VII. TECHNOLOGY AND INDUSTRY

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7. 1 CHEMICAL COMPOSITION

7. 1. 1 Whole fish

The chemical composition of fresh mackerel is reported by Chari (1948) as follows:

Edible portion	61.60%
Water	77.30%
Protein	18.92%
Fat	1,69%
Ash	1.58%
Phosphorus	0.69%
Calcium (Ca 0)	0.62%
Iron mg per 100 g	4.45%

Venkataraman and Chari (1951) have given figure of average chemical composition as revealed by analyses carried over a period of 2 years from 1947 to 1949, which are mentioned below:

Water	73.45%
Protein	20.95%
Fat	3.29%
Ash	1.66%

7. 1.2 Fish meal

The importance of mackerel fish meal as cattle and poultry feed is well known. It has digestible proteins, vitamins and minerals and is obtained by pressing the cooked fish and sun-drying the same. It is also prepared by beach drying i.e. by drying the fish on the beach in the open sun without being cooked. In both cases it is then powdered, sieved, and stored in tins. The composition of mackerel fish meal as worked out by Chari and Pai (1948) and Kamasastry and Rao (1965) is as follows:

Composition	Chari and Pai (%)		Kamasastry and Rao (%)
	Gutted	Ungutted	
Moisture	8.7	8.7	6.3
Protein	68.1	62.1	64.0
Fat	5.8	6.1	6.7
Ash	16.2	20.7	23.8
Acid insolubles	-	-	0.2
CaO	7.9	9.0	9.3
P_2O_5	6.7	6.9	10.7
NaCl	0.3	0.2	-
Insolubles	0.5	2.9	-
Non-protein nitrogen gm	-	-	1.1
Total volatile nitrogen mg	-	-	9.9
Amino nitrogen mg	-	-	77.0
Unidentified	1.2	2.4	-

The chemical composition of mackerel meal as analysed by Negi (1949) is given below:

Moisture	7.81%
Total organic matter	85.48%
Ether extract	5.28%
Carbohydrate	6.76%
Crude protein	73.44%
True protein	71.13%
Total ash	14.52%
Insoluble ash	0.31%
CaO	6.29%
P_2O_5	6.12%
MgO	1.14%
K_2O	0.73%
Na_2O	0.40%
Cl	0.01%

All the above mentioned workers have recorded high food values for mackerel fish meal, specially in protein. Comparatively, the protein value in the sardine meal was found to be low (Negi, *op.cit).* Chari and Pai (1948) found a difference in the protein and ash contents between gutted and ungutted mackerel fish meals. The ash content in the case of ungutted meal showed a higher percentage of insolubles than in the gutted one, probably due to the presence of sand and mud in the food taken by the mackerel. However, they advocate preparation of fish meals from the whole fish, considering the higher percentage of yield in the ungutted fish. Kamasastry and Rao (1965) did not find any appreciable decrease in the protein content of the meal during storage period. It was also observed by them that in the mackerel meal the moisture increased by 50% during the eight months storage period. While there was an increase in the non-protein nitrogen during the storage period, the fall in the amino nitrogen fraction was not quite significant. Venkataraman *et al.* (1953) observed no change in the moisture content during the storage of fish meal in sealed tins.

7. 2 PRESERVATION

7. 2. 1 Curing

The different methods of curing fish practiced along the west and east coasts of India have been given in detail in *Agricultural Marketing in India*(1951 a &b) and in subsequent publications (Pillai *et.al.,* 1956: Pillai and Kamasastry, 1958). There are some valuable earlier accounts by Nicholson (1909), Govindan (1916) and Sorley (1948) on the subject. The former two described the curing industry in Madras State and the latter in Bombay State. Pillai *et. al.(op. cit.).* analysed the chemical composition of the different types of cured samples of mackerel obtained from different place in India. Rao *et al.* (1958) studied in detail the pit curing methods of mackerel on the east coast of India and found that pit curing improved the "organoleptic properties by imparting a characteristic flavour and softness to the flesh" though their appearance was not favourable and they remained in good condition only for a few weeks after the cure. Investigations relating to dry salting and sundrying of mackerel with reference to curing of the fish with salts and chemicals and also studies on the storage characteristics and packaging

of sand dried and salted mackerel were carried out at the Central Food Technological Research Institute, Mysore (Sen *et al.,* 1961a; 1961b; 1961c: Lahiry *et.al.,* 1961a; 1961b).

