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Tetra-hybrid Pargo UNAM (Red tilapia) cultured in Biofloc system with moringa as carbon source: Preliminary study

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Abstract
The aim of this work was to evaluate the growth of the tetra-hybrid Pargo-UNAM in a Biofloc system with moringa as carbon source and with different diets. Plastic beakers of 250 L were conditioned with 150 L of water and were placed 60 juveniles of the tetra-hybrid Pargo-UNAM. The control diet was commercial trout pellet, one experimental diet was a commercial carotenoid pigment-rich diet (TetraColor®) and two formulated diets were also used, one based on carrots and the other based on beetroot. The diet based with beetroot was the one that obtained the best results with a final total length of 15.61 ± 0.90 cm and reaching a weight of 363.75 ± 0.29 g. The other pigment-rich diets obtained high values in the organism's growth too. In conclusion the addition of carotenoids pigments is important for the culture of fishes to reach a commercial size in less time.

Keywords: Biofloc, carotenoids, growth rates, Pargo-UNAM

1. Introduction

Mexico is among the countries that cultivate tilapia, it occupies an important place as a producer, with production systems dedicated mainly to its cultivation [1, 2]. The culture of tilapia in Mexico is relatively recent but its production has increased in a constant and progressive way, representing more of the 60% of national production [3]. In 2015, the production of 300 aquaculture farms reached a production of 80,000 tons [4].

Oreochromis nolíticus is considered as one of the species with better growth and survival among tilapias, showing tolerance to salinity conditions and has a good acceptance in the market [5]. Also, there is an increasing demand in the Mexican market of red tilapia (*Oreochromis* spp.) [6]. Despite this need, the increase of the production of red tilapia has not being significant since 1995 [7], due to their productive yields are not so economically attractive, compared to other tilapias [8]. Nevertheless, red tilapia, has the advantage to be highly tolerant to salinity and it adapts to any production system which makes it interesting for its culture [9].

Red tilapia Pargo-UNAM, is a tetra-hybrid produced from the cross of four representative species of *Oreochromis* genus: *O. mossambicus, O. niloticus, O. hornorum* and *O. aurea*. Each specie gives the hybrid its best characteristics, resulting in an organism with high potential for its culture around the world [2, 10].

Until 2009, the tilapia culture was made under a water recirculation system (WRS), where the water was treated by a mechanical and later biological filter, to return to the culture medium [2, 11]. The characteristics of these systems are the reuse of water, reduction of effluent discharge and optimal water conservation [12], which is treated in a biofilter for ammoniac nitrogen biological conversion to nitrate [13]. Culture of tilapia represents a valuable resource generating sources of employment and income for the national primary sector a valuable resource generating sources of employment and income for the national primary sector. In this system (WRS), it is necessary to have aeration and a pumping system to transport water, which makes it occupy space and represents high expenses in food and energy. Also, it remains the water cost, because water changes must be done and there is a greater expense of food due to the constant movement of water, food that is trapped in the mechanical and biological filters.

Because of the above, the search of new ways of aquaculture that are environmentally friendly and profitable are becoming more pressing.

So, it is necessary to develop an alternative culture system with less environmental impact in the water use and contamination, as well as, lower expense in food [14, 15]. This can be done using systems like the Biofloc system, where an external carbon source is added to produce heterotrophic bacteria communities beneficial for the elimination of nitrogenous compounds, specially ammonium, transforming it in usable compounds (nitrites and nitrates) [16, 17]. Therefore, allowing to obtain a high survival in fish as well as growth and weight gain [18].

Considering that this specie of tilapia must conserve its color and that aquatic species are unable to synthetize carotenoids, it is necessary to consider the supply of pigments or probiotic strains that produce these pigments, in the diet or culture media [19, 20]. Nevertheless, it must be considered that carotenoids have a physiological importance in fish as antioxidants and hormone precursors that intervene on reproduction processes. Also, improve the nutrient assimilation, accelerate growth rates, and allow larvae survival [20]. So, the development of this specie of tilapia can be improved.

Therefore, a preliminary study of the culture of Tetra-hybrid Pargo-UNAM (red tilapia) in a Biofloc system was made, using moringa flour as carbon source.

