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Feasibility of *Litopenaeus vannamei* (Crustaceae, Decapoda: Penaeidae) in areas from groundwater. Miranda Municipality, Zulia State, Venezuela

Factibilidad de *Litopenaeus vannamei* (Crustácea, Decápoda: Penaeidae) en áreas provenientes de agua subterránea. Municipio Miranda del estado Zulia - Venezuela

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Abstract

The purpose of this study was to evaluate the growth, survival and productive yield of *Litopenaeus vannamei* at planting densities of 22 Ind m-2 in low salinity waters. The results of the culture of the white shrimp *L. vannamei* are presented. PL of 0.023±0.013 g were planted in 1 ha pools at densities of 22 Ind/m2. Physicochemical parameters were measured in the field (dissolved oxygen, temperature, salinity, pH, ammonium, transparency, hardness and alkalinity). The average salinity during the days of culture was 4.8 ‰. PL were acclimatized and adapted to freshwater for 72 h, in 2000 L fiber tanks before starting the culture cycle. The seeded shrimp were fed a commercial diet (35 % protein) three times a day, the ration was adjusted daily according to the monitoring results of 9 feeding troughs located in the pools. A statistic with descriptive representation was used in the study of the derivations. The crop assumed a permanence of 128 days and the following production indicators were verified: 74 % survival, 14.92 g average weight, 1.9 FCA and a yield of 1935 kg/ha/cycle. The results obtained allow us to conclude that, at the El Retorno farm in the Miranda municipality, there is the possibility of planting these crustaceans with subway water, achieving growth and survival related to lucrative yield censuses at low salinity.

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Resumen

El propósito de este estudio fue evaluar el crecimiento, sobrevivencia y rendimiento productivo de *Litopenaeus vannamei* en densidades de siembra de 22 Ind m^{-2} en aguas de baja salinidad. Se presentan los resultados del cultivo del camarón blanco *L. vannamei*. Se sembraron PL de 0.023±0.013 g, en piscinas de 1 ha a densidades de 22 Ind/m^2. Los parámetros fisicoquímicos se midieron en el campo (oxígeno disuelto, temperatura, salinidad, pH, amonio, transparencia, dureza y alcalinidad). La salinidad promedio durante los días de cultivo fue de 4.8 ‰. Las PL estuvieron aclimatadas y adaptadas al agua dulce durante 72 h, en tanques de fibra de 2000 L antes de iniciar el ciclo de cultivo. Los camarones sembrados fueron alimentados con una dieta comercial (35 % de proteína) tres veces al día, la ración se ajustó diariamente de acuerdo a los resultados del monitoreo de 9 comederos de alimentación ubicadas en las piscinas. Se utilizó una estadística con representación descriptiva en el estudio de las derivaciones. El cultivo asumió una permanencia de 128 días y se verificaron los subsiguientes indicadores de producción: 74 % de sobrevivencia, 14.92 g de peso promedio, 1.9 FCA y un rendimiento de 1935 kg//ha/ciclo. Los resultados obtenidos, permiten concluir que, en la granja el Retorno del municipio Miranda tienen la posibilidad de la siembra de estos crustáceos con agua subterránea, logrando un crecimiento y supervivencia relacionados con censos lucrativos de rendimiento a baja salinidad.

Palabras clave:

Acuacultura, camarón, cultivo, crecimiento, producción.

Introduction

Coastal shrimp farming is in improvement, and nowadays it is an excellent option to study the ideal conditions for the development of these, because its production is increasing due to its great commercial demand and benefits reported through the fishing action[1-4]. For the production and economic income of productive coastal shrimp farming, the strategies should not be fixed but more malleable to agree with the changes that may occur in the same[5]. In addition, biosecurity has been shown to be a great need for the productive sector due to the periodicity, dimension and nature of the ailments that disrupt penaeid shrimp[6].

Its commercial production in Venezuela has expanded lately with great financial speed[7,8]. In the country almost all shrimp farming entities have expanded means of production with various methods of operation, which resulted in the knowledge of procedures used in other nations, as well as mechanisms, facilities and trained personnel[9,10].