Some better methods of curing fish that have been evolved as a result of research done in the recent past are mentioned below: Rao and Sen (1966) have suggested mixing of some chemical preservatives with salts issued to the fishermen for curing, so as to ensure storge of fish in good condition for a longer period. In the case of mackerel they recommend applying 250 kg of common salt, containing 1.25 kg of potassium sorbate, 0.625 kg of sodium benzonate and 3.75 kg of sodium acid phosphate for 1130 kg of whole fish.

An effective but simple method for longer preservation of cured fish with the chemical, sodium propionate, has been evolved by the Central Institute of Fisheries Technology, Cochin. By adding a mixture of small quantities of this chemical in powdery refined salt to the cured fish, it can be kept in good condition free from mould and other visible signs of spoilage up to a period of 9 to 12 months in the case of dry cured product and up to 3 months in the case of wet cured product. By incorporating butylated hydroxyl anisole (at 0.5% level) and 0.5% sodium sulphite into the preservative mixture, the onset of rancidity and the occurrence of browning effect respectively can be controlled to some extent (Valsan, 1968).

Pickling of mackerel in brine fortified with 0.5% and 0.25% propionic acid levels has been recommended to keep fish in good condition for about a year and up to 5 months respectively (Valsan, 1967). Studies on the effect of impurities on the penetration of salt in the curing of mackerel showed that the rate of penetration of salt had no relationship to these impurity contents of salt even at a level of 0.75% (Kandoran *et. al.,* 1967).

7. 2. 2 Canning

Procedure for the canning of mackerel have been worked out by the Central Institute of Fisheries Technology, Cochin and by the Marine Products Processing Training Centre, Mangalore (Fish Technology Newsletter, 5(2), 1964; Rai *et al.,* 1970). Use of enameled cans with SR lacquers has been suggested for a better presentation of the product. In the

canned mackerel tins, sometimes "curds" are formed, which settle down at the bottom of the can and give an unfavourable impression of the product. Their formation, which is due to the precipitation of soluble proteins in the meat, on heating can be lessened by some methods like "selection of fresh material, proper handling, correct brining and pre-cooking" (Rai *et al., op.cit.).*

7. 2. 3 Spoilage

Venkataraman and Sreenivasan (1952) made a study of the bacteria causing spoilage on mackerels and isolated 81 strains of bacteria from the slime, gills and guts of mackerel and also whole and putrid fish. Spore forming bacillus species formed the majority. The same authors (1953) also observed spoilage of mackerel in oil similar to 'sulphide stinker' caused by a bacterium belonging to the genus *Clostridium'* the source of which is suspected to be in the guts of mackerel.

Recent researches show that spoilage in mackerel takes place quickly as it contains more enzymes than other fishes and methods have been suggested to prevent it. A generous use of ice in transport, and while in storage and also quicker handling at the processing plants are recommended (Rai *et. al.,* 1970). It has been found that mackerel undergoes rapid deterioration even after irradiation, even though they may be free of bacteria. The enzymes present in mackerel cause the spoilage and hence they have to be inactivated by hot water or steam blanching before irradiation, so that the product may have the desired storage of life (Govindan, 1969).

7. 3 FAT CONTENT

The variation in the fat content of mackerel of different sizes and in different seasons and its correlation to the food available in the environment, intensity of feeding and state of maturity have been studied (Venkataraman and Chari, 1951 and Chidambaram *et. al.,* 1952). Venkataraman and Chari (*op. cit*) have reported that while the tendency of ash and protein content of mackerel is to remain constant, the water and fat components are subject to seasonal variation and have a reciprocal relationship. They further observed that the fat contents in mackerel rise to a maximum between September to November and fall thereafter gradually.

Chidambaram *et al.* (1952) found that mackerel of larger sizes show greater percentage of fat than the smaller ones (less than 16 cm), as shown in the following table, wherein the average value of fat content for different months for whole fish and flesh are given.

Months	Sizes less than 16.0 cm				Sizes more than 16.1 cm			
	Whole fish		Flesh		Whole fish		Flesh	
	Wet %	Water free %	Wet %	Water free %	Wet %	Water free %	Wet %	Water free %
August	1.87	8.00	1.36	5.78	3.47	12.65		
September	1.13	4.70	1.53	5.90	3.96	11.94		
October	-	-	-	-	7.58	25.14	3.85	13.37
November	1.49	6.10	0.93	3.80	8.12	22.19	4.04	14.36
December	-	-	-	-	5.57	19.72	2.74	10.38
January	-	-	-	-	6.96	24.14	2.32	8.78
February	-	-	-	-	6.43	23.77	1.95	7.81
March	-	-	-	-	3.91	14.19	2.96	10.78
April	-	-	-	-	4.60	16.19	4.15	15.73
May	-	-	-	-	4.06	14.02	2.88	10.80
June	1.14	4.22	0.69	2.86	-	-	-	-
July	0.82	3.80	1.00	4.37	3.06	10.23	-	-

