

ESTIMATING AQUACULTURE CARRYING CAPACITY FOR TILAPIA (*Oreochromis Niloticus*) ON CAGE CULTURE USING BEVERIDGE MODEL IN OYAN LAKE, OGUN STATE.

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Abstract

This study aimed at estimating the Aquaculture Carrying Capacity for tilapia (*Oreochromis niloticus*) on Cage Culture Using Beveridge Model in Oyan Lake. A total of 45 (fish, feed, sediment, and water) samples were collected from 3 different points labelled A, B, and C. The samples were analyzed to determine the Phosphorus content of the samples using different (AOAC) methods. Data on the Food conversion ratio of the fish, flushing rate, lake surface area, and depth obtained. The (TPP) obtained for fingerlings fishes were 23.8 x 106 metric tons, 71.2 x 106 metric tons and 44.3 x 106 metric tons, for juvenile fish were 86.39 x 106 metric tons, 63.67 x 106 metric tons and 60 x 106 metric ton, and for table size fish were 74.68 x 106 metric tons, 10.56 x 107 metric tons and 75.25 x 106 metric tons. According to water quality criteria for sustainable aquaculture, the capacity of the fish to be cultured on the lake should be 23.8 x 106 for fingerlings, 63.67 x 106 for juveniles, and 74.68 x 106 for table size fish. The phosphorus content of the water after aquaculture (Δp) sites varies, which shows that there is an alteration in the P-environment.

Keyword: Phosphorus Level, Feed conversion Ratio, *Oreochromis niloticus*

INTRODUCTION:

Aquaculture is the cultivation of aquatic plants and animals in a controlled environment or facilities in ponds, farms, cages on natural waters and reservoirs from hatchlings to matured size. Unlike fish that grow in the wild water bodies, without human interference, in aquaculture, activities such as feeding, fertilization, stocking, reproduction, and harvesting are controlled (Obasa, *et al.*, 2013). Circulating in the solid (ice), liquid, and gaseous (vapor) states, water supports the activities of living organisms on earth (Yanagi, 2004). The current aquaculture leasing process considers new proposals on their merit as prospective aqua-culturists identify areas to farm. One could say the process is reactive and fails to consider broader and future use of the public waters.

MATERIAL AND METHOD:

Oyan Lake is under the control of the Ogun-Osun River Basin Development Authority. The lake is located on latitude 7°15'N and longitude 3°16'E, on the confluence of Oyan and Ofiki rivers, both tributaries of Ogun River, North West of Abeokuta, Ogun State, Nigeria (Ufoegbune, *et al.*, 2011).

Sample collection:

A total of 45 samples were collected, nine samples of tilapia fish samples of different ages were obtained from Oyan Lake, and the fish samples (tilapia) were caught by cast netting, and kept in a sterile polythene cover in live condition. Nine samples of Water, sediment, fish feed each were collected, the samples were collected from 3 different points. Feed Conversion Ratio (FCR) of each were computed. The Lake Average depth, surface area, and flushing rate data were obtained from the Oyan Lake.

Quantification of Phosphorus content of the Samples:

10g of the sediment, fish feed, and fish samples were weighed using weighing balance, macerated using pestle and mortar, and homogenized with 100ml distilled water which formed an aliquot solution of the samples, the solutions were filtered for some time to remove the residues and large particles, 1ml of filtered aliquot solutions were pipetted into a different test tube and added 1ml of vanadate-molybdate reagent and allowed for about 10minutes, the absorbance of the samples was determined using UV-Vis spectrophotometer at a wavelength of 400nm, the absorbance was recorded and labelled accordingly.

RESULTS:

Table 1: Total Permissible Production of Tilapia Fingerling Fish Collected at Point A

