

MUSSEL FARMING: AN AVENUE FOR INCOME GENERATION IN COASTAL STATES

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Introduction

Mariculture of bivalves assumes greater importance in meeting the increasing protein demands of the human population. Bivalve groups such as oyster, mussel and clams are the most important cultivable organisms all over the world. Of these, *P. viridis* and *P. indica* forms the most dominant cultivable species. The Central Marine Fisheries Research Institute (CMFRI) has developed eco-friendly techniques for mussel culture. Recently, CMFRI has taken up efforts to popularize mussel culture in all coastal districts of Kerala.

Scope for mussel farming

Kerala state is endowed with rich mussel resources and survey reveal that two species viz., *Perna viridis* (green mussel) and *Perna indica* (brown mussel) are present along the rocky shores. The latter is mostly restricted up to the south of Kollam from Cape Comorin in West Coast and the former is distributed throughout. Annually about cape Comorian is west coast and the former is distributed throughout. Annually about 15000 t of mussels are exploited from these regions. During post – monsoon period there is heavy settlement of mussel spat along the entire Kerala coast. This seed can be used for farming (See Annexure for a recent estimate of mussel seed resources in central Kerala). Mussels reach harvestable size (55-70 mm) within 4-5 months when cultured.

Experiments indicate if farming activities confined to November to May, mussels can be successfully cultured in most estuaries of Kerala since ecological conditions will be congenial for good growth and survival. Similarly the Arabian Sea bounding the shores of Kerala can also be used to culture of mussels during the fair season (Oct to May).

Background information

The CMFRI has developed technologies for farming of mussels in early seventies and since then it have been upgraded and refined for commercial production. The Institute has conducted a series of experiments on location testing in various estuaries and sea along the west coast of India. In Kerala, location testing in various estuaries and sea along the west coast of India. In Kerala, location testing for mussel culture has been done in estuarine areas using rack and rope method.

The Calicut Research Centre of CMFRI, Calicut took steps to expand mussel culture practices in the north Kerala region in small-scale with the involvement of fishermen. The Research Centre successfully demonstrated mussel culture in the Dharmadam Estuary during 1995-96. This created some awareness among the local fishermen.

During 1996-97, mussel culture was done on a large scale at Padanna with the involvement of a group of twenty five fisherwomen. Financial support was extended by the DW CRA. These programme proved that mussel culture can be profitably undertaken utilizing the available water spread area in the estuaries of North Kerala. In Central Kerala it was demonstrated in the Chettuva estuary in Trichur district during 1997 and now it is extended upto Munambam estuary and nearby areas of Sathar Island.

Open sea culture of mussels was initiated by the CMFRI off Vizhinjam and off Calicut during the 1970's. Recently, a pilot scale demonstration of long – line culture was also carried out off Andhakaranazhi near Alleppey. During 1998-99, a group of fishermen from Vypin Island took the initiative to launch raft culture of mussels in the sea off Narakkal with technical collaboration from CMFRI. Currently farmed mussel production from Kerala state is estimated to be nearly 20,000 t.

Common names

English: Green mussel / Brown mussel

Malayalam: Kallumaekai /Kadukka/ Chippi

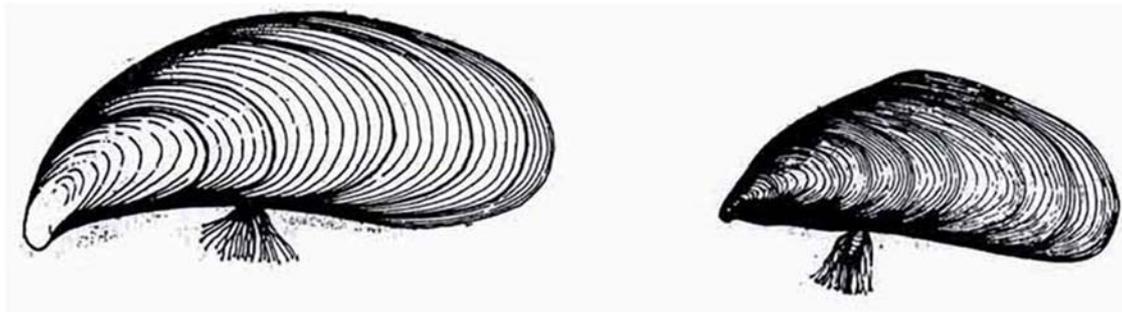
Tamil Pachai Aali/ Kallikai

Morphology

The external shell colour of young green mussel is beautiful jade green and in older specimens it is bluish-green at the anterior half. The shell colour of brown mussel is dark brown. Interior of the shell is margaritaceous and shining in both the species. Two equal sized shells protect the internal organs. The shells are thick, equivalve, equilateral, elongate, triangularly ovate in outline and hinged at the anterior end. The posterior end of the shell is almost round.