2. Materials and methods

2.1 Experimental design

Sixty juvenile of the tetra-hybrid Pargo-UNAM (red tilapia) were used, which had a mean initial weight and length per diet of: a) 3.16 ±0.68 g and 6.10 ±0.92 cm for trout pellet diet, b) 4.29±0.15 g and 6.62±0.48 cm for TetraColor diet, c) 7.70±0.41 g and 5.66±0.37 cm for carrot diet, and d) 7.35±0.32 g and 6.03±0.53 cm for beetroot diet. Fish were maintained in 250 L plastic beakers (0.80 m length x 0.70 m width x 0.70 m of diameter) with 150 L of water. With constant and strong aeration to keep the water column in movement (Fig.1). The temperature (23±2°C), pH (7.20 - 7.80); chlorine (0.02 – 0.13 mg L^{-1}); ammonium (NH_4) (0.03 – 0.13 mg L^{-1}); nitrates (NO_3) (18.5 – 33.00 mg L^{-1}); nitrites (NO_2) (3.00 – 10.00 mg L^{-1}; and phosphates (PO_4^-) (0.30 – 2.79 mg L^{-1}) were maintained during all experiment.

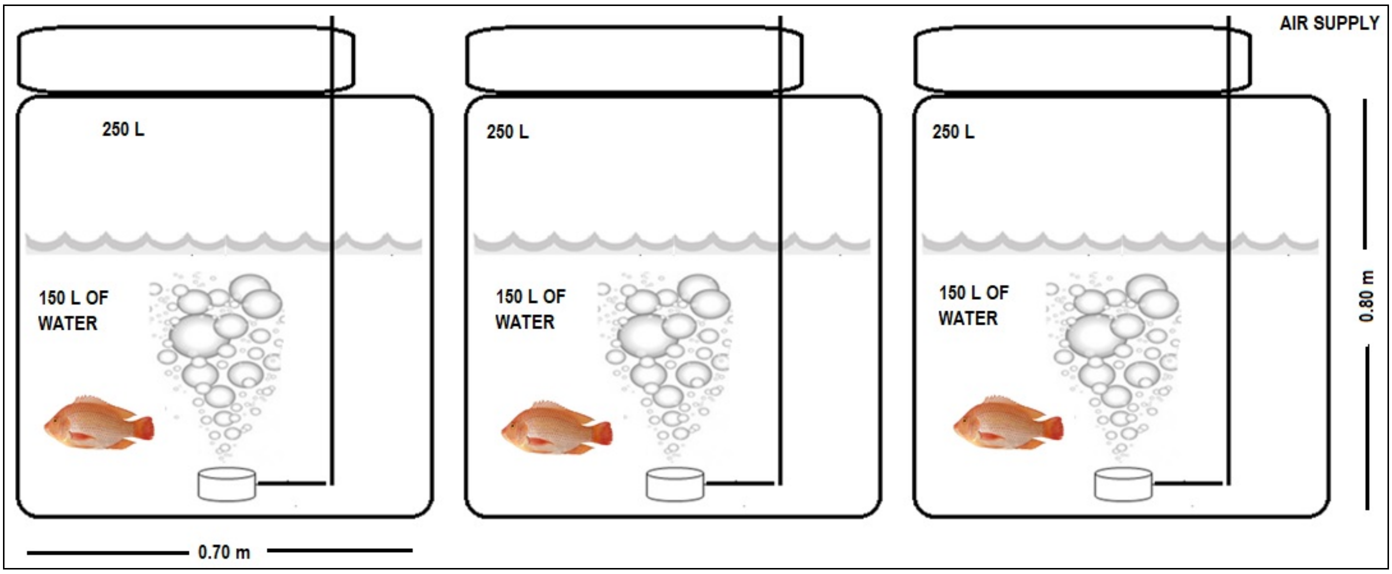


Fig 1: Culture system of tetra-hybrid Pargo-UNAM (red tilapia)

At the beginning and every seven days, the organisms were measured with aim of a digital Vernier Truper® ±0.001 mm and were weighted with a digital balance Nimbus ±0.01 g. The weight of the organisms was used to consider the 10% of total biomass in each experimental diet: a) Trout pellet, b) TetraColor, c) carrot, and d) beetroot. Also, the weight of the organisms was used to incorporate the carbon source (Moringa) in relation to the 0.1% of the total biomass to produce Biofloc.

