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Economic Impact and Feasibility of Striped Catfish Farming (*Pangasius hypophthalmus*) in Mexico

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ABSTRACT

Objective: To assess the productive behavior of *Pangasius hypophthalmus* in actual rural aquaculture farming conditions for the state of Veracruz, Mexico.

Methodology: The study had a duration of 331 days in a circular pond of 135 m^3, with no aeration. 2000 juveniles were bred upon attaining 7.9 g; they were fed once a day, four days a week. Their weight and length were assessed every 15 days.

Results: The growth of *P. hypophthalmus* reached 900 g in 150 days at temperatures between 26 y 34 °C, with growths of 100 g in 150 days at temperatures between 22 and 26 °C. An average final weight of 1254 kg and a survival of 87.8% were attained for a total production of 2.2 t. These organisms may attain 2 kg per year at 26 to 35 $°C^{-1}$.

Study limitations: For a period of 153 days, water temperatures greater than 26 °C limited the growth of this fish.

Conclusions: The *Pangasius hypophthalmus* species represents an aquaculture alternative with high potential for tropical areas of Mexico, mainly where electric power availability is limited.

Keywords: aquaculture; Mexican tropic, employment.

INTRODUCTION

Mexico imports US$129 million per year in frozen striped catfish from Vietnam (VASEP, 2020). The amount spent on striped catfish fillets amounts to MX$204.25 million per month, which equals to 55 203 monthly minimum wages (MX$3 700), upon considering import price (self-estimates with information from VASEP, 2020). Should consumer price be considered, this amount doubles to 110 606 monthly minimum wages. On the other hand, the import of striped catfish fillet accounted for 150 mil t in 2015; nevertheless, it was decreased to 100 mil t in 2019, and Mexico was a country with 130 million inhabitants and the biggest importer of striped catfish on the planet only second to the United States (US), which has 327.2 million inhabitants (VASEP, 2020). (Figures 1 and 2). The world per capita consumption of fish amounts to 20 kg $year^{-1}$ (FAO, 2020c).

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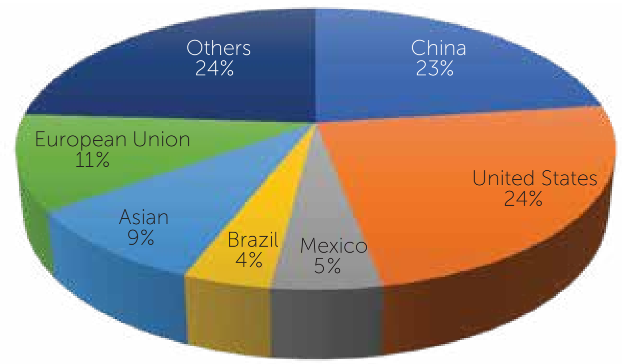

Figure 1. World *Pangasius* Imports from Vietnam (Percent). Source: Vietnam Association of Seafood Exporters and Producers (VASEP, 2020).

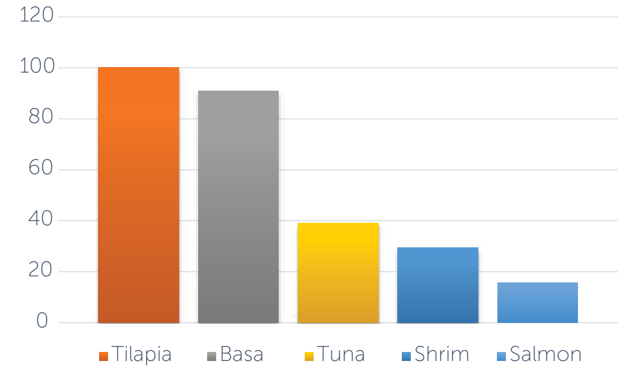

Figure 2. Mexican Imports of Fish and Seafood 2017 (Thousand t). Source: Ministry of Economy (2018).

Mexico has a *per capita* fish consumption of around 10 kg yr^{-1}, one of the lowest on the planet, despite having a great productive potential, in view of the amount of natural resources (water, light and temperature) that it has. Should Mexico wish to attain the 2030 United Nations Goal of consuming 36 kg of fish *per capita* per year^{-1} (FAO, 2020b), it needs to decrease its import, quadruplicate its supply and increase its aquaculture production 10-fold (Platas *et al*., 2017).

Pangasius hypophthalmus (Pangasiidae Family), commonly marketed in Mexican markets as striped catfish fillet, is a tropical fish that originates from Vietnam's Mekong River and Thailand's Chao Phraya River (FAO, 2020a). Its farming began in Vietnam in the decade of 1970 from juveniles captures from the rural medium. Striped catfish aquaculture began in 1996, with the development of controlled reproduction techniques (Phan *et al*., 2009). After one decade, it grew from a small backyard production to an industry producing more than 1.4 million t per year and generates more than 1.8 million rural jobs, with performances from 200 to 400 t ha^{-1} (De Silva & Phuong, 2011). Vietnam grew from 10 000 to 1.3 million t in 10 years (Figure 3).

