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Pond Culture of *Penaeus semisulcatus* (De Haan, 1844) in Sub-tropical Conditions of Türkiye

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Özet: Penaeus semisulcatus *(De Haan, 1844)'un Türkiye'nin yarı-tropik iklim koşullarında havuzda yetiştiriciliği.* Türkiye'nin yarı-tropik iklim koşullarında, *Penaeus semisulcatus*'un iki farklı stoklama yoğunluğunda (Havuz A: m^2'ye 10 karides ve Havuz B: m^2'ye 30 karides) havuzlarda yetiştiricilik potansiyeli çalışılmıştır. A Havuzu'nda, deneme boyunca doğal su sıcaklığı 19°C ile 31.5°C arasında değişmiştir. Karideslerde büyüme oranı 24°C'nin altında çok düşük (0.02 g $gün^{-1}$), ancak 25°C'nin üzerinde daha yüksek (0.07-0.18 g $gün^{-1}$) bulunmuştur. Günlük ortalama 0.11 g'lık bir büyüme ile karidesler, 180 gün içinde lineer olarak büyüyerek 0.6 g'dan 17.3 g'a ulaşmışlardır. Ortalama yem çevrim oranı (YÇO) ve yaşama oranı sırasıyla 1: 3.15 ve %60 olarak gerçekleşmiştir. B Havuzu'nda, çalışma boyunca su sıcaklığı 24°C ile 31.5°C arasında değişmiştir. B Havuzu'ndaki (m^2'ye 30 adet) karidesler 0.08 g'lık günlük bir büyüme oranıyla, 90 günde, 0.2 g'dan 7.7 g'a ulaşmışlardır. 23-24°C'de ilk ayda düşük olarak gerçekleşen büyüme oranı (0.3-0.5 $gün^{-1}$) daha sonraki aylarda, 27-31.5°C'lerde, yükselmiştir (0.08-0.12 g $gün^{-1}$). YÇO 0.69 ile 3.73 (ortalama= 2.07) arasında değişmiştir. Bu sonuçlar; semirtme havuzlarında su sıcaklığı 24°C'ye çıkana kadar *P. semisulcatus*'un seralar içinde ön-semirtmede tutulması gerektiğini göstermiştir. m^2'ye 30 adet olacak kadar yüksek bir stoklama oranının büyüme üzerine önemli ölçüde olumsuz bir etkisinin olmadığı, büyüme oranı ve YÇO'nın daha kaliteli yemler ve daha uygun yönetim stratejileriyle başarılabileceği düşünülmektedir.

Anahtar Kelimeler: *Penaeus semisulcatus*, semirtme, havuz, büyüme, yem çevrim oranı.

Abstract: Pond grow-out potential of *Penaeus semisulcatus* in two different stocking densities (Pond A: 10 shrimps per m^2 and Pond B: 30 shrimps per m^2) was studied in sub-tropical climate conditions of Türkiye. In Pond A, water temperature ranged between 19°C and 31.5°C throughout the study. Growth rate of the shrimps was extremely low (0.02 g day^{-1}) at temperatures below 24°C but was higher (0.07-0.18 g day^{-1}) above 25°C. The shrimps, with a mean daily growth rate of 0.11 g, grew linearly from 0.6 g to 17.3 g in 180 days. Mean food conversion rate (FCR) and final survival rate were 1: 3.15 and 60%, respectively. In Pond B, water temperature ranged between 24°C and 31.5°C throughout the study. Shrimps in Pond B (30 animals per m^2) grew from 0.2 g to 7.7 g with a mean daily growth rate of 0.08 g in 90 days. Growth rate was low during the first month (0.3-0.5 g day^{-1}) at 23-24°C but increased thereafter (0.08-0.12 g day^{-1}) at 27-31.5°C. FCR ranged between 0.69 and 3.73 (mean = 2.07). The current results have demonstrated that nursery culture of *P. semisulcatus* has to be carried out indoor (greenhouse) until water temperature in grow-out ponds is not less than 24°C. A stocking density of up to 30 shrimps per m^2 did not have a considerable negative impact on the growth. Higher growth rates and lower FCR could be achieved with better quality feeds and more appropriate management strategies.