This expansion has been characterized by an increase in the development of advanced technology, which is equally important at the national level. *Litopenaeus vannamei* is a type of crustacean cultivated in Venezuela, whose yield (kg ha^{-1}) is among the highest in Latin America[11,12]. The main markets for Venezuelan shrimp are Europe and the United States. During the course of the years 2010 and 2018, exports to the United States trade have remained more or less stable, ranging between 2000 and 4000 t per year[3]. Exports to the European market have suffered a greater fluctuation, since they maintained an upward trend in the period from 2010 to 2012, and then reversed between 2012 and 2014, with a downward trend that was significant, however, it was recovering from 2015. Exports of shrimp from Venezuela barely represent just over 2 % of the total of 685 000 t from Latin America for the year 2018, in this Ecuador is clearly the main exporter, with a share equivalent to almost 57 %. The rest of the exports were made by countries such as Brazil, Nicaragua, Honduras and Mexico[13].

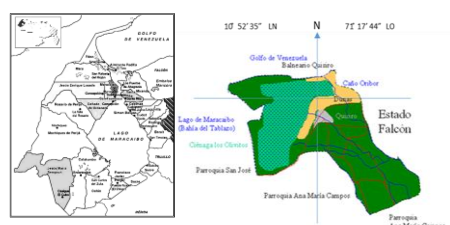
In this sense, Venezuela, with its boost in commercial production and its geographical location, provides quick access to the most important markets, in addition to offering suitable land, a vast network of water resources for exploitation, and stable weather conditions with little exposure to natural phenomena. The cultivation of marine shrimp in groundwater would provide a solution to this growing need to expand and increase this kind of exploitation to other areas separated from the coastal zones, as a productive alternative of high commercial value. This culture, using lower salinity groundwater, has been developed in different locations in North America, Ecuador, Thailand, China, Mexico and Venezuela[14].

It is important to point out that, in the current production, there are some difficulties related to climatic contexts, violent changes in water quality, stress and shrimp mortality due to diseases, genetic mutability, safe feeding rates and changes in the variety and quantity of phytoplankton, among other relevant aspects[15]. However, groundwater establishes a natural resource of the subsoil and a faculty for the development of agro-industrial projects, such as shrimp farms and other biospheres. In that sense, shrimp farms are a great option to spread this archetype of cultivation in low salinity waters with a possibility of valuable productive amount. Therefore, the purpose of this study was to evaluate the growth, survival and productive yield of *L. vannamei* at seeding densities of 22 Ind m^{-2} in low salinity waters.

Materials and methods

The work was carried out at a Granja Camaronera El Retorno Agropecuaria, C.A, located in Quisiro, Miranda municipality, Zulia state, Venezuela (10°52′33″ LN and 71°17′44″ LO) (Figure 1). Four ponds were used for the study, 0.25 ha in size, with approximately 500 shrimp each. The production phase was from January to May 2021, depending on the date of planting in the ponds, the production cycle was 128 days. The water used came from 2 deep wells of approximately 75 m depth. The following parameters were checked: dissolved oxygen (mg L^{-1}) and temperature (° C), analyzed with a multiparameter probe (YSI Pro20), salinity (‰) with a refractometer (ATC), transparency in (cm) was measured with Secchi disk, alkalinity, ammonium and hardness, an aquaculture kit model AQ-2 was used which incorporates rigorous equipment for harvesting fish in ponds[16]. Nine critical test factors can be determined efficiently and accurately on site. and the minerals analyzed were measured by atomic absorption spectrometry, a technique or procedure of methodical chemistry that allows to calculate the determined concentrations of a material in a composition and to establish a greater diversity of elements[17,18] at the Water Research Center of LUZ (University of Zulia). The postlarvae (PL 12) came from a commercial laboratory in the Paraguaná peninsula of Falcón state, and were subjected to a 72 h adaptation period. In this time interval, salinity was slowly decreased from 35 ‰ to 5 ‰. During the acclimatization process of PL 12, specific food consisting of artemia salina and dry diet of microparticles at 2 h intervals and pelleted concentrated food with 35 % protein were used. Once the acclimatization was finished, the larvae were seeded in the pools and fed the ration during the first 20 days and then fed three times a day.