The striped catfish has an increasing trend which will place it as an aquaculture species with greater production and consumption on the planet in the future. Above all, its production potential in units lower than 1 ha requires little capital; it is a mass consumption product by population with scarce resources, rich in high-quality protein and omega 3 and 6. (Platas *et al*., 2014).

Mexico is the fourth world importer of striped catfish only behind China and the US, although it shows a greater per capita consumption than the first two countries, as it consumes more than 150 mil t of fillets per yr^{-1}. (Platas *et al*., 2014). Nevertheless, Mexico does not produce striped catfish, reason why it imports 100% of its consumption and it is the second importing country behind the US (Figure 5). Should it be considered that 3 kg of live weight are needed for producing 1 kg of fillets, Mexico would import more than 300 000 t of whole fish from Vietnam. In Mexico, 1.0 t of whole striped catfish is sold at MX$70 000 (self-research in supermarkets of Veracruz City, Mexico, April 2019), which would represent the yearly rural income of one person. This represents thousands of jobs that Mexico pays to Vietnam producers, which could be

As a commercial aquaculture species, production, and distribution levels for *Pangasius* in world markets attain values nearby those of other species widely farmed, such as tilapia, white shrimp, and salmon. FAO (2018) reports that humanity consumes around 150 million t of fish and seafood. Currently, Vietnam is the greatest producer for this species and exports to more than 130 countries (Figure 4).

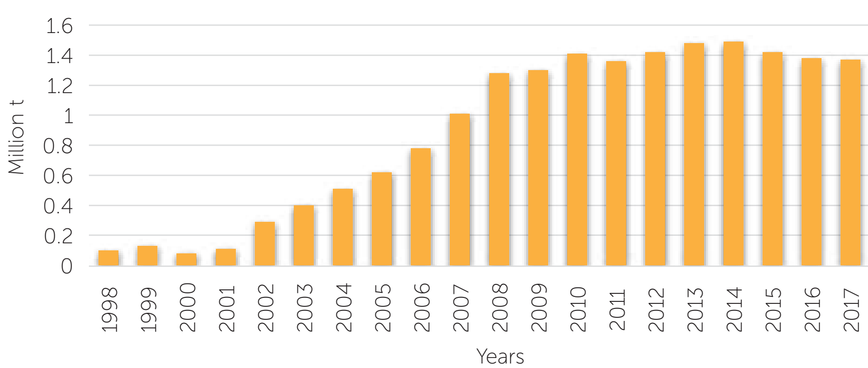

Figure 3. Vietnam *Pangasius hypophthalmus* Production 1998-2017. Source: VASEP (2020).

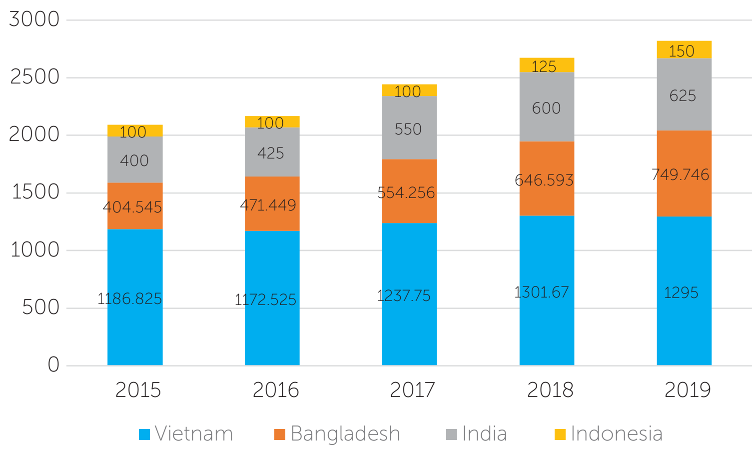

Figure 4. *Pangasius* production in selected countries (Thousand t). Sources: Global Aquaculture Alliance (2020).

created in Mexico. Striped catfish production would have a great economic and social impact in poor rural regions of the country.

