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Polyculture and growth of the Nile tilapia *Oreochromis niloticus* (Perciformes: Cichlidae) with shrimp *Litopenaeus vannamei* (Decapoda: Penaeidae) in sea water

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ABSTRACT

Globally, the tilapia is the second most important group of commercial fish. Polyculture and growth were studied for 181 Nile tilapia, *Oreochromis niloticus*, in a seawater pond (30-37‰) at a density of 50 fish/m^3 for six months (October to April) with 30 shrimp *Litopenaeus vannamei* at a density of 8 shrimp/m^3 in two months (December-February) in an open tank of 3,6m^3. They were fed Camaronina"pellets" *at libitum* in the morning. The pond bottom was siphoned every other day, was maintained with constant aeration. Water exchange was 80% every two weeks. The temperature varied from 18 to 32°C. The tilapia grew from 72mm to 220mm, and 7g to 232g, survival was 92%. The total biomass was 38,6 kg. The shrimp grew from 6,8 g to 11,5 g and 102mm to 121mm. The survival rate was 100%. Total biomass was 219g. The feed conversion ratio (FCR) was 1,3:1,0 in both species. There was no problem between species; this polyculture is recommended.

KEY WORDS

Polyculture, growth, *Litopenaeus vannamei*, *Oreochromis niloticus*, biomass, density

RESUMEN

Se estudió el policultivo y el crecimiento de 181 tilapias del Nilo *Oreochromis niloticus* en un estanque con agua de mar (30-37‰) a una densidad de 50 peces/m^3 en seis meses (octubre a abril) con 30 camarones *Litopenaeus vannamei* a una densidad de 8 camarones/m^3 en dos meses (diciembre-febrero) en un tanque abierto de 3,6 m^3. Fueron alimentados "pellets" Camaronina *at libitum* en la mañana. El fondo del estanque fue sifonado cada tercer día, se mantuvo con aireación constante. El intercambio de agua fue del 80% cada dos semanas. El rango de temperatura varió de 18 a 32°C. La tilapia creció de 72mm a 220mm, y de 7g a 232g, la supervivencia fue del 92%. La biomasa total fue de 38,6 kg. El camarón creció de 6,8g y 102mm a 11,5g y 121mm. La tasa de supervivencia fue del 100%. La biomasa total fue de 219g. La tasa de conversión alimenticia (FCR) fue 1,3:1,0 en ambas especies. No hubo ningún problema entre las especies; se recomienda un policultivo de ambas.

PALABRAS CLAVE

Policultivo, crecimiento, *Litopenaeus vannamei*, *Oreochromis nilotica*, biomasa, densidad, supervivencia

The tilapia is a fish with high commercial value, the growth period is relatively shorter than other species and has a high capacity to adapt to different production environments (Granados, Garduño & Muñoz, 2002). Globally, the tilapia is the second most important group of commercial fish. Josupeit (2010) estimated production of 3,9 million tons in 2010 and by 2015 it will be 5,0 million tons.

Gillett (2008) mentions that the recent capture of shrimp in the world is about 3,4 million tons per year. Shrimp is the most important group of aquaculture (FAO, 2008), the shrimp industry is booming with more than 45 000Ha of crops in Mexico; the expansion capacity was more than 1 500Ha (Gutiérrez-Venegas, 2006).

A national market research in Nicaragua, conducted by the Central American University in December 2005, recorded an increase of 50% tilapia market, which means a 75% current demand, Saavedra (2006) mentions a preference of the public for product, suggesting an increase in the current production of tilapia.

APT-Aquaculture Production Technology Ltd. (2012) mentioned that tilapia can be grown at the same time, along with the shrimp in the same tank. Each organism occupies a different niche in the pond, the tilapia is developed in the volume of water while shrimp in the pond bottom. The relationship is not competitive (in food and territory), but compatible. It has been shown conclusively that the presence of tilapia in shrimp ponds increases the efficiency of shrimp growth. In an intensive shrimp farm to a low salinity Martinez (2008) mentioned that tilapia introduced in a mixed culture with shrimp, tilapia reached a weight between 341 and 679g, with 1,6 of FCR and survival of 78%, while shrimp averaged 13g at 123 days and 57% survival.

The aim is to calculate the growth and survival of Nile tilapia (*Oreochromis niloticus*) in polyculture with shrimp (*Litopenaeus vannamei*) in seawater and detect problems between the two species.