Diagnostic characters	<i>Perna viridis</i> (Linnaeus, 1758)	<i>Perna indica</i> (Kuriakose&Nair, 1976)
Common name	Green mussel	Brown mussel
External shell colour	Green / Bluish green	Deep brown
Dorsal ligamental margin	Curved	Straight
Mid dorsal margin	Arcuate	Highly angular
Posterior margin	Rounded	Rounded
Ventral margin	Highly concave	Straight
Mantle margin colour	Yellowish green	Brown
Excurrent aperture opening	Mouth oval and wide; passage into the mantle cavity small; restricted by septum, rectum and posterior adductor not visible through the opening.	Mouth and passage into the cavity are of same width; rectum and posterior adductor prominently visible through the opening.
Ventral mantle margin	Inner fold of the posterior ventral margin thin,	Inner fold of the posterior margin very thick not

	extensible, smooth, tentacles or papillae absent.	extensible; provided with 18-22 thick branching tentacle.
Posterior byssal retractors	Two, short, thick bundles; anterior bundle arises from the posterior and diverges in the form of a 'V'	Two, short, thick bundles; anterior bundle arises from the posterior and diverges in the form of a 'W'



P. viridis (Linnaeus, 1758)

P. indica (Kuriakose & Nair, 1976)

Food and feeding

Mussels are ciliary-mucoid filter feeders, which feed on phytoplankton, zooplankton and detritus.

Growth

Green mussel shows a rapid growth rate by length of 8mm-13.5mm per month. Under average culture conditions, green mussel and brown mussel attain a length of 80-88mm with 36.4 - 40g weight and 65 mm with 25-40 g in 5 months respectively. The farmed mussels give a better meat yield compared to mussels from the natural bed. The average edible portion of the meat in cultured mussels' ranges from 34.5% - 40.5% where as in the natural bed the meat yield is 27.2%-33.3% of the total weight. Growth by length and weight are probably the most important criteria for assessing the success of the culture system.

The growth of mussel is influenced by a number of environmental factors such as water quality, food availability, settling density, water current and tidal exposure.

Reproduction

Mussels are known to be unisexual. Hermaphrodites are observed very rarely. The gonad of mature female can easily be distinguished by its bright orange-red colour from that of the male, which is creamy yellow.

Mussels attain sexual maturity in two months (15-28 mm). Spawning period is prolonged extending from January – September with peak spawning during June-September in Kerala. The four main stages in the reproductive cycle are spent/resting, developing, ripe and spawning. Fertilization is external. After

fertilization, it attains pediveliger within 15-35 days. Pediveliger attaches to the settlers with the help of byssus threads and metamorphose to spat. Spat settlement takes place from July to September and attains seeding size in September.

Condition index

$$\text{* Condition index} = \frac{(\text{dry meat weight X 1000})}{\text{Volume of shell cavity}}$$

$$\text{** Percentage edibility} = \frac{\text{Meat weight x 100}}{\text{Whole mussel weight}}$$

* Condition index is generally related to the reproductive cycle. Condition of mussel indicates the degree of fatness of a mussel or the extent to which the meat fills the cavity. The ideal condition index of mussel is 70 - 140. This will be high during non-spawning period.

**Percentage edibility, the percentage edibility is high the mussels can be harvested. Percentage edibility varies from 20 – 45%.
Distribution of Mussels

The green mussel *P. viridis* is widely distributed throughout the Indo Pacific area. It has been reported to occur in China, Japan, Persian Gulf, Indonesia, Hong Kong and in the Pacific Islands. *Perna indica* is found only along the Indian coast. *Perna perna* is found along the coasts of the African continent, South America and Sri Lanka.

