oreochromis niloticus)* of the four water bodies were in good health condition, that of Tiga dam (TG) were in the best health condition. The studied water bodies serve as good habitats for Nile tilapia (*Orechromis niloticus)* production. It is recommended to improve the management strategies of the two dam and the river for sustainable fish production. Also, genetic distinction study for the species was recommended in the studied water bodies.

Keywords: *Orechromis niloticus, Allometrics Growth Pattern, Isometrics Growth Pattern, Well-Being.*

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I. INTRODUCTION

Growth pattern of fish describe it change in absolute weight or length over time. Nile tilapia (*Orechromis niloticus)* can attain either isometric growth, negative or positive allometric growth (Asmamaw *et al*. 2019; Omatsuli, *et al*. 2017 and Migiro et al. 2014). Isometric growth is associated with no change of body shape as a fish grows. Negative allometric growth implies that the fish becomes more slender as it grows while positive allometric growth implies the fish becomes relatively stouter or deeper-bodied as it increases in length. Gupta & Tripathi (2017) reported that, Better body condition is correlated with high values of condition factor and poor body condition is obtained when the values of condition factor is low. Fish show high sensitive to environmental changes and adaptation by changing necessary morphometric character (Hossain *et al*, 2010). Cichlids are mostly freshwater fishes, and have considerable ability to tolerate salinity (Cnaani & Hulata, 2011). Tilapia is the most extensively farmed finfish worldwide, at least farmed in 85 countries (Al-Zaidy 2013). Tilapias are plastic animals that obtainable maximum size can be seriously influenced by the physical and biological composition of their environment (Nehemia *et al*, 2012).

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Haruna and Bichi (2005) reported that, study of condition factor is important in understanding the life cycle of fish histories and maintenance of the ecosystem equilibrium. This study aims to provide information from the growth pattern and well-being of Nile tilapia *(Oreochromis niloticus)* in view of determining the biological and ecological fitness of local tilapia production in semi-arid region of Nigeria.

II. MATERIALS AND METHODS

A. Study Area

This study was conducted using four selected water bodies of the four cardinal points in Kano State. These are Thomas Dam (Latitude 120 16 44" N - 120 18'35"N and Longitude 8 30'5"E - 8º 31'34"E), River Duddurun Gaya(Latitude: 11° 51' 38.30" N and Longitude: 9° 00' 9.72" E), Tiga Dam (Latitude: 11º26; 8.39"Nand Longitude: 8º 24;5.39"E,) and Bagwai Dam(Latitudes 11º 50'22"- 13º 01' 38"N and between longitudes 7º 81'42"- 8º 26'26" E) in the North, East, South and western part of the State respectively (Figure 1). Kano State has an Aridity index (AI) of 0.2-0.5 (UNEP, 1992). NiMet (2022) reported that, Kano State temperature varies from 21.67ºC to 38.89ºC and is rarely below 21.67ºC or above 38.89ºC.

