SEMI-INTENSIVE PRODUCTION OF *PENAEUS VANNAMEI* IN GUATEMALA

PRODUZIONE SEMI-INTENSIVA DEL *PENAEUS VANNAMEI* IN GUATEMALA

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SUMMARY

Because marine shrimp species convenient for aquacultural purposes live mainly in warm-water environments, commercial shrimp farms are located principally along tropical and sub-tropical marine coastlines. Other than the South-East Asiatic countries, the Latin America countries are important shrimp producers that contribute in satisfying the international demand of marine shrimp. Part of the imported shrimp in Italy come from Guatemala, where the shrimp aquaculture (representing around the 88% of the total aquaculture production) is based mainly on the Pacific white shrimp (*Penaeus vannamei*). Common rearing procedures of one of the biggest marine shrimp farms operating in Guatemala are described. Some productive parameters of *Penaeus vannamei* brought out by semi-intensive system in earthen ponds are quantified. Productive data result in a uniform distribution of weight classes at different days after stocking, besides the growth trend and feed conversion ratio agree with the growth performance of *Penaeus vannamei.* Growth data, fitted on the von Bertalanffy model, present the maximum weight gain (0.13 g/day) 28 days after stocking. Shrimp survival after a grow-out period of 80 days in a 2.44-ha pond is around 56% and the gross yield turns out to be more than one ton per hectare.

In conclusion, semi-intensive shrimp farming performed in Guatemala allows to have high productivities as well as a good quality product. On the other hand it must be highlighted that this kind of cultivation represents a risk for the environmental equilibrium along the coasts of tropical countries.

Key words: *Penaeus vannamei*, growth, semi-intensive, pond, Guatemala.

RIASSUNTO

Poiché le specie di gambero marino utilizzate a fini produttivi sono originarie principalmente degli ambienti con acqua a temperatura elevata, le aziende che producono questi gamberi sono situate maggiormente lungo le coste dei Paesi tropicali e sub-tropi-

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cali. Oltre ai Paesi del Sud-Est Asiatico, i Paesi dell'America Latina sono importanti produttori, che contribuiscono a soddisfare la domanda internazionale di gamberi marini. Parte dei gamberi importati in Italia proviene dal Guatemala, dove la produzione di gamberi, che rappresenta l'88% della produzione nazionale di acquacoltura, è basata principalmente sul gambero bianco del Pacifico (*Penaeus vannamei*). Vengono descritte le comuni procedure produttive di una delle più grandi aziende di gamberi marini operanti in Guatemala. Vengono inoltre valutati alcuni parametri produttivi del *Penaeus vannamei*, allevato con un sistema semi-intensivo all'interno dei bacini di questa azienda. I dati di peso risultano distribuiti uniformemente alle diverse epoche dopo la semina, inoltre l'andamento dei pesi e l'indice di conversione alimentare concordano con i parametri di crescita del *Penaeus vannamei*. I dati di crescita, stimati con il modello proposto da von Bertalanffy, evidenziano il massimo incremento di peso (0,13 g al giorno) al 28° giorno dalla semina. La sopravvivenza dei gamberi dopo un periodo di accrescimento di 80 giorni in un bacino di 2,44 ettari è di circa il 56% e la resa supera il quantitativo di una tonnellata per ettaro. Nel complesso l'allevamento di gamberi con sistema semi-intensivo, condotto in Guatemala, sembra fornire un'alta produttività combinata con una buona qualità del prodotto finale. D'altronde deve essere considerato che questo sistema d'allevamento rappresenta un serio rischio per l'equilibrio ambientale lungo le coste dei paesi tropicali.

Parole chiave: *Penaeus vannamei*, crescita, semi-intensivo, bacino, Guatemala.