Figure 1 Study area: Quisiro, Miranda municipality, Zulia state. Venezuela



To calculate growth, survival and production, weekly trials were carried out using a 4 m diameter and 1 cm pore size shrimp netting, the events were carried out in 9 transects in each pool until completing a total of 100 species. The feed conversion factor (FCA) was estimated based on the kg of feed used during culture. In the harvesting, the average final weight of the shrimp cultivated was obtained, also the weight was obtained in the totality of the sowing, it was used as a foundation to calculate the amount of shrimp obtain ned at the culmination of the harvesting cycle. The statistical analysis was carried out using Microsoft Excel. Survival in percentage (%), final average growth (g), growth rate (g/week) and production (kg m^{-2}) were evaluated.

Results

Table 1 Physicochemical parameters of water taken into account for cultivation

Parameters	Period	Average	Maximum	Minimum	SD
Parameters (P1)					
Dissolved oxygen (mg L^{-1})	AM	6.19	6.94	5.73	.41
	PM	7.89	8.7	7.35	.43
Temperature (°C)	AM	24.8	25.9	23.8	.90
	PM	27.6	28.5	26.7	.60
Turbidity (cm)	AM	32.5	32	18	5.03
pH (H^+)	AM	8.23	8.5	7.5	.33
Ammonium [NH_4^+]	AM	.015	.05	0	.02
Salinity (%)	AM	4.8	5	2	.70
Hardness (mg L^{-1}) ($CaC0_3$)	AM	378	425	319	54
Alkalinity	AM	157	245	60	80
Parameters (P2)					
Dissolved oxygen (mg L^{-1})	AM	5.31	6.12	4.63	.44
	PM	8.76	9.9	7.65	.61
Temperature (°C)	AM	25.3	28.5	23.2	1.22
	PM	28	29.6	26.9	.82
Turbidity (cm)	AM	34	40	20	7.27
pH (H^+)	AM	8.67	8.91	8.25	.23
Ammonium [NH/]	AM	.031	.05	0	.025
Salinity (%◦)	AM	4.8	5	2	.70
Hardness (mg L^{-1}) ($CaCO_3$)	AM	411	425	320	31.8
Alkalinity (mg L^{-1})	AM	160	240	120	50.4
Parameters (P3)					
Dissolved oxygen (mg L^{-1})	AM	4.55	4.52	3.75	.39
	PM	8.42	9.01	7.55	.41
Temperature (°C)	AM	25.6	26.8	22.6	.99
	PM	28.3	29.6	26.5	.77
Turbidity (cm)	AM	26.8	30	20	8.89
pH (H^+)	AM	8.3	8.9	7.5	.47
Ammonium (NH_4^+]	AM	.016	.05	0	.025
Salinity (%)	AM	4.8	5	2	.70
Hardness (mg L^{-1}) ($CaC0_3$)	AM	412	425	320	31.6
Alkalinity (mg L^{-1})	AM	154.8	240	120	56.2
Parameters (P4)					
Dissolved oxygen (mg L^{-1})	AM	5.31	6.14	4.05	.53
	PM	8.26	9.25	7.14	.66
Temperature (°C)	AM	25.4	27.6	22.7	.27
	PM	28.1	29.7	26.7	.87
Turbidity (cm)	AM	30	58	18	12.6
pH (H^+)	AM	8.29	8.7	8.5	.32
Ammonium (NH_4^+]	AM	.022	.05	0	.026
Salinity (%)	AM	4.8	5	2	.70
Hardness (mg L^{-1}) ($CaC0_3$)	AM	417	425	360	22.2
Alkalinity (mg L^{-1})	AM	168	240	120	51.7

Swimming pools: *P1, P2, P3, P4.

