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RESEARCH ARTICLE

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PERFORMANCE EVALUATION OF TILAPIA FINGERLINGS (*OREOCHROMIS NILOTICUS*) RAISED IN LAND-BASED TANKS DURING THE FATTENING STAGE

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ABSTRACT

The world population is increasing, and in order to meet the demand for food, viable alternatives have been found in aquaculture as a vital source of high quality protein, nutrients and essential vitamins. This research aimed to evaluate the performance of tilapia (*Oreochromis niloticus*) in land-based tanks during the fattening phase. Around 8500 fry were allocated in two rearing net enclosures each with 4250 fry, with an initial average weight of 0.2g and fed with commercial feed. In the frying stage, fisheswere fed 6 times a day with a 1mm diet containing 43% crude protein, in the juvenile phase, food based on a 2mm diet containing 34% crude protein was provided 3 times a day and in the fattening phase, 4mm ration containing 28% crude protein was fed 3 times a day. Regarding water quality, the temperature presented an average value of 22.6 ºC, 6.87 mg.L-1 of dissolved oxygen and average water transparency of 27.98 cm. At the end of cultivation, 94.11% survival, 1.12% food conversion, 264g of final average weight and 2110.4kg of net biomass were obtained. We concluded that *Oreochromis niloticus* fry have satisfactory productivity in land-based tanks.

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INTRODUCTION

Nowadays, aquaculture products have been an important source of animal protein for a growing number of people around the world, with the majority of this demand being met by commercial aquaculture (FAO, 2020). According to FAO (2022), there is increasing progress in aquaculture production, which is responsible for 46% of the fish consumed in the world, but it should be noted that it still does not meet the needs of the population. Tilapia farming is one of the fastest growing fish farming activities in the world, with global production projected to reach around 7.5 million tons in 2023 (FAO, 2022). This exuberant production, mainly in the tropics, was only possible thanks to the genetic improvement of species, nutrition and scientific technological advances in biotechnology, highlighting in this particular artificial reproduction, which is highly developed in China, Indonesia, Thailand, Egypt and Brazil the world's largest producers (FAO, 2020). Mozambique has potential for the development of aquaculture, such as access to good quality land and water, a stable business environment and the fact that aquaculture is a priority for the Government. However, this sector faces constraints inherent to the lack of infrastructure, good quality fry, fish feed, poor technical assistance and limited access to credit. Monitoring cultivation is essential to have good control over the development of fish, observing growth and the state of health and nutrition and checking for problems in time for them to be corrected (INAQUA, 2011). In this context, the present study aimed to evaluate the survival rate, daily weight gain, feed conversion factor and final biomass of Nile tilapia in the fattening phase in land-based tanks.

MATERIALS AND METHODS

Study Location: The study was carried out at the Aquaculture Research Center - (CEPAQ), between January and July 2023. CEPAQ is located in the Chókwè District, Gaza Province and occupies an area of 14 hectares of land (Figure 1).

