

Oyster Farming Techniques

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Introduction

Oysters, mussels, clams, scallops, cockles and abalones are major groups of molluscs which are cultured in different parts of the world. Edible oysters are the most important among them, as they are great delicacy and there is growing demand. There is an increasing interest in oyster culture in tropical countries in recent years. In India there is a growing demand for oyster meat in some parts of the country. They are highly esteemed sea food and considered a delicacy in USA, Europe, Japan etc. It is said that 'oyster' is scientifically the best known marine animal. It is one of the most widely cultivated species. As early as the first century BC the Romans were the first to develop simple methods of collecting oyster seeds and growing them for food. The Japanese developed 'Habitat culture technique i.e. culture in nets fixed to bamboo poles during the seventeenth century and at the turn of the 20th century they evolved off bottom culture, especially hanging methods. These methods yielded good results and were adopted by majority of oyster farmers of Japan as the environmental conditions of the coastal areas were highly favourable for practicing these methods. Until recently, oyster farming has been considered as a traditional practice followed only in the temperate countries. The awareness about the vast potentialities for development of oyster farming in tropics is recent. Serious efforts are now being directed in its development under tropical conditions.

Scope for oyster farming in India

Central Marine Fisheries Research Institute undertook scientific investigations at Tuticorin from early 70's and as a result, complete package of the technology is now available in the country. Vast stretches of backwaters, estuaries and bays spread over several lakh ha. are present along Indian coast harbouring natural population of the oyster suggesting suitability of the habitat for oyster culture. Being filter feeders, the oyster converts primary production in the water into nutritious sea food.

Oyster resources of India

The average annual production of edible bivalves during 1996 to 2000 is estimated as 1.52 lakh tones, about 2.5 times more than the average landings during the period prior to 1996. clams and cockles form 73.8%, followed by oysters (12.5%), mussels (7.5%) and window pane oysters (6.2%). The various genera and species are identified based on the shape, size, colour and other characteristics of the shell, anatomical feature of promyal chamber, gill ostia, heart and gut and the breeding habits. Confusion still exists in the identification of oysters at species level. *C. madrasensis* is the main species in India. It is euryhaline tolerates wide variations in salinity and inhabits backwaters, creeks, bays and lagoons and occurs, from the intertidal region to 17 m depth.

General information on oysters in India		
Scientific name	Common name	Local names
<i>Crassostrea madrasensis</i> (preston),	Indian backwater oyster	Kadalmuringa (Malayalam); Ali, Kalungu (Telugu) Patti (Tamil), Muri (Kannada)
<i>Saccoctrea cucullata</i> (Bom).	Rock oyster	
<i>Crassostrea gryphoides</i> (Schlotheim),	West coast oyster	

<i>Crassostrea rivularis</i> (Gould),	Chinese river oyster	
<i>Saxostrea cucullata</i> (A wati and Rai)	Bombay oyster	
<i>Hyostissa hyotis</i> (Linn aeus)	Giant oyster	Rare-east coast

Oyster resources of maritime states	
Species name	State
<i>Crassostrea madrasensis</i>	KER, KAR, GOA, MAH, GUJ, TN, PON, AP
<i>Saccoctrea cucullata</i>	KER, KAR, GOA, MAH, GUJ, TN, PON, AP
<i>Crassostrea rivularis</i>	KAR, GOA, MAH, GUJ, TN, PON, AP
<i>Crassostrea gryphoides</i>	KAR, GOA, MAH, GUJ, PON, AP

Oysters and their Biology

The edible oyster is a sedimentary animal belonging to the class Bivalvia. Oysters have a soft body, which is protected by hard shells. The following are the main parts of the oyster.

Shell:

Lower valve which is larger, usually cupped and attached to the substratum

Upper valve smaller and usually flat

Umbo:

The apex region where the two valves are attached by an internal ligament.

Adductor muscle:

About two thirds of the distance from the umbo is the adductor muscle which links the two valves. It works continuously against the spring action of the hinge.

Mantle:

Covers the soft body and plays an important role in secretion of shell, water movement and reproduction.

The shape of the oyster is extremely variable depending on the environment in which it is grown.

