Growth Performance of the Nile Tilapia, *Oreochromis Niloticus* Cultured in Cages in Two Dams in the Bongo District of Ghana

E. H. Alhassan[1], E. O. Kombat[2]* and D. Karim[1]
[1]*Department of Fisheries and Aquatic Resources Management, University for Development Studies, Tamale, Ghana*
[2]*Department of Applied Biology, University for Development Studies, Navrongo, Ghana*
*Corresponding Author: emmanuelkombat@yahoo.com

Abstract

This study was carried out to compare the growth performance and survival rate of Nile tilapia, *Oreochromis niloticus* cultured in cages in two different dams in the Bongo District of the Upper East Region of Ghana. Three cages with the same structural characteristics were constructed in each of the dams as replicates. Each cage was stocked with 9500 all male *O. niloticus* fingerlings and fed with 48 % nourish plus feed thrice daily for a period of eight weeks. Twenty-five samples of the fishes were randomly collected bi-weekly from each cage and measurements such as standard length and body weight recorded. Other growth characteristics such as specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER), mean weight gain (MWG), condition factor (K) and survival rate (SR) were estimated. The results revealed that, *O. niloticus* cultured in the Soe-Yidongo community dam recorded the highest growth performance in terms of final body weight, standard length, weight gain, specific growth rate, condition factor and protein efficiency ratio, and they were significantly different ($p < 0.05$) from those recorded in the Bon-Gurigo community dam which was attributed to the variations recorded in the physicochemical parameters of the two dams. It was concluded that tilapia cultured in cages might be an important alternative livelihood strategy for poor people in rural communities in Ghana.

Introduction

Aquaculture in Ghana is practiced mainly with Nile tilapia (*Oreochromis niloticus*) (FAO, 2005) though the African catfish (*Clarias gariepinus*) is being cultured by some fish farmers. According to FAO (2002), *O. niloticus* is one of the most suitable fish for culture in most parts of the world due to its rapid growth rate, tolerance to harsh environmental conditions, efficient feed conversion, ease of spawning, resistance to diseases and good acceptance by consumer.

Culturing fish in cages is one of the intensive aquaculture systems used to produce tilapia. Cage culture systems make it possible to grow tilapia and catfish together in water bodies. These cages are usually installed in lakes, large reservoirs and rivers. The construction of the Bon-Gurigo and Soe-Yidongo irrigation dams in the Bongo District of the Upper East Region in Ghana was seen as a pivot of development, not only in the area of food crop production, but also in the fishery subsector. Fish was to be produced and supplied as an important source of food, employment and income in the catchment areas and beyond. However, the economic benefits of these reservoirs are at risk as fish catch from them have been recording declining trends. This invariably has contributed to the worsening of the already high incidence of poverty among the fisher-folks in the Upper East Region in general. This assertion has been supported by the analysis of the 'Growth and Poverty Reduction Strategy' (GPRS II) that, nine (9) out of every ten people are poor in the Upper East Region (NDPC, 2005).

Individuals and groups have shown interest in using the dams as a medium of aquaculture but the productivity level of the dams and how well they can support the growth of fish is not known yet, hence the need for assessing the growth performance of fish in these dams. This study sought to compare the growth performance of cage cultured *O. niloticus* in the Bon-Gurigo and Soe-Yidongo community dams in the Bongo District of the Upper East Region of Ghana.

The information from this study will provide the necessary information to interested individuals and groups to embark on cage fish farming and encourage people in other communities in the Upper East Region to use their existing dams as mediums for aquaculture purposes. When this is achieved, there will be improvement in the lives of people in these communities through the production and sale of fish.

