Mussel Culture

P.S Alloycious
Senior Technician, CMFRI
Email:psalloy@gmail.com

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Introduction

Mari culture of bivalves greater importance in meeting the increasing protein demands of the human population. Bivalve groups such as oyster, mussel and clam 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.

Growth

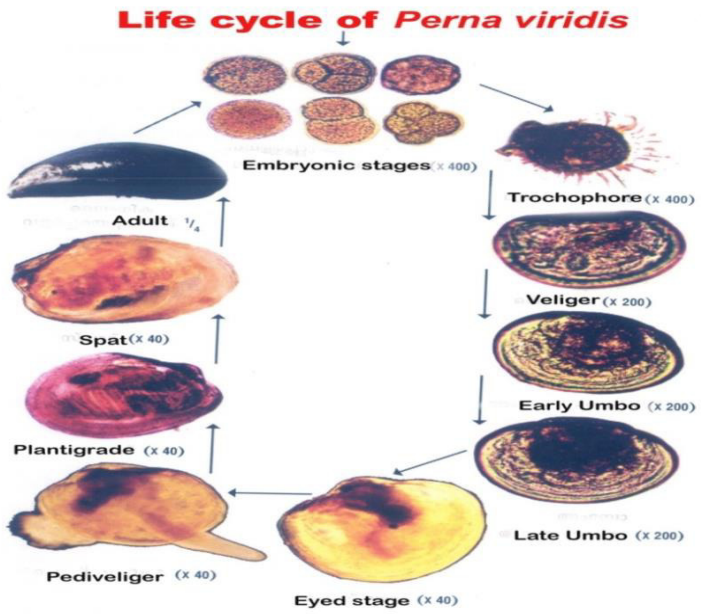
Green mussel shows a rapid growth rate by length of 8mm-13.5mm per month. Under average culture conditions, green mussel and brown mussel attain a length of 80-88mm with 36.5-40g weight and 65mm with 25-40g in 5 months respectively. The farmed mussels give a better meat yield compared to mussels from the natural bed. The average edible portion of the meat 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. The gonad of mature female can easily be distinguished by its bright orange-red color form that of the male, which is creamy yellow.

Stage	Male	Female
I (Immature)	Sperm non motile	Ova without any shape
II (Maturing)	Sperm non motile	Granulation in the ovary
III (Mature)	Sperm motile	Spherical ova
IV (Partially spent	Motile sperm and tissues	Spherical ova and reputed ova
V (Spent)	Reputed tissues	Reputed tissues
(Indeterminate)	Differentiation impossible	

Mussels attain sexual maturity in two months (15-28mm). 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.



Egg 2.Egg with sperm 3. 3-9 early developmental stages 10. Trochophore 11. Veliger 12. Eyed/ umbo stage 13. Plantigrade 14. Spat 15. Adult.

Condition index

*Condition index = (dry meat weight X 1000) / Volume of shell cavity

**Percentage edibility = Meat weight X 100 / Whole mussel weight

*Condition index is generally related to the reproductive cycle. Condition of mussel indicates 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 harvest3ed. Percentage edibility varies from 20-45%.

Mussel seed availability / area suitable for farming in Kerala

Location-Ashtamudi lake , Thangaserry Bay, Azheekode, Maliyankara, Sathar Island, Chettuva, Ponnani, Kadalundi, Dharmaadam, Valapattanam, Padanna, Neelaswaram etc.

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 materials for fabrication of long line and raft 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 id ideal for estuarine conditions. Fluctuation is 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/casurinapolse vertically and horizontally tying and lashing with nylon/coir ropes. Bamboo or casurina poles are drier driven into the bottom and spaced at a distance of 102m. 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 liter 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 5 X5 m. the raft are Positioned at suitable site in the sea using 50-100kg of iron, granite or concrete anchors. Three seeded rope can be suspended from one meter area of the raft.

Long –line method

This method is considered ideal in unprotected open sea conditions. The main line is synthetic rope of 16-20mm diameter. The long-line, which is supported by 200 litters 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 in the long-line.

Horizontal Culture

This method is ideal in shallow areas with a minimum level of water column. Seeded rope were suspended by tying upward by ropes to horizontal poles; but both the ends will be stretched and tied in vertical poles erected in opposite sides in the farm structure. In the estuaries of Malabar, most of the farmers are following this method.

Bouchot culture

Bouchot (stake culture) method was done in the shallow waters of Ashtamudi Lake at Dalawapuram, Kollam with farmer's participation. Mussel seed (20-25mm) were collected from the estuary and seeded on casuarina poles, bamboo split of one meter length @1.5kg/pole, strip. Production of 12kg/pole, bamboo split was obtained with in a period 3 months.