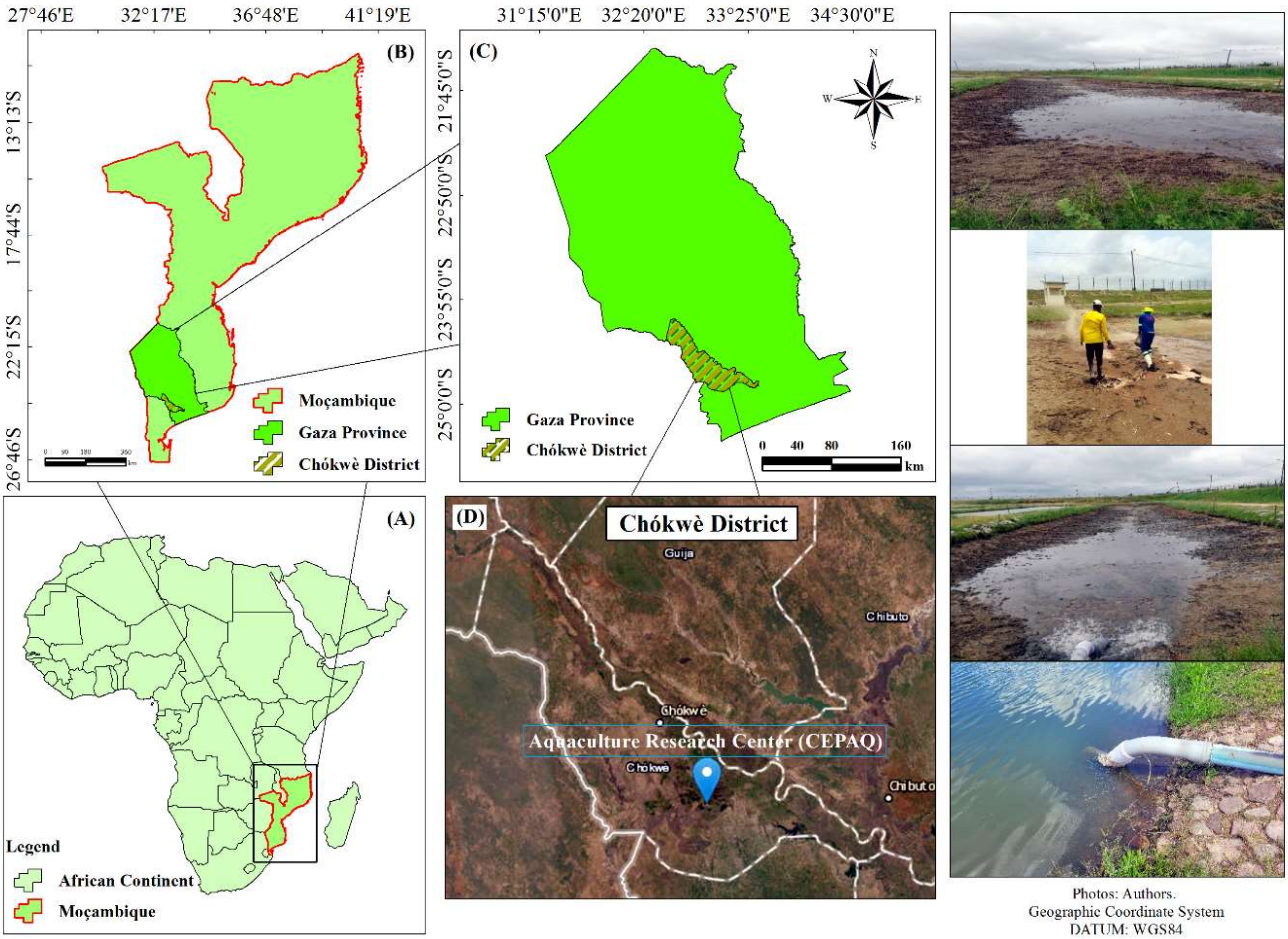

Fig. 1. Map showing the Aquaculture Research Center

Study animals: The fry were obtained from the Frying Department, with an average weight of 0.2 g. The settlement was carried out in accordance with the recommendations of Baloi, (2022). They consisted of indirect stocking, in which the fry are grown in net enclosures installed inside the fattening tanks, until they reach a size of 20-50 g and are then released into the tanks. 8500 fry of the species *Oreochromis Niloticus* and commercial lineage GIFT (Genetically Improved Farmed Tilapia) were populated, all of them sexually reversed males, divided into 2 net enclosures at a density of 200 fry per m³ inside the excavated tank measuring 1615m². The fisheswere raised in net enclosures until they reached an average weight of 24.08g and were then released into the same tank where the rearing net enclosures were installed.

Animal management: Feeding during the rearing phase was divided into six daily feedings, with powdered feed. In three meals in the Juvenile phase with 2mm ration and in three meals in the fattening phase with 4mm ration. The feed was administered after monitoring water quality parameters. In the rearing phase, food was supplied with the help of a feeding tube and in the last two phases with the help of a bowl for feeding the animals. During feeding, fish mortality and behavior (whether the fish were eating well or not) were observed. On rainy or cloudy days, food was reduced or even suspended. This is because, without the sun, water oxygenation is lower due to the lower oxygen productivity by photosynthetic organisms and the lower water temperature, which reduces its ability to retain oxygen, which can cause stress to the fish.

