Effects of Vermicompost Inclusion on Water Quality, Feed Intake, and Growth Parameters of Nile Tilapia (*Oreochromis niloticus*)

Efectos de la inclusión de lombricomposta sobre la calidad del agua, el consumo de alimento y los parámetros productivos de la tilapia del nilo (*Oreochromis niloticus*)

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ABSTRACT

Fertilizing the ponds with Vermicompost did not affect the survival rate (P = 0.630) when 0, 3000, and 6000 g of fertilizer were included per pound. The final weight, the weight gain and the percentage of weight gain, the specific daily growth rate, and the feed conversion ratio were different between the fertilization treatments with 0, 3000, and 6000 g/bag of Vermicompost and ponds. The higher yields are observed when fertilized with 3000 g/bag of Vermicompost and ponds. Vermicompost fertilization does not affect water quality. The water quality, under the conditions of this study, has been classified within good quality parameters for the culture of red tilapia. In conclusion, vermicompost inclusion as a feed fertilizer for water microorganisms will serve as natural feed for the general development of Nile tilapias and contribute to promoting the production of plankton in adequate quantities. Water quality is one of the important factors for successful pond fish culture and the inclusion of vermicompost will not alter its physical-chemical parameters, allowing a fast and normal growth of this species.

Keywords: growing tilapia; water quality; vermicompost; fertilization

RESUMEN

La fertilización de los estanques con Vermicompost no afectó la tasa de supervivencia (P = 0,630) cuando se incluyeron 0, 3000 y 6000 g de fertilizante por estanque. El peso final, la ganancia de peso y el porcentaje de ganancia de peso, la tasa específica de crecimiento diario, el índice de conversión alimenticia fueron diferentes entre los tratamientos de fertilización con 0, 3000 y 6000 g/bolsa de lombricomposta y estanques. Los mayores rendimientos se observan cuando se fertiliza con 3000 g/bolsa de lombricompost y estanques. La fertilización con lombricomposta no afecta la calidad del agua; la calidad del agua, bajo las condiciones de este estudio, fue clasificada como de buena calidad para el cultivo de tilapia roja. En conclusión, la inclusión de lombricompost como fertilizante alimentario para los microorganismos acuáticos, servirá como alimento natural para el desarrollo general de la tilapia del Nilo y contribuye a promover la producción de plancton en cantidades adecuadas. La calidad del agua es uno de los factores importantes para el éxito del cultivo de peces en estanques y la inclusión de lombricomposta no alterará sus parámetros fisicoquímicos, permitiendo un crecimiento rápido y normal de esta especie.

Palabras clave: tilapia en desarrollo; calidad del agua; lombricomposta; fertilización.

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1. INTRODUCTION

The aquaculture production systems are increasingly important due to the ease of contributing to the demand for fish and other fishery products worldwide and sustainable production parameters [1, 2]. The Nile Tilapia (*Oreochromis niloticus*) is among the most cultured freshwater omnivorous fish species for human consumption, contributing to food security, and providing affordable fish to low-income people in Ecuador and the world [1, 3, 4]. The selection of raw matter for feed diets in this species is extremely accessible, easy to handle and administer, and more than represents half of the operating costs in intensive production systems [5, 6].

The inclusion of feed alternatives is a significant acceptance to improve production conditions and maintain the integrity of good water quality, considering high-quality dietary ingredients on digestibility parameters, increased growth rate, and reproductive parameters [1, 7]. Therefore, there is a requirement for alternatives that lower costs, and influence the parameters and local availability such as agricultural by-products, energy and protein concentrates, and water fertilizers associated with fed [7, 8].

The growth parameters of Nile Tilapia are constantly evaluated, and researchers are dedicated to assessing the productive results by including conventional and unconventional feeds in tilapia feeding. However, the areas of intervention and the inclusion of feed alternatives are highly variable [8, 9]. Recent studies show that the use of feed alternatives and pond fertilization holds more promise to replace unconventional feeds or supplementary to meet tilapia requirements and improve water quality [1, 3, 10]. Vermicompost is easily produced with high nutrient concentrations [11] and its incorporation as fertilizer shows growth speed in tilapias and improvement of water quality [2, 3, 12].