Mussel is popularly known as " Kallumekai / Kadukka/ Chippi" in Malayalam. Green mussel *Perna viridis* and brown mussel *Perna indica* are available along the Indian coast. The green mussel, *P. viridis* is extensively distributed as subtidal and intertidal beds along both the coasts. Along the Kerala Coast, the major locations are Koduvally, Mahe, Chombala, Moodadi, Thikkodi, Elathur, Chaliyam and South Beach, Anchangadi, Ethai, Narakkal, Chellanam, Andakaranazhi, Azhikkal, Parimanam, Port Kollam and Neendakara.

FARMING TECHNIQUES

Site selection

Open sea and estuarine areas free from strong wave action are suitable for farming. Clear seawater with rich plankton production (17-40µg chlorophyll /l,) is ideal for mussel culture. Moderate water current (0.17-0.25m/s at flood tide and 0.25-0.35m/s at ebb tide) will bring the required planktonic food and will carry away the excessive build-up of pseudofaeces and silt in the culture area. The water should have a salinity of 27-35 ppt. and temperature of 26° C- 32° C. Site should be free from domestic, industrial and sewage pollution.

Open sea farming

In open sea farming, the depth at the site should be above 5m without strong wave action, less turbulent and with high primary productivity. Long line and raft culture techniques are ideal for open sea farming. Mussels grown on long lines become smothered by naturally settling juvenile mussels and other fouling organisms. Effective utilization of easily available material for fabrication of long line and rafts can be done. Disadvantages of this farming are the poaching and unpredicted climate changes. Protected bays are ideal for mussel farming.

Estuarine farming

Compared to open sea, estuarine ecosystems with less turbulent and shallow depth (<4m) are suitable for mussel farming. Culture of mussels on horizontal ropes results in high productivity due to the effective utilization of the primary productivity. Rack culture is ideal for estuarine conditions. Fluctuation in salinity during monsoon season and pollution through domestic and industrial waste are the main constraints in estuarine mussel farming.

Methods of farming

Rack method

This method is suitable for estuaries and shallow bays. The racks are fabricated placing Bamboo / Casuarina poles vertically and horizontally tying and lashing with nylon/ coir ropes. Bamboo or Casuarina poles are driven into the bottom and spaced at a distance of 1-2m. These stakes are connected horizontally with poles. The horizontal poles should be above the level of water at high tide and seeded ropes are suspended from the same.

Raft method

This method is ideal for open sea conditions. Square or rectangular rafts are fabricated with sturdy bamboo or casuarina poles. Buoyancy for the raft is provided by tying 5 barrels of 200-litre capacity one each at the four corners and one in the middle (metal oil barrel painted with anticorrosive paint or synthetic material). Ideal size of the raft is 5 x 5 m. The rafts are positioned at suitable site in the sea using 50-100kg of iron, granite or concrete anchors. Three seeded ropes can be suspended from one square meter area of the raft.

Long-line method

This method is considered ideal for unprotected open sea conditions. The main line is a synthetic rope of 16-20mm diameter. The long-line, which is supported by 200 liter barrels tied to it and spaced at 5m. The long-lines and barrels are anchored in position at both ends using concrete blocks and nylon ropes. Seeded ropes are suspended from the long line.

Seed collection and seeding on ropes

The site selected for collection of seed should be free from pollutants. Seeds collected from the submerged (sub tidal) areas will be healthier. After removing other organisms and weeds, the seeds were washed thoroughly in seawater. About 500- 750g of seed is required for seeding on one-meter length of rope. The ideal size of the seed is 15-25mm with 1-2g weight. The length of the rope is decided by considering the depth where the raft/ rack is positioned. While suspending the

seeded rope on rack it must be tied in such a way that the upper seeded portion of the rope should not get exposed during low tide.

Nylon rope of 12-14mm or 15-20mm coir rope can be used for seeding. Old cotton net, cotton mosquito net or cheap cotton cloth are used for covering the seeds around the rope. Cotton netting of required width and length is placed on the floor and required quantity of seed is spread over the net from one end to another. The rope is kept above the net and is tightly stitched in such a way that the seeds spread uniformly around the rope. The cloth will regenerate within 2-3 days. By this time the seeds will secrete byssus thread and will get attached itself to the rope.

To avoid slipping of the mussels, knots are made on seeded rope at a distance of 25cm. Placing split bamboo pegs in the rope (12-14mm) at regular intervals will also serve the purpose.