Materials and Methods

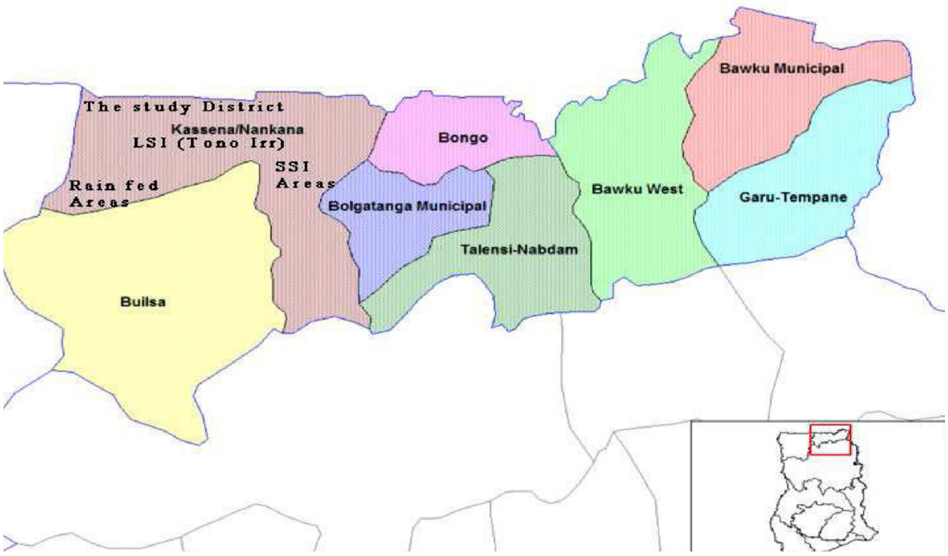
Study Area

This study was conducted in the Bongo District of the Upper East Region of Ghana (Figure 1). The district is located on the North-East corner of Ghana between latitudes 10º 30′ to 11º N and longitudes 0º to 1º 30′ W. Two community dams within the district were selected for the experiment - the Bon-Gurigo community dam and the Soe-Yidongo community dam. The Bon-Gurigo community dam has a surface area of 15.0 hectares and the Soe-Yidongo community dam also has a surface area of 18.6 hectares (Fisheries Commission, 2014).

Experimental cage units and stocking

A total of six (6) cages were used for the study. The size of each cage measured 5 x 5 x 4 m^3. Each treatment (thus, the Bon-Gurigo community dam as treatment one and the Soe-Yidongo community dam as treatment two) had three replicate cages. The cages were constructed using galvanized pipes welded into a cage frame and floated on the dams by empty metallic barrels, with the inner netting (1.0 inch) and outer netting (2.0 inches). Cage nets (15 mm square) were securely fixed to the cage platform using nylon twine.

The cages were anchored with 0.3 m^3 concrete blocks to prevent them from being dragged by water currents from their original positions. A free board (above water space) of 0.2 m was maintained in each of the cages throughout the duration of the experiment. The stocking density of each cage was 95fingerlings/m^3 which were of the same cohort of all male *O. niloticus* (average weight of 2.0 g ± 0.01) from Akosombo (Akosombo Strain). The experiment was conducted within a period of



Fi. 1: Map of the Upper East Region (Source: Wikipedia, 2016)

eight (8) weeks. It started on the 17th of March, 2016 and ended on the 12th of May, 2016.

Measurement of weight and length of fish

A total of fifty (50) fishes were sampled bi-weekly within the study period between 7:00 hours and 8:00 hours. The weight (g), standard length (cm) and total length (cm) of the sampled fishes were then measured using standard methods.

During each sampling day, fishes were randomly scooped from each of the three experimental cages in each treatment as described by Shelton *et al.* (1978). Fishes were returned immediately to their respective cages after measurements were done. Cages net were inspected and cleaned during each sampling period.

Physico-chemical Parameters of dams

Data on some selected physical and chemical water quality parameters were collected at both sites during every sampling period. The water quality investigations specifically focused on water temperature, dissolved oxygen (DO), water depths, transparency, pH, and conductivity. In order to detect changes in the water quality parameters, measurements were taken during morning hours between 7.00 am and 12.00 pm throughout the study period to avoid temporal variations during the day. Dissolved oxygen (DO), pH, temperature and conductivity were measured with Hannah multi parameter probe, while transparency and water depth were monitored with a Secchi disc and measuring tape respectively.

Feeding of fish

The cultured fish were fed a commercially available nourish plus starter feed with crude protein of forty-eight percent (48 %) protein, containing crude. They were fed three times (08:00 hours, 1200 hours and 16:00 hours GMT) daily with 0.5 mm diameter pellet feed at initial 6 % body weight during the first two weeks of culture. Thereafter, the feeding rates and frequencies declined as the fish grew following the method of Nandlal and Pickering (2004).

Fish Growth and Yield Analyses

The specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER), mean weight gain (MWG), condition factor (K) and survival rate (SR) of sampled fish were calculated for the determination of growth in each treatment over the experimental period as described below.

Specific Growth Rate (SGR)

The SGR for each treatment group of the study was estimated as:

$$SGR = \frac{InW2 - InW1}{T} \times 100$$ (Effiong *et al.*, 2009)

Where, W_1 is the weight (g) of fish at stocking; W_2 is the weight (g) of fish at each sampling time; $InW_2 - InW_1$ is the difference between the natural logarithms of W_1 and W_2; T is the time interval (in days) between stocking of fish and each sampling period.

Mean Weight Gain (MWG)

The MWG was estimated as:

MWG = FMW – IMW (Effiong et al., 2009)

Where, FMW is the final mean weight (g) of fish, while IMW is the initial mean weight (g) of fish.

Condition Factor (K)

Condition factor (K) was computed as:

$$K = \left(\frac{W}{SL^3}\right) \times 100$$ (Charo-Karisa *et al.*, 2005)

Where, W is the mean weight (g) of fish and SL is the mean standard length (cm) of the fish.