Key Words: *Penaeus semisulcatus*, grow-out, pond, growth, food conversion rate

Introduction

Penaeus semisulcatus is an Indo-Pacific species distributed along the coast of the Eastern Mediterranean and is one of the most important commercial species in this part of the world. Several studies have been carried out on its biology (Shelagman *et al*., 1986; cited in Issar *et al*., 1987; Kumlu *et al*., 1999a), induced

maturation and spawning in captivity (Browdy and Samocha, 1985a,b; Aktaş and Kumlu, 1999; unpublished data) and on its tolerance to environmental conditions during larval and postlarval stages (Kumlu *et al*., 1999b; 2000a, b). Only limited number of studies concerning pond culture of this species have been carried out worldwide mainly in Israel (Yashouv, 1971; Issar *et al*., 1987; Seidman and Issar, 1988).

Subtropical climate conditions, long coastline, clean coastal waters and close proximity to the European Markets are the main reasons, which are favouring shrimp farming in the eastern Mediterranean (Issar *et al*., 1987). Yet, grow-out period for shrimps in this climate is limited to only 5-6 months during which one crop per year can only be obtained. In order to allow shrimp farms to stock grow-out ponds with shrimps earlier in the year, spawning, larval and nursery culture of penaeid shrimps has to be carried out in greenhouses in winter months (Samocha *et al*., 1990; Sturmer and Lawrence, 1988) until water temperature of grow-out ponds is warm enough for fast growth.

P. semisulcatus is the most preferred marketable shrimp species fetching a premium price in the Turkish markets. A few commercial farms in Turkey had already practised its culture on a small scale. Yet, up to date, pond grow-out management techniques of *P. semisulcatus* have not been studied in depth.

The purpose of this study was therefore to obtain preliminary results on the grow-out practices of *P. semisulcatus* in semi-intensive (10 PLs per m^2) and intensive (30 PLs per m^2) stocking densities under local conditions.

Materials and Methods

This study was conducted in Marine Research Station of Faculty of Fisheries, University of Çukurova, Yumurtalık-Türkiye. The broodstock were caught off the Yumurtalık Bight and spawned at the station and the larvae were cultured until the PL stage on live feeds. Prior to stocking into the grow-out ponds the PLs (postlarvae) were reared until 0.6 g for pond A and 0.2 g for pond B in nursery tanks situated in a greenhouse in order to allow the shrimps to be stocked into grow-out ponds earlier in the year.

The PLs were stocked into 50 m^2 (5x10x1 m) earthen ponds at a density of 10 PLs per m^2 (Pond A) in the first week of April and at a density of 30 PLs per m^2 (pond B) in the first week of May 2001. The shrimps in pond A and B were grown for 180 days and 90 days respectively. 30-40 animals were randomly sampled every 10-days from the ponds and were weighed individually on an electronic balance to the nearest 0.01 g. The ponds were supplied with 40 ppt seawater and a 10-30% of daily water exchange was carried out throughout the study. A commercial pelleted feeds containing 45% protein (Pınar A.Ş., İzmir, Turkey) were offered 2-4 times a day. Feeding rate was calculated as percentage of the total biomass in the ponds and adjustments were made by using feeding trays. Continuous aeration in pond B was supplied with a blower.

Pond water temperature, pH, salinity and dissolved oxygen levels were monitored regularly throughout the study.

Results

Pond A (10 animals per m^2)

Water temperature ranged between 19°C (in the early May-late October) and 31.5°C (in the mid July) throughout the study (Figure 1). The pH and dissolved oxygen levels were kept above 8 and 5.2 mg L^{-1} respectively. Salinity ranged betwen 40 and 41 ppt.