Grow-out-phase

The seed, which get attached to ropes, show faster growth in the suspended column water. If the seed is not uniformly attached, crowded portion always show slipping. To avoid slipping, periodical examination of seeded rope and thinning of the same is essential. The ropes also should be suspended in such a way that it will not touch the bottom as well as the seeded portion is not exposed for longer period during low tide. Seeded mussel on the upper portion of the rope shows faster growth due to the abundance of phytoplankton. For better growth the seeded ropes should be spaced at a distance of 25 cm.

In open sea -farming, growth of mussel is very rapid. They attain 80 - 110mm in 5-6 months with an average growth of 13.5mm/month and an average weight of 35-45g. This growth is observed in farms at various locations. In estuarine farming, mussels attain 75-90mm in 5 months with an average weight of 35-40g and an average production of 10 - 12 kg/m rope

Management

Constant vigil is required to see that the raft/rack is in position. Thinning may be done if necessary to avoid loss of mussel and to provide enough growing space. Periodic removal of fouling organisms like Barnacles, Tubicolous polychaetes and Ascidians is to be done for improved growth.

Harvest, product development and marketing

Harvest will be done when the mussels reach marketable size and condition index is high, i.e., before the spawning and onset of monsoon. Normally harvest season is from April to June.

Mussel ropes are collected manually and brought to the shore for harvest and washed thoroughly using jet wash to remove grit and slit. The mussels separated from the ropes are maintained in re-circulating seawater for 24hrs and washed again in fresh seawater. This method of depuration is effective in reducing the bacterial load of the mussel meat by 90%.

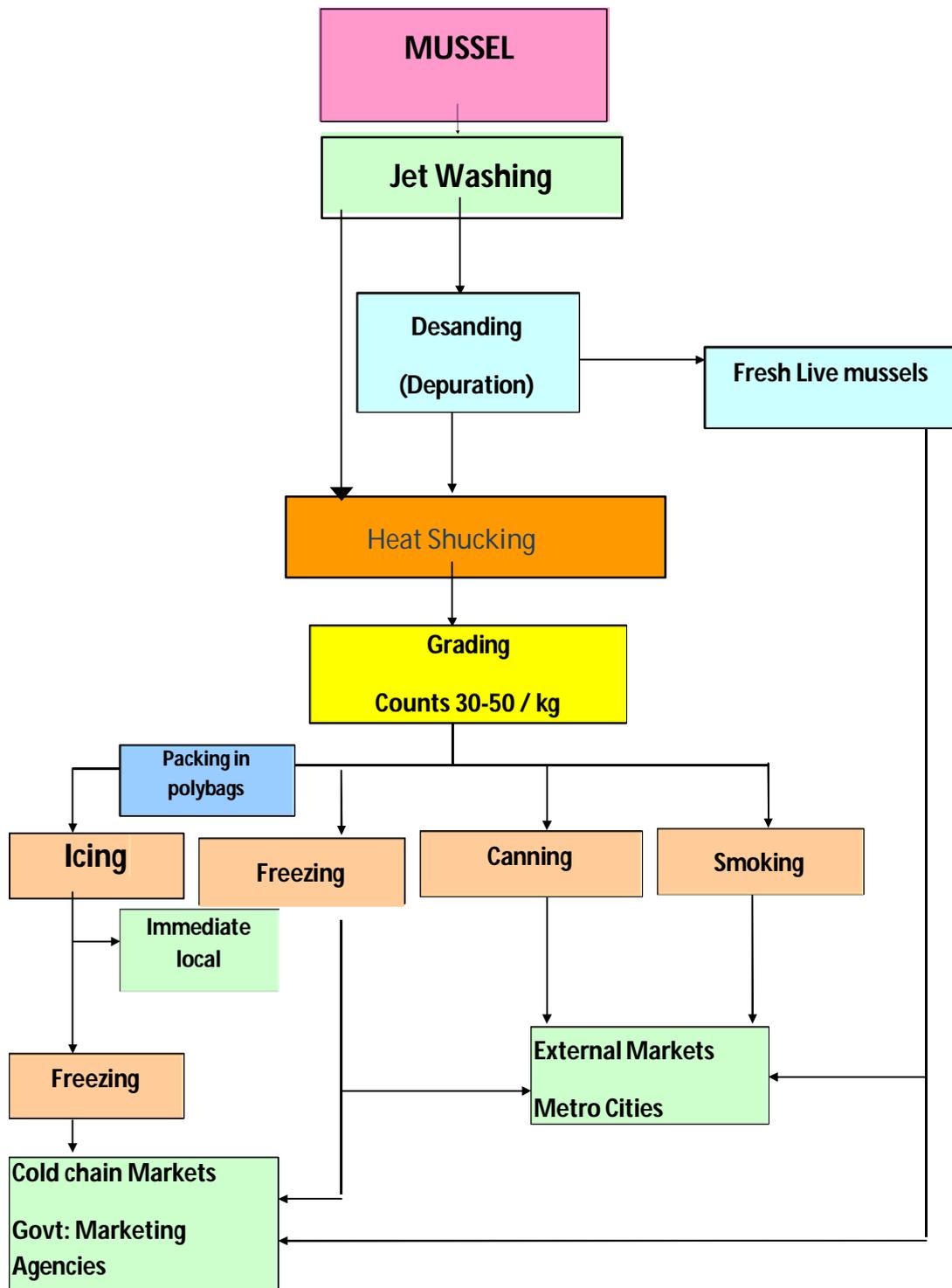
Depurated mussels are then mainly sold through local market as live shell-on mussel. At present processing units use only a small quantity of cultured mussel. New strategies need to be developed to fully exploit the domestic market.