Table 1 presents the physicochemical parameters of the water taken into account for the cultivation, presenting the average values of standard deviation (SD), maximum and minimum of dissolved oxygen, temperature, measured in the mornings and afternoons, as well as pH, water turbidity, ammonium, salinity, hardness and alkalinity, which were measured weekly during the cultivation period. Dissolved oxygen, temperature during the day in the four pools presented their maximums in the afternoon and minimums in the morning, with significant differences between the average values of the two variables.

The observations on the daily record presented the dissolved oxygen ranges from 5.73 to 6.94 mg L^{-1} in pool 1 (P1) with average 6.19 mg L^{-1}, in the morning time, while in the afternoon 7.35 to 8.70 mg L^{-1}, with average 7.89 mg L^{-1}, the average values of the in pool 2 and 3 (P2 and P3) were 5.31 and 4.55 mg L^{-1}.

Figure 2 Oscillation of dissolved oxygen in white shrimp -Litopenaeus *vannamei* culture waters

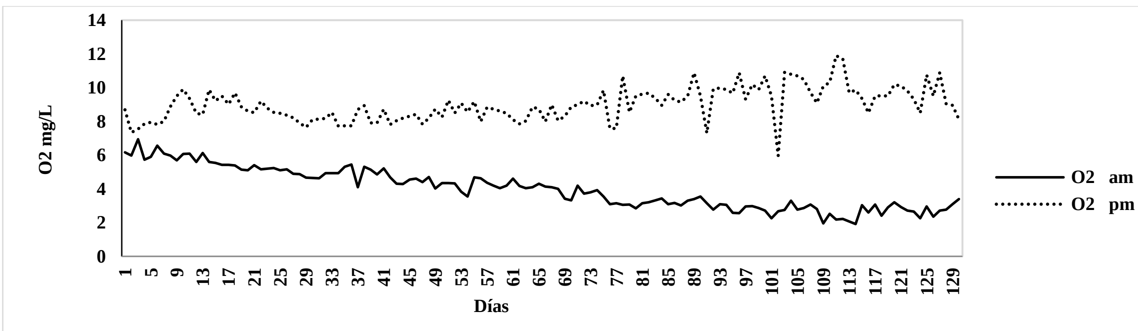
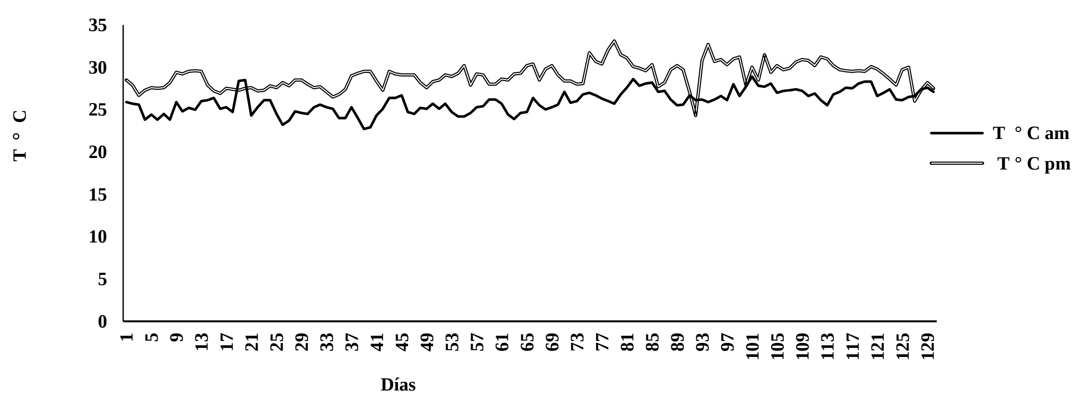


Figura 3 Variación de la temperatura en aguas del cultivo de camarón blanco - *Litopenaeus vannamei*



The dissolved oxygen in pool 4 (P4) presented maximum values of 6.14 mg L^{-1} and minimum values of 4.05 mg L^{-1} in the morning. The minimum values in the culture were presented in P3 with 3.75 mg L^{-1}, oxygen is a limiting variable in water of the natural environment as in the culture. Figure 2 shows the oscillation of dissolved oxygen in the water of the white shrimp *L. vannamei* culture.