Temperature was too low for the shrimps to grow during the first month of

the culture. Hence, the PLs were fed *ad libitum* and sampling was not performed until the first week of May when temperature was well above 23°C. The lowest daily growth rate (0.02 g day^{-1}) was obtained during this cool month. Growth rate from May onwards ranged between 0.07 and 0.18 g day^{-1} (Table 1). The PLs, with a mean daily growth rate of 0.11 g, grew linearly from 0.6 g to 17.3 g at a period of 180 days (Figure 1). FCR ranged between 0.92 and 5.25 (mean = 3.15). Final survival rate was 60% at the end of the experiment. SGR was high during the first months decreasing to the lowest towards the end of the experiment (Figure 1, Table 1).

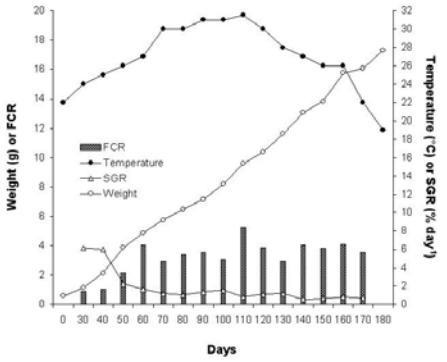

Figure 1. Water temperature, growth, food conversion ratio (FCR) and specific growth rate (SGR) of *P. semisulcatus* grown in a pond at a stocking density of 10 animals per m^2 for 180 days.

Table 1. Feeding rate, mean individual weight (n= 30-40), estimated survival rate, daily growth rate, total food consumption, food conversion ratio (FCR) and specific growth rate (SGR) of *P. semisulcatus* grown in a pond at a stocking density of 10 animals per m^2 for 180 days.

Days	Feeding rate (%)	Weight (g)	Est. Surv. Rate (%)	Growth rate (g day^{-1})	Food Cons. (g)	FCR	SGR (% day^{-1})
0	*Ad libitum*	0.60	-	-	-	-	-
30	8.0	1.15	96	0.10	433	0.92	6.16
40	7.0	2.13	94	0.18	862	1.05	6.00
50	6.0	3.88	92	0.10	960	2.13	2.25
60	5.8	4.86	90	0.09	1600	4.04	1.66
70	5.6	5.74	88	0.07	930	2.94	1.18
80	5.5	6.46	86	0.07	1012	3.41	1.05
90	5.4	7.15	84	0.10	1522	3.52	1.35
100	5.2	8.18	82	0.14	1800	3.09	1.60
110	5.0	9.60	80	0.08	1700	5.25	0.81
120	4.3	10.41	78	0.12	1500	3.85	1.10
130	4.2	11.62	76	0.15	1600	2.90	1.18
140	4.0	13.07	74	0.08	1120	3.93	0.57
150	3.8	13.83	72	0.09	1253	3.70	0.66
160	3.5	14.77	70	0.13	1395	3.09	0.84
170	3.0	16.06	68	0.12	1425	3.38	0.74
180	-	17.30	66	-	-	-	
Mean				0.11		3.15	1.81

Pond B (30 animals per m^2)

Water temperature ranged between 24°C in the mid May and 31.5°C (in the mid July) throughout the study (Figure 2). The pH and dissolved oxygen levels were maintained above 8 and 4.7 mg L^{-1} respectively. Salinity ranged between 40 and 41 ppt.

Shrimps at a stocking density of 30 animals per m^2 grew from 0.2 g to 7.7 g with a mean daily growth rate of 0.08 g in 90 days (Figure 2, Table 2). Daily growth

rate was low during the first month (0.3-0.5 g day^{-1}) at water temperatures of about 23-24°C, but increased thereafter (0.08-0.12 g day^{-1}) when water temperature remained between 27 and 31.5°C. At this high stocking density, FCR ranged between 0.69 and 3.73 (mean= 2.07). SGR was high during the first month (5.66-8.75% day^{-1}) decreasing to the lowest (1.74% day^{-1}) towards the end of the experiment (Figure 2 and Table 2). This experiment had to be terminated at the end of the third month as a result of technical difficulties in maintaining dissolved oxygen level above 5 ppt due to poor feed water stability, high biomass and low water exchange rate.

