PART I

GENERAL

PROCESSING ASPECTS OF INDIAN MACKEREL A REVIEW

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Indian mackerel belongs to the family Scombridae and the genus *Rastrelliger*. The Indian mackerel, *Rastrelliger kanagurta* (Cuvier), is a pelagic shoaling fish widely distributed in the Indo Pacific region with maximum abundance in Indian coasts. Another species, *R. brachysoma* (Bleeker), also is reported from the Andamans in Indian waters. However, the former is the species that supports the fishery in India (Nair, 1970).

Around India *R. kanagurta* is well known to occur all along the east and west coasts in inshore waters upto 25 metres, from Kathiawar in the north-western coast to Calcutta in the north-eastern coast. Trawlers operating from Veraval, Bombay, Karwar, Mangalore, Cochin and Calcutta have obtained the species from deeper regions in the continental shelf (Balakrishnan, 1970). However, the bulk of the catch, on an average 95%, is obtained from the west coast, intensive fishing being confined to the area from Retnagiri in Maharashtra to Ponnani in Kerala. The important centres of landing along this region are Malwan, Karwar, Malpe, Mockapatnam, Cannanore, Tellicherry, Calicut, Tanur and Ponnani. Mackerel shoals appearing sporadically on the east coast are exploited at centres like Mandapam, Nagapattinam, Madras, Kakinada, Pudimadaka and Visakhapatnam (Narayana Rao, 1970).

Fishing.

Fishing for mackerel is generally done from hand-rowed dug-out canoes called '*odam*' or '*vanchi*' of 9.8 - 10·7 m. long with 3-5 tonnes displacement usually employed for operating bag nets. A smaller type canoe called '*thoni*' of about 7.3 m. long and 2 tonnes capacity is used for drift net, gill net and cast net fishing. On the Canara and Konkan coasts, along with dug-out canoes, special type flat bottomed out rigger boats are used exclusively for the operation of 'rampani', a bagless beach seine. Five types of gears are generally in use, *viz*; bag nets (boat seines), drag nets (beach seines), gill nets, drift nets and cast nets. Among

these the most important gear is the boat seine which includes *ayilakolli vala*, *odam vala*, *paithu vala* and *madi vala* of Kerala and *kolli bala* and *paithu bala* of South Canara.

Season.

On the west coast some shoals of mackerel comprising younger fish first start appearing with the outbreak of south west monsoon which is followed by shoals of slightly bigger fish. The fishery of the west coast generally extends from September to April and its appearance exhibits variations in different regions. At Karwar the fishery starts only by October extending upto February or March, whereas along the Kerala coast it starts earlier as also lasts longer than at Mysore and Maharashtra coasts. On the east coast the fishing season is much longer at Tamil Nadu coast with peak catches in the third quarter whereas at the Andhra coast the fishing is comparatively shorter. It is the shortest along the Orissa coast with maximum landing during the first quarter (Narayana Rao, *op. cit.*).

Landing.

Wide fluctuations have been noticed in the landing of mackerel. Whereas its contribution to the total marine landing in the country was around 20% in 1971, the figure fell to as low as around 3% in 1974 (Table I).

Physical, chemical and biological phenomena associated with the environment are known to affect the mackerel fishery. The following gives an account of some of the principal factors affecting the mackerel fishery (Narayana Rao, *op. cit.*).

TABLE I

Annual landings of mackerel in relation to total marine landings
(Quantity in tonnes)

	Landing of mackerel	Total marine landing
1970	1,37,607	10,77,466
1971	2,04,575	11,61,389
1972	1,08,971	9,80,049
1973	79,423	12,20,240
1974	37,462	12,17,797

i. Delays in the onset of monsoon are often followed by delays in the fishing season.

ii. Peak landings generally coincide with the period when temperature, salinity and specific gravity of the surface water starts rising after reaching their minima during the south west monsoon period on the west coast and also with or following the plankton abundance in this area.

iii. Variations in the pattern of coastal currents.

iv. Sudden and localized monospecific blooming of several plankters adversely affecting the prospects of a good mackerel fishery.

Utilization.

