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53 The edible oyster culture

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ABSTRACT

In 1970s the CMFR Institute initiated oyster culture through rack and tray method. Large scale spat collection, preparation of spat collectors, season and seed availability were studied. In 1980, a hatchery was set up with annual production capacity of one million edible oyster seed and the techniques involved in hatchery system were standardized. The seed were supplied to other centres of this Institute and Gujarat Fisheries Department. The production rates for rack and tray, string and stake method were estimated as 120 t and 22 t respectively. As part of extension, one lab to land programme, 8 training programmes, one workshop and a summer institute were conducted. Results of experimental oyster culture work carried out at Mandapam, Madras, Bheemunipatnam, Kakinada, Mulki, Dharmadam, Ashtamudi and Cochin backwaters are given. Rearing 600 strings in 0.04 ha at Ashtamudi and harvesting 2.5t oysters pointed out 44.8% return with estimated production of 80-105t/ha. Further research priorities on oyster culture aspects are indicated.

Introduction

Edible oysters *Crassostrea madrasensis, C.gryphoides, C.rivularis* and *Saccostrea cucullata* are distributed along the coast,estuaries, backwaters and creeks. Hornell (1910) conducted experiments on spat collection of *Osterea (Crassostrea) madrasensis* using lime coated tiles at Pulicat Lake. Awati and Rai (1931) reported that oysters collected during March-May were stocked in farm sites at Kelwa, Navapur and Utsali in Maharastra. These sites mostly acted as the holding grounds till the oysters were marketed during October - May. Realising the commericial and nutritive value of edible oysters, efforts were made during 1970 s by the CMFR Institute to evolve a suitable technology for oyster culture.

Initially rack and tray method of culture was adopted to rear the oysters (Mahadevan *et al.*, 1980 : Nayar and Mahadevan, 1983). Rao *et al.* (1983) and Thangavelu and Sundaram (1983) experimented upon various spat collectors for spat collection from wild. Large scale spat collection was attempted at Tuticorin Bay using suitable cultch materials (Muthiah, 1987). Though early developmental studies on oyster have been attempted (Rao, 1983 ; Samuel, 1983) mass production of edible oyster seed through hatchery system was successfully achieved later (Nayar *et al.*, 1984). A shellfish hatchery was set up at Tuticorin (Nayar *et al.*, 1983). Using hatchery facilities, the techniques in broodstock management, larval rearing, setting and algal culture were standardized (Nayar et al., 1987a). In order to evolve cost effective culture methods, rack and string and stake methods were attempted. Based on encouraging results in the rack and string method, a pilot project on oyster culture funded by NABARD was implemented at Tuticorin in 1991.

Along with farming oysters, the associated activities such as harvesting, depuration, shucking and marketing of oyster meat were developed (Nayar *et al.*, 1983; Rajapandian and Muthiah, 1987). To extend the oyster culture to other areas, experimental culture works have been carried out at Bheemunipatnam (Reuben *et al.*, 1983), Kakinada (Syda Rao *et al.*, 1994), Mulki (Dhulkhed and Ramamurthy, 1983) and in Ashtamudi Lake (Velayudhan *et al.*, 1995). These studies have provided information on spat settlement and growth of oysters. As part of extension work and for propagating oyster culture, Lab to Land programme, and trainer's training programme were conducted. The oyster culture technology developed by the CMFRI has been accepted as a commercial venture by fisherfolk and entrepreneurs (Velayudhan *et al.*, 1995).

Material and methods

Seed collection and rearing form important aspects in oyster culture. For seed collection from nature, Thangavelu and Sundaram, (1983) , Rao *et al.*, (1983) stated the preparatory processes of various materials used as spat collectors. Muthiah (1987) indicated the seed availability, and techniques for large scale spat collection with various cultch materials. Nayar *et al.*, (1984, 1987a) explained the method for mass production of seed through hatchery system.

The technology on methods of oyster farming (Nayar, 1987) : rearing

oysters by rack and tray method (Nayar and Mahadevan, 1983); by rack and string method (Rao *et al.*, 1992 ; Velayudhan *et al.*, 1995) and by stake method (Muthiah *et al.*, 1994) are elucidated. Nayar *et al.* (1983) gave the plan for small scale depuration plant. Rajapandian and Muthiah (1987) dealt with the harvesting techniques, depuration, processing oyster meat and utilization of oyster shells.

