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Research Article

The productive assessment of two tilapia nilotica (*Oreochromis niloticus*) commercial strains in Sinaloa Mexico

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ABSTRACT. This study compared survival, growth, feed conversion rate (FCR) and harvested biomass of two commercial strains of tilapia (*Oreochromis niloticus*) cultivated in Mexico: Spring Genetic-Benchmark Holding® originated from the Genetically Improved Farmed Tilapia GIFT (Genebank: GIFT GU477624.1) and strain B from different line-breeding (Genebank: Philippines GU477626.1, Guangdong GU477627.1, and America GU477628.1). The study was performed in six geomembrane ponds (2,520 m^3; 30×40×1.5 m) with supplementary aeration, in Los Pozos farm, El Rosario, Sinaloa, Mexico. In July 2016, 26,762 ± 170 fries of each strain (2.9 ± 0.1 g and 5.4 ± 0.2 cm) were cultivated in the nursery under similar conditions in triplicate at 11 ind m^{-3} for 34 days; then, they were transferred to the grow-out ponds and fed with 30% crude protein balanced feed (Purina®) at a rate of 12% live weight day^{-1} in three rations (07:00, 12:00 and 17:00 h) for 123 days. The results showed that Spring had a lower variation coefficient (VC) and higher survival, growth rate in weight, initial and final size, and harvested biomass. Survival was 30.7% greater in Spring and doubled harvested biomass (Spring 10 ± 0.8 t ha^{-1} *vs*. B strain 5 ± 4.7 t ha^{-1}). Sixty percent of the Spring population reached a commercial weight of 500 g in day 123th of cultivation compared with 20% of B population in the same period. Except for FCR, VC was lower in the Spring strain. Differences in productive parameters were probably due to the genetic selection programs at which both strains were subjected.

Keywords: *Oreochromis niloticus*; tilapia; grow-out; biofloc; commercial production

INTRODUCTION

Considering that food production is extremely important for the socio-economic welfare of humanity, freshwater aquaculture has gained considerable importance within production systems in the last years because it is a viable option in bio-ecological, nutrimental and socioeconomic generation for individuals, communities and the companies that develop those (Espinosa-Chaurand *et al.*, 2011).

Tilapia cultivation has shown an exponential production increase close to 4.8 million t in 2015 (GLOBEFISH, 2015); It is an alternative to satisfy food demand worldwide because of its rapid growth, adaptability, easy management, and sound production indicators. Mexican tilapia production by fishing and aquaculture is approximately 179,919 t with a commercial value of ~UD$178 million dollars, placing this activity in the third position in fishing and aquaculture in the country and second in production value (CONAPESCA, 2017). Each one of the production stages of this organism should be considered from biological and management viewpoints by increasing exploitation levels but decreasing environ-mental impact. Tilapia has potential qualities, such as rapid growth, resistance to management and diseases, and tolerance to adverse environmental conditions, high hatching densities, and physical and chemical variations in its environment to adapt to conditions of different aquaculture systems (Yuan *et al.*, 2010; Gómez-Ponce *et al.*, 2011; Vega-Villasante *et al.*, 2011; Brol *et al.*, 2017).

Around the world including México, different strains of commercial tilapia offer adequate genetic

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resources, specialized or adapted to the conditions of aquaculture producers. Genetic species improvement promotes enhancing system productivity (Hamzah *et al.*, 2014). Nevertheless, despite innumerable studies in which physical-chemical cultivation water, environmental conditions, fecundity, feeding habits, health and growth conditions on production have been assessed (Shafland & Pestrak, 1982; Watanabe *et al.*, 1993; Sifa *et al.*, 2002; Filho *et al.*, 2009; Domínguez-May *et al.*, 2011; Zhang *et al.*, 2016; Boerlage *et al.*, 2017; Fadla *et al.*, 2017; Gophen, 2017; Hossain *et al.*, 2017; Stickney, 2017; Devic *et al.*, 2018), variability among research results within this species have been reported frequently (Peterman, 2011). This variability could be explained in part by the genetic differences among the particular strains of the species used (Eknath *et al.*, 1993).