Feed Conversion Ratio (FCR)

FCR was estimated as:

$$FCR = \frac{\textbf{Total feed given}}{\textbf{Total weight gain by fish}}$$ (Effiong *et al*., 2009)

Protein Efficiency Ratio (PER)

PER was computed as:

$$PER = \frac{\textbf{Total weight gained by fish}}{\textbf{Total protein fed to fish}}$$ (Effiong *et al*., 2009)

Where protein intake of each fish was estimated as the total feed given multiplied by the percentage crude protein in feed.

Data analysis

Data collected from the study were subjected to one-way analysis of variance (ANOVA) using statistix statistical software, 9th edition. Means of treatments were separated using Least Significant Difference (LSD) at 5 % probability.

Results

Standard length of O. niloticus at both dams

Figure 2 shows the standard length of *O. niloticus* at week 0, 2, 4, 6 and 8. At week 0, 2 and 4, the standard length of *O. niloticus* in both Bon-Gurigo and Soe-Yidongo community dams did not differ significantly (p = 0.94, p = 0.56 and p = 0.75 respectively). At week 6, *O. niloticus* in the Soe-Yidongo community dam had standard length of 7.81 ± 0.44 cm which was significantly ($p < 0.05$) different from that in Bon-Gurigo community dam (6.44 ± 0.44 cm). At week 8, the Soe-Yidongo community dam had *O. niloticus* with standard length of 12.94 ± 0.51 cm which was significantly ($p < 0.05$) different from that of Bon-Gurigo community dam (10.41 ± 0.51 cm).

Weight of O. niloticus at both dams

Weights of *O. niloticus* at week 0, 2, 4, 6 and 8 are shown in Figure 3. At week 0, weight of *O. niloticus* in cages of the Soe-Yidongo community dam was 2.03 ± 0.011 g and this was slightly higher than that of the Bon-Gurigo community dam which had 2.01 ± 0.011 g, but these were not significantly different ($p > 0.05$) from each other. Weight of *O. niloticus* at week 2 in the Soe-Yidongo community dam was 4.83 ± 0.003 g and this differed significantly ($p < 0.05$) from that in Bon-Gurigo community dam which had 2.97 ± 0.00 g. At week 4, weight of *O. niloticus* in the Soe-Yidongo community dam was 9.02 ± 0.005 g which was statistically different ($p < 0.05$) from that in Bon-Gurigo

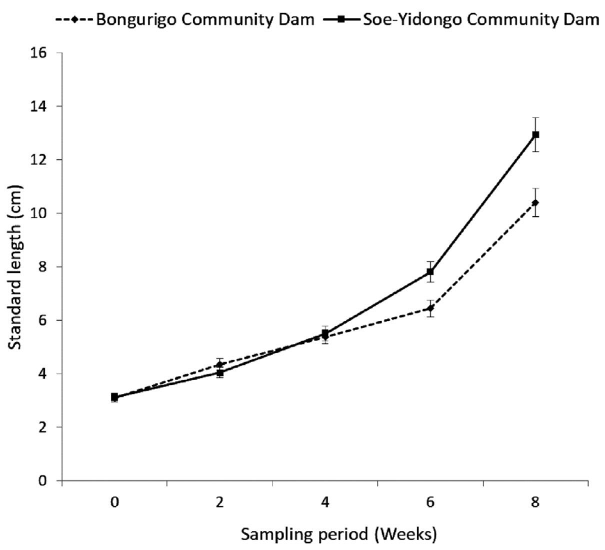


Fig. 2: Changes in standard length of O. niloticus at both dams

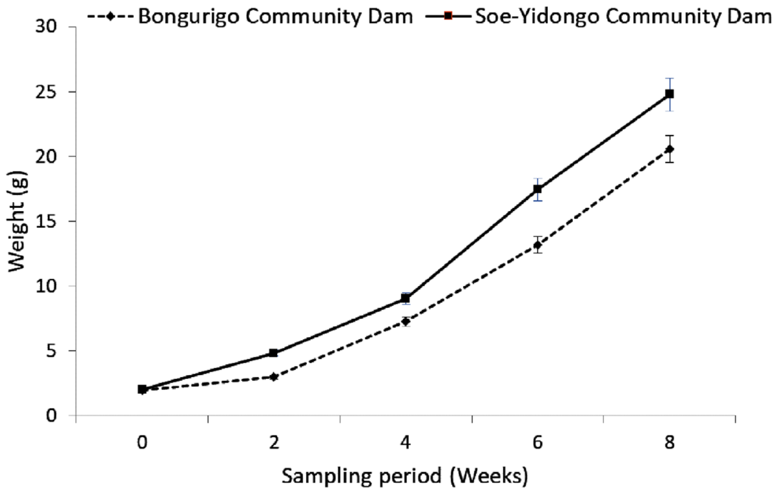


Figure 3: Changes in mean weight of O. niloticus at both dams

community dam which had 7.26 ± 0.005 g. Weight of *O. niloticus* at week 6 in the Soe-Yidongo community dam was 17.43 ± 0.003 g and this differed significantly ($p < 0.05$) from that in Bon-Gurigo community dam which had 13.15 ± 0.003 g. Finally, weight of *O. niloticus* at week 8 in the Soe-Yidongo community dam was 24.75 ± 0.43 g and this differed significantly ($p < 0.05$) from that in Bon-Gurigo community dam which had 20.59 ± 0.43 g.

