First findings on bioeconomic feasibility of the polyculture of Pacific fat sleeper (*Dormitator latifrons*) and Nile tilapia (*Oreochromis niloticus*) under tropical conditions

David J. Palma-Cancino[1], Fernando Vega-Villasante[1], Manuel A. Vargas-Ceballos[2], Carlos A. Álvarez-González[3], Rafael Martínez-García[3], Daniel Badillo-Zapata[1,4], Olimpia Chong-Carrillo[1]

[1] Universidad de Guadalajara, Centro Universitario de la Costa, Laboratorio de Calidad de Agua y Acuicultura Experimental, Puerto Vallarta, Jalisco, México. [2] Centro de Investigaciones Biológicas del Noroeste S.C. La Paz, Unidad La Paz, Baja California Sur, México. [3] Universidad Juárez Autónoma Tabasco, Villahermosa, División Académica de Ciencias Biológicas, Laboratorio de Acuicultura Tropical, Tabasco, México. [4] Programa Cátedra CONACYT, Consejo Nacional de Ciencia y Tecnología, Ciudad de México, México.

Introduction

The develop of native fish aquaculture represent an important alternative to mitigate ecological displacement generated by exotic fish with more developed markets. The introduction of native fish in polyculture systems with high commercial value fishes, has provide a useful strategy for development of native fish sustainable aquaculture (Wang & Lu, 2016).). The objective of this research was to analyze the bioeconomic feasibility of a polyculture system with the native fish *Dormitator latifrons* and *Oreochromis niloticus*, under controlled tropical conditions. A bioeconomic analysis approach was use to evaluate financial profitability of the production system.

Materials and Method

Biological. Juvenile of *D. latifrons* were captured in Quelele lagoon localized in Bahía de Banderas, Nayarit, Mexico, at 20°43'25.43'' N and 105°18'03.63'' W., and a total of 250 *O. niloticus* (Stirling) fingerlings were obtained from an aquaculture farm in Manzanillo, Colima, Mexico. The experimental unit consisted in a concrete pond with a capacity of 50 m^3, filled with running potable water, constant aeration and a 5% weekly water replacement. 250 organism of each species were placed in the pond, and for 90 days were fed two times a day using commercial feed Nutripec™ with daily fed portion adjusted according to total biomass at 4 %. Biometrics were taken monthly from random samples of 30 organisms per specie. Survival was obtained at the end of cultivation.

Economical. Initial investment was estimated for a total of six 50 m^3 concrete ponds. Estimation of an investment for six ponds was decided mainly based upon a minimum of 1,500 viable fingerlings per collect of *D. latifrons* juvenile. Operational costs estimated were fry (F_C), feeding cost (f_C), energy cost (E_C) and labor cost (L_C). Income were calculated using the total organisms of each specie (N_x) and the market value per kilogram of *O. niloticus* on site in Mexico (pT) (Domíguez-May *et al.*, 2020), and a unitary price per kilogram of complete organisms of *D. latifrons* (pD) twice the market size suggested by Basto-Rosales *et al.* (2020). To evaluate the financial profitability of the polyculture of *O. niloticus* and *D. latifrons*, the Net Present Value (NPV), Benefit-Cost Ratio (BCR) and Internal Rate of Return (IRR) were calculated with the following equations:

$$NPV = -INV + \sum_{t=1}^{T} \frac{NCF_t}{(1+i)^t}$$

$$BCR = \sum_{t=1}^{T} TI(1-r)^{-t} \Big/ \sum_{t=1}^{T} TC\,(1-r)^{-t}$$

$$IRR = \sum_{T=0}^{n} \frac{NCF}{(1+i)^n} = 0$$

Results and Discussion

Table 1. Zootechnical parameters from the polyculture of *Dormitator latifrons* and *Oreochromis niloticus* in concrete ponds. Data obtained ± SD. Different letters in each row represents statistical differences (P <0.05).

Zootechnical parameters	***D. latifrons***	***O. niloticus***
Initial weight (g)	16.9±5.6	13.1±4.3
Final weight (g)	152.1±62.6^b	187.5±70.3^a
Gained weight (GW) (g)	135.2±34^b	174.4±37.3^a
% gained weight (%GW) (%)	900±40.3^b	1431.3±46.7^a
Initial biomass (g)	4233.3±5.04	3270.5±4.3
Final biomass (g)	38,035.8±62.6	46,868.8±70.3
Gained biomass (g)	33,802.3±57	43,598.3±66
Total gained biomass (g)	77400.6	
Total feed consumption (g)	95040.65	
Specific growth rate (SGR)	2.44^a	2.96^a
Feed Conversion Ratio (FCR)	1.22	
Protein Efficiency Rate (PER)	2.33	
Survival (%)	98	98

The results suggest an absence of negative interactions and antagonistic behavior between both species. Individually, growth of *D. latifrons* was inferior to growth reported by Basto-Rosales *et al.* (2019). Survival in our research was high for both species, suggesting that *D. latifrons* can endure even higher stocking densities during mono and polyculture production systems. *Oreochromis niloticus* is a more active and voracious species than *D. latifrons*, which suggest behavior and feeding patterns may have an impact over individual gained weight (Hernández *et al.* (2014).

Table 2. Production costs, sales income and financial profitability indicators, estimated for a polyculture system of *O. niloticus* and *D. latifrons*, within six concrete ponds of 50m^3, a density of 10 fishes m^{-3}, and four cultivation cycles a year. [1]Estimated for a 10-year production. [2]Calculated with a discount rate of 6.66%. [3]Calculated with a MARR of 10% annually.

Production process	**Value (USD)**	
	Oreochromis niloticus	*Dormitator latifrons*
Fingerlings cost ($\boldsymbol{F_C}$)	240.00	360.00
Energetic cost ($\boldsymbol{E_C}$)	237.24	
Labor cost ($\boldsymbol{L_C}$)	584.1	
Feeding cost ($\boldsymbol{f_C}$)	1,072.06	
Annual investment depreciation	125.78	
Total Annual Production Cost ($\boldsymbol{TC}$)	2,619.18	
Profits	**Value (USD)**	
Annual income by species	2,668.22	1,054.63
Total Annual Production Income	3,722.84	
Financial feasibility analysis[1]	**Value**	
$\boldsymbol{NPV}$	12,925.88[2] USD	
$\boldsymbol{B/C}$	1.14[3] USD	
$\boldsymbol{IRR}$	19.61 %	

The economic analysis suggests that the initial investment is adequate for an aquaculture system in developing tropical regions. The IRR obtained during this research suggests the financial profitability of the polyculture system.

Figure 1 – 2. Examples of *Dormitator latifrons* obtained after a 90 days grow-out in polyculture with *O. niloticus*.

Conclussion

As a native fish with sub-develop regional market, introducing rural aquaculture of *D. latifrons* with a bigger market size fish like *O. niloticus*, may impact positively on the divulgation of its cultivation technology. The economic values obtained during the analysis, presented acceptable economic indicators, suggesting the financial profitability of the system. More studies with different densities and proportion of species are necessary to develop a sustainable production system.

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