The biological features of *Pangasius* are the baseline of its high production and have favored that it had reached world markets in little time; also, they make it an aquaculture alternative with great potential for tropical regions of Mexico (Platas *et al*., 2014). According to McGee (2009), this species has a rapid growth at 26 and 35 °C, its growth is reduced at 20 and 25 °C and it does not perform well under 20 °C. The farming adapts to high densities and direct oxygen may be extracted from atmospheric air, reason why no artificial aeration is required for the intensive farming thereof. It may also accept foodstuffs based on agricultural products and sub-products with no requirement of high animal protein content; also, it has a compensatory growth (Rohul *et al*., 2005). These features considerably reduce production costs and allow their farming in zones where electric power is limited or absent. *Pangasius* gathers biological features that allow it to adapt to low investment handling conditions, such as alternate feeding, no aeration and low maintenance. Natural conditions in Mexico are similar to those of Vietnam; the south-southeastern part of the country is a priority economic zone for rural development public policy and has sweet water; earth ponds for the production of this fish may be produced there. In Gulf of Mexico coastal zones, the only limitation would be a variation of low temperatures during winter, which is brought about by North winds.

Therefore, this study had the objective of assessing the productive behavior of *Pangasius hypophthalmus* in actual rural aquaculture farming conditions for the state of Veracruz.

MATERIALS AND METHODS

The study was made on a tilapia (*Oreochromis niloticus*) farm, located in the municipality of Paso de Ovejas, Veracruz, Mexico (19.293375 N, 96.370759 O, 13 masl). The commercial operation allocated a circular geomembrane pool of 12 m in diameter, 135 m^3 in capacity and with no aeration for the experiment. In autumn (30 August), with a water temperature of 30.5 °C, 2000 juveniles were farmed, and they had an average humid weight of 7.9±0.48 (standard error) g. They were fed on alternate days, once per day, 4 days per week. Commercial food with 35% protein and 8% fat was used. Before each feeding, water was discharged from the main drain for 3 min to partially remove accumulated sediment, and then the level was replaced with well water. A replacement of 20 to 30 % of water was performed once per week, depending on turbidity conditions. This handling procedure was performed for the 331 days of duration of the study. During feeding days, water temperature information was taken. A random sample was captured every 15 days for 30 individuals to assess standard weight and length.

RESULTS AND DISCUSSION

The water temperature record evidenced the stationary variation of temperature (Figure 6), which was important for this study.

The study began on 30 August (day 0), with a water temperature of 30.5 °C. As of this date, the water temperature was gradually decreased for 66 days until reaching 26.1 °C. On 19 November (day 81), the

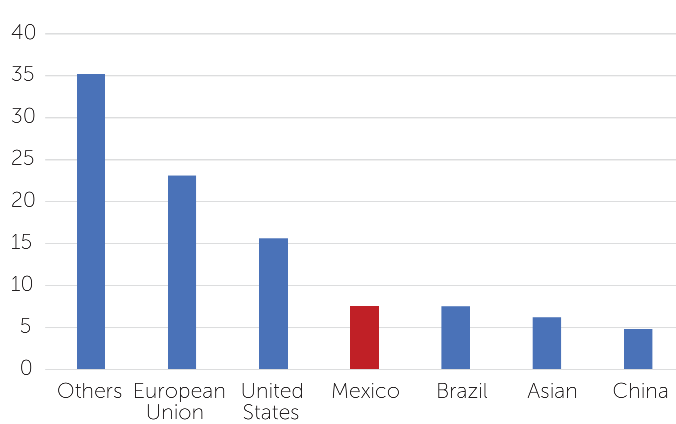

Figure 5. Vietnam's top *Pangasius* fish importing countries (Percent). Source: VASEP (2012).

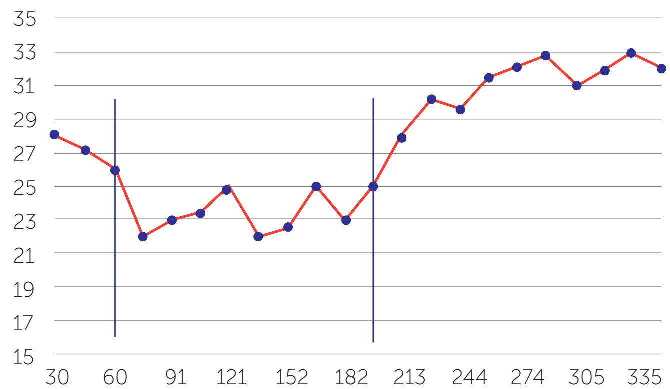

Figure 6. Water temperature (C) for the period of the *Pangasius hypophthalmus* growth trial on a rural farm in Veracruz state, Mexico. Short vertical lines delimit the winter period with temperatures below 26 °C.

temperature decreased rapidly down to 22 °C. This fall in temperature was due to the entrance of strong north winds derived from cold fronts characteristic of the central Veracruz region in winter. The gradual temperature recovery pattern, followed by a decrease thereof, repeated itself in winter. When spring began (21 March, day 203), a rapid temperature increase was produced up to 30 °C, followed by a gradual increase until 34 °C were reached on 24 May (day 268). This yearly variation of 12 °C, with a maximum of 34 °C and a minimum of 22 °C, influenced the growth of striped catfish.