INTRODUCTION

The shrimp world trade is very active for the high demand of the three key markets for this product, represented by the United States, Europe and Japan. In 2001 the European market imported more than 240,000 tonnes of shrimp, representing the 33% of the world shrimp imports (GlobeFish, 2003), mainly consumed in Spain followed by France, United Kingdom and Italy (16% of European imports). In Italy, where crustaceans imports were almost 69,000 tonnes in 2000 (ISMEA, 2002), the shrimp imports showed an increasing trend from 1995 to 2000, reaching 42,472 tonnes (+32%) consisting mainly of frozen (98%) shrimp (FAO, 2000). Among the countries contributing in satisfying the international demand of shrimp, other than the South-East Asiatic countries, the Latin America countries are determinant shrimp producers too. In the few last years, part of the imported shrimp in Italy came actually from Guatemala, a tropical nation in Middle America (15°30' N; 90°15' W), bordering the Caribbean Sea, between Honduras and Belize and bordering the North Pacific Ocean, between El Salvador and Mexico. This country, owing 400 Km of coastline, is one third of the total Italian area. The costal plains and the climatic condition render Guatemala favourable to shrimp culture, particularly with semi-intensive systems, allowing at least 2.5 production cycles per year. In fact the marine shrimp production represents around the 88% of the total aquaculture production in Guatemala (UNIPESCA - Unidad de Manejo de la Pesca y la Acuicultura, 2002). The Guatemalan shrimp aquaculture is based mainly on the Pacific white shrimp (*Penaeus vannamei*), which is the most important shrimp species in Latin America and represents one of the principal shrimp farmed in the world together with *P. monodon*, *P. chinensis,* and *P. japonicus*.

Since Guatemala is a commercial partner of Italy for the shrimp trade, the aim of this paper is to describe the common rearing procedures of one of the biggest shrimp farms operating in Guatemala and to quantify some productive parameters of the Pacific white shrimp brought out in this farm during the rainy season.

MATERIALS AND METHODS

This investigation was performed in a commercial shrimp farm producing more than one thousand tonnes of *P. vannamei* per year by semi-intensive system. The production is achieved by means of a total of 26 controlled-environment growing ponds, covering more than 200 hectares.

Rearing procedures carried out by the farm are briefly summarised. Soon after captured from estuaries, larvae are identified microscopically for the species, acclimatised to the salinity of the nursery ponds, counted and stocked at a density of 70-85 larvae/m^2. The nursery ponds are previously prepared for the introduction of the newly arrived larvae by inducing development of the natural food chain. A fertiliser (18-46-0) is used in the quantity of 27 kg/ha for the first application and around 9 kg/ha for the subsequent weeks. An initial single application of an organic fertiliser is also added, 900 kg/ha of hen-droppings. Lapsed around 20-30 days or when post-larvae reached 2-3 cm, nursery ponds are emptied and juveniles are counted, weighted and moved into the growing ponds using a stocking density of around 20 individuals/m^2. The ponds are prepared following up the same ground operations previously described for the nursery ponds. After the third week of culture, water is exchanged at 10-15% of pond volume once weekly. Moreover, a further 5% of the pond volume is exchanged if the early morning dissolved oxygen concentration is lower than 2.5 mg/l.

During the rainy season, the present investigation was executed evaluating some productive parameters of the growing ponds. For a 3-months period starting from stocking, one of the ponds was monitored weekly for the shrimp live weight and feed conversion ratio. All the other ponds, instead, were monitored once to collect the same productive parameters as global data. Supplementary feeding was given to the ponds using a commercial shrimp feed (32% crude protein), which was distributed late in the afternoon when the shrimp becomes very active. The feed quantity provided daily to each pond was determined on the basis of the biomass using feed consumption tables (Jory, 1995). The total feed offered was registered. Harvest took place by completely draining ponds when shrimp commercial size was reached. Pond density was estimated following random captures of shrimp samples, using a method of capture consisting in 20-30 throws with a cast-net from different sites of each pond. The total number of the collected shrimp was referred to the pond total area considering a correction factor based on the catch ability of the net-thrower. Among collected shrimp, mean live weight from at least 40 individuals per pond was taken and biomass was estimated. Feed conversion efficiency per pond was then calculated, considering the weight of total feed offered and the whole biomass. To describe the trend of shrimp growth, weight data were fitted on the von Bertalanffy (1957) model: $W(t)=W_{\infty}\cdot(1-e^{-k(t-t^{\circ})})^{3}$, where:

the value of W_{∞} represents the theoretical maximum weight; the value of k is the constant expressing the rate of approach to W_{∞}; the value of t° represents the theoretical age at which $W(t)=0$.