In intensive farming systems, improving profits requires access to cheap and sustainable feed ingredients that maintain fish growth and welfare [7, 13]. Therefore, this study aimed to evaluate the effect of including vermicompost as a feed alternative and pond fertilizer on water quality and growth parameters of Nile Tilapia in a growth stage.

2. MATERIALS AND METHODS

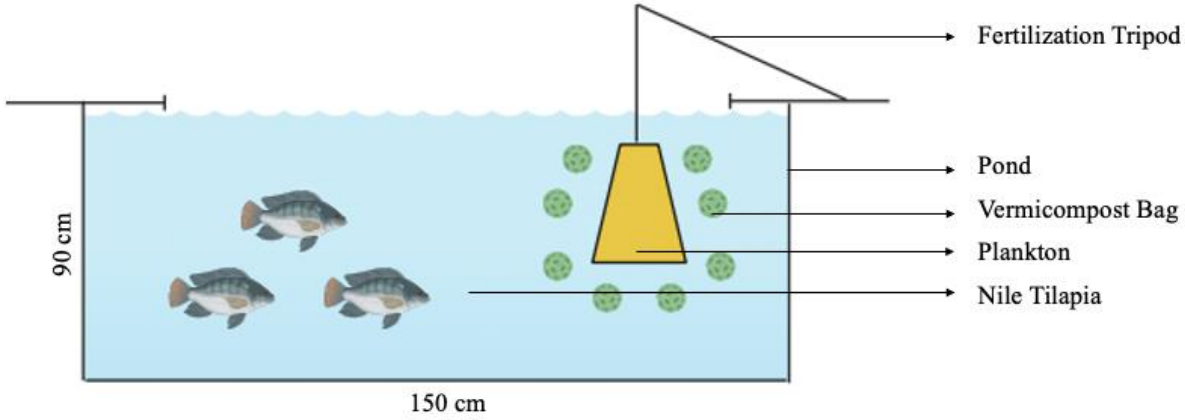
2.1. Diets, Animals, and Experimental Procedure

Three hundred growing red tilapias were acclimatized (*Oreochromis niloticus*, 2068 ± 21,01 g of average tilapia biomass) for 7 days to fertilization with vermicompost and diet, and into three homogeneous groups according to their tilapia biomass; each group was randomly assigned to one of the three experimental procedures (VE0, VE3 and VE6) in triplicate, furthermore, on 21 fish (one fish was sacrificed on day zero to take morphological measurements, data not yet published) were placed in 1300 L/pond (150 × 100 × 90 cm). Ambiental temperature was constant intro 22 and 28 °C and 90% of humidity. Vermicompost was included in three quantities one time to the started experimental work (0, 3000, and 6000 g/bag and pond from VE0, VE30, and VE60, respectability) in different bags fully submerged in each pond (2 pounds per quantity vermicompost or treatment, Figure 1). Vermicompost bags were included in the ponds after 7 d of acclimatization of the fish. During the experiment, fish were fed with a commercial diet concerning 8.8% body weight (feed labeled by the manufacturer: 24, 5, and 6 % of PB, EE, and FB dry matter basis, respectability) twice per day.

The water quality was measured on days 0, 10, and 20 of the experimentation at 09:00 in the morning, temperature (°C) and pH were measured (portable HANNA pH/ORP/Temperature meter HI 991002, UK). For water transparency, water samples were taken during the three days of measurement, the samples were exposed on a white surface under an intense and homogeneous light to evaluate their turbidity assigning to each of them a score of 1 (transparent), 2 (half-turbid) to 3 (turbid). The evaluation was performed by four trained persons, and the average score was used for statistical

analysis. Dissolved oxygen concentration in water was measured using a YSI Model 85 meter (Yellow Springs Instruments, Yellow Springs, OH, USA).