Management of water quality parameters: Water quality parameters such as dissolved oxygen and temperature were monitored twice a day in the morning (8:00 AM) and at the afternoon (2:00 PM) and water transparency once a day always afternoon (2:00 PM). On cloudy days or rainy days, water transparency was not measured. Water temperature, dissolved oxygen and transparency were monitored using a thermometer, an oximeter and a Secchi disk respectively.

Biometry: Biometrics were carried out monthly to evaluate fish growth, health status and adjusting the amount of feed to be supplied. Four biometric measurements were taken throughout the study, every 30 days, always in the early hours of the day to minimize animals stress. Fishes were fasted for 24 hours before biometry. For biometrics was used a trawl net, cast net, buckets, scales, ballpoint pen, a notebook to record the weight of the fish, and a *scupnet* to remove the fish from the net enclosures. For sampling, 10% of the populated animals were weighed individually.

Fishing: Fishing was carried out whenever the fish reached the commercial size of 250 g and consisted of removing two unloading monk boards to reduce the water in the tank and keeping the fishes 24 hours fasting to purify the stomach.

Zootechnical performance: The zootechnical performance parameters evaluated in the study were: survival rate (%), daily weight gain (g), final biomass (kg/m2), feed conversion factor, calculated according to the equations described below, using the by Santos and Silva, (2013) as follows:

1. Survival Rate (%) = (final number/start number) x100.
2. Daily Weight Gain (g) = final weight – initial weight/ days of cultivation x100.
3. Final Biomass (kg/m^2) = Average final weight x final number of fish.
4. Feed conversion factor = quantity of feed supplied (kg)/ liquid biomass.

RESULTS

Water quality parameters: The monthly average values of the physical-chemical parameters of water quality, observed in two periods (morning and afternoon) are presented in Table II. During the study, the average temperature was 22.6ºC, dissolved oxygen had an average of 6.89 mg.L-1 and transparency was 27.89 cm. all physiological activities (breathing, digestion, reproduction, feeding). The thermal comfort temperature of Nile tilapia is between 27 to 32°C however, temperatures between 22 and 27°C result in reduced consumption and temperatures below 22°C lead to fish mortality (Cavallieri, 2016). The temperature during the study presented average values of 21.0ºC in the morning and 24.2ºC in the afternoon,

Table I. Feeding protocol

Fishesweight (g)	Rationtype		Meals/ day
	Granulometry	%PB	
1-5	1mm	43	6
5-10	1mm	43	3
10-20	2mm	35	3
20-50	2mm	35	3
50-150	4mm	28	3
150-250	4mm	28	3
250-400	4mm	28	3

Kubitza (2011)

Table II. Monthly average values of physical-chemical water quality parameters

Months of cultivation	Period	Water quality parameters		
		T (ºC)	DO (mg.L^{-1})	Transp. (cm)
M1	Morning	24.1	4.98	24.0
	Afternoon	27.6	8.39	
M2	Morning	22.3	5.05	27.0
	Afternoon	24.9	9.42	
M3	Morning	20.2	3.02	29.9
	Afternoon	22.7	7.58	
M4	Morning	17.5	4.62	26.6
	Afternoon	21.0	9.83	
M5	Morning	20.0	3.67	30.9
	Afternoon	23.0	10.42	
M6	Morning	21.8	4.74	29.5
	Afternoon	26.0	10.67	

M – Mounth; DO –Dissolved Oxygen; Transp. – Transparency

Table III. Zootechnical performance data

Performance data	
Parameter	Value
Foodconversionfactor	1,12
Daily weightgain (g)	1,46
Final biomass (kg)	2110,4
Populatedfry	8500
Average final weight (g)	264
Averagestartingweight (g)	0,2
Feedoffered (kg)	2376,09
Survival rate (%)	94,11
Cultivation time (days)	180

Zootechnical Performance: The growth results of tilapia grown in land tanks during the staging period are illustrated in Table III.