RESULTS

The study allowed to obtain the following productive results. Shrimp growth is presented in Figure 1, where mean body weights of shrimp, sampled at different growing stages, are dotted. The observed

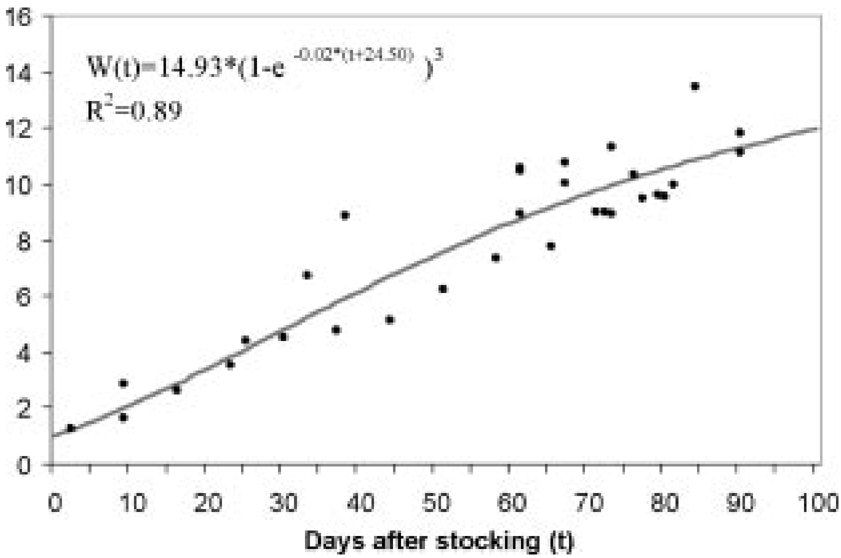

Fig. 1. Growth curve of *Penaeus vannamei*.

growth matches with data obtained in similar outdoor rearing conditions by Green et al. (1997). The sigmoidal growth curve presents the point of inflection 28 days after stocking, where the maximum weight gain (0.13 g/day) is achieved.

The grow-out period stopped when shrimp market size was achieved. Shrimp cultured in Guatemala had two possible markets, differing in the final weight requested and the product presentation. The expected shrimp sizes were:

- 12-14 g (achieved at around 100 days after stocking) commercialised as *whole shrimp* for the European Community market;
- less than 12 g or more than 14 g (achieved 80-90 days or more than 100 days after stocking, respectively) commercialised as *shrimp tails* for the United States market.

Cumulative feed conversion ratio at different stages from stocking is presented in Figure 2. As predictable, the lowest values came out during the first period of the observation, corresponding to the first twenty days from the stocking, then the global trend of the feed conversion efficiency increased. However, approaching the market sizes feed conversion values agreed with the known productive performance of *Penaeus vannamei* (Martinez-Cordova et al., 1998).