The temperature in the morning in P1 had a range of 23.8 to 25.9° C, with an average of 24.8° C, while in the afternoon 26.7 to 28.5° C, with an average of

27.6° C, the lowest temperatures occurred in P2 and P3 during the morning and in the afternoon were higher in P3 (26.5 - 28.3° C) and P4 (26.7-29.7° C), as shown in Figure 3.

Once PL 12 was acclimatized from 35 ‰ to 5 ‰, salinities in the four pools ranged from 2 to 5 ‰ with an average of 4.8 ‰. Water transparency had a maximum of 58 cm and the lowest of 18 cm (±12.6), this was verified with Secchi disk, being frequent in the first culture cycle and was within the recorded range.

Table 2 Initial physicochemical analysis of groundwater with limit values in the area

Chemical Analysis (dissolved minerals mg/L)	Results	Limit
Total alkalinity, mg L^{-1} $CaCO_3$	137	< 100
Bicarbonate mg L^{-1}	167.1	----------
Calcium mg L^{-1}	520	>100
Carbonate mg L^{-1}	0	----------
Total magnesium mg L^{-1}	< .03	> 50
Sodium mg L^{-1} Na^+	106	> 200
Potassium K^+	8	---------
Salinity ‰‰.	1.2	---------
Chlorides mg L^{-1}	651	> 300
Nitrates mg L^{-1} (NO_3^-)	0.2	----------
Nitrites mg L^{-1} (NO_2^-)	< .01	----------
Phosphates mg L^{-1}	0.64	----------
Silica mg L^{-1}	1.7	----------
Dissolved Salts		
Calcium hardness mg L^{-1} $CaCO_3$	1300	> 150
Total hardness mg L^{-1} $CaCO_3$	2400	> 150
Heavy metals		
Total copper mg L^{-1}	< .01	Not detectable (*)
Total lead mg L^{-1}	< .005	Not detectable (*)
Total zinc mg L^{-1}	.16	< 100 ppb
Total iron mg L^{-1}	.54	< 1.0

*Non-detectable. According to the methods approved by the Ministry of People's Power for Socialism.

The pH presented an average of 8.23 and varied between 7.5 and 8.91 being higher in P2 and P3 and lower in P1. Ammonium fluctuated between 0.0 and 0.05 with an average of 0.015 in P1. Likewise, in P2, P3 and P4 the ammonium oscillated between 0.0 and 0.05, being higher in P2 with 0.031. The hardness presented maximum values of 425 and lower of 411 mg L^{-1}, and they are within the indicated measures. The alkalinity presented values ascending to the optimum condition, the $CaCO_3$ attachment in the water exceeded 240 mg L^{-1} and the lowest at 120 mg L^{-1} (Table 2). This current variable may be related to the hydrated lime used in order to discard or disable the propagation of planktonic communities in the water and thus decrease the higher ammonium values in the pool.

In Table 2, they indicate the physicochemical analysis of the groundwater source and a recommendation on the analysis used and also with limitations that must be taken into account to maintain any control in the crop. The sample presents a content of total dissolved minerals in the place of 1591.6 ppm. The chloride values presented a value of 651 mg L^{-1}. In the analysis of metals such as copper, iron, lead and zinc, had proportions of less than 0.1 mg L^{-1}.