Reproduction

In the genus *Crassostrea* sexes are separate but occasionally hermaphrodites occur. The ovary and testis consists of a series of branching tubules, also called follicles, on either side of the body. During spawning, ripe eggs and sperms are discharged into the exterior where fertilization takes place. During the non-breeding season the gonad is replaced by connective tissue called Leydig tissue which mostly consists of glycogen. In this stage the sex of the oyster cannot be determined. The sex of the oyster may change during the breeding season. Temperature food availability and salinity are considered as important exogenous factors, in influencing the maturation of gonads.

In *C.madrasensis*, young oysters primarily function as males (60-75%) and later change their sex. Proper understanding of sex ratio in relation to size is necessary to select the brood from the hatchery work. The egg of *C.madrasensis* measure 48-60 um in diameter. A single female measuring 80-90 mm spawns 10 to 15 million eggs at a time.

The information on spawning period is necessary for seed collection

Condition Index

The condition index of the oysters denotes the quality of the meat and it is useful to determine the best period for harvest. It is also helpful to assess the suitability of a locality for culture. High condition indicates greater proportion of meat in the whole weight

of the oyster; those in prime condition are tasty when compared to the flaccid and watery meats of oysters in poor condition.

The soft body of the oyster undergoes changes, which are usually related to the reproductive cycle. During the maturation process the gonad increases in weight resulting in increase in the weight of soft body. Before the commencement of spawning the condition index reaches high value and with the release of gametes, the soft body of the oyster loses weight. The condition factor is studied based on weight, volume of both. The percentage of wet flesh weight in total weight gives the condition index, also called percentage edibility. A commonly followed method is the ratio of the dry meat weight (oven-dried at 90-100°C to constant weight) of the oyster to the volume of the shell cavity, and is expressed as:

Condition factor = $\frac{\text{weight of dry meat} \times 1000}{\text{volume of shell cavity}}$

In *C. madrasensis* the condition is considered as high if it is above 140 and poor if it is below 70. The other important measurements in oyster farming are length and meat weight. The antero-posterior axis (long axis) is called length and dorso-ventral axis is referred to as width.

Quality of oyster meat and shell.

Oyster meat is relished in most nations. The proximate composition of the oyster meat and the medicinal values attributed to it are given below.

- ❖ Oyster meat consists of 52% protein, 14% glycogen and 11% fat.
- ❖ Oyster powder contains wide range of minerals and vitamins and the amino acid taurine, which has complex medical properties.
- ❖ Oyster powder has shown good results in skin care, numerous heart ailments, blood pressure, liver problems, arthritis and rheumatism, diabetes, water retention, premenstrual tension etc.

Edible Oyster Farming in India

Oyster farming technology developed by Central Marine Fisheries Research Institute is a simple and easily adaptable technique. Since 1993 concerted effort has been put in by CMFRI to popularize this technology. Kerala, is the first state to commercialize this technology and many coastal villagers have benefited from this. These farming activities have increased national production of farmed oyster from nil to 140 tonnes in 2000. One of the significant factors is that more than 80% of the oyster farmers in Kerala are women and they have emerged as productive, self-reliant participants for improving the families' nutritional and living standards.

Culture Technology

Edible oyster culture is a very simple technology, which can be easily practiced. There are a few critical factors (such as seed collection and harvesting period) which are governed by the biology of the species which affect the profit of the farming operations. The farmer can easily understand these aspects by observation and practice. The oyster culture protocol practiced in India is given.

Seed Collection

Oyster seed are collected from estuaries by placing suitable collectors called cultch in the water column at appropriate period. During spawning seasons the spat collectors are suspended from racks.

Preparation of cultch

Cultch is the term used for spat / seed collector. For suspended method of oyster culture cultch made of oyster shells have been found to be ideal. Empty oyster shells are cleaned manually to remove the foulers and then washed to remove silt. A small hole is made on the shell and these are strung on 3mm dia nylon rope with

a spacing of 15 to 20 cm between each shell (5 shells per meter rope). Such strings are called ren. The spaced rens can be used as such for grow out system. For seed collection purposes the shells are strung continuously without spacers (10 to 15 shells per meter) and after the attachment of seed they shells can be removed and restrung at the rate of 5 shells per meter which is the ideal density for grow out.

When to place the cultch for seed collection?

One of the main factors that determine the success of the farming operation is the period when the clutches are placed for seed collection. If they are laid in advance of spatfall, they may be covered with silt or settlement of foulers , making them unsuitable for the oyster larvae to settle. The larval period in *C. madrasensis* is 15-20 days. The ideal time for laying the spat collectors in the water is about 7 -10 days after peak spawning (as determined by gonad examination and abundance of early larval stages in the plankton). Strong currents interfere with larval settlement and may result in poor spat collection.

