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"Effect of enzymes in bioremediation of water and sludge from semi-natural ponds on the production process of paco (*Piaractus brachypomus*) at Alegría, Madre de Dios"

Abstract

The present study was carried out in the facilities of Fundo San Miguel, Alegría Locality, Madre de Dios, from January to June 2018. The objective of this study was to investigate the effect of enzymes in the bioremediation of water and sludge of semi-natural ponds on the productive process of paco (*Piaractus brachypomus*) at Alegría Locality, Madre de Dios. 3000 paco fingerlings of 5 ± 0.2gr were used, randomly distributed in 3 treatments with two repetitions each under a Completely Randomized Design (CRD). The study was conducted over 05 months. The treatments were: T1 (control), T2 (0.01g / m2) and T3 (with 0.03 g / m2), the same ones that were evaluated during the 03 stages of paco growth (ONSET, GROWTH, FATTENING), besides evaluating for 5 months each week the physical-chemical parameters of water. The results do not show significant differences (P> 0.05) in the productive parameters evaluated (average weight gain, biomass, and food conversion), however high averages were obtained in the physical-chemical parameters of water: dissolved oxygen (4.5ppm), transparency (6cm) and pH (6.58), Nitrite (0.02ppm) and ammonium (1.35ppm). It is concluded that the use of the enzyme in fishponds has not affected the productive parameters and physical-chemical parameters evaluated, observing only a better growth in the feed conversion with the inclusion of 0.03% enzyme.

Keywords: bioremediation, water quality, paco (*Piaractus brachypomus*), enzymes.

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Introduction

Fish farming is a relatively recent productive activity in the Peruvian Amazon. From its inception until about five years ago, it was practiced in a limited way, mainly at the family level. In recent years it has had an accelerated development, mainly due to the advances obtained in the process of producing fingerlings of native species such as *Colossoma macropomum* "gamitana" and *Piaractus brachypomus* "paco" (Reyes, 1998).

Bioremediation is considered the most effective way to remediate contaminated soils, in contrast to more expensive alternatives such as incineration. Biological soil degradation treatments can be efficient and economical if the biodegradation conditions are optimized.

The activity of present microorganisms in sludge and water can be favored by improving certain soil conditions, adding nutrients, enzymes, water, oxygen and modifying the pH. Another way is the introduction of new species to increase the concentration of microbiota present.

Currently, degradation by enzymatic action has the principle of adding enzymes to the contaminated place and/or site to degrade harmful substances or toxic compounds that affect fish and shrimp. These enzymes are obtained from microorganisms specially designed to obtain large quantities and of high specificity and are marketed by biotechnology companies.

In the Madre de Dios region, fish farming continues to be carried out without using technologies that improve productive yields, increase fish stocking density, and make adequate use of water. On the other hand, carrying out a greater number of campaigns increases production costs, generating several suspended solids and organic matter as a result of fish overfeeding.

On the other hand, in the studies carried out by Isuiza,[1] where he evaluated bioremediation using effective microorganisms (EM) in fish ponds without the presence of fish, he points out that treatment 3 s had the most significant effect ($p<0.05$) on the bioremediation of water and sludge quality in fish ponds. This treatment was the most effective in improving water quality, where high averages were obtained in the physicochemical parameters of dissolved oxygen (4.04 ppm), transparency (4.57 cm) and pH (6.33); and low average in the parameters of ammonium (1.29 ppm), nitrite (0.04 ppm), CO2 (10 ppm), alkalinity and hardness (23.73 and 20.33 ppm).

Materials and methods

3000 paco fingerlings of 5gr ± 0.5 were used. These were randomly distributed in three treatments with two replications each, from the Fish Center – La Cachuela of the Regional Government of Madre de Dios. As a control diet, two ponds were used without any type of enzymatic treatment. Three treatments were evaluated: Treatment 1: T1 (control), Treatment T2 (0.01g enzymes/m2), and Treatment 3: T3 (with 0.03 g of enzyme/m2), for the growth stages: ONSET, GROWTH, and FATTENING.