The strain from the Genetically Improved Farmed Tilapia (GIFT) program is an example of selective fry that has given place to a variety of freshwater fish strains used in aquaculture (Hamzah *et al.*, 2014). This strain was developed through a collaborative research program among the World Fish Center, the Institute for Norwegian Aquaculture Research (AKVAFORSK) and the Bureau of Fishing and Aquatic Resources (BFAR) of Luzon State University, Philippines, from 1988 to 1997 (Eknath *et al.*, 1993; Bentsen *et al.*, 1998; Eknath & Acosta, 1998). It has been cataloged as one of the most important strains worldwide because of its continuous betterment and feedback program, giving rise to new strains and production increase in the systems that have implemented it. Comparative studies have been carried out on its growth at experimental level where strain GIFT has been successful beyond local varieties, such as those in the studies of Sifa *et al.* (2002), Ridha (2006), Wijenayake *et al.* (2007), Santos *et al.* (2013), Hamzah *et al.* (2014), Silva *et al.* (2016) and Hossain *et al.* (2017). Through free commercial competence, products continue being developed to define their position in the market with genetic resources adapted to particular conditions of the regions and countries in search for incorporating the hybrid line-breeding vigor of strains and species (Eknath & Hulata, 2009; El-Zaeem & Salam, 2013; Day *et al.*, 2016), which has allowed having a wide array of options for brood stock. Thus, it is of great importance for the producer of the genetic resource, those in charge of the grow-out stage and participants in the tilapia production chain, to know the development of the strains generated and the existing betterment programs at a real production level. Therefore, the objective of this research was to compare two of the commercial tilapia *Oreochromis niloticus* of greater importance in the central western Mexican coast productively during the grow-out stage and biofloc culture at a commercial level.

MATERIALS AND METHODS

Organisms and experimental conditions

This study was performed in the commercial aquaculture production farm Los Pozos, in El Rosario, Sinaloa, Mexico (22°58'14.64"N, 106°09'07.98"W at 2 m.s.l.). The two strains with higher demand and importance in the central western Mexican coast: Spring (Spring Genetic-Benchmark Holding® originated from GIFT (Genebank: GIFT GU477624.1) and different line-breeding strain B (Genebank: Filipina GU477626.1, Guangdong GU477627.1, and America GU477628.1) produced in a laboratory in the state of Jalisco, Mexico were challenged in a commercial production system with biofloc technology.

A total of 132,000 ± 950 tilapia *Oreochromis niloticus* fry or stock with similar size and weight (2.27 ± 0.35 cm; 0.39 ± 0.05 g) were maintained in initial acclimation in raceway-type ponds of 40×5×1 m (200 m^3) with supplementary aeration (4 HP $tank^{-1}$) at a density of 660 ind m^{-3} for 35 days. The organisms at this maternity stage were fed at a ratio of 10% live weight in four daily portions (08:00, 11:00, 14:00 and 17:00 h) of commercial feed (Purina®, Jalisco, Mexico; 53% crude protein (CP), 12% moisture, 15% fat, 2.5% crude fiber, 12% ash, 5.5% nitrogen-free-extract). The two ponds used one per strain, were inoculated previously with 50 m^3 of a mature biofloc and enriched once a day (12:30 h) with 1.52 ± 0.45 kg of wheat flour and 3.50 ± 1.04 kg of sugar to maintain a density of 10.34 ± 1.11 mL L^{-1} in Imhoff cones. Water conditions were maintained stable at 30.75 ± 0.54°C, pH 8.06 ± 0.34, 5.95 ± 0.38 mg L^{-1} dissolved oxygen (DO), 1.46 ± 1.26 mg L^{-1} ammonium and 9.18 ± 0.45 ups.

From the initial strain after 33 acclimation days at sowing, 26,762 ± 170 organisms of similar size and weight (5.38 ± 0.15 cm; 2.95 ± 0.05 g) were selected per tank of 2,520 m^3 (30×40×1.5 m) at a density of 11 ind m^{-3} in the period of summer-autumn. Three ponds were used per strain with random distribution under a "blind" test to avoid management bias; the ponds used had geomembrane coating, and air diffusion was performed with a double-blade blower (10 HP $tank^{-1}$) located at opposite corners to generate circular flow in the tank. The biofloc in the ponds was generated directly in each one through system enrichment by adding 2.92 ± 1.64 kg wheat flour and 7.70 ± 4.03 kg molasses daily, which maintained a density of 10.31 ± 1.34 mL L^{-1} biofloc sediment particles in the Imhoff cones. Total water recharge of 276.1 ± 23.33% was

performed per tank (14.29% each 4.11 ± 0.36 days) in all the period. Fish were provided with commercial feed (30% CP; Purina®, Jalisco, Mexico) with 12% live weight of biomass per tank three times a day (07:00, 12:00 and 17:00 h) for 123 days. The ration was adjusted with weekly biometry. The physical and chemical parameters (temperature, oxygen, pH and salinity) were taken twice a day in the same feeding schedule with a multi-parameter; ammonium was measured by the colorimetric method with Kit API (Aquarium Pharmaceutical®).