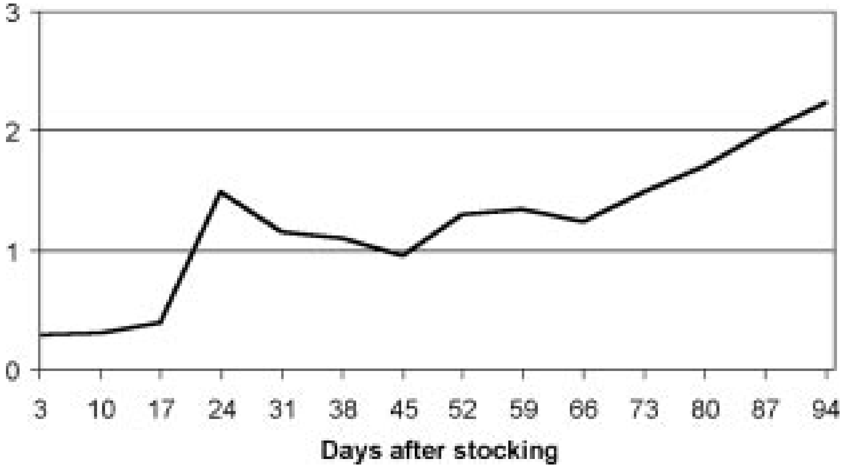

Fig. 2. Cumulative FCR by semi-intensive culture of *P. Vannamei*.

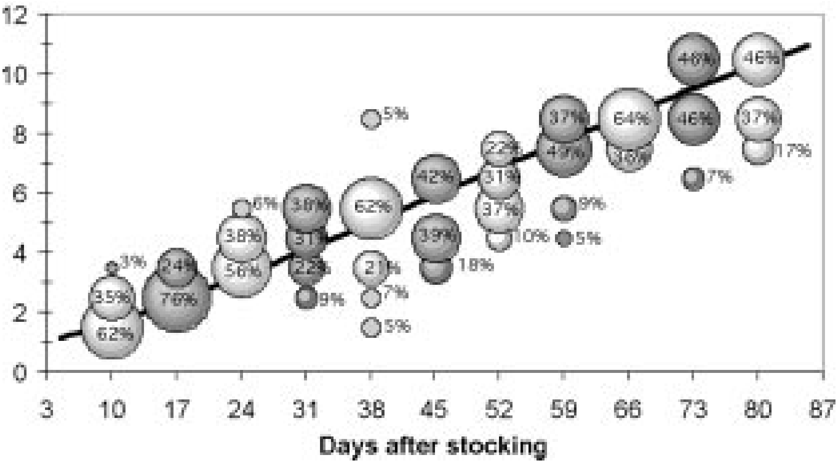

Fig. 3. Frequencies of weight classes and growth trend of the pond analysed in detail.

As described before, one of the 26 growing ponds was analysed in detail for a more complete examination of the productive data. Shrimp were sampled weekly throughout the 80-days growing period and the frequencies of ten weight classes were determined using one-gram intervals, starting from 1 (Fig. 3).

A quite uniform distribution of weight classes at different days after stocking was noticed, showing a high correlation coefficient

Tab. I. Rearing conditions and productive performance of *Penaeus vannamei* cultured in a 2.44-ha pond.

Stocking density (PL/m^2)	21.06
Grow-out (days)	80
Stocked post-larvae (n.)	513,900
Harvested shrimp (n.)	285,400
Survival (%)	55.67
Shrimp final weight (g)	9.63
Weight gain (g/week)	0.79
F.C.R.	1.40
Gross yield (Kg/ha)	1,126.39

(0.996). Growth trend of this pond was similar to the one reported previously, resulting from data coming from all the ponds.

Other productive data of the same pond are indicated in Table I. The shrimp cultivated in this pond were intended for the US market, as indicated by mean live weight at harvest (9.6 grams), which was carried out after a grow-out of 80 days.

Shrimp survival was quit good considering the dimension of the pond and the sanitary risks outdoor-reared shrimp can undergo to (Green et al., 1997; Martinez-Cordova et al., 1998). The appreciable feed conversion ratio value indicates good rearing procedures combined with a suitable environment and a good shrimp biological responsiveness.

DISCUSSION

The results of this study show that semi-intensive shrimp farming performed in Guatemala allows to have high productivities as well as a good quality product, satisfying the demand of the United States and European Community markets. On the other hand it must be highlighted that this kind of cultivation represents a risk for the environmental equilibrium along the coasts of tropical countries, though the negative impact on the environment comparing to the intensive farming is less. However, on the point of view of a long term period, the damage to the environment could be dramatic.

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