Growth patterns in humid weight (Figure 7) truly reflected the temperature trends. *Pangasius* growth may be divided into three clear periods - the first appears before winter, with temperatures >26 °C, where an increase in average weight of 1.73 g per day^{-1} is seen. During the second period, corresponding to winter and temperatures <26 °C, fish grew 0.77 g per day^{-1} only. During the third period, with temperatures ≥30 °C, fish grew 7.3 g per day^{-1} in average; this growth rate is similar to that recorded by Cremer *et al*. (2002). In this period, fish grew from 217.1 g to 1254 g in 142 days; that is, a live weight increase of 1.04 kg per fish in 4.7 months. This is an accelerated growth if compared with the typical tilapia growth, which grows in the same farm and usually reaches 0.5 kg in 6 to 7 months, which is attained with greater handling, feeding and supplementary aeration (Rakocy, 1989).

The accelerated growth of *Pangasius*, even without requiring aeration and under limiting feeding conditions alternated once per day for 4 days per week, represents an extremely simple handling that requires little labor and low production costs. This means that the striped catfish may be produced easily in several conditions present in Veracruz. Nevertheless, low water temperatures present naturally are to be considered upon the arrival of cold fronts. Juveniles, the most sensitive stages, may be kept in controlled temperature conditions within small greenhouses. Likewise, breeders are to be kept at the same temperature conditions. Under this handling and feeding system, with previously mentioned market prices, the striped catfish in Mexico turns out to be highly profitable, with production costs of MX$22.00 kg^{-1} (self-estimation based on the cost of inputs for 2018).

During the winter period, fish considerably decreased food consumption (observed indirectly as it showed more non-consumed food residues during the periodic pond draining); also, it was observed that its abdominal area was flattened (with no food). The above suggests that growth decrease was due to a decrease in food consumption, brought by the decrease of metabolic activity at low temperatures. Despite its low growth during winter, 87.8% survived, which allowed a total production of 2.2 t. This amount is considered to be adequate for a pond of 12 m in diameter and represents an outstanding alternative both for backward aquaculture and commercial aquaculture. It also represents a great potential for tropical regions in Mexico, mainly where there is no electric power available. Several rapidly growing individuals reached 2 kg or more during this study, which does not discard the possibility of obtaining even greater yields with better handling of feeding, temperature and water quality.

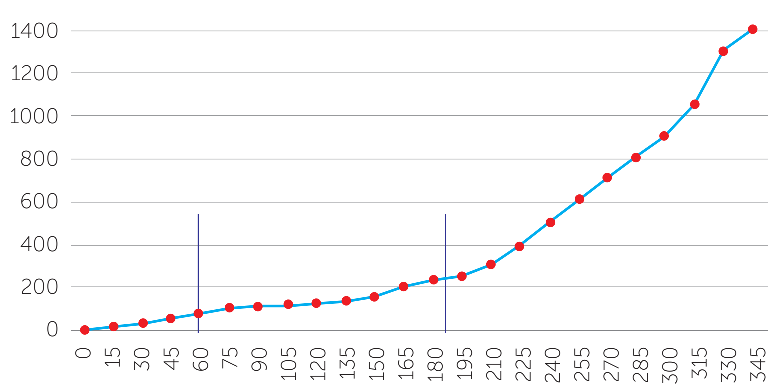

Figure 7. *Pangasius hypophthalmus* wet weight (g) growth curve on a rural farm in Veracruz State, Mexico. Short vertical lines delimit the winter period with temperatures below 26 °C.

Temperature influence in growth has important implications for the development of aquaculture farming handling for this species. Hence, when spring begins, stripe catfish juveniles could be farmed to seize the entire period of temperatures greater than 26 °C without going through the winter period. In order to attain this, a controlled breeding program is required during the winter in order to supply juveniles upon the occurrence of adequate temperatures. Another option is to breed when winter begins in order for the offspring to grow under greenhouse conditions and farming juveniles of an advanced size in uncovered ponds when spring begins. Each of both forms requires a controlled breeding program. Despite the limitations for this preliminary essay, results offer a clear feasibility insight for the farming thereof and show the importance of keeping temperatures above 26 °C during their growth period. This information also shows the need of research on this species in order to adapt the farming of this species consumed widely in Mexico to local rural conditions. Mexico has approximately 30 million hectares of tropical lands that allow producing *Pangasius* in the south-southeast region of the country and has an unsatisfied demand in the market. This simple production system may create hundreds of thousands of rural jobs, as well as supply high-quality protein rich in omega 3 and 6 for mass consumption by the population with low income.

CONCLUSIONS

Pangasius production is an aquaculture alternative that may be adapted successfully to the conditions of rural farms in tropical zones of Mexico, with water temperatures greater than 26 °C, both for rural backyard aquaculture and commercial aquaculture with potential to generate a great amount of jobs and quality protein at low cost.

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