Productive parameters

Growth parameters were calculated with an initial and final biometry of 200 ind/tank^{-1} and weekly biometry of 50 ind/tank^{-1}; for this purpose, the organisms were measured (ichthyometer; cm) and weighed (digital balance Scout pro OHAUS®; 0.0 g). To determine survival, all organisms were recorded for total biomass at the start of the experiment and by total count of organisms harvested per tank. Production parameters were calculated according to the following: survival (%) = 100 - (ind. initial - ind final/ ind initial) ×100; change in size (cm d^{-1}) = final size - initial size/ experiment days; change in weight (g d^{-1}) = final weight - initial weight/experiment days; % increase in length (IL; %) = [(final size - initial size)/ initial size] ×100; % weight increase (WI; %) = [(final weight - initial weight)/ initial weight] ×100; specific growth rate in weight (SGR) = [(ln final weight - ln initial weight)/ experimental days] ×100; food consumption (FC) = food provided/fish in tank; crude protein consumption (CPC) total (g ind^{-1}) = CPC provided/fish in tank; feed conversion ratio (FCR) = food apparently consumed/ increase in weight; protein efficiency rate (TEP) = increase in weight/protein apparently consumed.

Statistical analyses

A one-way analysis of variance (ANOVA) was applied to productive yield generated data (survival, initial and final weight, change in weight, initial and final size, change in size, IL, IP, SGR, FC, FCR and TEP), previous to normality tests (Kolmogorov-Smirnov, $\alpha = 0.05$) and homoscedasticity (Bartlett, $\alpha = 0.05$). Arcsin square root transformation was applied to data shown in percentage (survival, IL and WI) (Zar, 1999). Significant differences among treatment means were determined by Tukey's multiple comparison method ($\alpha = 0.05$). All tests were performed with the statistical software SigmaStat v3.1 (2004).

RESULTS

The results obtained after cultivation (157 days) are shown in Table 1. No significant differences were observed in growth parameters at maternity or grow-out ($P > 0.05$) stages. In the maternity stage, only were weights and initial and final sizes compared; for 33 days, weight gain at the maternity stage was 3.07 ± 0.00 g and size 3.55 ± 0.05 cm with 0.99 ± 0.02 FCR between both groups of organisms under the same culture and management conditions. An apparent final difference was observed in survival between Spring strains with a percentage unit of 5.93 more organisms than strain B.

In the grow-out stage (123 days), no statistical differences in growth parameters were observed between both strains ($P > 0.05$), with a final weight of 465.45 ± 89.11 g (528.46 ± 53.05 g strain Spring and 402.44 ± 102.32 g strain B), size of 26.38 ± 1.47 cm and FCR of 1.02 ± 0.05. However, a higher growth behavior was observed in Spring. With a difference between average final weights of 126 g, 1.02 g in daily weight gain and 2.08 cm in final length, and FCR was 0.07 lower in Spring than in B. A stronger, but not a statistical difference ($P > 0.05$), was observed in Spring strain (71.25 ± 1.79% of survival) with 30.68 percentage units above B strain where its variation coefficient (CV) was 86.94%. This result implied production superiority per hectare of Spring with double tons produced compared with B (10.02 ± 0.84 t ha^{-1} for Spring *vs*. 5.00 ± 4.74 t ha^{-1} for strain B) showing a CV of 94.88% in final biomass and production of kg m^{-3}.

In terms of product yield, no significant differences were observed between both strains ($P > 0.05$), showing a yield of gutted fish of 88.85 ± 0.86% and in fillet of 26.71 ± 1.24% with a weight per fillet of 128.35 ± 29.75 g, and volume of 136.40 ± 24.98 cm^3 (13.61 ± 0.64×7.03 ± 0.45×1.42 ± 0.14 cm). Despite these results, and in productive terms, a higher mean (38.30 g and 1.21 cm in Spring fillets (147.50 ± 21.79 g; 14.23 ± 0.75 cm) were observed compared with B (109.20 ± 25.26 g; 12.99 ± 2.23 cm). The growth trend of the two strains assessed during grow-out is shown in Figure 1.

