Some Observations on the Growth and Cyst Production Characteristics of the Brine Shrimp *Artemia* sp. (Gujarat strain) in Pond Culture and its Potential for Import Substitution

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Experimental culture of the brine shrimp *Artemia* sp. (Gujarat strain) and production of cyst is discussed. The qualitative and quantitative aspects of the cyst and its economic potential for import substitution are highlighted.

Ever since Scale (1933) and Rollfsen (1939) discovered the utility of brine shrimp *(Artemia)* larva in hatchery aquaculture, it has been preferred to others for more than 85 % of the marine organisms cultured all over the world (Kinne, 1977). Out of the 243 findspots of brine shrimp in the world, representing 150 different populations consisting of diverse geographical strains, only 1000 tonnes of biomass and 100 tonnes of cyst are harvested, mainly from U.S.A., France and Canada (Sorgeloose, 1980). Though the brine shrimp can adapt to wide fluctuations in salinity ranging from 35 ‰ to 300 ‰ the major factors limited its abundance and survival are, the scarcity of adequate food in the environment for its continuous feeding habit, easy predation by fishes like *Aphanius dispar* tolerant to 150 ‰ hyper salinity conditions and above all the human destruction of the ecosystem due to changing plans of salt condensation. In India, out of the seven findspots (Sorgeloos, 1980), none is reported to have yielded commercial quantities of cyst. In 1981–82 and in 1984–85, the authors collected and processed 170 kilos (dry weight) and 120 kilos (dry weight) respectively from two separate saltworks, located 50 kms. apart, in Mithapur. Strangely, neither of them yielded large quantities of cyst thereafter. The present experiments were designed to study the pond culture and the growth and maturity characteristics of the Gujarat *Artemia.*

Materials and Methods

The cyst of the Gujarat strain of brine shrimp was used in the study. The hydrated cyst had an average diameter of 0.256 mm. (0.226 to 0.290 mm.range) with a choriondiameter of average 0.0097 mm. The cysts weighed 1,66,240 to 2,17,075 nos. per gram and yielded on an average 1,77,500 nauplii. The cyst was hatched in 35 ‰ salinity, 8.0 PH and 30°C temperature. The nauplii were directly stocked into the grow out system immediately (within 4 hours) after hatching.

In the first experiment, a concrete tank of 5 x 3 m with 0.5 m water depth having 50 ‰ salinity was used. Artificial feeding with suspension of groundnut oil cake and plentiful compressed air supply were provided in the tanks. In the second experiment, an exclusive earthen pond within the saltworks, having 280 x 40 m with 0.5 m water depth having 145 ‰ salinity was used. The pond was fertilised with raw cow dung before and during the culture. The cysts, produced by adults and released were collected by scooping out from the pond sides where they had gathered along the plastic sheet collectors fixed for the purpose. The cysts were dried in shade upto 10 % dry weight.

Results and Discussion

Growth and maturity

Gujarat brine shrimp, like other brine shrimp strains reported from elsewhere in India is a parthenogenetic strain. Bowen *et al.* (1978) considered the Kutch and Tuticorin strains identical. The observations of

Royan *et al.* (1978) and Rayan (1980) in respect of the Tuticorin brine shrimp were largely confirmed during the present study.

The freshly hatched nauplii ranged from 0.442 to 0.520 mm in length. At 2.2 mm, they developed to juveniles with big antennae and unstalked eyes. By 3.4 mm the eyestalk development started and was complete at 4.5 mm. The brood pouch of the female was noticed at 7.1 mm indicating sexual maturity. Males were totally absent. At 8.5 mm the brood pouch had 15 to 16 developing eggs along the periphery and at 10.1 mm, the fully mature gravid female had 60–65 eggs in the pouch.

