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74. POST HARVEST TECHNOLOGY OF MUSSEL PROCESSING AND PRODUCT DEVELOPMENT

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ABSTRACT

This paper deals with studies on depuration, handling, transportation and product development carried out using mussels *Perna viridis*. Best method of depuration is shown to be starvation in water from natural habitat. Fresh mussel stored in ice remained organoleptically acceptable upto eight days. However, when intended for canning the iced storage should not be more than two days. It has been shown that fresh frozen mussel meat remained acceptable for 40 weeks when stored at -23°C whereas frozen meat prepard out of material iced stored for 8 days was acceptable only upto 15 weeks at -23°C. Standard process has been worked for canning mussel meat in oil and brine. Processes have also been worked out for mussel meat pickle, dried, smoked and marinated mussel meat, mussel chutney powder and lime from mussel shell.

INTRODUCTION

Mussel meat processed in different ways is very popular in several countries. There is a fairly large world trade in such commodities as can be seen from the figures of production and export presented in Tables 1A and 1B.

Green mussel *(Perna viridis)* and brown mussel *(Perna indica)* are fairly heavily distributed in the west and east coasts respectively of India. However, the estimated annual production from these natural sources is only around 3,079 tonnes (Alagarswami et al 1980). This is too meagre a quantity to support a mussel meat based processing industry. Normally mussel is sold for fresh consumption in local areas.

TABLE 1 A. *Production of Mussel meat products (MT)*

Countries	Canned			Dried			Frozen		
	1982	1983	1984	1976	1977	1978	1982	1983	1984
Netherlands	11,000	10,979	8,000						
Chile, Denmark, Korean Republic, Newzealand and Spain	17,568	15,018	17,392						
Hongkong	—	—	—	2	3	1			
Chile, Denmark, Korean Republic, Newzealand, South Africa and U.S.A.							2,559	8,016	8,726

Source: Yearbook of Fishery Statistics, Vol. 59, 1984, FAO, Rome.

TABLE 1 B. *World trade in fresh chilled or frozen mussel meat*

Countries		Imports			Exports			Quantity: mt Value: US $ 1000
		1982	1983	1984	1982	1983	1984	
France, Belgium, Italy, Netherland, FRG, U. K., Switzerland, Denmark	Q.	1,00,508	1,18,485	1,23,367				
	V.	40,991	41,534	32,059				
Netherlands, Spain, Newzeland, France, U. K., FRG, Italy, Denmark, Chile, Korean Republic.	Q.				69,546	1,04,789	1,30,396	
	V.				26,795	39,395	47,623	

Source: Year Book of Fishery Statistics : Vol. 59, 1984, FAO, Rome.

Some attempts have been made in the past to export processed mussel meat, the quantity involved being very little. There are steady trade enquiries for processed mussel meat. The lack of assured supply of raw material is a major impediment in exploiting such potential.

A right step in increasing mussel resources in the country is the importance given to developing the farming techniques by different agencies in India. It is reported that large scale culture of mussel has been successfully demonstrated (Kuriakose, 1980). No account is available of the actual production of mussel by farming. However, with production from capture and culture techniques, its production is likely to increase several fold. In the absence of a system for effective conservation by processing into stable products and marketing, the returns from the increase in production is liable to be uneconomic. This need was anticipated by the Central Institute of Fisheries Technology well in advance and research and development activities on utilisation of mussel meat were initiated which have resulted in providing a complete spectrum on different aspects of preservation and processing of mussel meat including utilization of mussel shell. These studies were largely carried out using green mussel *(P. viridis)* from natural sources.