The summary of their findings is as follows.The fat contents are at the maximum twice in a year viz. October-November and March-April. In the former period, 16 to 20 cm size group predominates in the catches while in the latter period the fishery is comprised of size group 20 cm and and above. In both the periods the fatty condition is attributed to their intensive feeding on the plankton which is abundant in the respective months. The heavy accumulation of fat during March-April period is for building up reserve energy for the purpose of spawning which follows immediately, when feeding is very much restricted. The fish becomes lean after spawinng. The fat in immature ones(16.0 cm and less) never rises above 3% in flesh whereas in the mature ones it is as high as 8.5%. The corresponding figures for the whole fish are 2.32 and 12.5%. A great range of variation in the fat content has been noticed in respect of sexes and gonads at different stages of maturity.

Venkataraman and Chari (1953) made estimation of fat in the plankton and correlated it with the fat in the muscle of the mackerel and also in the whole fish. Their observations confirmed the findings of Chidambaram *et al*. (1952) that the fat contents are at the maximum in October-November and March-April. They noted that the plankton during the period was fatty enough to be correlated with the fattiness of the fish, even though the peak of fat in the plankton was during February and May. They attributed the high fat content in March-April and October-December to the mackerel's intense feeding on plankton rich in fat.

7. 4 OTHER CHEMICAL STUDIES

The composition of fatty acids in phospholipids and neutral lipids of mackerel was worked out, the details of which are given below (Fishery Technology Newsletter, 9(1), 1968):

	Palmitic acid	Stearic acid	Oleic acid	Eicosa-pentaenoic acid	Docosahexa-eonic acid
	as mole per cent of methylesters				
Phospholipids of mackerel	19.3	15.7	20.0	5	17.5
Neutral lipids of mackerel	24.3	5.8	12.2	8.6	Traces

Chemical tests on the keeping on the quality of some important fishes showed that the approximate shelf life in ice storage of mackerel is 14 days and this can be extended by about another 5 days by dipping the specimens for 10 minutes in 50 ppm cholrotetracycline before being stored in ice (Fishery Technology Newsletter, 3(1)).

7. 5 UTILISATION

7. 5. 1 Fresh

Though in the past, more than half of the mackerel catches used to be salt-cured by the dry and wet process or pickled according to Colombo method, in recent years the consumption of mackerel in fresh condition has greatly increased owing to the provision of better transport and preservation facilities. The construction of a large number of ice plants and laying of feeder roads have opended the interior markets,

thereby vastly enlarging the scope for marketing fresh fish in the higher to inaccessible areas. The value of mackerel has also been rising in the last few years, as could be seen from the value per tonne of mackerel shown below from 1960-61 onwards calculated from the figure in the Administrative Reports of the Fisheries Department, Kerala.

Year	Value per tonne in rupees
1960-61	185
1961-62	343
1962-63	281
1963-64	284
1964-65	303
1965-66	429
1966-67	473
1967-68	604

It is noted that the value has more than trebled over a period of eight years and this can be attributed to two factors,one being the general rise in prices of all commodities due to inflation and the other being the poor catches of mackerel.

7. 5. 2 Cured

Cured mackerels used to be exported mostly to Ceylon. However our export of dried fish to Ceylon considerably declined from 25,932 tons valued at Rs. 4.43 crores in the year 1959 to 5,102 tonnes valued at Rs. 1.32 crores during 1968-69. Though efforts were made to encourage exports of dried fish, they did not appear to have been met with success for various reasons. The internal demand for fresh fish increased with the provision of more and more ice and cold storage facilities. Further mackerels became scarce because of the poor catches in recent years barring some exceptions.

7. 5. 3 Canned

It is estimated that only 0.6% of the total fish catch in India is canned. Canning of mackerel and oil sardine was attempted by the Madras Government at Chaliyam, near Calicut in the earlier half of this

century, but it proved to be a commercial failure due to many practical and technical difficulties. In the recent past, entrepreneurs, realizing the vast scope in the seafood canning industry, have started canning factories at Calicut, Cochin and Malpe where sardine and mackerel are canned to a limited extent. Though mackerel is very suitable for canning, only negligible quantities are tinned, the bulk of which goes to the defence service. The various handicaps facing the industry are the lack of regular supply of fish, high cost of tins and the ground nut oil. If the cost of production can be brought down by making available tins and groundnut oil at concessional rates to the industry there are immense possibilities to develop the market for them not only in India but also broad, thereby earning valuable foreign exchange.