2.2 Experimental diets

Trout diet contain 45% of protein, 15% of lipids and 3% of fiber. TetraColor contained 47.5% of protein, 6.5% of lipids and 2% of fiber. The two wet diets based in carrot and beetroot contained 30% of protein and 10% of lipids proportionated by chicken gizzards, two vitamin E capsules, and 35% of fiber apported by using apple, banana, and 250 g of oatmeal. Wet diets were agglomerated with gelatin (50 g). The four diets were supplied twice a day, while the carbon source (moringa) once per day.

2.3 Information processing

Every seven days, the biometric parameters of total length, height, width, and weight were incorporated to an Excel 2010 data base to obtain the descriptive statistic, as well as its growth tendency curves. Also, it was obtained the gain, absolute growth rate (AGR) and instantaneous growth rate (IGR).

To obtain the gain values (G) of biometric values the following formula was used:

G = Final value - Initial value

To obtain AGR the following formula was used:

$$AGR = \frac{\text{Final value} - \text{Initial value}}{\text{Total culture days}}$$

To obtain IGR the following formula was used:

$$IGR = \frac{\text{Ln (Final value)} - \text{Ln (Initial value)}}{\text{Total culture days}} \times 100$$

2.4 Statistical analysis
Significant differences (p<0.05) in the four biometric measurements (total length, height, width, and weight) between experiments were determined through an ANOVA test. When significant differences were obtained, it was made a multiple mean test through Tukey test, using the statistical program of Systat 13.0®.

3. Results and discussion
3.1 Survival
Trout and TetraColor diet presented survival values below 50%, while carrot and beetroot diet had values above 90%. Regarding to survival and organisms productivity in the control and TetraColor diet, this could be affected by the supplied diets because as mentioned by Zehra and Khan [21] and Gultepe *et al.* [22], an excess in the protein quantity in diet increases the values of ammonium in water, which can affect the growth and wellbeing of fishes. That is why, it was presented a high mortality in these diets, while in the formulated diets with carrot and beetroot, that had 30% of protein, had survival rates higher than 90% and in the case of beetroot diet, better results in size and weight growth. Among red tilapia, Pargo-UNAM has proved to have a better productive performance compared to *Oreochromis mossambicus* and *Oreochromis niloticus*, making the commercial culture of Pargo-UNAM a viable option [21].

3.2 Total length, height, width and weight

Table 1: Mean values (±S.D.) of initial and final data are presented in

Parameter	Culture day	Experimental diet			
		Trout	TetraColor	Carrot	Beetroot
Length	0	6.10±0.92	6.62±0.48	5.66±0.37	6.03±0.53
	140	9.29±0.76[a]	15.71±0.47[a,b]	12.87±0.47[a,b]	15.61±0.90[a,b]
Height	0	1.28±0.67	2.46±0.20	2.41±0.36	2.34±0.58
	140	8.65±0.89	11.45±0.57[a]	8.91±0.44	7.99±0.50[a]
Width	0	1.25±0.67	1.21±0.59	1.00±0.28	1.12±0.28
	140	6.18±0.75[a]	7.01±0.41[a]	7.23±0.50[a]	7.66±0.74[a]
Weight	0	3.16±0.68	4.29±0.15	7.70±0.41	7.35±0.32
	140	183.08±0.64[a]	372.16±0.48[a]	290.32±0.29[a]	363.75±0.29[a]

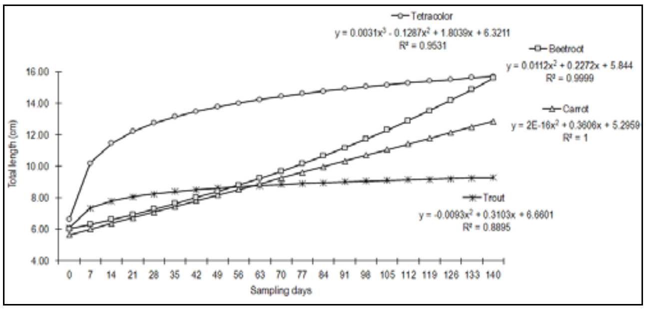
Note: Same letter in a row show significant differences (p<0.05).