Selection of farm site

For site selection several factors are to be considered

Sl. No.	Parameter	Range	Methodology for determination of the parameter
1	Salinity (ppt)	10 to 38	By titration or refractometer
2	Depth (m)	1.5 - 4	By sounding or manual
3	Temperature ° C	23- 34	Using thermometer
4	Dissolved oxygen mg/l	3 - 5	Winkler method or by using probe

5	pH	6.5 – 8.5	pH meter or pH paper
6	Turbulence due to wave (m)	< 0.5 to 1	By observation and local enquiry
7	Water current m / second	1 – 5	Current meter or from literature
8	Clarity (m)	0.5 –1.5	By Secchi disc
9	Availability of seed	Within 100 m	By enquiry / observation
10	Local market	Average to good	By enquiry / observation
11	If free from various pollution like	Faecal	By enquiry / observation
		Industrial	
		Agriculture	
		Sewage	
		Retting	
		Oil	

Sheltered areas offering protection from strong wave action are preferred. From intertidal region to areas extending upto about 5 m depth can be considered for adopting suitable culture method. Similarly the culture technique is adopted depending upon the type of substratum. On-bottom culture method is substrate-specific while off-bottom method has little to do with the nature of substratum. Large-scale mortalities have been reported in salinities below 10 and above 40 ppt when the natural oyster populations of *C. madrasensis* were exposed for prolonged periods. The natural populations occur at a temperature range of 21 to 31 °C.

Farming methods

They are broadly grouped as bottom (on bottom) culture and off-bottom culture. Raft, rack, long-line and stake are used in the various off-bottom culture practices. The off-bottom culture methods are advantageous over the bottom culture in the following respects.

1. Relatively rapid growth and good meat yield.
2. Facilities three-dimensional utilization of the culture area.
3. The biological functions of the oyster such as filtration feeding etc. are carried out independent of the tidal flow,
4. Silting and predatory problems are negligible.

On bottom culture

The oysters are grown either in the intertidal or subtidal area directly on hard substratum. For intertidal culture a minimum of 16 hours submergence is suggested to ensure adequate food supply. Oyster seed attached to the collectors are planted on the bottom and allowed to grow for the market. The disadvantages of this method are increased exposure to benthic predation, siltation and low production. In U.S.A. the production is estimated at 5 t/ha/year and in France 7.5 t/ha/year. This method is yet to be experimented in India.

Rack and Ren Method

The racks are constructed in 1 to 2.5 m depth. There are several variations in the types of racks. The single beam rack consists of a beam placed and secured to the top of posts driven into the bottom. A series of single beams are placed in a row. The crossbeam rack is constructed by placing cross bar on top of single posts and two long beams are secured on the end of cross beams. In the farm, the shell strings are suspended from racks. The mortality (including those fallen) is about 45%.

Rack and Tray Method

The nursery-reared single spat (cultch-free) measuring about 25 mm are transferred to trays of size 40 x 40 x 10 cm at a density of 150 to 200 oysterlings/ tray. The tray is knitted with 2 mm synthetic twine of appropriate mesh and is suspended from rack. Once the oysters reach 50 mm length they are segregated and transferred to rectangular tray of size 90 x 60 x 15 cm these trays are placed on the racks. Each tray holds 150 to 200 oysters. The average growth rate of the oyster is 7 mm/month and at the end of 12 months the oysters attain an average length of 85 mm in Tuticorin. The production is estimated at 120 t/ha/year. Compared to the string method, this method gives production but the production cost is high.

Stake culture

A stake is driven into the substratum and on the top end one nail and on the sides two nails are fixed. The nail holds in position a shell with spat attached. The stakes are placed 60 cm apart. In this method, the nursery rearing of spat is carried on the same stake . For about two months the spat on the top end of the stake are covered by a piece of velon screen. Once the oysters attain 25-30 mm the velon screen is removed and in another 10 months they reach the marketable size. The growth rate of the oysters in this method is the same as that of the oysters raised by the string method. The production is estimated at 20 t/ha/year.

Farm management

Periodic checking of the farms is essential. The main points to be checked are replacement of broken farm structure and resuspending loosened rens which touch the estuarine bottom. High mortality rates have been observed when the rens fall on the ground. To tide over these problems periodic checking is essential.