Spat collection

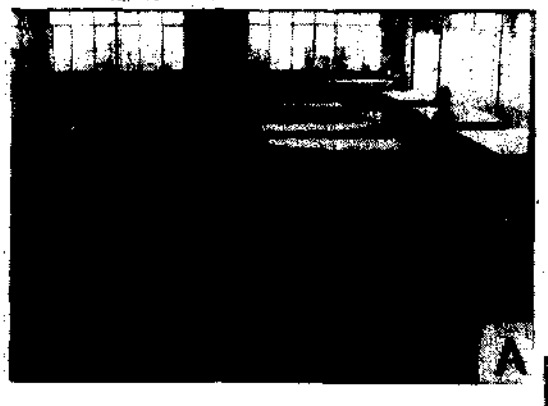
Cultch materials such as lime coated tiles, oyster shells, asbestos sheets, bamboo frames, PVC tubes, velon screen and polythene liner sheets were used for spat collection (Rao *et al.*, 1983; Thangavelu and Sundaram, 1983 ; Muthiah, 1987). Of these, spat settlement on lime coated tiles with an average of 33.5 oysters/tiles with a maximum of 120 per tile and on oyster shells an average of 7 spat/shell with maximum of 25/shell were observed. The rate of settlement on netlon sheets and used automobile tyres were 161/per sq.m. 25/sq.m. respectively. On tiles the rate of settlement was 316/sq.m and on oyster shells it was 263/sq.m area of the cultch.

Experimenting upon spat collection in 3 different areas, the number of spat per sq.m of surface area of tiles was high (316 per sq.m) in the Bay than 92.3 per sq.m in natural oyster bed and 76.9 per sq.m in creek. These observations indicated greater potentiality of oyster seed availability in shallow intertidal Bay areas (Muthiah, 1987).

By employing 25-50 thousand tiles in April-May spawning season during 1978-81, 0. 8-5 .6 lakhs of spat were collected. It was also demonstrated that during the April - May spawning season the settlement was more (35/ tile) than August - September spawning (5 / tile) (Muthiah, 1987; Silas et al., 1982). Thus using tiles, during 1978-1988, totally 12.79 lakhs of seed were collected. By providing 100 rens each with 15-17 shells, anually 8300 spat could be collected from natural resources.

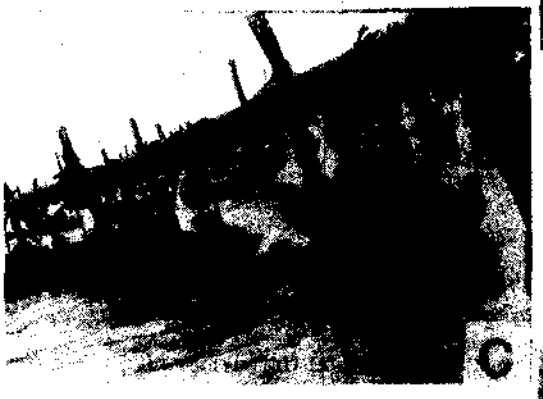
Mass production of seed through hatchery system

Nayar *et al.*, (1984) set up a shellfish hatchery, one among the four pilot hatcheries in Southeast Asian counteries for the production of molluscan seed (Plate 1.A). With the facilities for conditioning the broodstock and continual culturing of algal food and larval rearing in the 20 x 10.8 m edible