Though mackerel is generally cheaper compared to other table fish like seer, pomfret etc., it is equally nutritious and is greatly in demand as a table fish.

TABLE II

*Proximate composition of mackerel

Moisture	—	73.45%
Protein	—	20.95%
Fat	—	3.29%
Ash	—	1.66%

*Venkataraman and Chari (1951)

It is a rich source of animal protein with comparatively lower percentage of fat. The proximate composition of mackerel is given in Table II.

Though in the past more than 50% of the mackerel landed used to be salt cured, in recent years its consumption in fresh condition has immensely increased thanks to the increased demand from the interior parts of the country and the developments in the distribution system like employment of trucks for transport, provision of motorable roads connecting landing centres with interior markets, ready availability of ice at landing centres and the employment of improved know-how in handling, preservation and transportation etc.

Curing.

Since mackerel, like sardines, is a seasonal fishery and the bulk of the landings takes place in a narrow strip of time preservation of excess catch often becomes necessary. Since early times a substantial portion of the mackerel catch used to be salt-cured by dry or wet process or pickled according to Colombo curing method. A portion of such products used to be exported to Ceylon.

As far as preservation of mackerel is concerned curing used to be the most important process applied and a good amount of technological research has been carried out in this field. Different methods of fish curing practised along the Indian coasts have been detailed in the *Agricultural Marketing in India* (1951) and later by Pillai, Valsan and Nair (1956) and Pillai and Kamasastri (1958). Pillai, Valsan and Nair (*op. cit.*) carried out an extensive study on the chemical quality of commercial samples of cured fish including mackerel processed by different methods. Rao, Nair and Valsan (1958) carried out preliminary studies on pit curing of mackerel. They proposed a ratio 1:5 of salt to fish and salting period of 2 days and found that pit curing improved the organoleptic properties of the fish imparting a characteristic flavour and softening flesh. However their fixation of the proportion of salt had been made on an arbitrary basis. Later, Lahiry, Sen and Visweswariah (1961), working on the effect of varying proportions of salt to dressed fish on the quality of sun dried mackerel proposed that a ratio of 1:7 or 1:8 would be adequate if the salted fish is dried at the end of 18-24 hours' salting without stacking. When dried to about 40% moisture level the sodium chloride content would be more or less sufficient to saturate its moisture content and would not be in solid phase, thus imparting a better appearance to the product. Sen, Visweswariah and Lahiry (1961) reported that at a salt to fish ratio of 1:5 maximum water loss took place in 24-26 hours for gutted fish and in 18 hours for split

open fish. They found that this proportion of salt was sufficient to saturate the moisture content of fish and, as such, any excess amount of salt will be in the solid phase and so, useless. The same authors (1961a) carried out studies to evaluate the efficacy of certain bacteriostatic and fungicidal agents such as CTC, sorbic acid, sodium propionate and sodium benzoate on the keeping quality of the product. In sample prepared in the laboratory with 30-40% moisture reddening or bacterial spoilage was observed. CTC (50 ppm.) followed by salting prevented browning to a large extent. Dip in 10% sodium propionate for 5 minutes checked the fungal attack. Lahiry, Sen and Visweswariah (1961 a) studied the effect of different chemical agents on tenderisation of the meat of sun-dried mackerel and concluded that whereas acids had a negative effect sodium carbonate, sodium bicarbonate and sodium hexametaphosphate improved the texture at moisture level above 35%. Sen *et al.* (1961) have carried out studies on the storage characteristics of commercial samples of sun-dried mackerel wrapped in different packaging materials and stored at different atmospheres of temperature and humidity. Later Rao and Sen (1966) suggested the use of a mixture containing potassium sorbate, sodium benzoate, sodium acid phosphate and common salt for curing of mackerel. Sen and Sripathy (1967) also have recommended the use of a similar curing mixture for use with mackerel.

Valsan, Nair and Rao (1961) reported that fishes like mackerel could be successfully pickled and preserved for a long period by giving a predip treatment in propionic acid bath followed by usual heavy salting. For the control of reddening and mold growth usually met with in stored dry-cured fish, Rao and Valsan (1962) suggested dipping eviscerated and split open fish in 4% propionic acid for 10 minutes followed by salting (1:4 salt to fish) for 48 hours and subsequent sun-drying. Storage life could be extended to 62 weeks as against the normal 19 weeks by this method.