Table 3 Production performance of *L. vannamei* (Crustacea, Decapoda: Penaidae) during harvesting

Swimming pool	Seeding density (Ind/m²)	Pool area (m²)	Final density (Ind/m²)	Time of cultivation (Days)	Average harvest[1] (g)	Weekly increase (g)	General increase (g)	Survival (%)	Food (kg)	Final Biomass (kg)	FCA
P1	22	10000	13.6	128	14.47	.76	.79	68.7	3786	2030	1.8
P2	22	10000	15.8	128	14.6	.76	.8	74.4	1887	2245	1.7
P3	22	10000	10.9	128	15	.79	.82	52.1	3453	1527	2.2
P4	22	10000	12.3	128	15.6	.84	.84	57.1	3755	1936	1.9

[1]Average weight of shrimp. [2]Feed conversion factor (total feed supplied in kg/total shrimp harvested in kg).

Figure 4 Comparative graph of shrimp growth – *L. vannamei* in the four ponds versus days of culture

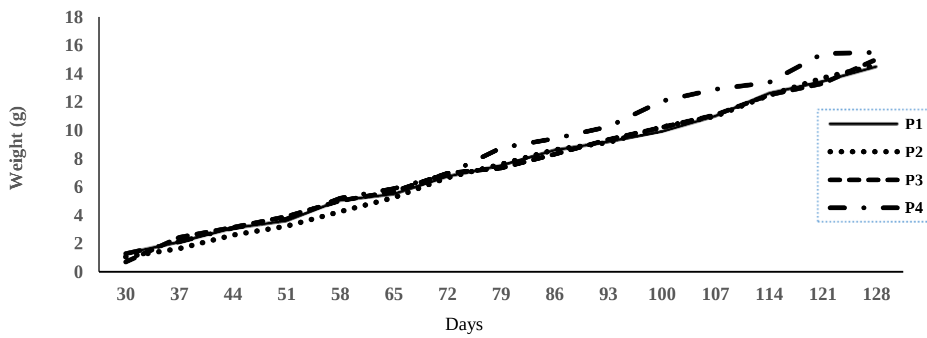


Table 3, shows the calculations of production achieved in 128 days, the survival in P1 was 68.7 %, while in P2 was 74.4 %, 52.1 % P3 and 57.1 % P4. The weekly increments registered in the four pools were between 0.76 to 0.84 g during the culture cycle. Finally, organisms of 14.47, 14.60, 15 and 15.6 g were harvested in 17 weeks.

As shown in Table 3, the biomass harvested from each pool was 2030, 2245, 1527 and 1936 kg ha^{-1} for final densities of 13.6, 15.8, 10.9 and 12.3 Ind m^{-2} respectively. In addition, the Feed Conversion Factor (FCR) was in the range of 1.7 to 2.2, being higher at P3 and lower at P2.

In Figure 4, it can be observed that the shrimp grew as expected, the difference between the growth rates in the four pools showed statistically no significant difference ($P < 0.05$). The shrimp fed with commercial feed at 35 % protein reached a higher growth rate of 0.89 g in the week. Graphically, an approximate condition can be observed between the four densities of seeding, on the variable average weight per week.

Discussion

The results of the study are similar to those reported by Boyd et al.[19], who point out that species commonly grown in ponds grow best in the range of 23 and 31° C and although some of them can grow at less than 20° C, temperatures at 35° C or higher are harmful to their growth. In fact, the observed temperature values were within the recommended ranges, so there were no unfavorable influences on the development of the organisms in the pools. Likewise, it recommends that the increase of shrimp growth is obtained with dissolved oxygen measurements between 3.5 mg L^{-1} of saturation, values lower than 1 mg L^{-1} can be lethal[18]. Also, Yu et al.[20] recommend that for intensive shrimp farming the optimal range of dissolved oxygen to obtain water quality should be between 4.5 and 10 mg L^{-1}. Similarly, a low oxygen according to what was observed by Huang et al.[21] by Chen et al.[22], could be determined by climatic circumstances and with a greater dispersion of stored organic matter, favoring the presence of algae and microorganisms for this ecosystem and whose result shows a slow progression of this crustacean.