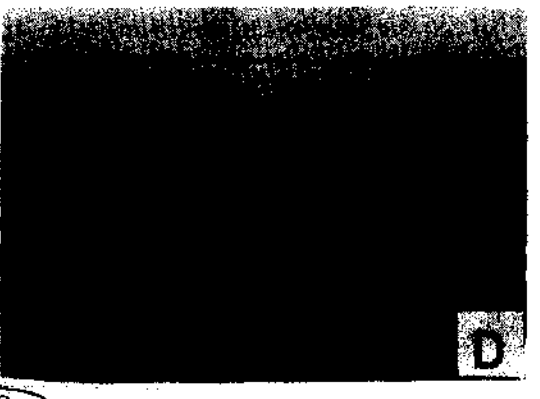


(A) View of Oyster hatchery

(B) Rack and tray method



(C) Rack and string method



(D) Stake method

oyster hatchery, Nayar *et al.*, (1984) successfully accomplished mass production of seed oysters. Nayar *et al.*, (1987a) described the standardized techniques for broodstock maintenance, induced spawning, larval rearing density, feeding protocol and provision of spat collectors for production of cultch free as well as cultched spat. Experiment conducted on induced maturation showed that gonadal maturation was attained in 15-20 days, for oysters fed either with mixed algae at the rate of 3 liter/oyster/day or with corn meal flour or *Chlorella*. Among them, oysters fed with mixed algae registered 40.5% of spawning when thermally stimulated (Nayar *et al.*, 1988). During off season, 20-60% of oysters (fed with mixed algae) were induced to spawn (Rani Palaniswamy and Sathakkathullah, 1992). Thus annually on an average 25 larval rearings could be accomplished and annual spat production was 1.1 million edible oyster seed. With average settlement of 107 spat/oyster shell, 1693 strings were annually transferred from the hatchery to nursery. 20-30 days after settlement, the strings kept in velon screen bags, are reared for 2 months by suspending them from racks erected in coastal ponds before transferring to the farm.

Seed supply and transportation

Apart from rearing , seed produced at Tuticorin were supplied to the Gujarat Fisheries Department and various centres of the CMFR Institute either to propagate oyster culture or for loction testing experiments to find suitable areas for oyster farming. During 1987-1988 a consignment of 5800 seed of 8.0-38.5mm were packed in wet gunny bags and kept in tin carriers (Chellam *et al.*, 1988). These, after initial 6 hr road journey, were air lifted from Trivandrum to Jamnagar. After 39 hr of transportation 95% survival was observed. Experiments showed that hardened seed periodically exposed to air withstood arid condition upto 120 hrs with 76% survival (Muthiah, 1987). Particulars of consignments sent to Fisheries Departments, Cochin, Calicut, Mangalore, Karwar, Madras and Kakinada centres of CMFR Institute is given in *Table. 1.*

Table 1 : Particulars on seed supply and transportation.

Year	Place	Number of seed	Size (mm)	Mode of transport	Duration of transport (hrs)	Mortality %
1981-82	Madras	250	15-25	Road	17	0.4
,,	Narakkal	2,500	15-20	Road	14	Nil
1987-88	Jamnagar	5,800	8-38.5	Road & Air	36	9
1988-91	Jamnagar	5,500	9-60	Road & Air	36	100%
	,,	10,000	1-5	Road &Air	36	Nil
1992-93	Cochin	4, 500	10-55	Road	10	Nil
,,	Calicut	4,500	,,	Road & Train	18	Nil
,,	Mangalore	4,500	,,	Road & Train	22	Nil
,,	Karwar	4,500	,,	Road	30	Nil
,,	Madras	4,500	,,	Train	15	Nil
,,	Kakinada	4,500	10-55	Train	30	Nil
1995-96	Pondichery	1,500	1.4-42.6	Road	15	Nil
	Karwar	3,725	27.3-58.4	Road	28	Nil

Culture methods and production

Though different methods of farming exist, first rack and tray method was attempted to rear the oysters (Nayar and Mahadevan, 1983). Through this method the production per rack containing 4000 oysters at the end of one year was 425 Kg (shell-on) ; this indicates a production of 119t/ha with a meat yield of 9t/ha (Plate 1.B). The seed collected from natural spat- fall had grown to a mean length of 49.2mm in 3 month and to 78 mm in 12 months with an annual average growth increment of 6.5mm (Fig 1). So as to evolve cheaper methods of culture since rearing trays formed 74.9% of initial investment (Nayar *et al.*, 1987b) , the rack and string method of culture was experimented upon. Based on successful results, Rao *et al* (1992) attempted rack