RESEARCH INPUTS IN PROCESSING AND PRODUCT DEVELOPMENT

COMPOSITITION OF MUSSEL MEAT

Mussel meat is a protein rich food. It also contains substantial quantities of glycogen which is primarily responsible for its characteristic sweet flavour. Chemical composition of

TABLE 2. *Composition of mussel meat*

Moisture %	78.24-80.28
Protein %	11.02-13.82
Fat (ether extractibles) %	2.38-3.02
Glycogen %	5.36-10.78
Ash %	3.6-4.20
Inorganic phosphate (mg %)	15.1-43.18
Free amino acids (mg %)	
Phenylalanine	1.234
Glycine	2.938
Cystine	0.132
Tyrosine	0.932
Histidine	1 938
Valine	0.127
Lysine	0.937
Methionine	0.998
Glutamic acid	1.107
Isoleucine	0.031
Leucine	1.767
Serine	1.087
Tryptophane	0.016
Proline	0.985
Arginine	1·372
Threonine	0.343

mussel meat including the free amino acid contents is given in Table 2 (Balachandran and Unnikrishnan Nair 1975; Balachandran and Prabhu 1980 a, b; Chinnamma et al 1970).

Depuration

Mussel is a sedentary bivalve growing attached to rocks in coastal waters by means of byssus threads. They are filter feeders and therefore, at any given time, their stomachs are likely to be loaded with mud/sand besides bacteria. Surendran et al (1984) studied the distribution of faecal indicator bacteria in clams, mussels and oysters and their aquatic environments and found them to harbour large bacterial populations including faecal coliforms, *Escherichia coli* and faecal streptococci. Based on a study on the bacterial profile of mussel and its aquatic environment, Surendran et al (1986) concluded that mussel is a good indicator of faecal pollution of aquatic environments, particularly of immediate past origin.

It is rather easy to purify mussels of bacterial pollution because they cleanse themselves of all pollution bacteria if kept in clean sea water for some hours. This treatmeet can also free mussels of most of the sand in the stomach. Balachandran and Nair (1975) experimentally proved that mussel kept alive in sea water for 24 h expelled sand almost completely. More recently Surendran and Balachandran (1986), studied in detail depuration of live mussels in different systems and concluded that best results are obtained by depuration in clean sea water from rhe natural habitat of mussel. The extent of bacterial cleansing and removal of sand by this method is shown in Table 3.

Preservation and transportation

Balachandran and Prabhu (1980 a) have studied transportation of mussel in different forms and its further iced storage with a view, particularly, to use the meat subsequently for canning. Whole mussel, meat shucked from live mussel as well as meat shucked from boiled mussel were transported in ice from Calicut to Cochin and used for canning during progressive iced storage, simultaneously following the changes in chemical characteristics. The results are presented in Table 4.

Analysis of the canned samples prepared out of material stored in ice showed that products prepared out of meat from whole mussels or meat shucked from live mussels and stored in ice upto two days can be used for cannning. Meat from boiled mussels stored in ice rated poorer compared to the other samples. The corresponding organoleptic rating of canned mussel meat processed out of iced stored material are given in Table 5.

Meat shucked from iced stored whole mussel was slightly better in organoleptic characteristicts compared to fresh shucked meat stored in ice. However, transportation of whole mussel involves the transportation of shell

TABLE 3. *Effect of depuration of live mussels in different systems for 18 hrs. (overnight) on the quality of mussel meat*

	Raw meat before depuration	Natural water (sea water)	Natural water chlorinated at 5 ppm level	Potable water	Potable water chlorinated at 5 ppm level	Sodium chloride solution (2.3%)	Sodium chloride solution (2.3%) chlorinated at 5 ppm level
Total bacterial count/g	8.3×10^{6}	4.38×10^{6}	6.1×10^{5}	7.82×10^{5}	9.86×10^{5}	4.9×10^{6}	5.62×10^{6}
Total coliforms/g	6.71×10^{2}	105	238	218	486	118	118
E. coli/g	230	93	108	124	138	92	105
Faecal streptococci/g	486	124	118	230	238	108	114
Acid insoluble as (sand) %	0.42	0.02	0.032	0.088	0.18	0.02	0.06
Glycogen %	5.36	4.82	4.54	4.60	4.22	4.90	4.63