On the other hand, the results indicate that these crustaceans acclimatize to low salinities, however, it is conceived that *P vannamei* larvae can grow in salinities between 20 and 45 ‰[23], since it is a euryhaline specimen. However, there is evidence that the larvae of the Penaeus shrimp cannot withstand harsh changes in salinity, since their gills and some of their structures have not advanced to full[24].

In addition, the pH reported in this study coincides with Chong-Robles et al.[25], who indicate that the pH estimates range between 7.5 and 8.5 favorable for shrimp development, according to the above, we establish that the pH values did not negatively affect the growth of the organisms. According to the results of the water analysis in the culture pools, for the variables ammonium, temperature, pH and oxygen, it is indicated that these variables are in the acceptable intervals for the breeding of *P. vannamei*[26-31]. In the same line of research, Valenzuela-Quiñones et al.[14], reported values of temperature, oxygen, pH and ammonium for rearing these crustaceans and they were similar to those of this research. As well as, the works developed by Gao et al.[30], who reported that the pH and temperature were appropriate and similar to those reported in the present work. In this regard, Boyd et al.[19], indicate that *L vannamei* should be planted in fresh water, when there is absolute hardness and mineral control. Likewise, Chen et al.[32] prove that shrimp demand special concentrations of the main anions: bicarbonates, chlorides and sulfates, as well as the important cations: calcium, magnesium, sodium and potassium.

Hence, the alkalinity in the culture pools are an important parameter, its value at harvest cannot be lower than 80 mg L^{-1} $CaCO_3$ to achieve excellent growth and survival[33,34]. According to the study carried out by Chen et al.[32], to obtain excellent growth and optimal survival, the alkalinity in a harvest reservoir of *L. vannamei*, has to be between 80 to 120 mg L^{-1}. Li et al.[35] state that this variable has correspondence with the pH, since significant changes in pH can produce stress in the growth and even mortality of this crustacean.

In the same way, chloride ion is regularly present in natural and waste waters, in densities that differ from a few ppm limits up to several g L^{-1}. This ion is integrated to water in natural conditions, through leaching of rainwater. The presented chloride values differ from those reported by Zhang et al.[33], who indicate values observed in their study higher than 300 mg L^{-1}. Other ranges obtained with *L. vannamei* fattening systems without ionic compounds have been obtained from the United States, producing individuals from 19 to 24 g in water with higher ranges of chlorides (699 mg L^{-1}) and higher indicative of hardness (499 to 699 mg L^{-1})[36]. Consequently, it is necessary to emphasize that the sample presented a content of total dissolved minerals in the place of 1591.6 ppm, value that is considered important for the breeding of shrimp in captivity, in addition it is considered for the addition of lime in the order of 20 g m^{-3} of water in order to raise its pH and the calcium and magnesium ions, which is a basic component in the matter of ecdysis and physiology of the crustacean and favors the microbial action and the disintegration of the organic components.

It should be noted that in published studies on the survival of white shrimp under low salinity conditions, suggest that *L. vannamei* should be seeded with a salinity of 4 ppt without generating discrepancies in survival and growth tested with the harvest at 30 ppt. Producers such as Li et al.[35] did not achieve significant differences in postlarvae maintained in salinities between 25 and 7 ppt, after five days, however, there are no reports of survival higher than 85 % of a culture cycle greater than 100 days in fattening phase.

It is important to note that in trials under similar conditions have been achieved in Brazil with values of 0.60 g/week, Saavedra-Olivos et al.[36] have obtained averages in Ecuador of 0.67 (+) 0.15 g/week. Other observations on the growth of blue shrimp with different stocking densities have been found with intervals of 0.75 to 1.5 g/week[37]. Other observations of commercial cultures have been experimented with mixtures of white shrimp, in densities exceeding 16 Ind m^{-2}, in this experience the highest rate of increase was at 0.81 g/week[38]. Other results report that, when raising blue shrimp in small ponds smaller than 0.14 ha, using densities of 15 to 30 PL/ha, the growth achieved is much lower than that found in the current study.