Meat from depurated mussel can be shucked in fresh condition or after boiling or steaming. Further processing of the mussel meat can be done after blanching in 5% salt solution for 5 minutes.

Depuration

To avoid risk in consuming the mussel meat and to increase the quality of mussel, depuration is essential. During the process of feeding, mussels accumulate all suspended biological materials including harmful microorganisms. Before the product reaches the market, these materials have to be removed from their gut. The process of such purification is called depuration.

The mussels 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 mussels are cleaned by water to remove the accumulated feces. 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 mussels are held for about one hour in 3 ppm chlorinated seawater, and then washed once again in filtered seawater before marketing.



Post harvest procedures / processing

Products and export

A variety of products have been developed in India from mussel meat. These products have been developed by R & D activities of CIFT, Kochi.

In the retail market, few mussel products are available. The latest product in line is the condiment incorporated ready-to-eat fried mussel meat in vacuum packs.

For further economic utilization, value added products of mussels like seafood cocktails are prepared and marketed by seafood export firms in India. The export of these items from India is showing an increasing trend.

Overseas markets

Mussels are exported to different countries in the frozen and dried condition. They are also airlifted in the iced condition to the Gulf countries where mussels are in great demand. There is an increasing demand for mussels in the global markets, especially in UAE, China, Mali, Singapore, Srilanka, Australia, Greece, Japan, Lebanon, Mexico, New Zealand and Rep. Korea. The export of mussel products shows an increasing trend.

Present status of mussel culture

In India mussel production through culture shows an increasing trend. Now under NATP programme mussel culture became a popular one in most of the maritime states of India. In the Indian subcontinent estuarine farming of mussel was first started in Kerala particularly at Dharmadom in Kannur district, Padanna and Cheruvatur in Hosdurg Taluk of Kasargod district.

The establishment of mussel farms in Kerala State led to an increase in mussel production. In Kerala, the important event that has taken place in mussel farming is the women participation (Women Self Help Group).

Seed production in captivity

Keeping brood stock in captive tanks and by induced maturation and spawning, seed can be produced in hatchery. In India, CMFRI has developed hatchery technology for mussel seed production. But hatchery production of mussel seed is not yet commercialized.

Role of CMFRI in mussel farming

Training programmes are conducted in collaboration with Aquaculture Development Agencies to different categories of trainees like in-service personnel, private entrepreneurs, NGO's, and fisher groups especially women. Demonstration farms are set up in all the suitable areas like estuaries and open sea. Creating awareness among funding agencies, other state government organizations and panchayats for release of funds under various developmental schemes have helped in the commercialization of mussel farming in all the maritime states especially in Kerala.

One of our farmers (Shri. G.S Gul Mohamed) received the "**KARSHAKA SIROMANI**" National award for the year 2002, constituted by the Ministry of Agriculture, Govt. of India for the best Mussel farmer. This is the first time that such a prestigious national award to a Keralite farmer from fisheries sector. Shri. Gul Mohammed started mussel farming in estuaries from 1996 utilizing the technology developed by Central Marine Fisheries Research Institute (CMFRI).