Specific Growth Rate (SGR) of O. niloticus

Table 1 shows the SGR of *O. niloticus* in cages of the Bon-Gurigo and Soe-Yidongo community dams from week 0 to 8. From week 0 to week 2, the *O. niloticus* in Soe-Yidongo community dam had specific growth

TABLE 1
Specific growth rate (SGR) of *O. niloticus* in both dams

SGR	**Bon-Gurigo Community Dam**	**Soe-Yidongo Community Dam**	**ANOVA**
1 (Week 0 – 2)	7.01 ± 1.04^{b}	14.41 ± 1.04^{a}	F = 50.89 (p = 0.002)
2 (Week 2 – 4)	6.40 ± 0.01^{a}	4.46 ± 0.01^{b}	F = 60399.3 (p = 0.00)
3 (Week 4 – 6)	4.24 ± 0.00^{b}	4.70 ± 0.00^{a}	F = 15545.9 (p = 0.00)
4 (Week 6 – 8)	3.22 ± 0.14^{a}	2.51 ± 0.14^{b}	F = 25.60 (p = 0.01)

Means ± Standard error of difference (SED); Means in a row with the same alphabet indicate no significant difference at 5 %.

TABLE 2
Feed Conversion Ratio (FCR) of *O. niloticus*

Treatment	**Means**	**ANOVA**
Bon-Gurigo Community Dam	0.96 ± 0.36a	F = 0.26
Soe-Yidongo Community Dam	0.78 ± 0.36a	p = 0.63

Means± Standard error of difference (SED); Means in a column with the same alphabet indicate no significant difference at 5%.

rate of 14.41 ± 1.04 % which was significantly different ($p < 0.05$) from that in Bon-Gurigo community dam which had 7.01 ± 1.04 %.

From week 2 to week 4, the *O. niloticus* in Soe-Yidongo community dam had specific growth rate of 4.46 ± 0.01 % which was lower and significantly different ($p < 0.05$) from that in Bon-Gurigo community dam which had 6.40 ± 0.01 %.

From week 4 to week 6, the *O. niloticus* in cages of the Soe-Yidongo community dam had specific growth rate of 4.70 ± 0.00 % which was significantly higher ($p < 0.05$) from that in Bon-Gurigo community dam which had 4.24 ± 0.00 %. From week 6 to week 8, the *O. niloticus* in Soe-Yidongo community dam had specific growth rate of 2.51 ± 0.14 % which was significantly lower ($p < 0.05$) from that in Bon-Gurigo community dam which had 3.22 ± 0.14%.

Feed Conversion Ratio (FCR) of O. niloticus

Table 2 gives the FCR of O. niloticus in cages of the Soe-Yidongo and Bon-Gurigo community dams. The FCR of *O. niloticus* did not differ significantly ($p > 0.05$) between both dams. However, *O. niloticus* in Bon-Gurigo and Soe-Yidongo community dams had FCR of 0.96 ± 0.36 and 0.78 ± 0.36 respectively.

Protein Efficiency Ratio (PER) of O. niloticus

From week 0 to 2, PER of *O. niloticus* in cages of the Bon-Gurigo Community Dam of 2.75 ± 0.32 and that of Soe-Yidongo Community Dam of 7.62 ± 0.32 was significantly different ($p < 0.05$) as shown in Table 3. There was significant difference ($p < 0.05$) at week 2 to 4 among the two community dams. Similar trend was observed ($p < 0.05$) from week 4 to 6. However, there was no significant difference ($p > 0.05$) from week 6 to 8 among the two community dams.

Mean Weight Gain (MWG) of O. niloticus

The MWG by *O. niloticus* from week 0 to 8 is shown in Table 4. From the table, the

TABLE 3
Protein efficiency ratio of *O. niloticus*

Weeks	Bon-Gurigo Community Dam	Soe-Yidongo Community Dam	ANOVA
1 (Day 0 – Week 2)	2.75 ± 0.32^{b}	7.62 ± 0.32^{a}	F = 230.57 (p = 0.000)
2 (Day 0 – Week 4)	$3.83 \pm 4.02 \times 10^{-3a}$	$3.73 \pm 4.20 \times 10^{-3b}$	F = 480.50 (p = 0.000)
3 (Day 0 – Week 6)	$2.69 \pm 1.52 \times 10^{-3b}$	$3.84 \pm 1.52 \times 10^{-3a}$	F = 573049 (p = 0.000)
4 (Day 0 – Week 8)	1.76 ± 0.10^{a}	1.73 ± 0.10^{a}	F = 0.08 (p = 0.788)

Means± Standard error of difference (SED); Means in a row with the same alphabet indicate no significant difference at 5 %.