In fact, the products obtained are similar to those harvested in Panama with individuals of *L. vannamei*, with weights of 13 g after 93 days of sowing using river water. Also, in Ecuador, Saavedra-Olivos et al.[36] indicate better derivations with organisms of 15 g after 3 months of harvest. Hasyimi et al.[37] reached favorable effects in fattening, using pools with well water having salinities of 1.6 to 1.9 ‰, achieving specimens between 14.6 to 19.5 g in a time of 94 to 105 days. According to Dai et al.[38], growth estimates for intensive and aerated regimes range from 0.8 g to 2 g per week with conclusive weights of 16.5 g for a 124-day harvest under optimal circumstances. On the other hand, Chen et al.[32] achieve growths of 0.5 to 0.7 g with conclusive weights of 14.2 g in the course of 120 days, this result was similar to the projected weight for this type of culture that lasted 128 days in fresh water and that takes reference to average growths for this species cultivated in a brackish medium, confirming what Huang et al.[9] that during the first periods of progress, the growth is much lighter and is reduced exponentially as the organism approaches its mature stage. With respect to biomass levels, higher levels have been reported in farms in Falcon state, Venezuela based on the use of densities of 30 Ind m^{-2} and using three varieties of pelleted food with fundamental concentrations of crude protein of 41 % and fertilizations to increase the production of primary order that favors the feeding of these crustaceans.

On the other hand, the FCA is a sign of food utilization in crustaceans[32], which represents that in the pools there were causes that affected the FCA estimations: greater amount of food, presence of larvae of other species and algae blooms that deteriorate the water quality and other organisms such as crustaceans and fish in devouring their nutrients, which are the result of a greater conversion during the end of the productive cycle, contradicting what was stated by Huang et al.[9] For shrimp weighing more than 10 g in semi-intensive regimes, the FCA cannot be higher than 1.5:1.

In summary, the physicochemical factors such as average temperature, maximum temperature, dissolved oxygen observed are in the ranges suitable for the breeding of this species. Therefore, water quality conditions should be maintained in the pools, as a preventive measure against climatic adversities and thus prevent further proliferation of algae. In attention to the degree of hardness was greater than 417 mg L^{-1} as $CaCO_3$, alkalinity levels greater than 168 mg L^{-1}, potassium values higher than 8 mg L^{-1}, are limiting factors to determine the ability to successfully cultivate the culture in freshwater, because any sudden change in salinity must be done through a slow process of acclimatization to ensure that the postlarvae survive[18].

Finally, to evaluate the survival of L. vannamei in planting densities of 22 Ind m^{-2} in low salinity waters, significant differences in survival are obtained with 74.4 % followed by P1 with 68.7 %, P4 with 57.1 % and P3 with a lower percentage of 52.1 %.

Regarding growth and productivity indicators presented significant derivations, due to the fact that the evaluated variables have been fundamental in their increase, when carrying out a comparative analysis of the results reported in other essays carried out in the cultivation of these crustaceans. Consequently, the results obtained in the farm El Retorno of Miranda municipality have the possibility of the sowing of these crustaceans with underground water, achieving a growth and survival related to lucrative censuses of yield at low salinity.

Source of financing

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Conflicts of interest

The authors of this study certify that there are no conflicts of interest related to this research.

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Ethical considerations

The research was approved by the Ethics Committee of the company Granja Camaro-nera El Retorno Agropecuaria, C.A., located in Quisiro, Miranda municipality, Zulia state, Venezuela, following the rules laid down by the aforementioned committee.

Authors' contribution to the article

Rosario Mireya Romero Parra, methodological support (materials and methods) in the research, as well as the discussion of the results and the redaction of the final article. *Henry Enrique Briceño García*, experimental work, state of the art, results and discussion. *Luis Andrés Barboza Arenas*, statistical analysis of results and literature review. *Eudy Eugenio Velazco Sánchez*, support in the experimental work and background review. *Brinolfo Moreno Uzcátegui*, support in the experimental phase, discussion of the results and revision of the manuscript.

Research limitations

The authors state that there were no limitations to the study.

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