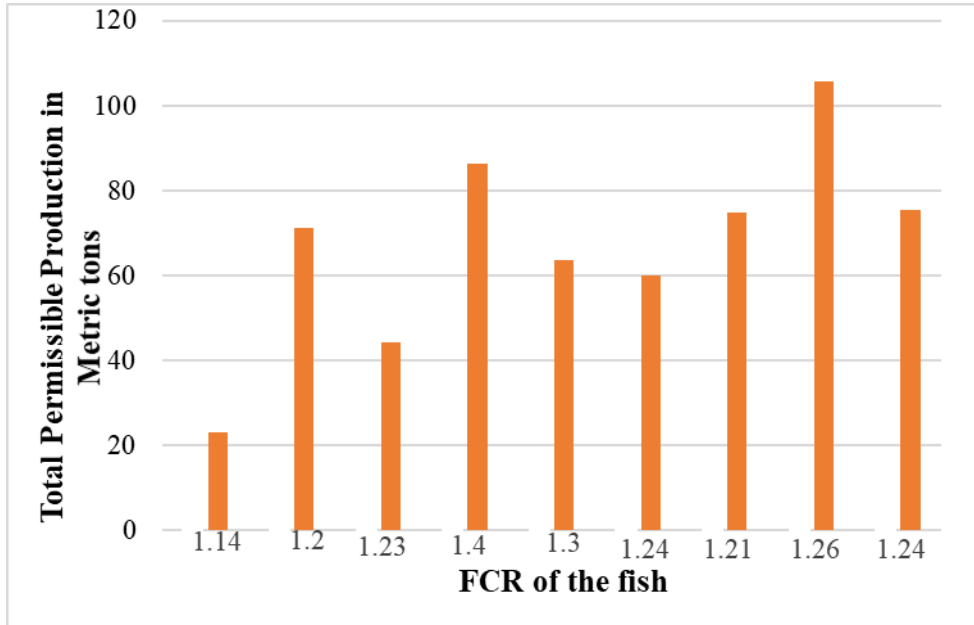
Parameters	Values	Units
FCR(feed conversion ratio)	1.14	
P-food = P-feed x FCR	38.7* 1.14	kg of P/ton feed
P in fish species (p-fish)	16.7	kg of P/ton fish
P-environment = P_food - P_fish	44.12 - 16.7 = 27.418 to grams27418	g of P/ton Produced
Average Depth (Z)	25	m
Flushing rate (p)	39680	Year
R_fish (P lost to sediment)	2.53	kg of P/ton sediment
Surface Area (A)	40,000,000	m ²
P_final (Desired P level after Aq)	0.252	mg/l
P_initial (Initial/ Ambient P level)	0.227	mg/l
Delta P (P_final-P_Initial)	0.025	mg/l
L_fish (loading from fish) = Delta P*Z*p/1-R_fish	0.025*25*39680/1.52 = 16315.8	
Total Permissible production = L_fish*A/ P_env	16315.8*40,000,000/27418 = 23,803,049	metric tons/year

Table 2: Total Permissible Production of Tilapia Juvenile Fish Collected at Point A

Parameters	Values	Units
FCR(feed conversion ratio)	1.4	
P-food = P-feed x FCR	32.65*1.4	kg of P/ton feed
P in fish species (p-fish)	45.71	kg of P/ton fish
P-environment = P_food - P_fish	31.13	
Average Depth (Z)	45.71-31.13 = 14.58kg to grams14580	g of P/ton Produced
Flushing rate (p)	25	M
R_fish (P lost to sediment)	39680	Year
Surface Area (A)	2.89	kg of P/ton sediment
P_final (Desired P level after Aq)	40,000,000	m ²
P_initial (Initial/ Ambient P level)	0.287	mg/l
Delta P (P_final-P_Initial)	0.227	mg/l
L_fish (loading from fish) = Delta P*Z*p/1-R_fish	0.06	mg/l
Total Permissible production = L_fish*A/ P_env	0.06*25*39680/1.89 = 31492.06	
	31492.06*40,000,000/14580 = 86,397,770	metric tons/yr

Table 3: Total Permissible Production of Tilapia Table Size Fish Collected at Point A

Parameters	Values	Units
FCR(feed conversion ratio)	1.21	
P-food = P-feed x FCR	44.12* 1.21 = 53.39	kg of P/ton feed
P in fish species (p-fish)	39.86	kg of P/ton fish
P-environment = P_food - P_fish	53.39 – 39.86 = 13.53kg to grams 13530	g of P/ton Produced
Average Depth (Z)	25	m
Flushing rate (p)	39680	Yr
R_fish (P lost to sediment)	2.61	kg of P/ton sediment
Surface Area (A)	40,000,000	m ²
P_final (Desired P level after Aq)	0.268	mg/l
P_initial (Initial/ Ambient P level)	0.227	mg/l
Delta P (P_final-P_Initial)	0.041	gm/l
L_fish (loading from fish) = Delta P*Z*p/1-R_fish	0.041*25*39680/1.61= 25262.1	
Total Permissible production = L_fish*A/ P_env	25262.1*40,000,000/13530 = 74,684,701	metric tons/yr



Note: Total Permissible Productions are in millions

Figure 1: Chart of total permissible production results from change in FCR of the fish.