TABLE 4
Mean weight gain by *O. niloticus*

Weeks	Bon-Gurigo Community Dam	Soe-Yidongo Community Dam	ANOVA
1 (Day 0 – Week 2)	1.01 ± 0.12^{b}	2.80 ± 0.12^{a}	F = 230.57 (p = 0.000)
2 (Day 0 – Week 4)	$4.30 \pm 4.71 \times 10^{-3a}$	$4.19 \pm 4.71 \times 10^{-3b}$	F = 480.50 (p = 0.000)
3 (Day 0 – Week 6)	$5.89 \pm 3.33 \times 10^{-3b}$	$8.41 \pm 3.33 \times 10^{-3a}$	F = 573049 (p = 0.000)
4 (Day 0 – Week 8)	7.44 ± 0.43^{a}	7.31 ± 0.43^{a}	F = 0.08 (p = 0.788)

Means± Standard error of difference (SED); Means in a row with the same alphabet indicate no significant difference at 5 %.

TABLE 5
Condition factor (K) of *O. niloticus*

Weeks	Bon-Gurigo Community Dam	Soe-Yidongo Community Dam	ANOVA
0	6.98 ± 1.44[a]	6.75 ± 1.44[a]	F = 0.02 (p = 0.88)
2	4.27 ± 1.63[a]	7.33 ± 1.63[a]	F = 3.52 (p = 0.13)
4	4.99 ± 1.20[a]	5.42 ± 1.20[a]	F = 0.13 (p = 0.74)
6	5.21 ± 1.15[a]	3.66 ± 1.14[a]	F = 1.81 (p = 0.25)
8	1.84 ± 0.19[a]	1.16 ± 0.19[b]	F = 12.80 (p = 0.02)

Means± Standard error of difference (SED); Means in a row with the same alphabet indicate no significant difference at 5 %.

TABLE 6
Physicochemical parameters measured during the culture period at both dams

Week	Treatment	Dissolved oxygen (mgl^{-1})	Temperature (^{O}C)	Electrical conductivity (µscm-1)	Transparency (cm)	pH	Water depth (m)
0	T1	4.00±1.82[a]	30.98±0.46[a]	122.25±0.90[a]	31.63±0.30[a]	7.95±0.21[a]	3.95±0.0.32[a]
	T2	4.95±1.82[a]	31.73±0.46[a]	125.25±0.90[a]	31.20±0.30[a]	8.52±0.21[a]	1.70±0.032[b]
2	T1	3.27±1.73[a]	31.65±0.11[a]	120.50±0.73[a]	32.25±0.18[a]	8.32±0.16[a]	4.40±0.0.46[a]
	T2	5.50±1.73[a]	31.30±0.11[a]	122.75±0.73[a]	29.00±0.18[b]	8.25±0.16[a]	2.15±0.46[b]
4	T1	4.42±0.26[b]	32.53±0.71[a]	121.75±0.25[b]	36.00±0.38[a]	8.31±0.25[a]	3.80±0.82[a]
	T2	6.55±0.26[a]	31.50±0.71[a]	127.75±0.25[a]	28.40±0.38[b]	7.16±0.25[a]	2.05±0.82[a]
6	T1	4.65±0.62[b]	31.98±0.14[a]	121.00±1.00[a]	35.55±0.33[a]	8.06±0.05[b]	4.10±0.50[a]
	T2	6.70±0.62[a]	32.35±0.14[a]	125.50±1.00[a]	30.10±0.33[b]	9.03±0.05[a]	1.60±0.50[b]
8	T1	3.45±0.43[b]	30.88±0.30[a]	132.25±1.25[a]	36.85±0.18[a]	8.48±0.08[a]	4.05±0.66[a]
	T2	6.3±0.43[a]	30.63±0.30[a]	132.25±1.25[a]	32.00±0.18[b]	8.48±0.08[a]	2.40±0.66[a]

T1 = Bon-Gurigo Community Dam; T2 = Soe-Yidongo Community Dam. Means with same alphabet in the same week indicate no significant difference at 5 % in a parameter.

mean weight gain by *O. niloticus* from week 0 to 2, 2 to 4 and 4 to 6 in cages of the Bon-Gurigo Community Dam and Soe-Yidongo Community Dam were significantly different ($p < 0.05$) from each other. There was no significant difference ($p > 0.05$) between the mean weight gain by *O. niloticus* in Bon-Gurigo community dam and in Soe-Yidongo community dam from week 6 – 8.

Condition Factor (K) of O. niloticus

K of *O. niloticus* in cages of the two dams did not vary significantly ($p > 0.05$) except at week 8 ($p < 0.05$). At week 8, the condition factor of *O. niloticus* in the Bon-Gurigo community dam was 1.84 ± 0.19 and this was statistically different from that of Soe-Yidongo community dam (1.16 ± 0.19) (see Table 5).

Variation in Physicochemical Parameters of Water over Experimental Period

Table 6 presents the physicochemical parameters measured during the culture period of *O. niloticus* in the two dams.