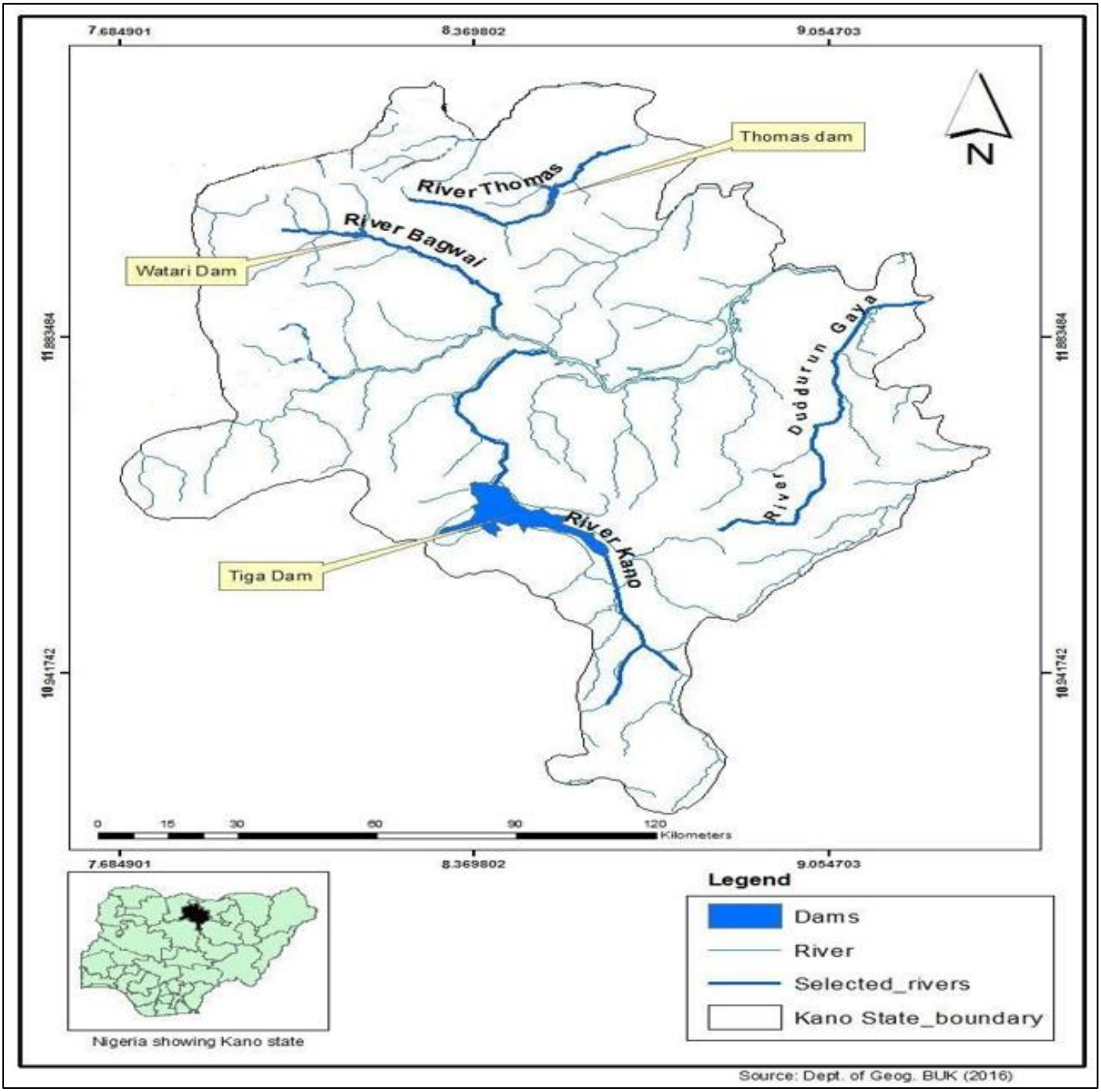

Fig 1 Map of Kano State Showing the Sampling Water Bodies

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➢ *Sample Collection Nile Tilapia (Oreochromis niloticus) from the Four Water Bodies*

Nile tilapia *(Oreochromis niloticus)* was identified and confirmed using it features provided by the fishermen of the four water bodies. Ninety-six (96) samples of Nile tilapia *(Oreochromis niloticus)* samples were purchased from commercial catch of the fishermen from the four water bodies from early august to early September, 2021. Each fish sample, after draining off using filter paper, was subsequently given a serial identity number and transported in well-labelled large bowls to the Laboratory of Bioresources Development Centre, Kano. Measurements and counts were taken in the laboratory immediately at arrival.

- *Morphometric Measurements*

Total length (TL) was measured in centimeter (cm) using flexible measuring tape and Body weight (BW) in grams using a sensitive weighing electronic balance.

➢ *Study Design and Statistical Analysis*

Data of the Morphometric Measurements were computed in excel. Statistical relationship between length (L) and weight (W) of the sampled fish (Nile tilapia *(Oreochromis niloticus)***)** was established by using the parabolic equation from $W = aL^b$ (Froese, 2006). Where, W = weight of fish (g), L = length of fish (cm), a = constant and b = an exponential expressing relationship between length-weight. Isometric growth pattern occurs when b is equal to 3, while allometric pattern of growth when b is not equal to 3 (positive allometric, if the value of b was greater than 3 or negative allometric, if the value of b was less than 3).

The relationship ($W = aL^b$) when converted into the logarithmic form gives a straight line relationship graphically Log W=Log a + bLog L (Oliva-Paterna *et al*, 2009). Where b represents the slope of the line, Log^a is constant.

The condition factor (K) was computed according to Gomiero and Braga, (2005). Using the formula:

$K = 100W/L^3$

Where

W = weight of fish samples

L = total length of fish samples.