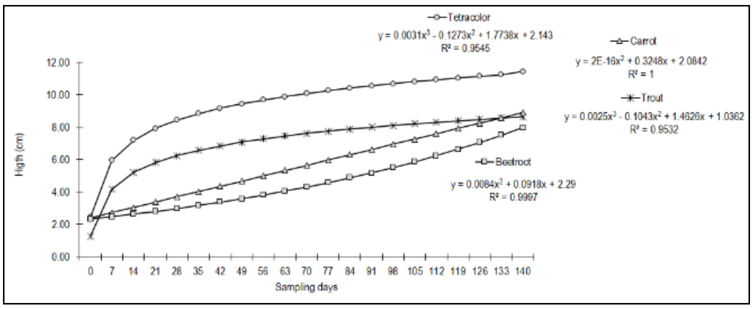
Highest length was obtained in the TetraColor and and Beetroot diet with 15.71±0.47 cm and 15.61±0.90 cm respectively. The lowest length was presented in fish fed with Trout pellet with 9.29±0.76 cm. The ANDEVA and Tukey test showed significant differences (p>0.05) between trout diet and the rest of diets, as well as, between carrot diet and TetraColor and Beetroot diets. According to the obtained results in this investigation, the pigment-rich diets had better results than control diet, pointing out, beetroot diet which obtained the best results having a mean final total length of 15.61 ± 0.90 cm and reaching a weight of 363.75 ± 0.29 g. This positive effect of carotenoids has been proved in salmons by Torrisen [23] and Christiansen *et al.* [24], also, Pitt [25], points out that astaxanthin can improve the growth of fish.

Highest height was obtained with TetraColor with 11.45±0.57 cm, while the lowest value was presented in beetroot diet with 7.99±0.50 cm. The ANDEVA and Tukey test showed significant differences (p<0.05) between TetraColor and beetroot diet regarding the other two diets; trout and carrot diet did not present significant differences between them (p>0.05). Highest width was presented in the Beetroot diet with 7.66±0.74 cm, while the lowest values were found in the organisms fed with trout pellet with 6.18±0.75 cm. The ANDEVA and Tukey test presented significant differences between all the diets.

Highest weight was obtained with the beetroot diet reaching a value of 363.75±0.29 g, while the lowest weight was presented in the trout diet with 183.08±0.64 g. The ANDEVA and Tukey test presented significant differences between all the diets. Morales-Alamán *et al.* [26] when making a culture during 123 days with 20 juveniles of Pargo-UNAM in 750 L ponds, obtained a final weight of 396.3 g, being a higher value to the one obtained in this investigation in 140 days of culture. Likewise, were obtained better results than some works made with *O. niloticus,* like the one of Rodríguez-González *et al.* [27], which obtained a mean final weight of 354.64 g after 160 days of culture, while in this work it was obtained a mean final weight of 363 g in 140 days of culture.

Growth tendency curves of total length, height, width, and weight were shown in Fig. 2.





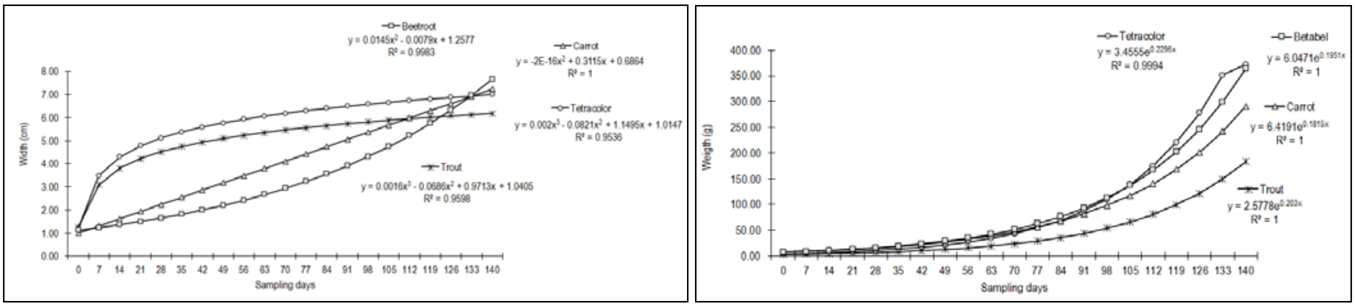


Fig 2: Growth tendency curves of total length, height, width, and weight of tetra-hybrid Pargo-UNAM in the four experimental diets.