Discussion

Growth Performance of O. niloticus

The results revealed that there was a steady increase in body weight and length of *O. niloticus* throughout the study period (from week 0 to week 8) at both Bon-Gurigo and Soe-Yidongo community dams. Comparatively there were no significant difference ($p > 0.05$) of length of *O. niloticus* among weeks 0, 2 and 4 (p = 0.94, p = 0.56 and p = 0.75 respectively). Generally, *O. niloticus* cultured in cages in the Soe-Yidongo gained more weight than that of Bon-Gurigo. The superiority in growth performance shown by the same cohort of *O. niloticus* in one treatment over the other has been observed in other studies (Goda *et al*., 2007; Sorphen and Preston, 2001; Offem *et al*., 2009). The Mean Weight Gain (MWG) was statistically different ($p < 0.05$) from each other except for week 6 - 8. Although the same quantity of feed was given, the variation could be attributed to the availability of natural feed in the habitat and the fishes feeding on them.

The Specific Growth Rates (SGR) for fingerlings in cages at Soe-Yidongo were significantly higher ($P < 0.05$) than that of Bon-Gorigo dam. Week 0 - 2 recorded 7.01 ± 1.04 for SGR at Bon-Gorigu which decreased to 3.22 ± 0.14 in week 6 - 8, while it recorded 14.41 ± 1.04 in week 0 - 2 and decreased to 2.51 ± 0.14 in week 6 - 8 in cages at Soe-Yidongo. This result may have been due to the different ecological conditions in both dams. It is evident from the results that, SGR decreased with increasing age of *O. niloticus*. This finding conforms to Medawar's fifth law which states that "the specific growth declines more and more slowly as the organism increases in age" (Medawar, 1945).

The best Feed Conversion Ratio (FCR) was observed in *O. niloticus* cultured in cages in the Soe-Yidongo community dam which suggests better feed utilization than those cultured in the Bon-Gurigo community dam, although they were not significantly different ($p > 0.05$). However, the average FCR estimated in this study (0.96 ± 0.36 for Bon-Gurigo community dam and 0.78 ± 0.36 for Soe-Yidongo community dam) were not significantly at variance with the typical FCR values (1.4 to 2.5) for *O. niloticus* cage systems in Africa (Beveridge, 2004; Ofori *et al*., 2010). The relatively better FCR obtained in cages at Soe-Yidongo community dam suggests more efficient food utilization through the extraction of nutrients from the feed and converting it into flesh that reflected on growth of the fish.

With respect to the Protein Efficiency Ratio (PER), all values estimated were significantly different ($p < 0.05$) from each other except for those at week 6 - 8. However, the PER at both treatments were higher and this could have been due to the high level of animal protein in the feed. This is because most plant materials have lower crude protein levels their digestion by fish result in a lower PER (Drew *et al*., 2007).

Generally, *O. niloticus* cultured in cages at the Soe-Yidongo community dam recorded the highest value for condition factor, but were not statistically different ($p < 0.05$) except for week 8. The better condition factor observed in cages at the Soe-Yidongo dam could be attributed to judicious use of both the starter feed and the natural feed for somatic growth as it was shown in weight gain. Anani *et al*. (2010) stated that feeding and food availability influence the condition factor of fish because food reserves accumulated though feeding increase the fish's condition.

Water quality plays a significant role in the biology and physiology of fish and may impact on the health and productivity of the culture system (Boyd, 1997). Throughout the experiment, water quality across all the treatments was within the favorable range required for tilapia (Boyd, 1997).

Variation of dissolved oxygen (DO) in the two dams was observed in week 4, 6 and 8. The higher values of DO recorded at the

Soe-Yidongo community dam may have been due to the abundance of phytoplankton as indicated in the transparency reading that increase photosynthetic activity leading to production of large amount of DO. The recorded dissolved oxygen level among all the dams was favorable for fish culture (Boyd, 1990) and comparable with results of Abdel-Tawwab *et al*. (2007) and Ali (2007). The variation of dissolved oxygen (DO) level might also be attributed to: Firstly, excess concentration of phytoplankton algae, though algae are DO producers, they also reduce light penetration and consume dissolved oxygen (DO) in the dark. Excess algae therefore reduce DO production in the lower layers of the water and increase the rate of depletion of DO during the night. Secondly, abundance of organic matter on the dams bottom which increases bacterial population rapidly and consumes oxygen (Khouraiba, 1989).

Water temperature is one of the most influencing environmental factors affecting cage dynamics and both the metabolism and growth of fish (Boyd, 1990; Herzing and Winkler, 1986; Weatherley and Gill, 1983). Boyd (1990) mentioned that water temperature in fish ponds and reservoir are related to solar radiation and air temperature. In the present study, water temperature did not differ significantly ($p > 0.05$) and was favourable for fish culture in both Bon-Gurigo and Soe-Yidongo community dams respectively as mentioned by Boyd (1990).