Pickling mackerel in saturated brine fortified with 0.5% and 0.25% propionic acid has been found useful for keeping the fish in good condition for periods of one year and 5 months respectively (Valsan, 1967). Valsan (1968) further suggested that by smearing a mixture of 3% sodium propionate, 0.5% butylated hydroxy anisole and 0.5% sodium sulfate in dry powdered salt over cured fish at 10% level the product can be kept for 9-12 months free from any visible signs of spoilage, browning or rancidity. In the case of wet cured fish sodium propionate at 2% level is sufficient.

Balachandran and Muraleedharan(1975) have worked out an improvement over the traditional Colombo curing of mackerel by incorporating sodium benzoate as a chemical preservative in combination with salt and 'goruka puli' normally used Devadasan, Muraleedharan and George Joseph (1975) subjected mackerel to smoke curing after treating the fish with brine containing propionic acid and turmeric extract separately followed by smoking and turned out an attractive product.

Freshness of the fish as well as the quality of salt used for curing are factors which can influence the quality and stor-

age life of the processed product. Unnikrishnan Nair and Valsan (1971) studied the former aspect and reported that maximum permissible time lag between catching of mackerel and its curing should be 8 hours when the fish is kept at room temperature and 3 days if iced. In the former case the shelf life and organoleptic characteristics showed a proportionate downward trend as the period of storage prior to curing advanced. Kandoran, Rao and Valsan (1967) investigated the effect of impurities in curing salt on its penetration into mackerel and showed that rate of penetration of salt had no relationship to the impurities content even at a level of 0.75%

Canning.

Canning of mackerel has remained a relatively less attended field in India. Whereas there exists a large world trade for canned mackerel (Table III), India, having substantial mackerel landing, has not made any contribution to this. In the world market more than 90% is contributed by Japan. What little mackerel is canned in the country has been exclusively for internal market.

Indian mackerel, though relatively smaller in size compared to their Atlantic counterparts, is quite suitable for canning. Process details for canning mackerel has been worked out in the country (Anon; 1964). Rai, Saralaya and Parashuram (1970) have detailed the canning operations suitable for mackerel and dealt with some of its problems. After careful study of the chemical and physical changes taking place during ice storage and their effect on the subsequently canned product, Madhavan, Balachandran and Choudhuri (1970) ascertained that mackerel stored for more than three days in ice is not suitable for canning. Several attempts have been made in diversifying the type of canned mackerel. Rai, Saralaya and Parashuram (1971) have provided the recipe of a curry medium suitable for canning mackerel and its economics compared with that of other types of packs. Still later, Saralaya, Parashuram and Rai (1975) have given an account of a process for canning skinless mackerel fillets in oil. Research and development activities on canning mackerel is in progress in diffferent laboratories.

TABLE III

*Export of canned mackerel by certain countries.
(Quantity in Tonnes)

Country	1970	1971	1972	1973
Japan	1,62,200	1,77,300	1,84,500	1,78,000
Morocco	6,300	5,800	—	—
Portugal	—	10,300	11,000	9,900
Norway	—	1,101	800	900

*Source: Year Book of Fishery Statistics; 1972, 1973. FAO.

Freezing:

Technological research carried out in the field of freezing of mackerel has been still less. Jadav and Magar (1970 a, b, c) have studied the bacteriology of fresh and frozen mackerel, its frozen storage life and the retention of vitamin and minerals during frozen storage. They have reported a storage life of 4 months for mackerel slow frozen in blocks and glazed with water.

It has been indicated that spoilage in mackerel takes place quickly. A generous use of ice during transport, handling at processing plants etc. as also quick handling at the processing plants have been recommended as precautionary measure (Rai *et al., op. cit.*). Even after irradiation mackerel undergoes rapid deterioration which is brought about by the enzymes present in them. To obviate this the enzymes have to be inactivated by hot water or steam blanching before irradiation if the desired shelf life is to be achieved (Govindan, 1969).

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