3.3 Gain, AGR and IGR

In Table 2 are presented the gain, AGR and IGR values of the organisms in the four experimental diets.

Table 2: Gain, AGR, IGR (%) mean values of Tetra-hybrid Pargo, UNAM fed with the four experimental diets

Biometrical variable	Experimental diets											
	Trout			TetraColor®			Carrot			Beetroot		
	Gain	AGR	IGR (%)	Gain	AGR	IGR (%)	Gain	AGR	IGR (%)	Gain	AGR	IGR (%)
Total length (cm)	3.19	0.02	0.30	9.09	0.06	0.62	7.21	0.05	0.59	9.59	0.07	0.68
Height (cm)	7.37	0.05	1.36	8.99	0.06	1.10	6.50	0.05	0.93	5.65	0.04	0.88
Width (cm)	4.93	0.04	1.14	5.80	0.04	1.25	6.23	0.04	1.41	6.53	0.05	1.37
Weight (g)	179.92	1.29	2.90	367.87	2.63	3.19	282.63	2.02	2.59	356.40	2.55	2.79

The highest values of gain of total length and width were obtained in beetroot diet with 9.59 cm and 6.53 cm respectively, while the highest values in height and weight were obtained with TetraColor diet with 8.99 cm and 367.87 g. Hernández-Barraza *et al.* [2] which also cultured *O. niloticus* and Spring hybrid (*O. niloticus* x *O. mossambicus*) in a recirculation system, after 60 days, obtained a gain of 30.53 g and 30.17 g respectively, while Pargo-UNAM at 70 days of culture obtained gains of 20.89 g in control diet, but 39.25 g in TetraColor diet, 39.57 g in carrot diet and 44.36 in beetroot diet. For AGR values the highest values were obtained with beetroot (0.07 cm day^{-1}), TetraColor (0.06 cm day^{-1}), beetroot (0.05 cm day^{-1}), and TetraColor (2.63 g day^{-1}) for total length, height width and weight respectively. AGR values obtained by the organisms under beetroot diet was of 2.55 g day^{-1} which mean that the organisms would reach its commercial weight of 250 g in a period of 4.5 months, lower than the six months reported by CEIEGT [28], and the 10 months than normally takes to *O. niloticus*, which represents lower production costs. For IGR the highest value of total length was presented in beetroot with 0.68% day^{-1}, in trout for height with 1.36% day^{-1}, for width it was obtained in carrot diet with 1.41% day^{-1}, and for weight it was obtained in TetraColor with 2.90% day^{-1}. Comparing the obtained results to other works made with Pargo-UNAM, Hernández-Barraza *et al.* [2] made a culture in a recirculation system, using a commercial diet of Purina Nutripec, with 50% of protein, 15% of raw lipids, 2.5% of raw fiber and 12% of ashes; obtaining a growth rate of 0.256% g day^{-1}, a lower value to the one obtained in this investigation were it ranged from 2.59 to 2.90% g day^{-1}. Finally, it must be mentioned that the growth of the organisms is also due to the Biofloc system because this system converts nutrient excess in aquaculture systems into microbial biomass which can be consumed by fish in culture, lowering the maintenance costs because it can be used as food supplement of commercial organisms in cultivation, improving the food harvesting rates [29, 30].

4. Conclusions

The obtained results indicate that the contribution of diets rich in carotenoid pigments mean an improvement in height and weight gain in the culture system, allowing to obtain commercial sizes in a shorter period of time, making the culture of this organisms more profitable by reducing the maintenance time. Also, the use of Biofloc technology keeps proving to be a profitable alternative for tilapia culture. Nevertheless, it is recommended to determine an optimal level of protein in diet that allow a better growth, wellbeing and appearance of fish.

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