III. RESULTS AND DICUSSION

➢ *Condition Factor (Ponderal Index) of Nile Tilapia (Oreochromis niloticus) from the Four Water Bodies*

Table 1 shows rate of Condition factor of Nile tilapia *(Oreochromis niloticus)* samples collected from four water bodies. Condition factor of Nile tilapia *(Oreochromis niloticus)* collected from four water bodies ranges from 1.61-1.80, in which Nile tilapia *(Oreochromis niloticus)* of Tiga dam (TG) had the highest value (1.80), and that of Bagwai dam (BG) had the least (1.61). Nile tilapia *(Oreochromis niloticus)* of Thomas dam (TD) and River Dundurun Gaya (DG) Condition factor values as 1.68 and 1.65 respectively. Nile tilapia *(Oreochromis niloticus)* of Thomas dam (TD) had the highest weight value than others.

➢ *Length-Weight Relationships of Nile Tilapia (Oreochromis niloticus) Samples Collected of the Four Water Bodies*

The Length-weight relationship of Nile tilapia *(Oreochromis niloticus)* samples collected from the four water bodies was shown in Figures 1,2,3 and 4. The b and r^2 values of Nile tilapia *(Oreochromis niloticus)* of Bagwai dam (BG), River Dundurun Gaya (DG), Thomas dam (TD), and Tiga dam (TG) were (2.094 and 0.7439),(3.0196 and 0.9336), (2.7626 and 0.8579) and (2.8417 and 0.9276) respectively. Only the b value of Nile tilapia *(Oreochromis niloticus)* of river Dundurun Gaya (DG) was equal to 3, while others were below 3. Also, the r^2 value of Nile tilapia *(Oreochromis niloticus)* of River Dundurun Gaya (DG) was the highest while Tiga dam (TG) was the least.

Table 1 Condition Factor (Ponderal Index) of Nile Tilapia *(Oreochromis niloticus)* of the Four Water Bodies

Water Bodies	Specie	BW	TL	K-factor
DG	ON	53.06	14.67	1.68
BG	ON	53.46	14.93	1.61
TD	ON	63.33	15.66	1.65
TG	ON	48.15	13.89	1.80

K-Factor =Condition Factor, TL =Total Length, BW= Body Weight, BG=Bagwai Dam, TG =Tiga Dam, TD =Thomas Dam, DG= Dundurun Gaya, ON = Nile Tilapia *(Oreochromis niloticus).*

➢ *Growth Pattern and Well-Being of Nile Tilapia (Oreochromis niloticus) Samples of the Four Water Bodies*

Nile tilapia *(Oreochromis niloticus)* of TD had the highest BW, while that of TG had the least. Nile tilapia *(Oreochromis niloticus)* of TD had the highest TL, while that of TG had the least. These indicate high availability of feed in Thomas dam (TD) than others. The length-weight relationship (LWR) of the tilapia samples collected form the four water bodies indicated both isometric and allometric growth. Length-weight relationship values of Nile tilapia *(Oreochromis niloticus)* in this study indicated a negative allometric growth in BG, TD and TG, and isometric growth in DG. Strong relationships were also observed in Nile tilapia *(Oreochromis niloticus)* from the four water bodies with that of DG being the strongest. These indicated that

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suitability of the environmental factors (ecological status) of DG than others. All b values were in agreement with the report of Froese (2006), that b value for tropical fish range from 2.5 to 3.