MATERIALS AND METHODS

In 2005 and 2006 the laboratory of the Mazatlan Academic Unit used an open air concrete tank (1,66 x 3,64 x 0,6m) with a volume of 3,63m^3 of seawater to grow tilapia *Oreochromis niloticus* began with 181 tilapias at a density of 50fish/m^3 for six months before acclimated to salt water in four days. The increase was gradual salinity 0-37‰ seawater, the first day began with 0‰ the second day with 18‰, the third day with 26‰, the fourth day was with 35-37‰ (Ortega-Salas, Castro & Núñez-Pastén, 2005). The tilapia started with an average of 72mm in total length an average weight of 7g began October 7, 2005 to April 27, 2006. Later 30 shrimp *Litopenaeus vannamei* were added from December 12 to February 15, 2006 to a density of 8shrimp/m^3 with an average of 102mm and 7g. Fish and shrimp were fed Purina pellets, "Camaronina" (with 40% protein) provided in two trays of food once a day, as required according to the food found in the trays. The amount of food provided was approximately 193g, at the end of the experiment the FCR was calculated for both species. The pond bottom was siphoned every other day and water was changed almost 80% at least every 15 days, salinity was measured with a refractometer, the values ranged between 30 and 37‰, if required, fresh water was added to balance evaporation. The temperature was between 18 and 32°C measured with a thermometer cuvette. Ten fish and five shrimp were measured with a ruler (mm) and weighed (monthly with an Ohaus 480 (0,001g.). Excel package was used for the calculation and graphics and the model of von Bertalanffy (Bertalanffy, 1938) to calculate the total growth of length of the fish over time (Fig. 1), taking into account the average at successive intervals in time, this model formed the basis for use regression total weight-total length (Fig. 3) to calculate the weight total overall length in time (Fig. 2). Survival was calculated at the end of experiment bearing in mind the number of initial organisms and harvested.

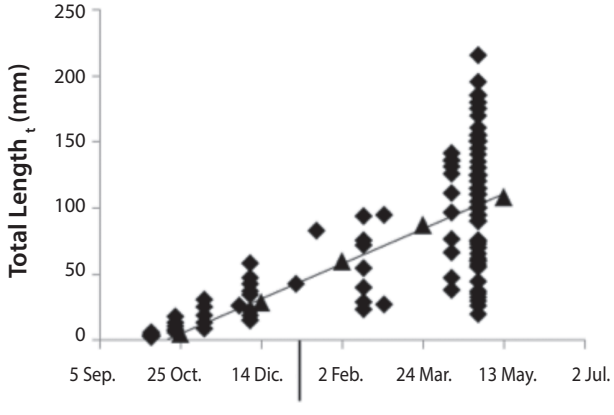

FIG.1. Variation in the total length in time points: ▲ The constants of Bertalanffy equation are as follows: K = 0,4618, L ∞= 249,32, T_0 = 0,12. The vertical line marks the year 2005 to 2006.

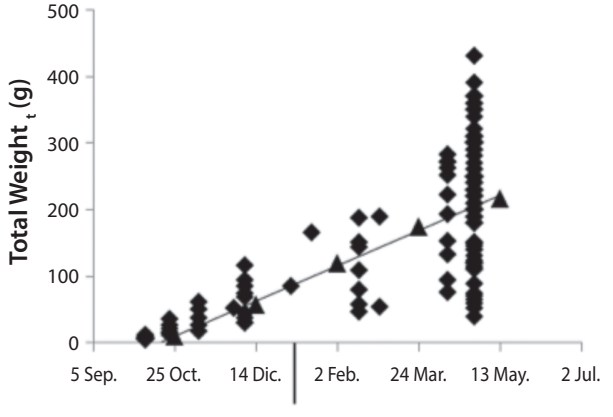

FIG. 2. Change in total weight over time. Points calculated (▲) with the equation of the weight-length relationship W_t(g) = 0,0000165Lt ^{3032} that based on the lengths in time obtained at constant intervals, using the equation of Bertalanffy; you get the following: time (t) 1 = 68g, 2 = 58g, 3 = 119.7g, 4 = 175g, 5= 298,5g. The vertical line marks the year 2005 to 2006.

RESULTS

The Bertalanffy model was used to calculate the total length and the total weight of fish growth over time (Fig. 1 and 2) with mean 58,4±SD 190mm and a total weight of 170g±112,1 SD, although there was 280mm with 480g tilapia, the total biomass was 36kg in six months at an initial density 50 fish/m^3. Survival was estimated at 92% with 167 fish. The FCR was 1,3:1,0.