In the grow-out stage a greater growth was observed at 123 days in strain Spring, making a difference in a superior growth trend starting from day 70 of the productive challenge (200 g in weight); Additionally, strain B would need 12 days more than Spring to reach the commercial weight of 500 g (five days after ending challenge). From 9 to 52 days of culture, a sanitary contingency took place in the six culture ponds (shady area under the curve trend, (Fig. 1); the organisms were detected with bacteria *Acinetobacter* sp., *Aeromonas hydrophila*, *Aeromonas* sp., *Aeromonas veronii*, *Bacilli* sp., *Bacillus* sp., *Citrobacter freundii* and *Pseudomonas* sp. in the spleen, diagnosed by Laboratorio de Referencia, Análisis y Diagnóstico en Sanidad Acuícola

Table 1. Growth parameters at maternity and grow-out stages in the productive assessment of two commercial tilapia *Oreochromis niloticus* strains (Spring *vs.* strain B) for 157 days (34 days in the nursery and 123 in grow-out) in Los Pozos farm, El Rosario, Sinaloa, Mexico. Average ± standard deviation. [+]For the calculations, two replicates were used for mortality of 98.63% in the third replicate. *No significant differences ($P > 0.05$). **No statistical analysis was performed. One water recharge was performed starting from day 46 of culture. Variation coefficient = (standard deviation × 100) / average.

Stage	Nursery		Grow-out		Variation coefficient (VC)	
Parameter	Spring**	B**	Spring*	B*	Spring	B
Survival (%)	94.48	88.55	71.25 ± 1.79	40.58 ± 35.28	2.51	86.94
Initial weight (g)	0.43 ± 0.12*	0.36 ± 0.13*	2.99 ± 0.21	2.91 ± 0.06	7.13	2.18
Final weight (g)	3.49 ± 0.89*	3.43 ± 0.76*	528.46 ± 53.05	402.44 ± 102.32	10.04	25.42
Weight change (g d^{-1})	0.09	0.09	4.27 ± 0.43	3.25 ± 0.83	10.14	25.61
Specific growth rate (SGR)	6.36	6.84	4.21 ± 0.14	3.99 ± 0.21	3.28	5.38
Initial size (mm)	2.02 ± 0.30*	2.52 ± 0.37*	5.28 ± 0.54	5.49 ± 0.04	10.27	0.70
Final size (mm)	5.61 ± 0.58*	6.03 ± 0.64*	27.42 ± 0.67	25.34 ± 1.53	2.44	6.05
Size change (mm d^{-1})	0.11	0.11	0.18 ± 0.01	0.16 ± 0.01	3.17	7.89
Food consumption (g d^{-1})	0.09	0.09	4.18 ± 0.11	3.80 ± 0.58+	2.75	15.38
Feed conversion ratio (FCR)	0.98	1.00	0.98 ± 0.08	1.05 ± 0.04+	8.18	3.71
Protein efficiency rate (TEP)	2.04	1.99	3.41 ± 0.29	3.18 ± 0.12+	8.48	3.71
Crude protein consumption (g d^{-1})	0.05	0.05	1.25 ± 0.03	1.14 ± 0.18+	2.75	15.38
Tank volume (m^{-1})	200	200	2520**	2520**		
Water recharge (%)	100	100	14.29**[1]	14.29**[1]		
Days between water recharge	1	1	4.10 ± 0.32	4.12 ± 0.47		
Initial density (ind m^{-3})	650.00	650.00	10.57 ± 0.07	10.67 ± 0.02	0.62	0.17
Final density ((ind m^{-3})	614.12	575.57	7.53 ± 0.22	4.33 ± 3.73	2.92	86.87
Initial biomass (kg $tank^{-1}$)	55.67	46.64	79.59 ± 6.15	78.21 ± 1.63	7.72	2.08
Final biomass (t $tank^{-1}$)	0.43	0.39	10.02 ± 0.84	5.00 ± 4.74	8.34	94.88
Biomass (kg m^{-3})	2.14	1.97	3.98 ± 0.33	1.98 ± 1.88	8.34	94.88
Eviscerated yield (%)			88.31 ± 0.69	89.39 ± 0.69		
Fillet yield (%)			26.92 ± 1.55	26.49 ± 1.15		
Fillet weight $fish^{-1}$ (g)			147.50 ± 21.79	109.20 ± 25.26		
Fillet length (cm)			14.23 ± 0.75	12.99 ± 2.23		
Fillet width (cm)			7.16 ± 0.51	6.90 ± 0.44		
Fillet thickness (cm)			1.45 ± 0.19	1.40 ± 0.11		

cola at CIBNOR; a sanitary combat protocol and commercial prevention were applied with enrofloxacin, oxytetracycline and florfenicol dosed to the biomass of each tank using the feed supplied for 43 days.