Figure 1. Pond design (1300 L/pond of capacity, 150 cm long, 100 cm width, and 90 cm deep) and location of vermicompost bags (0, 3000 and 6000 g/bag and pond from VE0, VE30 and VE60, respectability. Illustrated with https://app.biorender.com).



2.2. Vermicompost preparation

The vermicompost was prepared following the modified methodology of Bansal and Kapoor [14], *Eisenia foetida* also known as red earthworm was used to convert organic matter into vermicompost for 65 d. the production cubicles were used to prepare 27 kg of vermicompost. Cow dung and vegetable residue, and leaf litter were used as vermicomposting materials, about 2000 to 2500 earthworms were released on the top layer of vermicomposting cubicles, in addition, water was sprayed with 3-day intervals during processing to maintain adequate moisture and body temperature for the earthworms. The prepared vermicompost was packed in nylon bags for pond fertilization. The composition of the vermicompost was 2,61 % of nitrogen, 2,28 % of phosphorus, 0,9 % of potassium, 1,78 % of calcium, and 8,88 % of carbon.

2.3. Calculations and Statistical analyses

The growth performance parameters, weight gain, and weight gain percentage, specific daily growth rate, and feed conversion ratio were calculated using the equations described by Pirarat et al [15], and survival rate was calculated as [(total number of harvests / total number) * 100] of stocks [10]. Data were analyzed as a one-way ANOVA using the procedure of INFOSTAT [16], followed by the Duncan test. Significance was declared at $P < 0.05$, whereas $P < 0.10$ values were considered as a trend.

3. RESULTS AND DISCUSSION

The chemical composition of the vermicompost was equivalent to that elaborated by Rahman et al [10], Musyoka and Nairuti [17], and Chakrabarty et al [18], who used similar raw materials, parameters, and production methods, also included vermicompost (VE) as water fertilizer for tilapias. The effects of fertilizer in the water with vermicompost on the growth parameters of red tilapia are shown in Table 1. Fertilizing the ponds with VE did not affect the survival rate ($P = 0.630$) when 3000 and 6000 g of VE were included per pound, nor when it was not used, obtaining an average survival of 99% per pound. However, the final weight, the weight gain and the percentage of weight gain, the specific daily growth rate, and the feed conversion ratio were different ($P < 0.001$) between the fertilization treatments with 0, 3000, and 6000 g/bag of VE.

The ponds fertilized with 3000 g of VE showed 3415 g at the final weight and 1336 g of total weight gain, equivalent to 64.2 % of the biomass, respectively, unlike not fertilizing the ponds or fertilizer with 6000 g of VE (average value: 33%). Farming growing red tilapias and fertilizer the ponds with 3000 g/bag/pond of VE improved the specific daily growth rate and feed conversion ratio (2.48 % and 2.70, respectability) compared to using no fertilizer or using 6000 g/bag and pond of VE (Average values: 1.42 % and 5.10, respectability). As outlined above, zooplankton is the preferred natural feed for red tilapia juveniles [18], with a protein content of up to 60%, shower the better tilapia growth parameters when the ponds were fertilized with 3000 g of VE to improve plankton production as a natural feed source under the conditions of this experiment [20, 21].

In addition, trials that used VE as a fertilizer for Tilapia are compatible with the parameters obtained in this experiment. Rahman et al [10] reported a final weight and percentual weight gain (130 g and 116 g, respectability) like the one used in the present study. In contrast, Musyoka et al [2] under the same fertilization parameters for Nile Tilapia, showed a Feed conversion ratio of 1.7 different from that reported in this study when ponds were fertilized with 3000 g of VE (Feed conversion ratio: 2.70), the differences were possibly due to the quantity and growth rate of the tilapias under the conditions of this study.

Table 1. Initial and final weight, weight gain and weight gain percentage, specific daily growth rate, feed conversion ratio, and survival rate of growing red tilapias fertilization with vermicompost and fed commercial diet.