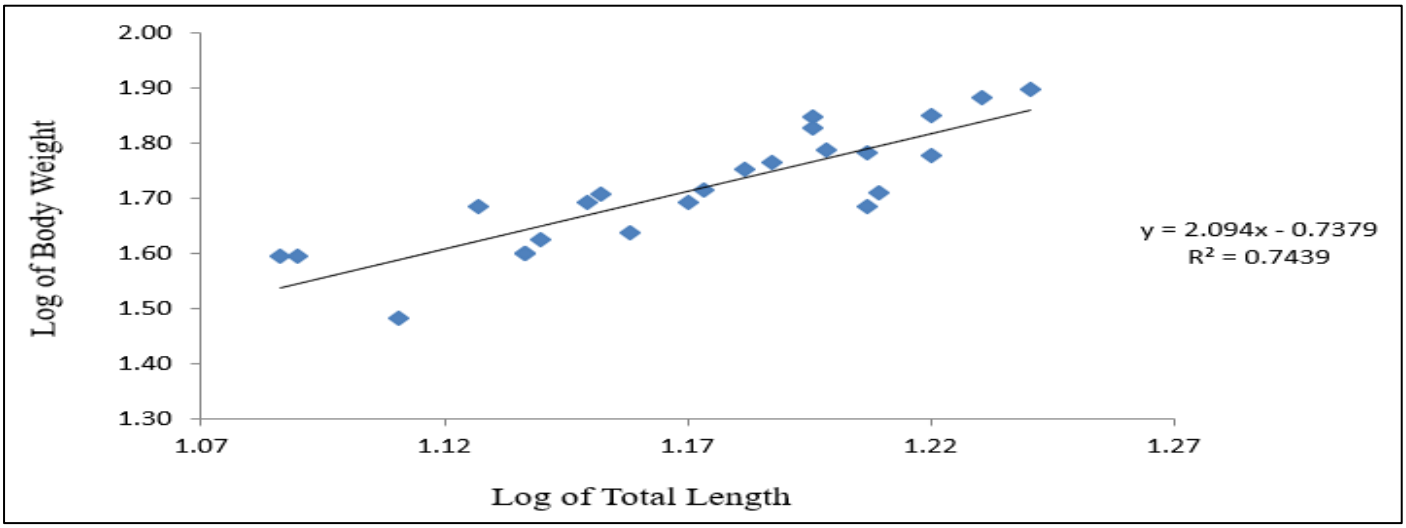

Fig 2 Negative Allometric Growth Pattern of Nile Tilapia *(Oreochromis niloticus)* in Bagwai Dam

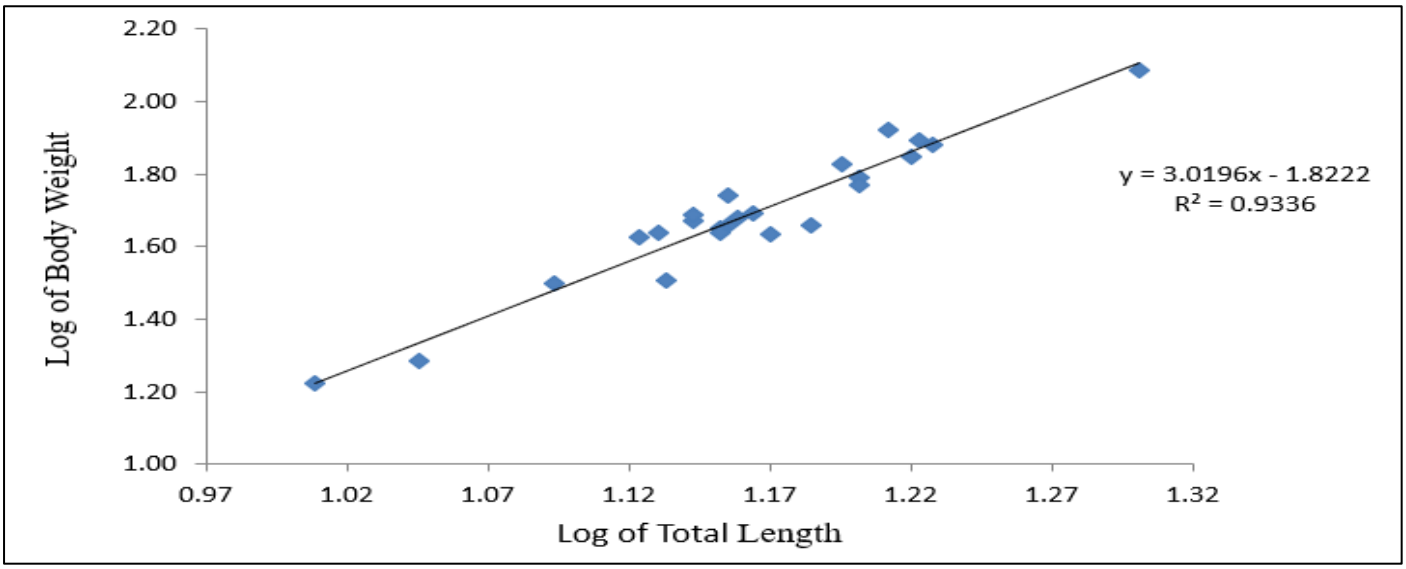

Fig 3 Isometric Growth Pattern of Nile Tilapia *(Oreochromis niloticus)* in River Dundurun Gaya