The growth and maturity of the Indian strains of brine shrimp have been differently reported. Royan *et al.* (1978) recorded 12 days to maturity in 138 ‰ to 231 ‰ salinity in Tuticorin saltworks. However, in the laboratory experiments, Royan (1980) observed 23–27 days to attain maturity in 35 ‰ salinity and 19 days in 35 ‰ to 145 ‰ salinity for the same strain. Dwivedi *et al.* (1980) observed 14 days in salinity range of 30 ‰ to 75 ‰ for the Bombay brine shrimp and Tobias *et al.* (1980) reported 14 days in salinity of 34.8 ‰ for the Tuticorin brine shrimp in laboratory culture. In the present study, we obtained maturity in 41 days in 50 ‰ to 200 ‰ salinity and in 57 days in 125 to 160 ‰ salinity ranges. In one of the experiments in cement tank, when the salinity was diluted to 125 ‰, the adults released cysts which in turn hatched to nauplii. These nauplii matured to adults in only 10 days in 125 to 170 ‰ salinity. Royan *et al.* (1978) also reported a similar observation of Tuticorin brine shrimp taking only 12 days in the salinity range of 150 ‰ to 188 ‰ to develop to adults. While discussing the physiological adaptation mechanisms of the brine shrimp, Persoone & Sorgeloos (1980) expressed possibility of an unobserved dilution of the 150 ‰ salinity which might have triggered the hatching of cysts observed by Royan (1980). In the present study there was no possibility of the dilution of salinity below 125 ‰. It therefore appears that the capacity of the brine shrimp to produce nauplii in the higher salinities may be a characteristic feature of the Indian parthenogenetic strains. In the second experiment, the nauplii innoculated into the earthen pond in 150 ‰ salinity matured to adults in 160 days and produced cysts until the salinity dropped to 95 ‰ In 95 ‰, the nauplii were again observed which further matured and produced fresh batch of cysts within 32 days, as the salinity rose to 120 ‰. In an earlier experiment, in an earthen pond, the adults were observed within 40 days of innoculation of nauplii, in the salinity range of 90 ‰ to 125 ‰.

Cyst production

The data in Table 1 indicate the pattern of cyst formation in the Gujarat brine shrimp. As could be noticed, innoculation in a lower salinity would have accelerated growth and increased cyst productivity. At an innoculation rate of 1.0 per litre density in 150 ‰, 0.924 kg/ha cyst (dry weight) was produced in 212 days of culture period. Baker (1966) cited by Persoone & Sorgeloos (1980) reported 5 kg/ha wet weight per week and on 10% dry weight basis, it indicated production rate of 15 kg/ha in equal time as in the present experiments, Santos & Sorgeloos (1980) obtained 0.140 kg to 0.620 kg/ha per day suggesting an estimate of 30 to 131.4 kilos per hectare (dry weight) in same culture period. In Thailand, innoculating in 70‰ salinty, @ 12.5 nos/litre density, production rates of 10 kilos (dry weight)/0.5 acre/45 days was reported from culture in earthen ponds fertilized and monitored for salinity change ranging upto 145 ‰. The present study has, thus highlighted the tremendous potential of the Indian brine shrimp for pond culture to produce biomass and cyst both equally useful in aquaculture.

Rao (1978) estimated the need of 5237.5 million postlarvae of shrimp for farming an estimated 1.42 million hectares of coastal area suitable for aquaculture. Based on Platon (1978), 150 million brine shrimp nauplii would be required for producing 1 million postlarval shrimp in hatchery. Accordingly, Indian requirements for the aquaculture programme, would be around 7,85,625 million nauplii or 4.5 tons cyst of brine shrimp per annum. At the current import price and duties (US $ 20–30 per kilo, F.O.B. price) an estimated Rs. 3.7 million would be needed for only meeting the brine shrimp nauplii feed requirement of hatcheries. It is in these circumstances, that

Table 1. *Details of cyst production of the Mithapur strain brine shrimp Artemia in pond culture*

Date	Duration (days)	Development	Cyst production wet weight kg	Remarks
31/8		Innoculated nauplii @ 1 no/ litre	—	Salinity 145‰
4/11	65	Matured pouch contains 16–22 eggs	0.018	
26/11	87	Fully matured pouch with 60–65 eggs		
19/12	110	—	0.250	
26/12	112	—	0.285	
27/12	118	—	2.150	
28/12	119	—	0.760	
31/12	121	—	0.810	
5/1	126	—	0.530	
7/1	128	—	1.380	
12/1	134	—	0.560	
14/1	136	—	0.400	
19/1	141	—	0.622	
27/1	149	—	0.476	
30/1	152	—	0.466	
4/2	157	—	4.224	
9/2	162	Nauplii seen	—	Salinity dilution 95 ‰
19/2	172	Matured pouch with eggs	1.627	
1/3	183	—	0.667	
22/3	204	—	1.341	Salinity 120 ‰
25/3	207	—	1.561	
30/3	212	—	0.912	
23/4	236	Population diminished	—	
29/4	242	,,	0.286	
20/5	264	Population diminished greatly, only few animals seen	—	Salinity 150 ‰

the cultivability and cyst production potential of the Indian brine shrimp become relevant as a substitute for the import of brine shrimp cyst from abroad.

The authors wish to express their gratitude to the management of the Company for facilities received and specially to Shri S.N. Bhattacharya, Deputy General Manager for his constant encouragement and keen interest in the present study. They also thank Shri K.M. Pillai, K.D. Joshi, V.V. Somaiya and M.I. Devmurari their colleagues.

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