Figure 2 shows the growth frequency analysis at 123 days with type intervals of 50 g in the productive comparison of two commercial tilapia *Oreochromis niloticus* strains in the farm Los Pozos, El Rosario, Sinaloa. The growth trend of the class groups of the two populations showed that 60% of strain Spring had an equal or superior growth to 500 g. In contrast, strain B had equal or superior weight than the other one in only 20% of its population in the same period with a lag of 150 g between weight frequencies of the two strains with greater organism presence.

DISCUSSION

Currently, at a productive level, few scientific reports are available on assessment of the strains that are offered in the market under environmental and management conditions with which the producers usually have to face up cycle after cycle of production. This study did not find significant environmental variations in 156 days of the experiment, maintaining the production system within the optimum intervals for the species (30 ± 2°C; pH 7.5 ± 1.0; DO 4 ± 2 mg L^{-1}, and ammonium 1.3 ± 0.7 mg L^{-1}; Vinatea, 2002; Saavedra, 2006; Vega-Villasante *et al.*, 2009; Marín, 2013), ruling out the influence of environment factors on the productive results of the strains. Temperature is considered one of the main environmental factors that

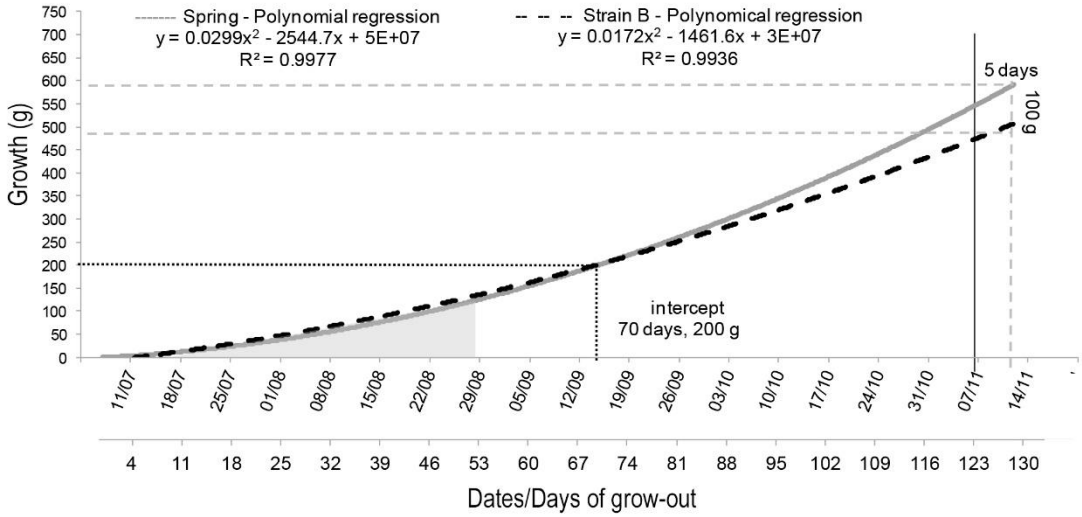

Figure 1. The growth trend in the productive assessment of two commercial tilapia *Oreochromis niloticus* strains (Spring *vs*. strain B) in the farm Los Pozos, El Rosario, Sinaloa, Mexico. The vertical black line marks 123culture days. Dotted gray lines show the intersection point of the growth trend lines between strains. Dashed gray lines show growth projection after 123culture days. The gray-shaded area under the trend line shows the sanitary contingency period (from 9 to 52 days of culture).