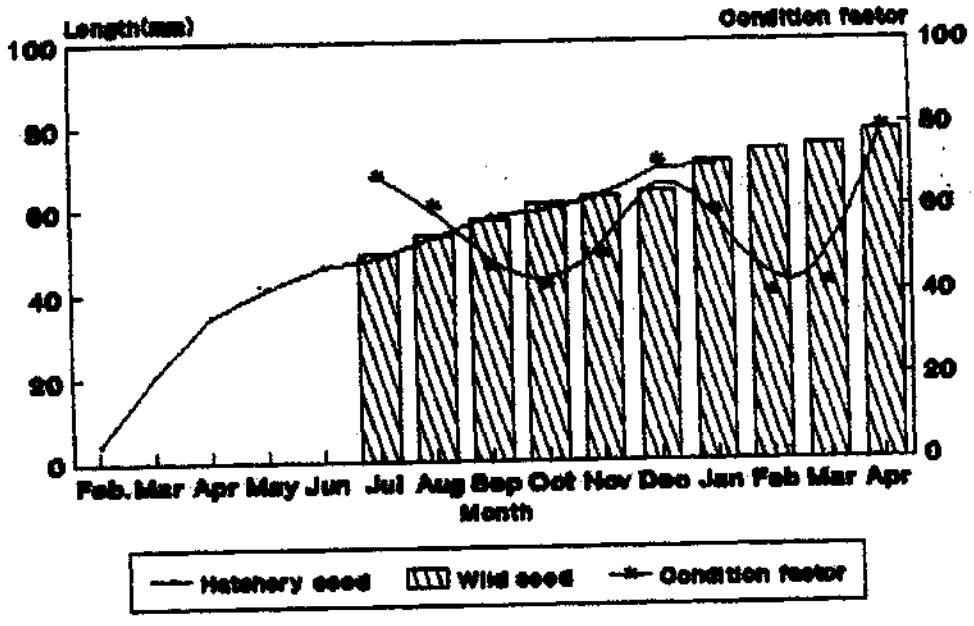


Fig.1. **Growth of oyster seed and condition factor.**

and string method for farming with 90 strings per rack occupying 80 sq.m and the production rate was estimated at 80 tonnes / hectare (Plate 1.C). For rearing oysters in shallow bays, experiments on stake method of culture were conducted (Plate 1.D). The production rate was estimated at 22t (shell on) per hectare, with 14 oysters per stake (Muthiah *et al.*, 1994). Rearing oysters in cages and trays, 95% survival was observed (Nayar and Mahadevan, 1983). In stake and ren methods, the survival rates were 93 and 80% respectively. The studies on growth of wild seed and hatchery raised seed reared (*Fig.1*) in the above culture methods showed an initial increment of 10.2-10.6mm per month and at 12th month it declined to 5.5mm with average growth rate of 6.6mm per month (Nayar *et al.*, 1984 ; Muthiah *et al.*, 1994). At the end of 12 months, mean size of oysters ranging from 70.3 to 78mm with maximum length of 105.1mm was observed.

Oyster culture at other places

Apart from Tuticorin, experimental oyster culture works were conducted

at Mandapam, Madras, Kakinada, Bheemunipatnam, along east coast and Ashtamudi, Cochin backwater, Dharmadam, and Mulki along west coast.

Rao *et al.* (1983) stated that peak spat fall occurred during January-April at Athankarai estuary. Oysters at the end of one year measured average length of 86.7mm with maximum 110mm. Sarvesan *et al.* (1990) observed peak spat settlement in February-March and September - October with average of 55 spat / tile and oysters attained 70 mm in length with average monthly growth increment of 7 mm in Muttukadu backwaters, Madras. At Kakinada, oysters of 27mm attained 72mm in 9 months. The mean shell- on weight of oyster was 68.6 g with meat weight of 6.5g. With 83% survivial Syda Rao *et al.* (1994) indicated the estimated production of 3.5 Kg/m of rope. At Bheemunipatnam backwater of Andhra Pradesh, peak settling of oysters was noticed during March-October. The settlement varied from 15-120 numbers/ 10 sq.cm. In 12 months oysters attained mean size of 81.8mm with maximum of 110mm (Reuben *et al.*, 1983).