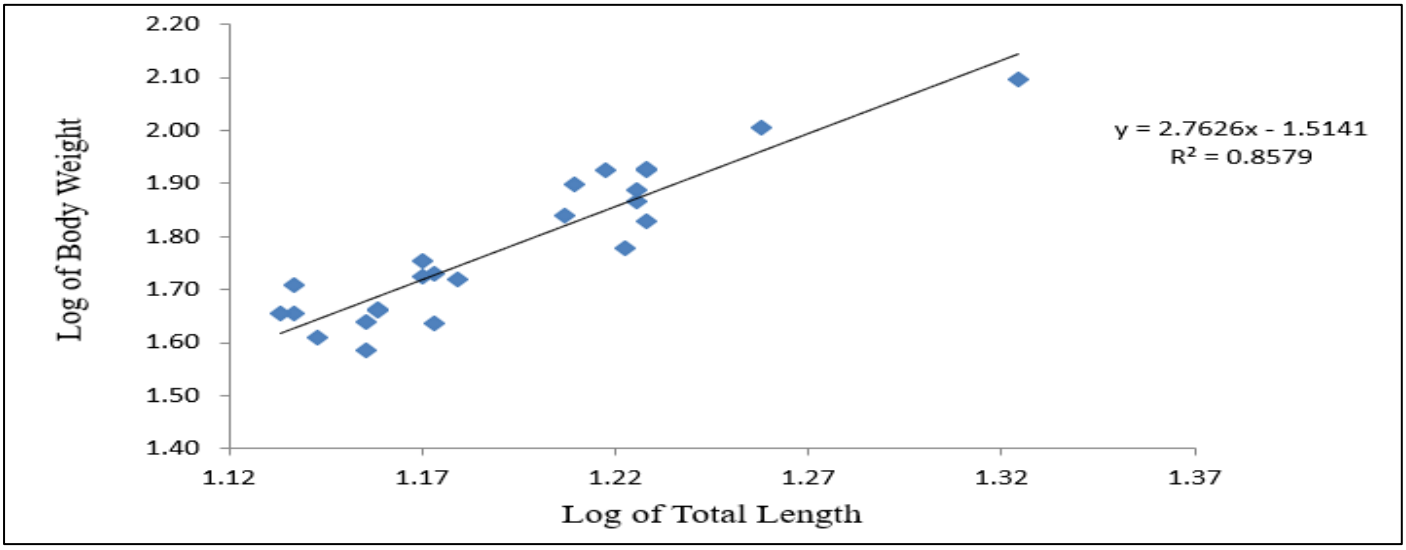

Fig 4 Negative Allometric Growth Pattern of Nile Tilapia *(Oreochromis niloticus)* in Thomas Dam

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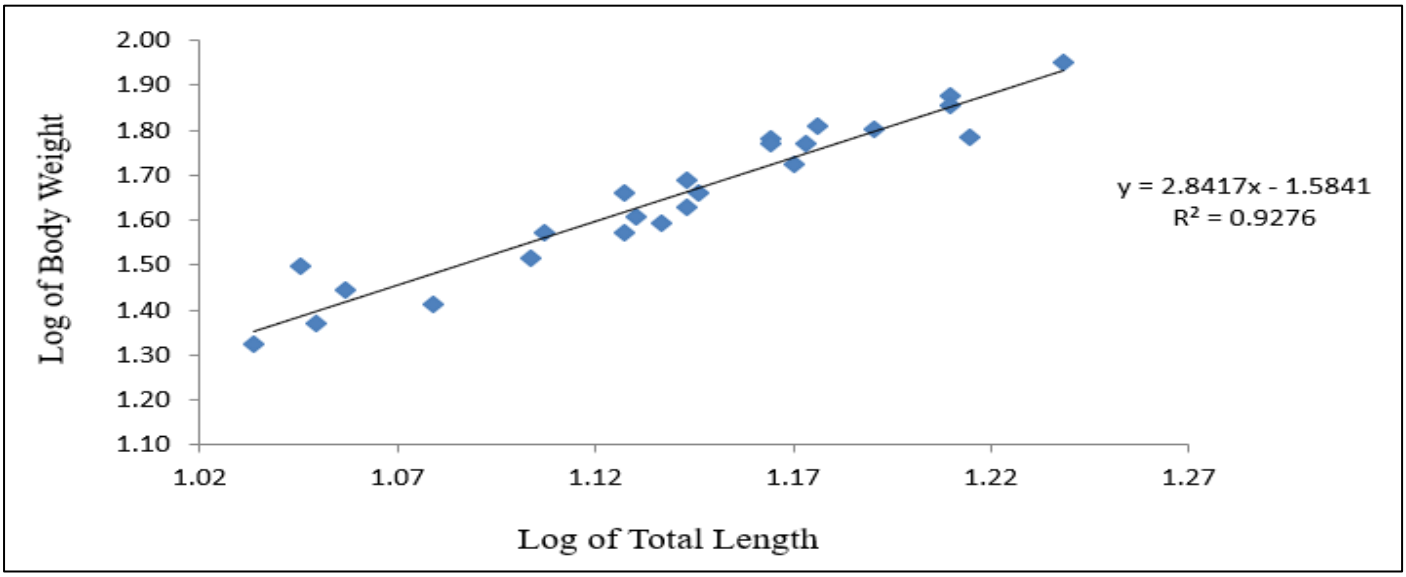