Seed collection and seeding on rope

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 sea water. About 500-750g of seed is required for seeding on one meter length of rope. The ideal size of the seed is 15-25mm 1ith 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 the 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 seeds spread over the net from one end to the. 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 disintegrate within 2-3 days. By this time 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 the distance of 25cm. Placing split bamboo pegs in the rope(12-14mm) at regular intervals will also serve the purpose.

Growth-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 80-110 mm 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, tubiculouspolycheates and ascidians is to be done for improved growth.

Diseases and Poisoning

Mussels are said to be harmful when consumed during periods of re tide (in Malayalam it is called polavellam). This mainly occurs due to dinoflagellates bloom or bloom of diatoms, or cyanobacteria. They will produce potent toxins that can find their way through the food chain to humans, causing a variety of gastro-intestinal and neurological illnesses, such as: paralytic shellfish poisoning, diarrhaeortic shellfish poisoning, amnesic shellfish poisoning, neurotoxin shellfish poisoning. Another new toxin identified is yessotoxin, which affects the nervous system.

Calendar of mussel farming activities in Kerala

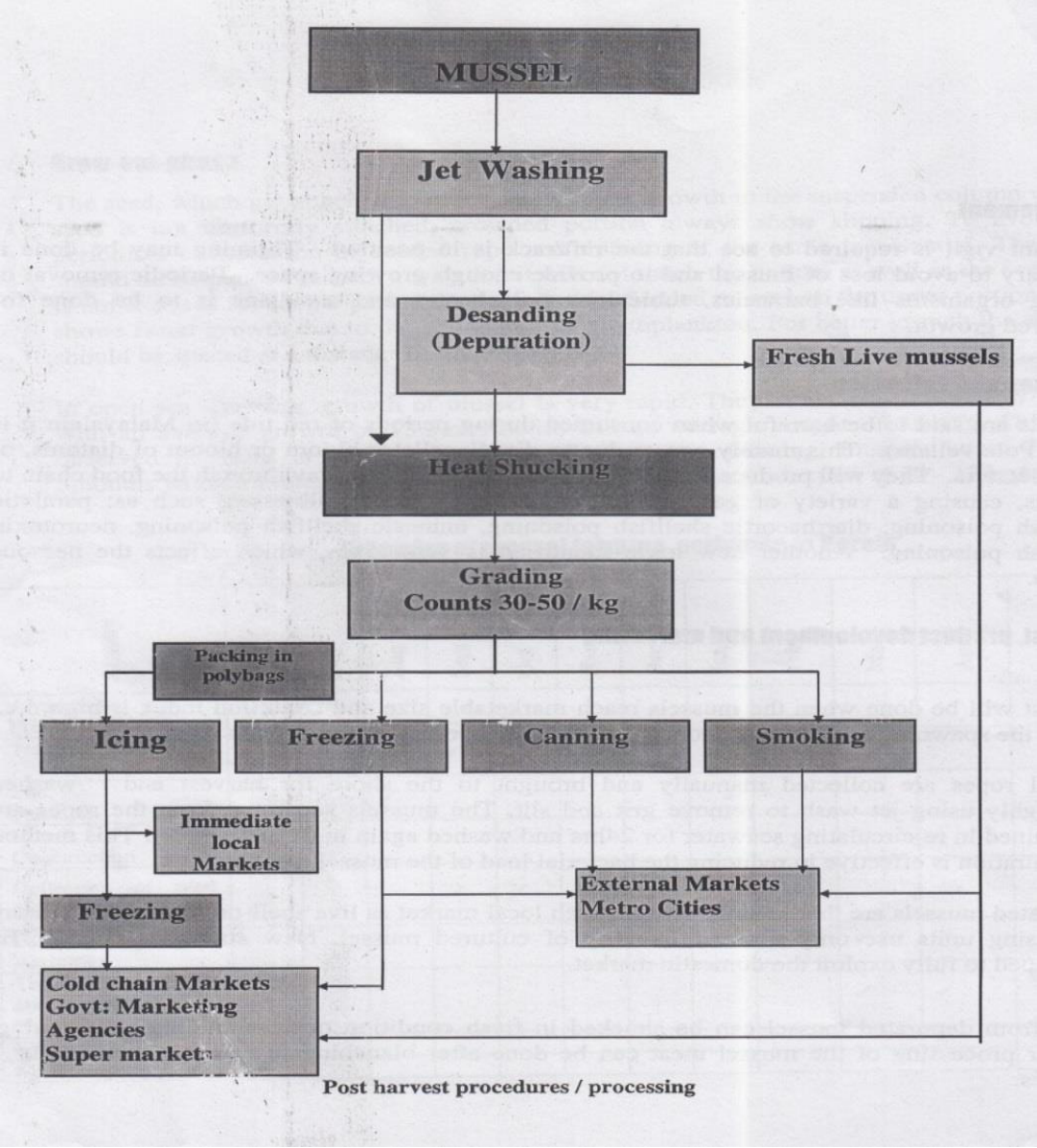
Activity	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Awareness Programmes	✓	✓	✓									
Training (Phase-I)				✓	✓							
Site Selection		✓	✓									
Farm Construction					✓	✓						
Collection of seed and seeding				✓	✓	✓						
Farming Activities							✓	✓	✓	✓	✓	
Training programme and workshop PhaseII)										✓	✓	
Harvest												✓
Marketing												✓