Considering the average at successive intervals in time, the total weight-total length relationship of tilapia (Fig. 3) was used to calculate the total weight over time (Fig. 2) on the basis of calculation of growth by the total length in time with the method of von Bertalanffy.

At 60 days, the shrimp grew 102mm (0,6mm/day) with 6,8g (0,16g/day) to 121mm and 11,5g of 121mm although there were some shrimp with 13,6g, the biomass increased from 129g to 138g, although the density of 8 shrimps/m^3 is low, it is representative, when taking into account the density of tilapia. Shrimp survival was 100% with 30 shrimps. Its total length-weight relationship overall was as follows: $P\ (g) = 0{,}0000047\ L\ (mm)^{0{,}3075}$ $R^2 = 0{,}97$ (Fig. 4).

DISCUSSION

Many tilapia species are euryhaline, although the results of pre-acclimation to high salinity produce better survival rates in all commercial species of *Oreochromis* spp (Al-Amoundi, 1987). In this work, growth and survival at 35‰ salinity had good results. In this regard Mena-Herrera, Sumano-López and Macias-Zamora (2002) obtained at salinities of 35‰ an average weight of 358,58g at 27 weeks and a weight gain of 1,49g per day, also mentions a tendency to decrease the average weight by increasing the salt concentration. In this work the total weight gain per day was 1,22g and 217g were obtained at 24 weeks, although exceptionally, one tilapia reached 280mm and 480g, the density was 50 fish/m^3 in the 3,6m^3 water tank outdoors.

Suresh (1999) mentions that underfavorable environmental conditions tilapia can produce 30-40 g in the range of 2-4 months, which means a gain of 0,5g per day, while Cabrera, Millán, Rosas and Rangel (2001) mentioned that salinities between 28 and 36‰ growth of juvenile tilapia are more efficient when the temperature ranges of 27-32°C. The results of this investigation indicate that the salt ranged from 30 to 37‰ and temperature of 18 to 32°C had a gain of 1,22g per day at six months, the temperatures were similar and the density was high in small tank.

In this study, we had a survival of 92% to about 1,3:1,0 FCR in tilapia and shrimp, the shrimp reached an average total weight 11,5g, 100% survival at 60 days. These results show a mutual benefit so it is recommended you have more tanks like this outdoors, both species were also very healthy.

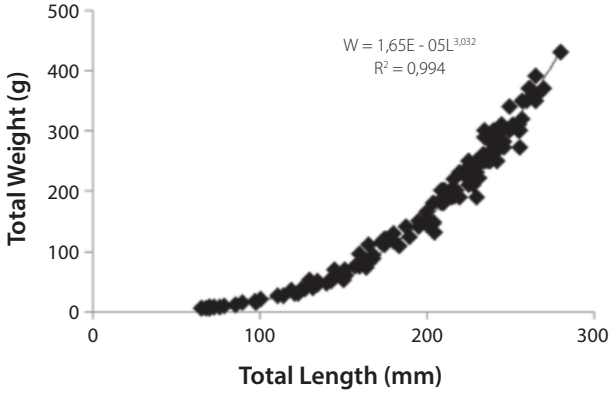

FIG. 3. Weight-length relationship of tilapia grown in a tank of 3,6m^3 in six months.

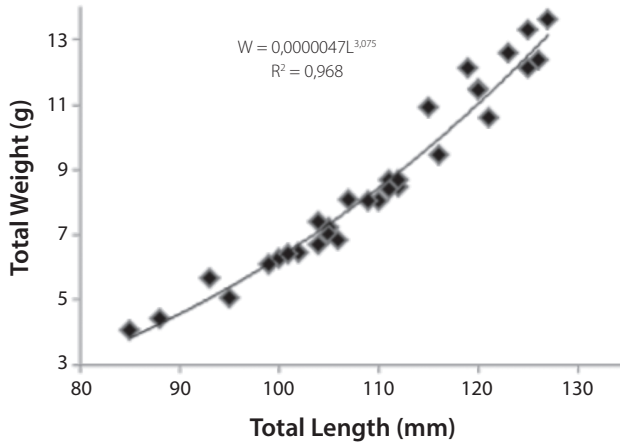

FIG. 4. Length-weight relationship for the shrimp.

The study shows that it is possible to make a mixed culture of tilapia with shrimp in sea water, they have a good growth rate and betteer survival.

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