Along the west coast, Dhulkhed and Ramamurthy (1983) noted that the oyster spat settlement at Mulky, Dakshina Kannada was intense during December. The average spat set on tiles ranged from 5-12.

Oyster culture at Ashtamudi was initiated in 1993 as the Insitute's location testing programme. By setting up a farm of 0.04ha area, spat collection was attempted by providing shell strings. Velayudhan *et al.*, (1995) observed the peak spat settlement during December and January with 23 spat/ shell. Best period for spat collection was indicated as November to February The oysters attained 57mm from an initial 24mm in a period of 7 months. By rearing 600 strings in 0.04 ha farm, adopting rack and string method, 2.5t of oysters were harvested. Harvesting could be carried in May-June. The economic analysis for the oyster culture undertaken in 300 sq.m area at Ashtamudi indicated 44.8% return (Velayudhan *et al.*, 1995). Appukuttan and Muthiah (1996) stated that accomodating 24 units each of 300 sq.m in one hectare, the oyster production has been estimated as 80-105 tonnes per crop of 7-8 months duration. The encouraging results abtained have motivated more fishermen and entrepreneurs to take up oyster culture at Ashtamudi and Dharmadam along Kerala coast.

In addition to the above, the National Institute of Oceanography, Cochin

and the Fisheries College, Mangalore carried out oyster culture experiments at Cochin Backwaters and Mulki estuary respectively. Purushan *et al.*, (1983) noted spat settlement of 84 / 0.2 sq.m and average size of 60-62 mm with 5 g oyster meat was obtained in 5 to 5.5 months period at Cochin Backwaters. At Mulki, Mohan Joseph and Shantha Joseph (1983) ; Mohan Joseph (1993) indicated 7.2cm growth in 7 months for the oyster seed collected on shell collectors and possible harvesting during May before onset of monsoon.

Pest, parasites and predator

In oyster farming system, pests, parasites and predators cause considerable loss of stock. Common pests on clutch materials and on oysters are barnacles, ascidians, serpulids, *Anomia* sp. and sponges, which have to be periodically removed. Though predation by crabs and star fishes was absent, predatory gastropod *Cymatium cingulatum* caused 13% mortality of the oysters cultivated through rack and tray meathod (Muthiah *et al.*, 1987 ; Thangavelu and Muthiah, 1983). Whereas predation by this gastropod occurred in the oysters cutivated either by rack and string or stake method. A low percentage (1%) of trematod. *Bucephalus* sp., infecting the gonad of oyster was observed (Samuel, 1978). *Perkinsus marinus* a haplosporidian with weighted incidence of 0.05-0.35% indicated low level of infection (Muthiah and Nayar,1988).

Harvesting

The cultured oysters were periodically harvested depending on the condition factor (dry meat weight/volume of shell cavity x 1000). The average condition factor ranged from 41.4 during postspawning periods to 78.8 during prespawning periods (Fig.1). Nayar *et al.*, (1983) designed and set up a purification plant with capacity to depurate 14,400 oysters (1300 Kg) per day. Utilising the facility the harvesting, depuration and shucking processes were undertaken (Rajapandian and Muthiah, 1987; Rajapandian *et al.*, 1988). During 1979-95, totally 7.208 t oyster meat were sold to Integreated Fisheries Project, which arranged canning for marketing the oyster meat in the interior and northeastern regions (Samuel *et al.*, 1982). Locally 685.6 Kg of oyster meat were sold. For popularisation of oyster meat and for demonstration purposes, 230 Kg were utilized.

The shells have important commercial value. The 3-4 mm size particles

obtained from the oyster shell were found to be suitable shell grit for use as poultry feed (Rajapandian and Muthiah, 1987). In 1995, 32 t of oyster shells were sold at the rate of Rs. 250 per tonne to poultry feed industry. The oyster shells, on ignition yield 52-55% of calcium oxide which is an important raw material for calcium carbide, lime and other industries. In 1990, 81.7t oyster shells were sold to local calicum carbide industries and 30 kg oyster shells were sold for medicinal purpose.

For processing and canning the oyster meat, 818 kg of oysters were supplied to Central Institute of Fisheries Technology, Integrated Fisheries project, Cochin and 220 Kg to Tamil Nadu Fisheries Development Corporation, Madras for marketing live oysters.