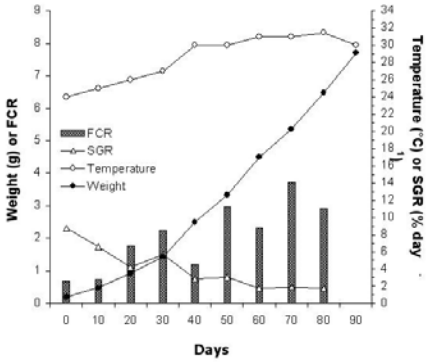

Figure 2. Water temperature, growth, food conversion ratio (FCR) and specific growth rate (SGR) of *P. semisulcatus* grown in a pond at a stocking density of 30 animals per m^2 for 90 days.

Table 2. Feeding rate, mean individual weight (n= 30-40), estimated survival rate, daily growth rate, total food consumption, food conversion ratio (FCR) and specific growth rate (SGR) of *P. semisulcatus* grown in a pond at a stocking density of 30 animals per m^2 for 90 days.

Days	Feeding rate (%)	Weight (g)	Est. Surv. Rate (%)	Growth rate (g day^{-1})	Food Cons. (g)	FCR	SGR (% day^{-1})
0	10.0	0.20	98	0.03	300	0.69	8.75
10	8.0	0.48	96	0.05	550	0.76	6.61
20	7.0	0.93	94	0.05	1250	1.77	4.23
30	6.0	1.42	92	0.05	1560	2.26	5.66
40	5.8	2.50	90	0.11	1785	1.20	2.87
50	56	3.33	88	0.08	3124	2.96	3.01
60	55	4.50	86	1.12	3612	2.33	1.75
70	54	5.36	84	0.09	4225	3.73	1.9
80	5.2	6.48	82	0.12	4328	2.93	1.74
90	5.0	7.71	80	-	-	-	
Mean				0.08		2.07	4.06

Discussion

The present results indicate that there is little advantage of stocking *P. semisulcatus* PLs into grow-out ponds early in the year before water temperature reaches 24-25°C. Regardless of the stocking densities, growth rate of the PLs remained very low (0.02-0.05 g day^{-1}) in temperatures between 18 and 23°C (April and second week of May). Therefore, it is suggested that nursery culture of this species has to be prolonged in greenhouses until grow-out pond water temperature exceeds 24°C.

It is well known that there is an inverse relationship between stocking density and growth rate. At the low stocking density, growth rate was 0.11 g day^{-1} between 30 and 120 days in comparison to that at high stocking density (0.08 g day^{-1}). At the stocking density of 10 per m^2 the shrimps (Pond A), with a mean daily growth rate of 0.11 g, grew from 0.6 g to 17.3 g within 180 days. This finding is similar to that

reported in Israel by Issar *et al*., (1987); who obtained a growth rate of 0.12 g day^{-1} at the stocking density of 8 shrimps per m^2 during a grow-out period of 162 days. In current work, growth curve in the high stocking density (pond B) was not linear and could be examined in two periods. During the first period (day 0-30), mean growth rate was only 0.05 g day^{-1}, while during the second period (day 30-90) it increased up to 0.10 g day^{-1}. This low growth rate obtained during the first period appeared to be due to low water temperatures encountered in this period. Issar *et al*., (1987) obtained similar growth rates (0.06-0.09) at 28-29 shrimps per m^2 during the nursery culture of *P. semisulcatus*, which continued for 38 days. In spite of a three fold increase in stocking density in the second phase of pond B, growth rate remained similar to that obtained in pond A. Şereflisan *et al*., (1998) report that 0.10-0.12 g day^{-1} growth rate can be achieved with *P. semisulcatus* at stocking densities of between 20 and 40 pieces per m^2 at 23-26°C in fibreglass tanks. These results are encouraging in terms of successful intensification of this species. Yet, further works have to be carried out on intensification rate of *P. semisulcatus* and appropriate feed and water quality management practices must be achieved before a conclusion could be drawn.