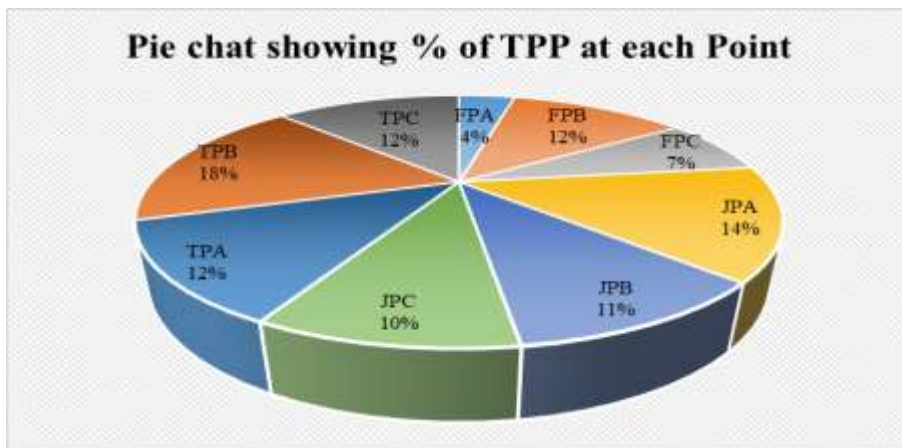


Figure 2: Pie Chat Illustrating the % of total permissible production of each sample collection points.

Note:

FPA: Fingerlings Point A, **FPB:** Fingerlings Point B, **FPC:** Fingerlings Point C, **JPA:** Juveniles Point A, **JPB:** Juveniles Point B, **JPC:** Juveniles Point C, **TPA:** Table Size Point A, **TPB:** Table Size Point B, **TPC:** Table Size Point C.

DISCUSSION:

Phosphorous is a macromineral which is essential in the life of plants and animals, especially aquatic animals, in the aquatic environment, phosphorous enter water either through aquaculture inputs or water-shed run-off. According to EPA water Quality Criteria on phosphorus content of water, the standard is 0.05mg/l for lakes, reservoirs, streams, and rivers standards, as 0.1mg/l while for streams running into lakes is 0.08mg/l. Roberto *et al.*, (2016) reported that; the environmental carrying capacity was calculated according to the data from Brazilian National Water Agency, which established

that the maximum increase in total phosphorus in the aquatic environments promoted by aquaculture shall not exceed 5mg/m³. The Beveridge model does not typically account for nutrient contributions from the watershed. Yet this can be accomplished by factoring in estimated watershed Phosphorus inputs into the permissible change in Total-Phosphorus for the water body (EPANS, 2014). David *et al.*, (2015) reported that Ecological carrying capacity was estimated based on the [Dillon and Rigler \(1975\)](#) mass balance model, considering limnological and farming field loads data to evaluate area-specific Phosphorus loads that can be assimilated in these

environments. The total permissible production (TPP) for aquaculture of tilapia fingerlings obtained from the 3 different regions varied, due to variations in Phosphorus-content of the water during/after aquaculture, also FCR and the Phosphorus-content of the fish, which means the input load of each point differs. TPP of fingerling at point A is 23.8 x 106 metric tons, point B the TPP is 71.2 x 106 metric tons and 44.3 x 106 metric tons for point C, for juveniles' tilapia TPP was 86.39 x 106 metric tons, 63.67 x 106 metric tons and 60 x 106 metric tons respectively, for Table size tilapia TPP was 74.68 x 106 metric tons, 10.56 x 107 metric tons and 75.25 x 106 metric tons. Roberto *et al.*, (2016) reported that the Paranapanema River has a mean production of 125 kg fish m³ cycle¹ in 1.5 cycles per year, which produced an approximate value of 280 MT /ha/year (only considering the area effectively occupied by farming structures). However, to increase the accuracy of the estimates, the data were calculated within a confidence interval range of $\pm 15\%$ for phosphorus loads and farming production. The influence of phosphorus in the water environment on aquaculture production carrying capacity is very evident (Table 9) with a whole lake model. Total permissible production experienced a great reduction from the lower change in phosphorus content of water estimate (Table 2) and a significant increase after factoring in the higher phosphorus in the water environment estimated site. The influence of phosphorus in the water environment on aquaculture production carrying capacity is very evident (Table 9) with a whole lake model, total permissible production experienced a great reduction from the lower change in phosphorus content of water estimate (Table 2), and a significant increase after factoring in the higher phosphorus in water environment estimated site. Josh, (2015) reported that the difference between results for aquaculture production alone and with the higher watershed estimate ranged in reductions of approximately 3,000 tons/year for less desirable inputs, to almost 15,000 tons/year for optimal inputs. The difference represented by the range of watershed estimates is also significant for each variable. Reductions to total permissible production from the two watershed estimates ranged from approximately 500 tons/year for less desirable variables to reductions upwards of 2,000 tons/year for optimal variables.

CONCLUSION:

This study shows that Total Permissible Production varies according to aquaculture input and the ambient aquatic environment minerals content, and the possible productivity of tilapia at a different age, also impacts the influence of intensive aquaculture practice on the water body. Conclusively, this study has been of educational importance to farmers that are operating aquaculture practice on the lake and to (OORBDA), meanwhile, the result can be used to give a recommended capacity of tilapia fish to be cultured on that water, based on age per year, to ensure best management practice and to avoid eutrophication.

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