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 rope is collected manually and brought to the shore for harvest and washed thoroughly using jet wash to remove grit and silt. The mussels separated from the ropes are maintained in re- circulating seawater for 24 hrs and washed again in fresh seawater. This method of depuration is effective in reducing the bacterial load of the mussel meat by 905.

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.



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 mussel 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.

Nutritional value of 100g heat blanched mussel meat.

Composition	quantity	Adult male (%) of daily requirement	Adult female (%) of daily requirement
Energy	172 Kcal	2.9	3.8
Protein	23.8 g	19	24
Oil (fat)	4.48 g	2.2	2.9
Omega 3 fatty acids	782 mg	*	*
Cholesterol	27 mg	-	-
Calcium (Ca)	56 mg	7	
Iodine (I)	0.065 mg	43	43
Iron (Fe)	7 mg	70	47
Phosphorous (P)	285 mg	29	29
Potassium (K)	270 mg	11	11
Selenium (Se)	0.038 mg	19	19
Sodium (Na)	410 mg	13	13
Zinc (Zn)	0.95 mg	6	6
Vitamin A (Retinol)	0.05 mg	5	5
Vitamin E (Tocopherol)	1.9 mg	19	19
Vitamin B1 (Thiamine)	0.009 mg	0.6	0.6
Vitamin B2 (Riboflavin)	0.28 mg	16	21
Vitamin B6 (Pyridoxine)	0.19 mg	9.5	12
Vitamin B12 (Cyanaocobalamine)	0.009 mg	0.5	0.5
Niacin	1.4 mg	7	9.3
Pantothenate	<1 mg	< 20	20
Vitamin C (Ascorbic acid)	4.4 mg	7	7

Ratio Omega 3 to Omega 6 is 13:5
Source; United State Dept. of Agriculture Handbooks
“Composition of Foods Nos. 8.15,1987 & 8.13,1989.

Overseas markets

Mussels are exploited 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, Sri Lanka, Australia, Greece, japan, Lebanon, Mexico, New Zeeland, and rep. Korea. The export of mussel products shows an increasing trend.

With globalization, seafood trade will be subjected to increasingly greater regulation, control, issue related to environmentally sustainable practices. Seafood safety would assume greater significance in the future. Eco- labeling and HACCP certification would be made mandatory for all seafood products. Contaminants frequently

monitored include bacterial loads, heavy metals, antibiotics and pesticides, algal blooms for HAB (Harmful Algal Bloom) toxins.

Economics for a model mussel farm

Rack and rope culture in estuary Mussel farm 5m x 5mSeeded rope 100 nos.

1. Fixed cost (material cost)			
Item	**Quantity**	**Rate**	**Amount**
Bamboo poles (9= poles + 10 horizontal poles	19 nos	350	6650
Nylon rope (3mm/4mm)	1kg	250	250
Nylon rope (12mm)	13kg	250	3250
PVC pipe (2.5 "/3")	1m	100	100
Total			**6850**
1. Recurring cost (Labour charge)			
Stitching charge	100	7	700
Canoe hire charges	5 days	300	1500
Labour charges (farm construction, seeding and harvesting	8 days	850	6800
Mussel seed (20-25 mm)	150kg	50	7500
Cotton netting materials	25m	40	1000
Marketing (shell on) **	800 kg	25	20000
Miscellaneous			1000
Total			**38500**
3 Labour charges (Meat shucking)			
Depuration charge *	800kg	6/kg	4800
Shucking charge	200 kg	30	6000
Fuel charges			2000
Marketing	200 kg	40	8000
Total			**20800**
Total financial outlay			
Shell on (1+2+3 *) = 6850+38500+4800 = Rs.50,150			
Heat shucked meat (1+2**+3) = 6850+ 18500+20800= 46,150			

**Except the marketing charge
* Depuration charge only

Total yield			
Product	Total quantity	Rate	Amount
Shell on	800kg (8kg/rope)	Rs.100/kg	80,000
Heat shucked meat	200kg (25% meat)	Rs.400/kg	80,000

Net profit
Shell on = 80,000 –50,150 = 29,850
Shucked meat = 80,000 –46,150 = 33,850.