Predators and foulers are also a menace to oyster farmers. Crabs, fishes, starfishes, polychaetes and gastropods are the predators of oysters.

Barnacles are fouler that settles on the wooden structures, trays and oysters. It competes for food with the oysters. It also increases the weight of the ren causing damage to the farm structure.

Harvest of oysters

The oysters are harvested when the condition is high. At Tuticorin good meat yield is obtained during March-April and August-September and along Kerala harvest is ideal during May in Vembanad and Chettuva estuary and during August - October in Ashtamudi Lake. Generally high condition index is obtained when the gonad is ripe prior to spawning. Harvesting is done manually.

Post-Harvest Processes

The technology adoption of oyster farming has been slow, mainly because of the difficulty in post-harvest handling of oysters and the limited markets. Even among oyster consumers, the preference is for cooked meat, rather than whole and live, making heat shucking a necessity. Heat shucking is tedious in the case of oysters as compared to mussels, as they open their valves only on strong steaming. Besides, oyster processors invariably complain about cuts and bruises on their hands while shucking the oyster meat. So much so, many first-time oyster farmers in Ashtamudi, Kayamkulam and Vembanad Lakes of Kerala have switched to mussel farming. However, this trend is recently being reversed due to better market price and also the realization that oysters are more euryhaline than mussels, and hence more conducive for culture in an estuarine environment.

Depuration

Oysters, like other filter-feeding bivalves, accumulate pathogenic organisms in their body. By depuration the bacterial load is brought down to permissible levels, also faeces, sand particles and silt are removed from the alimentary canal of oysters.

The oysters are placed for 24 hours in cleaning tanks under a flow of filtered seawater. About 10-20% of the seawater is continuously replaced. At the end of 12 hours the water in the tank is drained and oysters are cleaned by a strong jet of water to remove the accumulated faeces. The tanks are again filled with filtered seawater and the flow is maintained for another 12 hours. Then the tanks are drained and flushed with a jet of filtered sea water. The oysters are held for about one hour in 3 ppm chlorinated seawater, and then washed once again in filtered seawater before marketing.

Transport and storage

Oysters kept under moist and cool conditions survive for several days. However it is desirable that they reach the consumer within three days of harvest. Studies indicate that oysters packed in wet gunny bags are safely transported for 25-30 hours without mortality and in good condition.

Shucking

The removal of the meat from the oyster is called shucking. A stainless steel knife is used for the purpose. To render shucking easy, oysters are subjected to a wide range of treatments such as exposure to weak hydrochloric acid, heat cold, vacuum, microwaves and lasers. Freezing the oysters, or immersing them in hot water are the two methods commonly followed. However in India steaming the oysters for 5 to 8 minutes has been found to be ideal to make the oysters open the valves

Processing

Oysters are eaten in fresh condition in the half shell in many countries. The oysters are processed in several ways.

Frozen oysters

After depuration whole oysters (shell-on) are frozen by spreading them in a single layer of trays in an air blast freezer with polypropylene film stretched over each tray. Frozen whole oysters packed in polythene bags remain in good condition for six months in cold storage at 25 o C. The liquid within the shell acts as a glaze to protect the meat from dehydration. Shucked oyster meat is also frozen either in blocks or individually.

Canned oysters

Oyster meat is chilled, washed and blanched in 3% brine containing 0.1% citric acid for 4 to 5 minutes. The balanced meat is packed in cans, and hot 2% brine with 0.1% citric acid is added to the cans. The cans are seamed, sterilized at 115o C for 25 minutes and immediately chilled and stored

Smoked oysters

The meat is washed, treated with 5% brine for 5 minutes, drained, dipped in edible oil, spread in a single layer on a nylon wire mesh, drained again and loaded into a smoking chamber. The meat is held in dense smoke and maintained at a temperature of 40 o C for 30 minutes and later at 70 o C for 90 minutes. The smoked oysters are filled in cans with hot refined oil. The cans are seamed, sterilized at 115°C for 25 minutes and immediately chilled and stored.

Oyster stew

Oyster which are too large or badly cut while shucking or those in low condition, are prepared as for canning but are chopped into small pieces and added to milk and spices.

Byproducts and utilization

The two shell valves constitute about 85% of the total weight of oyster and contain 52-55% calcium oxide. They are used in the manufacture of calcium carbide, lime, fertilizers and cement. They are useful spat collectors in oyster culture. The shells are broken to pieces and used as poultry grit.

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