TABLE 4. *Changes taking place in mussel composition during iced storage*

Material used	Days of storage	Moisture %	TN %	NPN %	Glycogen %
Stores in ice	0	78.36	1.98	0.352	5.43
Whole mussel	2	81.26	1.87	0.361	5.06
	3	82.34	1.81	0.314	3.04
	4	82.40	1.82	0.272	3.01
Fresh shucked meat	0	78.36	1.98	0.352	5.43
	2	81.49	1.82	0.324	4.92
	3	82.64	1.80	0.302	3.16
	4	82.91	1.76	0.264	2.95
Boiled and shucked meat	0	74.27	2.03	0.382	3.94
	2	76.59	1.98	0.317	3.03
	3	76.43	1.96	0.310	2.76
	4	76.86	1.89	0.312	2.58

TABLE 5. *Organoleptic rating of canned mussel meat processed out of correspondingly iced stored material*

Days of storage	Material used	Overall organoleptic rating
Initial	A	Very good
	B	Very good
	C	Good
2	A	Good
	B	Good
	C	Fair
3	A	Good - Fair
	B	Good - Fair
	C	Fair
4	A	Fair
	B	Fair
	C	Fair - Poor

A - Whole mussel B - Meat shucked from fresh mussel C - Meat shucked from boiled mussel.

making the process uneconomic. Therefore, it was concluded that when used for canning, it is ideal to transport fresh shucked meat in ice. On the basis of studies on iced storage characteristics of whole mussel, Chinnamma (1970) reported that it remained in organoleptically acceptable condition upto 8 days even though the prime quality was maintained only for 2 days.

Freezing

Changes in chemical, bacteriological and organoleptic qualities of mussel during freezing and subsequent frozen storage in relation to pre-process iced storage was studied by Chinnamma George (1974). Whole mussels were stored in ice, samples withdrawn at regular intervals of 2 days upto 8 days, meat shucked and frozen with adequate glaze at 40°C and stored at 23°C. Analysis of the frozen samples at regular intervals showed that fresh frozen mussel meat remained in an organoleptically acceptable condition upto 40 weeks whereas the samples prepared from mussel iced stored for 8 days had a shelf-life of only 15 weeks.

Chinnamma George and Nair(1976) studied the effect of pre-process iced storage on the quality of cooked frozen mussel meat.

Whole mussel was cooked and stored in ice upto 5 days. Similarly uncooked whole mussel was stored in ice, samples withdrawn at periodic intervals and then cooked. Meat was shucked from both specimens and frozen at 40°C and stored at -23°C. Analysis of the frozen stored material indicated that samples prepared out of cooked whole mussel iced stored for one day had a shelf-life of 38 weeks and those stored for 3and 5 days had a shelf-life of only 28 days. Storage life was on an average of only 16 weeks for samples prepared out of raw mussel stored in ice and then cooked and frozen.

Canning

Canning mussel meat is a popular item of commerce. Mussel meat renders well for canning in oil, brine or sauces. Balachandran and Nair (1975) carried out studies on working out a standard process for canning mussel meat. The process of canning consists of the following steps Whole live mussels after depuration are either heated in open vats or steamed in autoclave until the meat becomes firm enough to render shucking easay. The shucked meat after washing well is blanched in 5% brine for 5 minutes. Blanched meat is filled in cans, the medium added, exhausted, seamed and heat

processed in steam at 115°C for 20 minutes. Suitability of iced stored mussel for canning has been discussed earlier.

Development of other products

A number of processes involving low cost technology have also been developed for utilization of mussel meat which includes processes for pickles, marinades, dry meat, smoked meat and preparation of lime from mussel shell.