The lower visibility at Soe-Yidongo community dam as compared to Bon-Gurigo community dam could have been due to the higher abundance of phytoplankton in the Soe-Yidongo dam. Green water systems provide natural feeds for the fish. The algae remove nitrogenous compounds and produces oxygen for the fish. The greener the water, the more natural food is available. The additional nutrition the fish derived from feeding on the natural food in the green water at Soe-Yidongo community dam reflected in their growth performance. Although, the water was not analyzed for nutrients and natural food availability, using the greenness of the water as an indication of natural food availability, in general showed.

The pH varied significantly ($p < 0.05$) only at week 6 between Bon-Gurigo and Soe-Yidongo dams. This variation may be due to the higher Nitrogen and phosphorus concentrations at Soe-Yidongo which contains more phytoplankton than Bon-Gurigo. Moreover this could essentially be explained by the physico-chemical and biological reactions due to the presence of dense phytoplankton growth. Autotrophic activity increases pH through carbon dioxide (CO_2) absorption, while heterotrophic activity decreases pH through respiration, since the autotrophic and heterotrophic processes affect the measured variables in opposite ways (Boyd and Lichtkoppler, 1979). The present results are in agreement with Boyd (1990), Saeed (2000) and Ali (2007).

Throughout the study period water depth variation was observed only at weeks 0, 2 and 6 at the two dams. This variation was as a result of rainfall during the period and probably domestic use of water from the various dams. From the results it is obvious that the growth parameters increase (body weight and body length) as the water depth increases in both treatments. These findings are in agreement with Dan and Little (2000), Takashi and Tadashi (2003) and Stoll *et al*. (2008).

Conclusion

Comparing the growth performance of Nile tilapia (*Oreochromis niloticus*) cultured in cages in the two dams in the Bongo District, the Soe-Yidongo community dam achieved better results than the Bon-Gurigo community dam, though Bon-Gurigo community dam also had good production. This results could have been influenced by the variations recorded in the physicochemical parameters such as dissolved oxygen (DO), transparency, temperature and pH of the two dams. The research revealed that there is a great potential of cage fish farming in the Bongo District. Therefore, cage culturing of tilapia should be used as an important livelihood alternative for the poor people who cannot afford livestock product as their source of protein in the Bongo District of the Upper East Region of Ghana.

Acknowledgment

The authors wish to express their profound gratitude to the Directors of Association of Church-based Development Projects (ACDEP) for allowing us to use their facilities for the study, most especially, Mr. Peter Kwame Akpaglo for his support and contribution to the success of this work. Not forgetting the aquaculture beneficiaries of Bongo District for their cooperation.

References

Abdel-Tawwab, M., Abdelghany, A. E. and Ahmad, M. H. (2007). Effect of diet supplementation on water quality, phytoplankton community structure, and the growth of Nile tilapia, *Oreochromis niloticus* L., common carp, *Cyprinus carpi*o L., and silver carp, *Hypophthalmichthys molitrix* V. polycultured in fertilized earthen ponds. *J. Appl. Aquac*., 19, 1:1-24

Ali, A. N. (2007). Ecological study on some water characteristics used in fish farms and their relation to fish productivity. *PhD Thesis*. Al-Azhar Unive., Fac Sci., Chemistry Dept., Egypt

Anani, F. A., Ofori-Danson, P. K., Abban, E. K. (2010). Pen culture of the black-chinned tilapia, *Sarotherodon melanotheron* in the Aglor Lagoon in Ghana. *J. Ghana Sci. Assoc.*, 12, 21-30

Aquastat (2005). Food and Agriculture Organisaion's Information System on Water and Agriculture. Water Report No. 29, 2005, FAO, Rome. http://www.fao.org/nr/water/aquastat/countries/ghana.stm. (01.03.16)

BDA (2006). District Medium Term Development Plan (2006-2009), Bongo, Bongo District Assembly, Ghana

Beveridge, M. (2004). Cage aquaculture (3rd edition). *Wiley-Blackwell Publishing, Oxford*

Boyd, C. E. (1990). Water Quality in ponds for aquaculture. Agriculture Experiment Station, Auburn Univ., Alabama, U.S.A. 482pp

Boyd, C.E. (1997). Practical aspects of chemistry in pond aquaculture. *Prog. Fish-Cult.,* 59, 85–93

Boyd, C.E. and Lichtkoppler, F. (1979). Water quality management in fishpond, Research and Development Series No.22. International Centre for Aquaculture and Agriculture (I.C.A.A.), Experimental station Auburn University, Alabama, 45-47

Charo-Karisa, H., Rezk, M. A., Bovenhuis, H., Komen, H. (2005). Heritability of cold tolerance in Nile tilapia, *Oreochromis niloticus*, juveniles. *Aquaculture*, 249, 115-123

Dan, N.C. and Little, D.C. (2000). Overwintering performance of Nile tilapia, *Oreochromis niloticus* (L.) broodfish and seed at ambient temperatures in northern vietnam. *Aquaculture Research*, 31, 485-493

Dickson, K. B., Benneh, G. (1988). A new geography of Ghana. Longman Group Ltd, Essex.