Measurement of average weight gain, biomass gain, and feed intake was performed once a week. A digital scale with a capacity of 100 kg and a sensitivity of 1.0 g was used. Balanced, previously weighed feed, was fed daily at 8:00 a.m. using a commercial feed.

Measurements of production parameters Variables evaluated

1. Average Weight (g)
2. Biomass gained (Kg)
3. Feed Intake (Kg)

Feed conversion

It was calculated from the total dry matter intake. It means of the effect of the treatments were analyzed using the Completely Randomized Design, with three treatments and eight replications per treatment, and the analysis of variance (ANVA) was performed for the productive parameters. Data were processed with the statistical program SAS version 8.0. For the comparison of means, the Duncan test was performed to determine the statistical differences between treatments with a significance level of 5%[2] (Figure1).

Cumulative feed = Total dry matter intake (g)

Conversion Total live weight gain (g)

Results and discussion

According to these results of the three treatments, the analysis of variance was carried out in the increases in weight, final biomass, and feed conversion, no significant differences were found in both the productive and physical-chemical parameters of the water according to the doses evaluated with enzymes. However, numerically, treatment 2 had a greater response effect on weight gain, feed conversion, and weight gain in the three stages of the paco production process (Start, Growth, and Fattening) (Table1-3).

Figure 1 Conditioning of semi-natural ponds.

Table 1 Evaluation of the behavior of the water quality parameters initially before the enzymatic bioremediation system START stage (30 DAYS)

	Dissolved oxygen (ppm)	Temperature (°C)	Ammonia (ppm)	Hardness (ppm)	pH
Treatment 1 ENZIMA1 R1	4	29	2.2	120	6.5
Treatment 2 ENZIMA 1 R1	3.5	27	2.5	120	7
Treatment 2 ENZIMA 2 R1	2.5	28	2	200	6.5
Treatment 2 ENZIMA 2 R2	2.8	27	2.2	200	6.8
Treatment 3 WITHOUT ENZIMA R1	2.5	28	2.5	250	5.5
Treatment 3 WITHOUT ENZIMA R2	2.2	29	2	250	5.8

Table 2 Behavior of the water quality parameters at the end of evaluation with the enzymatic bioremediation system GROWTH stage (60 DAYS)

	Dissolved oxygen (ppm)	Temperature (°C)	Ammonia (ppm)	Hardness (ppm)	pH
Treatment 1 ENZIMA1 R1	2.5	28	2	120	6.5
Treatment 2 ENZIMA 1 R1	3.5	28	2	120	7
Treatment 2 ENZIMA 2 R1	2.8	29	1.5	200	6.5
Treatment 2 ENZIMA 2 R2	3	29	1.5	200	6.8
Treatment 3 WITHOUT ENZIMA R1	3	30	1.5	250	5.4
Treatment 3 WITHOUT ENZIMA R2	3.1	30	1.5	250	5.8

Table 3 Behavior of the water quality parameters at the end of evaluation with the enzymatic bioremediation system ENGORDE stage (30 DAYS)

	Dissolved oxygen (ppm)	Temperature (°C)	Ammonia (ppm)	Hardness (ppm)	pH
Treatment 1 ENZIMA1 R1	2.5	28	2	120	6.5
Treatment 2 ENZIMA 1 R1	2.5	28	2	120	7
Treatment 2 ENZIMA 2 R1	3.1	28	1.5	200	6.5
Treatment 2 ENZIMA 2 R2	2.9	29	1.5	200	6.8
Treatment 3 WITHOUT ENZIMA R1	3	28	1.5	250	5.4
Treatment 3 WITHOUT ENZIMA R2	3.1	29	1.5	250	5.8

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Research on other species, such as that carried out by Colquehuanca,[3] shows the effect of paco cultivation in ponds, reporting a total weight gain in fry and juveniles of 50g and 150g using sacha inchi cake, surpassing the control treatment that they won 45gr and 145gr (Table 4,5) (Figure 2).