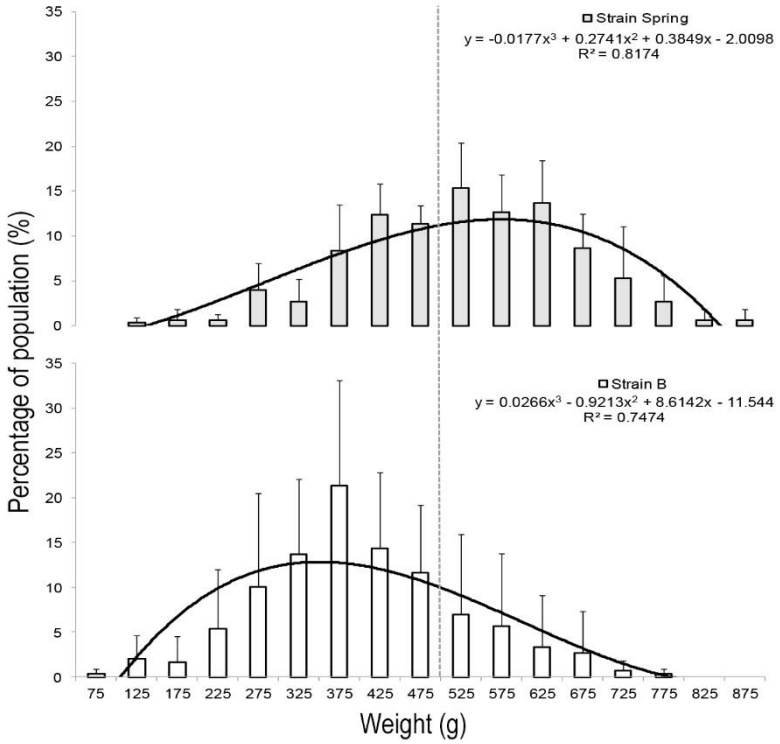

Figure 2. Frequency analysis of weights at 123-culture days in the productive assessment of two commercial tilapia *Oreochromis niloticus* strains (Spring *vs*. B) in the farm Los Pozos, El Rosario, Sinaloa, Mexico. Weights in the horizontal axis are the mean of the type 50 g intervals. Vertical lines above the bars show the standard deviation of the population percentage per type interval. Gray dotted vertical line shows the commercial weight of 500 g. Gray line curves show the accumulation trend of the population concerning the final weight of the organisms.

affect the metabolisms on cultured organisms, as well as on their development and survival. Santos *et al.* (2013) mentioned that temperature could have an influence on weight and inflection on fish age; thus, the

effect of thermal fluctuations in tilapia growth depends on organism size where these fluctuations favor growth of small juveniles and are inadequate in the exponential growth phase (Azaza *et al.*, 2008). Temperature could exert an accelerating effect on chemical reactions, such as those in metabolism, so their increase could intensify oxygen transport and consumption problems (Eckert, 1990; Xie *et al.*, 2011) while a decrease in temperature implies a decrease in fundamental functions, leading to a reduction in metabolic capacity, feed, growth, reproduction and locomotion (Gándara, 2003).

When speaking of species strains and varieties in productive terms, a wide array of results exist because growth yield depends on the genetic materials used, food, management, feeding type, stocking density, grow-out time and environmental conditions (Gjedrem, 1997; El-Sayed, 1999; Ashagrie *et al.*, 2008; Santos *et al.*, 2013). The majority of studies are performed at the experimental level and at the moment of scaling up the results, they confront changing conditions of the production systems to which the aquaculture producers face up day by day. Furthermore, the vast offer of new strains in tilapia farms show different growth, mortality, adaptability, resistance to environmental conditions, food consumption/conversion and fry uniformity (Santos *et al.*, 2013). Therefore, the systematic effort for genetic quality of the organisms used in aquaculture becomes necessary (Bentsen *et al.*, 1998; Hamzah *et al.*, 2014) to have reproducible results and with minimum variation in productive yield parameters to provide certainty to the aquaculture sector.

This study did not show statistical differences in the production parameters assessed. However, a trend of better mean values for the majority of the Spring strain parameters and high dispersion of the resulting values in strain B was observed. Standard deviation is the variation measure of a set of data intervening in the analyses of variance to determine the statistical differences. Sometimes, it is not possible to find differences between the assessed sets when the dispersion of a data set is broad concerning its mean. Nevertheless, a relative measure of this variance, when expressing the standard deviation as a percentage of the mean (variation coefficient), constitutes a useful statistic tool to compare the variability of two or more variables (Zar, 1999; Daniel, 2009). Within aquaculture practice, sometimes a high dispersion results when an unusual event modifies one of the variables involved in the system. In this study, the only modified variable between treatments was the type of strain. One high variation coefficient within any production parameter in aquaculture represents economic losses for the producer and uncertainty in its production due to the low reproducibility of the results and sustainability for the system. This result was observed in the high coefficient variation of the productive results that strain B showed, which could suggest an intrinsic productive characteristic of its own given its absence or by the genetic improvement program it had (Moreau & Pauly, 1999; Gupta & Acosta 2004; Kamaruzzaman *et al.*, 2009), reducing its commercial appeal.