DISCUSSION

Water quality parameters: Human actions on the environment alter the physical, chemical and biological factors of the water, reducingitsquality. As a result, continuous water monitoringmust be taken into accountin the fish farming emphasizing the physical and chemical factors, which are of great importance due to their influence on the metabolic processes of cultivated fish (Mardine, 2000; Cipriano, 2017). Monitoring and evaluating water quality for raising fish in land-based tanks has a great influence on the productive performance and profitability of cultivation (Baloi, 2022). The values of water quality variables must be within the ideal limits for better growth of the species under cultivation. With the exception of temperature, all water quality parameters analyzed in the present study were within the ideal values for tilapia cultivation (Leira et al., 2017). Temperature, among the various abiotic factors, is what has the greatest effect on the development and growth of fish, influencing values below the ideal cultivation temperature for this species according to Cavallieri (2016). The temperature values obtained throughout cultivation showed a variation typical of tropical and subtropical climates 17.5 to 27.6ºC, decreasing as winter approached and were always in the range in which tilapia reduces its consumption, but without never stop completely (Martell et al., 2005). Dissolved oxygen is the most important water quality parameter within aquaculture. The main source of oxygen for water is photosynthesis, but there are also direct and indirect means of incorporating O_2 into water, such as the use of compressors and aerators (Kubtiza, 2017). Macuacua (2015), mentions that the appropriate level is above 3mg/l, meaning that tilapia fish is quite tolerant to low concentrations of dissolved oxygen being able to withstand oxygen levels close to zero for several hours. Dissolved oxygen was within the recommended range during the study according to Lima, (2015). Transparency is the measurement of depth, in centimeters, which indicates the penetration of sunlight into the water. It varies depending on the presence of phytoplankton, turning the water green, or if there is excess clay in suspension, turning the water brownish (Baloi, 2022). For transparency, the studyshowed values between 24 and 30 cm considered satisfactory andideal transparency values should range between 25 and 35 cm

(Baloi, 2022). It should be noted that on cloudy and biometric days, transparency was not monitored.

Zootechnical Performance: Zootechnical performance directly depends on productive management, water quality and fish health (Santos, 2017). Stocking density, food management and fish genetics are fundamental to ensuring successful production (Frasca-Scorvoet al., 2011). Increased stocking density generally worsens food conversion rate (FCR) as it reduces the availability of natural food per fish and accelerates the degradation of water quality due to the higher levels of food management required (Hermes, 2009). The closer the nutrient composition available in the food is to the nutritional requirements of the fish, the better-feed conversion will be. The palatability and stability of feed in water also affect food conversion rate (Rodrigues, 2015). FCR is one of the main productivity rates used in animal production and is defined as the proportion of total food supplied divided by the total biomass produced, ranging from 1.5 to 2.5 in land-based tanks and from 1 to 1.71 in cages (Ranaand Hassan, 2013). FCR is determined by individual feed efficiency and survival, because fish that die during the cultivation period eat feed until death, but do not contribute to the total biomass produced (Ranaand Hassan, 2013). In this study, FCR was 1.12, which is considered satisfactory and was within the ideal range. The low food conversion value can be credited to the type of semi-intensive farming system that generally has better conversions, since in addition to the supply of commercial food, the animals have a greater quantity of plankton available for their food (Silva et al., 2014). The average daily weight gain during the study period was 1.46g (Table III). These results contradict with those obtained byFuruyaet al. (2020) who worked with tilapia in the fattening phase, at temperatures between 8 and 24°C, during 150 days of cultivation, obtaining an average gain of 3.90g per day. This low value found can be explained by the lack of feed in the first days of cultivation and the low temperatures during the study. Throughout the study, there was a mortality rate of 5.89% that can be attributed to predators, therefore, even with fluctuations in environmental conditions that possibly compromised the animals' feed consumption. Thesurvival rate was 94.11% as shown in the table III, considered excellent. According to Zanoniet al. (2000), survival rates for Nile tilapia are related to the quality of the cultivation water, the animals' nutrition, the prevention of parasites and diseases and the elimination of predators.

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