Drew, M. D., Borgeson, T. L., Thiessen, D. L. (2007). A review of processing of feed ingredients to enhance diet digestibility in finfish. *Anim. Feed Sci. Technol.* 138, 118-136

Effiong, B.N., Sanni, A., Fakunle, J.O. (2009). Effect of partial replacement of fishmeal with duckweed (*Lemna paucicostata*) meal on the growth Performance of *Heterobranchus longifilis* fingerlings. *Report Opin*., 1, 76-81

FAO (2002). Interactions between Inland

Capture Fisheries and Aquaculture and their Contribution to Food Security and Poverty Alleviation in Sub-Saharan Africa, Yaounde, Cameroon. Available at http://faostat.fao.org/. (accessed 17.03.16)

FAO (2005). Aquaculture production. Year book of Fishery Statistics, 96/2: Food and Agriculture organization of the United Nations, Rome, Italy. Available at http/www.science direct.com. (accessed 21.02.16)

Fisheries Commission (2014). Data on dam census 2014. Inland Fisheries unit, Fisheries Commissions, Ghana

Goda, A. M., Wafa, M. E., El Haroun, E. R., Chawdhury, M. A. K. (2007). Growth performance and feed utilization of Nile tilapia *Oreochromis niloticus* (Linnaeus 1758) and Tilapia galilae *Sarotherodon galilaeous* (Linnaeus 1758) fingerlings fed plant protein-based diets. *Aqua. Res.*, 38, 827 – 837

Herzing, A. and Winkler, A. (1986). The influence of temperature on the embryonic development of three cyprinoid fishes, *Abramis brama, Chalcal burnus*, **Chalcoides mento** and *Vimba vimba*. *J. Fish Biol.* 28, 171-181

Khouraiba, M. H. (1989). Rearing of bony fish in experimental fish farms and impact of environmental conditions. PhD Thesis, Faculty of Agriculture, Sues Canal University

Nandlal, S., Pickering, T. (2004). Tilapia fish farming in pacific island countries: Tilapia hatchery operation. Noumea, New Caledonia

NDPC (2005). Growth and Poverty Reduction Strategy (GPRS II), 2006-2009: National Development Planning Commission, Accra

Offem, B. O., Ikpi, G. U., Ayotunde, Z. O. (2009). Effect of stocking size of the predatory African catfish (*Heterobranchus longifilis* V.) on the growth performance of Nile tilapia, *Oreochromis niloticus* in pond culture. Int. *J. Fish. Aqua.*, 1, 38 – 4.

Ofori, J. K., Abban, E. K., KariKari, A. Y., Brummett, R. E. (2010). Production parameters and economics of small-scale tilapia cage aquaculture in the Volta Lake, Ghana. *J. Appl. Aqua.*, 22, 337-351.

Rad, F., Bozaoğlu, S., Gözükara, S. E., Karahan, A. and Kurt, G. (2006). Effects of different long-day photoperiods on somatic growth and gonadal development in Nile tilapia *Oreochromis niloticus* L. *Aquaculture*, 255: 292–300.

Saeed, M. S. (2000). A study on factors affecting fish production from certain fish farms in the delta. M. Sc. Thesis. Ins. Environmental studies and Research. Ain Shams Univ. Egypt.

Shelton, W. L., Hopkins, K. D., Jensen, G. L. (1978). Use of hormones to produce monosex tilapia for aquaculture, in: Pullin, R. S. V, Bhukaswan, T., Tonguthai, K., Maclean, J. L. (Eds.), The second International Symposium on Tilapia in Aquaculture. ICLARM Conference Proceedings 15. Department of Fisheries, Bangkok, Thailand, and Manila, pp. 10-33.

Sorphen, P., Preston, T. R. (2001). Effect of processing pig manure in a biodigester as fertilizer input for ponds growing fish in polyculture. *Livestock Res. Rural Dev.* 13, 1 – 14.

Stoll, S., Fischer, P. Klahold, P. Schelfhacken, N. Hofmann, H. and Rothhaupt, K.O. (2008). Effects of water depth and hydrodynamics on the growth and distribution of juvenile cyprinids in the littoral zone of a large pre-alpine lake. *Journal of Fish Biology*, 72:1001–1022.

Takashi, K. and Tadashi, K. (2003). Water Depth as a Factor Influencing Growth Rate and Size of the Japanese Endemic Crayfish *Cambaroides japonicus* (*Crustacea: Decapoda*). *Japanese Journal of Benthology*, 58:11-15

Weatherley, A. H. and Gill, H. S. (1983). Protein, lipid, water and caloric contents of immature rainbow trout (*Salmo gairdneri*, Richardson) growing at different rates. *J. Fish Biol*. 23: 653-673.