FCR values obtained in the two ponds were higher than expected. An important factor that might account for these high FCR is poor feed water stability. It is well known that shrimps are slow feeders and that their feeds must remain stable in water at least 2 h. The pellet feed used in the current study remained intact in water for only 15-20 minutes after which it dissolved and polluted the water and in particular the sediment. It may also be assumed that some of the nutritional components might have been lost before the shrimps ingested the feed. Therefore, it can be reasonable to expect that better growth performances of *P. semisulcatus* could be obtained with relatively more stable feeds.

The main conclusions of the present study are:

Nursery culture of *P. semisulcatus* has to be carried out indoor (greenhouse) until water temperature in grow-out ponds is not less than 24°C.

A stocking density of up to 30 shrimps per m^2 did not have a considerable negative impact on the growth rate, hence higher stocking densities (>30 shrimps per m^2) have to be studied in order to explore intensification potential of this species,

This species can be grown from 0.6 g to 17.3 g in 6 months, but higher growth rates, and lower FCR could be achieved with better quality feeds.

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References

Aktaş, M., Kumlu, M. 1999. Gonadal Maturation and Spawning of *Penaeus semisulcatus* (Penaeidae: Decapoda). Turk J. Biol. 23, 61-66.

Browdy, C.L., Samocha, T.M. 1985a. The Effects of Eyestalk Ablation on Spawning, Molting, and Mating of *Penaeus semisulcatus* de Haan. Aquaculture, 49, 19-29.

Browdy, C.L., Samocha, T.M. 1985b. Maturation and Spawning of Ablated and Non-ablated *Penaeus semisulcatus* de Haan, 1884. J. World Aquacult. Soc. 16, 236-249.

Issar, G., Seidman, E.R., Samocha, Z. 1987. Preliminary Results of Nursery and Pond Culture of *Penaeus semisulcatus* in Israel. Bamidgeh, 39(3), 63-74.

Kumlu, M., Başusta, N., Avşar, D., Eroldoğan, O.T. 1999a. Some Biological Aspects of Penaeid Shrimps in Yumurtalık Bight of North-eastern Mediterranean. Turk. J. Zool. 23, 53-59.

Kumlu, M., Eroldoğan, O.T., Aktaş, M. 1999b. The Effects of Salinity on Larval Growth, Survival and Development of *Penaeus semisulcatus* (Decapoda: Penaeidae). Bamidgeh,51(3), 114-121.

Kumlu, M., Eroldoğan, O.T., Aktaş, M. 2000a. Effects of Temperature and Salinity on Larval Growth, Survival and Development of *Penaeus semisulcatus.* Aquaculture, 188(1/2): 167-173.

Kumlu, M., Eroldoğan, O.T. 2000b. Effects of Temperature and Substrate on Growth and Durvival of *Penaeus semisulcatus* Postlarvae. Turk. J. Zool. 24, 337-341.

Seidman, E.R., Issar, G.1988. The Culture of *Penaeus semisulcatus* in Israel. J. World. Aquacult. Soc. 19(4), 237-245.

Samocha, T.M., Lawrence, A.L., Biedenbach, J.M. 1990. A New Concept for Water Management Strategy for Nursery of Penaeids Postlarvae in Raceways. Abstracts, World Aquaculture 90, 1990, Halifax, Canada.

Sturmer, L.N., Lawrence, A.L. 1988. Feeding Regimes for Enhanced *Penaeus vannamei* Production in Intensive Nursery Raceways. J. World Aquacul. Soc.; 19: 68A.

Şereflişan, H., Kumlu, M., Tekelioğlu, N. and Şereflişan, M. 1998. The Effects of Different Stocking Densities on the growth of *Penaeus semisulcatus* (Crustacea: Decapoda). In: B. Papathanassiou (Ed.), Proceedings of the 4th Balkan Conference on Operational Research, Volume II, Hellenic Operational Research Society (Helors), Macedonia–Thrace Branch, pp. 611-616.

Yashouv, A. 1971. On the Possibility of Developing Shrimp Culture in Israel. Daig Umidgeh, 4(2), 24-33.