Table 4 Productive parameters for the START stage of paco fingerlings

	Initial Biomass (Kg)	Final Biomass (Kg)	Initial Weight (G)	Final Weight (G)	Feed Conversion
Treatment 1	4.8	49.5	4.9	49.7	1.6
ENZIMA1 R1					
Treatment 2	4.9	51	5.1	48.4	1.8
ENZIMA 1 R1					
Treatment 2	5	53	5.3	50.2	1.83
ENZIMA 2 R1					
Treatment 2	50	52	4.8	49.6	1.71
ENZIMA 2 R2					
Treatment 3 WITHOUT ENZIMA R1	4.8	50	5	50.1	1.94
Treatment 3 WITHOUT ENZIMA R2	4.9	51.2	4.9	49.9	1.9

Table 5 Productive parameters for the GROWTH stage of paco juveniles

	Initial Biomass (Kg)	Final Biomass (Kg)	Initial Weight (G)	Final Weight (G)	Feed Conversion
Treatment 1	49.8	159.4	49.8	155.2	1.91
ENZIMA1 R1					
Treatment 2	52	156.5	49.6	160.3	1.86
ENZIMA 1 R1					
Treatment 2	51.0	157.3	51.32	152.6	1.82
ENZIMA 2 R1					
Treatment 2	52.0	157.2	49.8	151.5	1.88
ENZIMA 2 R2					
Treatment 3 WITHOUT ENZIMA R1	50.0	160.3	55.3	150.2	1.81
Treatment 3 WITHOUT ENZIMA R2	50.0	158.1	55.3	156.2	1.85

Figure 2 Physico-chemical parameters of water.

The results obtained indicated that the final weight variables reached by the fish did not show significant differences between treatments at the level of variance, nor at the level of comparison of means (Table 6). However, treatment 2 shows a slight increase in comparison. with the other two, and the weights reached this density correspond to commercial weights that are widely accepted in local markets.[4] Report the same results with the species *Piaractus mesopotamicus*, at densities of 5,000 and 10,000 fish ha-1 without finding significant differences in weight. According to the results, we observed that the increase in the enzyme improves water quality during fish growth (Figure 3).

Figure 3 Production monitoring of the paco fattening stage.

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Table 6 Productive parameters for the stage FATTENING of paco adults

	Initial Biomass (Kg)	Final Biomass (Kg)	Initial Weight (G)	Final Weight (G)	Feed Conversion
Treatment 1	160.0	440.1	160.2	455.2	1.9
ENZIMA1 R1					
Treatment 2	160.2	445.3	158.2	456.3	1.85
ENZIMA 1 R1					
Treatment 2	158.5	423.8	158.6	458.3	1.84
ENZIMA 2 R1					
Treatment 2	158.9	420.9	157.5	452.4	1.78
ENZIMA 2 R2					
Treatment 3 WITHOUT ENZIMA R1	157.8	424.7	156.2	415.2	1.8
Treatment 3 WITHOUT ENZIMA R2	157.5	426.1	150.3	399.5	1.91

The feed used for the genus *Piaractus* in different works in Latin America varies from 14% to 40% of crude protein, with a feeding rate of 2 to 5% of its biomass, reaching feed conversions of 1.9 to 3.8.[4]

When working in the experiment with a diet with 33% protein, an initial and final feeding rate of 10% and 2.5%, feed conversions of 0.54 to 3.55 were obtained, with the treatment of 5,000 fish reaching a value of 1.09, the closest to 1 compared to the other two.

Conclusion

The use of enzymes in pond water and sludge for the paco production process in its three stages did not significantly affect any productive and physical-chemical parameters. However, treatments with enzyme addition had a numerical increase.

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