Economics

Nayar *et al.*, (1987b) reported an estimated rate of net income to investment as 30% for rack and tray method. Rao *et al.*, (1992) projected an annual net profit of Rs. 22,505 by incurring Rs. 82,495 annual operational cost for a farm of 0.4ha, adopting rack and string method of oyster culture.

Extension programmes

i) Lab to Land programme

During 1979-80, under Lab to Land programme on oyster culture, 15 smallscale fishermen were selected and given orientation training. Infrastructure facilities were privided for rearing the seed oysters supplied to them. During the period, 33% of spare time out of 964 mandays available to these fishermen was effectively utilized in oyster farming. In total 566.25 Kg of oyster meat were harvested. During this programme wide publicity on oyster farming and nutritive value of oyster meat was made through pamphlets, articles in the local dailies, through A.I.R. and T.V. programmes. The harvest mela organised at Dalavapuram, Ashtamudi lake in August,1995 created an awarness among the local fishermen about the techno- economic viability of oyster farming. Subsequently seven farmers initiated small scale farming in this area.

ii) Training programmes

Apart from this, regular training programmes were conducted. Participants from the departments of Fisheries of Maritime States and personnels from collages were exposed to the techniques on spat collection, rearing methods, farm maintenance, harvesting and shucking of oyster meat.

In may, 1980 through a Summer Institute programme on culture of Edible Molluscs 16 participants and during 1983, through one month training course on oyster culture, 8 participants had the benefit of training in oyster farming techniques. In addition to the above, during 1986 to 1993, 3 short term training courses on oyster hatchery were conducted. Totally 17 trainees were trained in the mass production of oyster seed through hatchery system. Another 15 candidates were trained in oyster culture through 4 short term training courses conducted by this Institute under Trainers Training Programmes. A short-term training course on oyster farming was conducted for the officials of MPEDA at Cochin in June, 1996. Training was given to field officers of Kerala State. Co-operative Bank in October, 1996 on oyster farming. 200 fishermen around Ashtamudi lake were given 3 days training in oyster farming at Kollam,Kerala.

iii) Workshop :

Under the auspices of NABARD sponsored and funded project, a workshop on oyster culture was held on 27 th and 28th September 1992. In the workshop aspects on oyster culture and its prospects were discussed. An harvest mela was conducted on 27th March 1993 at Tuticorin.

Future research priorities

In the culture of normal diploid oysters, time of harvest depends on the spawning season. The oysters could be harvested only during prespawning periods to maximise return. The triploid oysters with enhanced meat weight and condition factor are harvestable, irrespective of the spawning seasons. For better yield, production of triploid oyster seed and culturing the triploids has vast potential.

Though mass production of seed oysters has been successfully achieved, in some experiments, bacterial diseases caused larval mortality. Studies on larval diseases and effective control measures have to be undertaken to increase the seed production rates in the hatchery system.

Though considerable work has been attempted on *C.mardrasensis* little is known on *C. gryphoides*, a dominant species along the Maharashtra and Gujarat coasts. Attempts on seed production and culturing *C. gryphoides* have to be undertaken as envisaged by James et. al (1993).

Environment monitoring of shellfish growing areas is of much importance since the coastal regions are subjected to bacterial, industrial, and domestic sewage pollution. Incidences of shellfish poisoning occured in the country (Silas *et al*, 1982) warranted the need to monitor the concentration of causative dinoflagellates. Depuration should be made mandatory for bivalves before marketing. Depuration systems have to developed at production centres as common facility since individuals could not afford to run a depuration plant.

Oyster culture is labour intensive. Possible mechanisation in some of the post harvesting processes has to be pursued. This will, to a large extent, ameliorate the non-availability of skilled labourers and increasing labour cost.

Another aspect of concern is the limited market demand and low market prices for molluscan shellfishes. The future of molluscan shellfish mariculture will greatly depend on the successful development of market. Live oyster marketing has to be explored. Product diversification, quality control and efforts to produce innovative and value added products have to be pursued relentlessly, to stimulate domestic consumption and enter the export market.

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