Mussel meat pickle

A very successful product which has met with ready acceptance from consumers is mussel meat pickle. A recipe for preparation of pickle is give below:

Blanched mussel meat (Stomach removed)	—	1 Kg
Green chilly (Split)	—	100 g
Ginger (Skinned and cut into small pieces)	—	100 g
Garlic (Skinned)	—	100 g
Curry leaves	—	10 g
Chilly powder	—	150 g
Turmeric powder	—	5 g
Mustard, crushed	—	25 g
Oil (Gingelly or groundnut)	—	300 ml.
Vinegar (Acetic acid content 4%)	—	400 ml
Salt	—	To taste (around 100 g)

Process

Mussel meat is blanched for 5 minutes in boiling brine (50 g salt in 750 ml water). After draining and cooling, the gut content is chopped off and the remaining part cut into small pieces. Wash well and drain. Fry the meat in oil until the colour turns brown and set apart. Fry green chilly, ginger, garlic in oil followed by other spices. Mix together all the ingredients, allow to cool and add Vinegar and salt to taste. Mix thoroughly and fill in clean wide mouthed bottles. Care is to be taken to see that no solid material is exposed. A layer of oil should be present at the top in packed samples. (Muraleedharan, Joseph and Devadasan 1982).

Dried mussel meat

The simplest method of preservation of mussel meat is by drying. Process details and shelf life of dried mussel meat have been worked out by Unnikrishnan Nair et. al (1983). The method involves blanching meat shucked from fresh depurated mussel in 5% boiling brine for five minutes and then drying in sun or an artificial dryer until the moisture content is 10-15%. After equilibration of moisture, the dried meat is packed either in glass bottles or polythene bags. The product had excellent organoleptic characteristics and was found bacteriologically. Shelf-life studies revealed that dry meat remains well at room temperature in good condition upto 6 months after which rancid flavour develops as also the colour becomes slightly brownish. The product yield is approximately 20% of the meat. After rehydration for 30 minutes in water it can be used for ordinary preparations.

Smoked mussel meat

A popular processed mussel product is light smoked and dried mussel meat. Smoking improves the flavour and succulence of the product and hence its acceptability. The process worked out for the preparation of smoke cured mussel meat is as follows:

The meat shucked from depurated mussel is blanched for 5 minutes in 5% boiling brine. This is dried to a moisture level of 40-45%. The dried meat is smoked at 80-90°C for 30 minutes which imparts characteristic smoked colour and flavour to the product. The smoked meat is further dried to a final moisture level of 10%. It has been shown that at this moisture level the product has a shelf life of not less than six months (Muraleedharan, Nair and Joseph, 1979).

Mussel meat 'Chutney' powder

Another product which has been developed out of mussel meat is a dry 'Chutney' powder (Anon 1980). This can be used with the breakfast snacks like *Iddli* or *Dosai*. This is easy to prepare, handle and store. Recipe and preparation method are as follows:

Dried mussel meat	500 g
Skinned black gram	500 g
Red chilly	75 g
Coriander	50 g
Asafochera	5 g
Salt	To taste

Mussel meat is fried in a pan until the colour is brown. The other ingredients except salt are fried together and all are powdered and mixed together with sufficient salt. For consumption the chutney powder should be mixed with a little warm edible oil.

Marinated mussel meat

The best process for preserving mussel meat for a short period of 2-3 months is by marinating. A process worked out suitable for the species available locally (Unpublished data) consists in blanching meat from live depurated mussel in 3% brine for 5 minutes, followed by cooking and packing the meat in glass jars and covering the meat with a solution containing 3% salt and 3% acetic acid. The product remains in prime condition upto 2 months and in acceptable condition upto 3 months after which the meat tends to become very soft. The product has the advantage over dried/smoked meat in that no rehydration is required before further processing for the table and the texture does not become hard.

Utilization of shell waste

No serious attempts had been made on utilization of the mussel shell. Except using a small quantity as liming agent in coconut plantations no other use for it was known. The possibility of converting the shell into lime was experimented and it was found out that good quality lime can be prepared out of this shell waste. The process is similar to making lime from clam shells. The process has been reported to be quite profitable (Kalaimani, et al 1984).

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