Fig 5 Negative Allometric Growth Pattern of Nile Tilapia *(Oreochromis niloticus)* in Tiga Dam

Also, Fagbuaro, *et al*., (2016) reveal the exhibition of allometric growth in both females and males of *Oreochromis niloticus* and *Coptodon zillii*. *O. niloticus* (2.29), *T. mariea* (0.72) and *S. galilaeus* (2.47) exhibited negative allometric growth while *C. zillii*, exhibited positive allometric growth (Olufeagba *et al.* 2015). According to Azua *et al*., (2017), there was a strong relationship between log of body weight and standard length using regression analysis with r^2 value of 0.8689 in *Oreochromis niloticus*. Riedel *et al*., (2007) reported that Isometric growth is associated with no change of body shape as an organism grows. Negative allometric growth implies more slender of the fish as it increase in weight, while positive allometric growth implies relatively stouter or deeper-bodied of the fish as it increases in length. Fishes of tropical and sub-tropical water systems experienced growth fluctuations due to many factors such as environmental changes, food composition changes, competition within the food chain, changes in the physical and chemical properties of the aquatic medium (Adedeji & Araoye, 2005; Abowei & Davies, 2009).

This study reveals that the highest weight value was observed in Nile tilapia *(Oreochromis niloticus)* of Thomas dam, which indicated high well-being condition of the fish. According to Nehemiah *et al* (2012), it comprises the state of wellbeing of a fish and is based on a hypothesis that a heavier fish of a given length is in better condition than a lighter one of the same length. In the present study, high values of condition factor (K) were observed from Nile tilapia *(Oreochromis niloticus)* samples collected from the four water bodies. This indicates that the specie was in good condition as shown by the report of Omatsuli *et al*., (2017) that fishes with condition factor higher than one (>1) were in good condition. Gupta and Tripathi (2017) reported that better body condition is correlated with high values of condition factor and poor body condition is obtained when the values of condition factor is less. The results of this study are in agreement with that of Asmamaw *et al*., (2019), who reported the mean condition factor (K) of male, female and combined as 1.64, 1.70, and 1.66, respectively. The authors concluded that *Oreochromis niloticus* in Koka Reservoir were in good health status and general well-being. The heterogeneity results obtained from this study, unveiled the variation of Nile tilapia *(Oreochromis niloticus)* growth pattern and its levels of well-being in its habitats (studied water bodies). Length-weight relationship and Condition factor (K)(ponderal index) used in this study, revealed the growth pattern and well-being of Nile tilapia *(Oreochromis niloticus)* in Bagwai dam (BG), river Dundurun Gaya (DG), Thomas dam (TD) and Tiga dam (TG).

Conclusively, Nile tilapia *(Oreochromis niloticus)* displayed negative allometrics and isometric growth, and a high condition factor. Growth pattern and well-being are important parameters in biological and ecological study of Nile tilapia *(Oreochromis niloticus)*, reflecting to its interaction among feeding condition, parasitic infection, physiological factors and recent physical and biological circumstances. Bagwai dam (BG), Thomas dam (TD) and river Dundurun Gaya (DG) had poor nutritional and environmental conditions, while Tiga dam (TG) has good nourishment from abundant food supply and favourable environmental factors. Genetic distinction study for the species was recommended in the studied water bodies.

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