Many producers have considered that growth and betterment of the organisms give one of the main characteristics of a productive yield by the selection program that offers its improvement (Santos *et al.*, 2013). A clear example of selection used in aquaculture that has given place to a wide variety of freshwater fish fry is the GIFT (Hamzah *et al.*, 2014) strain. This strain has been used and experimented around the world, monitoring its performance and finding a more significant and sustainable improvement in weight and harvest time beyond other strains and local varieties (Bentsen *et al.*, 1998; Santos *et al.*, 2013; Hamzah *et al.*, 2014; Silva *et al.*, 2016). This behavior was also observed in this research in weights measured and production time between strains Spring (GIFT) and B.

Santos *et al.* (2013) compared three temperatures (22, 28 and 30°C) and growth of the strains GIFT, Supreme and Red for 120 days, utilizing fry of 1.47 a 1.88 g initial weight; the most significant growth was shown by the GIFT strain in the three temperatures with an increase in maximum weight of 397.52 g and variation coefficients for the strain less than 36%. Silva *et al.* (2016) assessed the optimum tilapia nilotica fry density between the strains GIFT and Thai; they found that GIFT showed a better yield for total length and biomass compared with Thai without interaction among biological variables between strain and density. Tenywa *et al.* (2016) assessed growth parameters of four varieties and one strain from the largest lakes of Uganda, Lake Victoria, Lake Kyoga, Lake Edward, Lake Albert and a farm in Kampala for 132 days sowing fry from 1.21 to 19.25 g. The best productive yields were obtained with a variety of Lake Victoria, whose results were attributed to the genetic and environmental factors to which these organisms are adapted. Lake Victoria has a high genetic exchange rate among populations and primary productivity, while those coming from Kampala farm showed consanguinity of more than five generations caused by utilizing the same broodstock (Hussain & Mazid, 1999; Tenywa *et al.*, 2016). Both studies agree with ours, where the genetic factor was the one providing the difference among the results obtained, of which the strain GIFT (Spring) was the one that obtained the best results. On the contrary, Ribeiro *et al.* (2008) did not find differences attributed to the strain in the performance study between the strains Bouaké and Chitralada in mixed systems.

Workagegn & Gjoen (2012) mentioned that the growth obtained was from 40.63 to 51.64 g, with SGR of 2.3 to 2.6 and FCR of 1.72 to 1.82 at 20°C when comparing tilapia varieties of Ethiopia main lakes (Lake Hawassa, Lake Ziway, Lake Koka and Lake Hora) for 60 days. They reported that the variation found in all varieties was not affected by the extreme factors or initial size of the organisms but by the intrinsic variation of the strain. It agrees with that found in this study where the differences in product yield and growth parameters might have been due to the variations of the strains utilized once the variations by the effect on management, feeding, system and environment were dismissed, finding a greater sustainable response in strain Spring (GIFT). Several studies that have assessed yield and productive behavior of different varieties and strains of tilapia nilotica (*Oreochromis niloticus*) agree with this result. They found that the variation in productive yield and parameters were affected by the differences among the varieties and strains utilized (Eknath *et al*., 1993; Palada-Vera & Eknath, 1993; Abdel-Tawwab, 2004; Ridha, 2006; Ibrahim *et al.*, 2012; Workagegn & Gjoen, 2012; Brol *et al.*, 2017), which increases the use of this commercial strain for continuous improvement of the production systems at socioeconomic level.

According to what was previously mentioned, we can conclude that the strain Spring (GIFT) had the best productive yields in time, growth and stability of the productive results at the level of commercial culture under the environmental characteristics and management in the central western coast of Mexico. The difference between results and variability could be attributed to the characteristics of the strains. Thus the difference in the productive parameters between the two strains studied was very likely due to the genetic selection of the strain Spring and its management program, compared with the genetic variability of strain B composed by line breeding. Therefore, utilizing a genetic resource that offers homogeneity in the final commercial product with excellent productive indicators as required by the markets represents an advantage for producers.

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