Item[1]	VE0	VE30	VE60	SEM[2]	P value
Initial weight, g	2046	2079	2078	8.74	0.059
Final weight, g	2686	3415	2789	31.8	< 0.001
Weight Gain, g	640	1336	711	29.37	< 0.001
Weight Gain, %	31.3	64,2	34.2	1.40	< 0.001
Specific daily growth rate, %	1.36	2,48	1.47	0.05	< 0.001
Feed conversion ratio, g/g	5.65	2,70	5.10	0.01	< 0.001
Survival rate, %	98.3	100	98.3	1.36	0.630

[1] Fertilization with vermicompost: VE0, VE30, and VE60 = 0, 3000 and 6000 g/bag and pond from respectability (per biomass), [2] SEM: Standard error of the mean

The effects of fertilization with vermicompost on water quality are shown in Table 2. Transparency and dissolved oxygen were not different (P > 0.05) between vermicompost fertilization treatments and water quality for red tilapia, during days 0, 10, and 20 of the trial. The water in the experimental stage was classified as good water (on a transparency scale: water transparency was scored from 1 (transparent), 2 (half-turbid) to 3 (turbid)). The average dissolved oxygen for the ponds on the days of experimentation and inclusion of fertilization treatment was 6.39 mg/L. Rahman et al [10] researchers fertilized with 8000 g/pond of vermicompost and achieved a dissolved oxygen concentration of 7.05 mg/L when culture Nile tilapia, similar to dissolved oxygen concentrations in this experiment. In addition, under similar conditions, Ahmed et al [3] fed Nile tilapia with earthworm, showed concentrations of 7.08 mg/L of dissolved oxygen. The water temperature as part of the water quality was similar between the vermicompost fertilization treatments (Average value: 31 °C, P = 0,418), nevertheless, differences (P < 0.05) were observed in the water temperature at 0 and 20 days of experimentation in the ponds fertilized with VE0, VE30 and VE60 (Average value: 27, 29 and 28 °C, respectively), possibly this event occurs due to an increase in the plankton population in fertilized

ponds [10, 17, 21].

Table 2. Water quality of growing red tilapias fertilization with vermicompost and fed commercial diet.

Item	VE0	VE30	VE60	SEM[1]	P value
Temperature, °C					
Day 0	24.0	26.0	24.5	0.42	0.022
Day 10	29.3	31.8	31.7	1.41	0.418
Day 20	30.1	31.2	31.5	0.31	0.043
pH					
Day 0	7.80	7.80	7.20	0.21	0.433
Day 10	8.07	8.20	7.20	0.16	0.039
Day 20	7.20	8.20	6.45	0.40	0.191
Transparence[2]					
Day 0	1.33	1.66	1.33	0.33	0.729
Day 10	1.33	1.33	1.33	0.33	0.999
Day 20	1.33	1.67	1.00	0.27	0.296
Dissolved oxygen, mg/L					
Day 0	5.97	6.50	6.67	0.23	0.156
Day 10	6.57	6.566	6.20	0.30	0.623
Day 20	6.57	5.833	6.67	0.26	0.125

[1] SEM: Standard error of the mean, [2] Water-transparency was scored from 1 (transparent), 2 (half-turbid) to 3 (turbid)

Water quality, under the conditions of this study, has been classified within good quality parameters for the culture of red tilapia. Refer to those waters with temperature and dissolved oxygen, suitable for cultivation, in addition, that contain limited levels of metabolites and transparency, therefore, it is recommended to take good care of ponds by regularly observing conditions, fish behavior, and color of water for abnormal variations [3, 22].

4. CONCLUSIONS

The inclusion of vermicompost as a feed fertilizer for water microorganisms will serve as natural food for the general development of Nile tilapias and contribute to promoting the production of plankton in adequate quantities. Water quality is one of the important factors for successful pond fish culture and the inclusion of vermicompost does not alter its physical-chemical parameters, allowing a fast and normal growth of this species.

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