2. MATERIAL AND METHODS

The material for this study was collected from the sharks landed at Integrated Fisheries Project, Cochin by the Government of India vessels operating along the south west coast during April 1983 to March 1988. Sharks were landed by seventeen fishing trawlers of size ranging from 19.0 to 40.5 M, six of which belongs to Integrated Fisheries Project, five to Central Institute of Fisheries Nautical & Engineering Training, Cochin and the remaining six to Fishery Survey of India, Cochin. These vessels operated different types of fishing gears like pelagic trawls, mid water trawls, bottom trawls and long lines in different depth range along the south west coast and brought a number of species of sharks. Species wise study of the Shark landings in Integrated Fisheries Project showed that major percentage of the landings was formed by a few species only. The catches could be grouped into two categories viz. Coastal sharks and Oceanic sharks. Among the coastal sharks brought by trawlers, *Scoliodon palasorra* was the predominant species with size ranging from 40 to 90 cm and weight ranging from 250 to 5000 gm. The long liners brought a variety of oceanic sharks like *Carcharhinus limbatus*, *Carcharhinus melanopterus*, *Sphyra zygaena*, *Galeocerdo cuvieri* and *Alopias vulpinus*. *Centrophorus granulosus* was brought occasionally by the vessels operating bottom trawls in the
deep sea areas of Quilon and Lakshadweep. Out of the above species *Scoliodon palasorra*, *Carcharhinus limbatus* and *Centrophorus granulosus* were selected for this study.

Due to the biological and physiological differences from the bony fishes, the shark meat is more difficult to handle in the fish processing halls. The present study started with an intention to find out the possibilities for producing good quality products from this neglected group by proper handling and timely processing. The use of ice, refrigeration and other modern techniques have brought a new dimension to the utilisation of shark resource.

The study started with the aim of producing consumer food products of desirable quality attributes. In order to maintain the quality of the products, the raw material has to undergo some kind of preparation before processing. This is done in the form of bleeding, beheading, gutting or cutting of the fish in a particular way etc.

Shark contains a high percentage of urea in the blood, which will coagulate after the death and give an unpleasant smell and taste to the meat. Hence bleeding must be done immediately after the catch. Tishin (1969) state the chopping of caudal fin and hanging before death helps maximum bleeding which in turn help to lower the urea content of the meat. After the bleeding the shark was gutted and washed in ice water and stored in freezer or in crushed ice. Torrejan et al.
(1975) recommended that beheading, gutting and inserting a water circulation into the main vein help to eliminate maximum blood from the bigger shark which will maintain the quality of the meat. The chemical composition of the meat of the selected species before and after processing were estimated (Table-10). The variation of urea content in the meat of three species (selected for study) before and after ice water washing was studied (Table-13). The moisture, protein and fat content in the fresh meat of the three species were estimated. The percentage of moisture content was estimated using Stark-Dean apparatus. Protein was analysed using Kjeldahl's method and the fat content was estimated using Soxlet extraction method. The above chemical components were estimated before and after processing. After the initial preparation the shark was utilized for the production of various diversified fishery products like dressed shark, shark fillet, minced meat, dried shark fins, shark fin rays, shark hide, silage etc. Methodology of each products were followed.

2.1 Dressed shark

Sharks of size less than 60 cm length were mainly utilized for the production of 'Dressed shark'. After weighing, the materials were transferred to the filleting table. From each shark, fins were removed first and afterwards the head was cut off by making a cut from the top to the side of the gills in an angular way without losing much flesh. The gut was removed and the belly portion was washed with potable water. The cleaned shark was then kept in ice water for 3-4 hrs. in the ratio
1:3 to reduce the urea content. It was then drained for a few minutes and packed as block (1 kg size) using polythene lining. These packed products were frozen in a plate freezer, packed in master cartons and stored in a cold storage at -20°C or below. (Flow sheet given in page 58)

2.2 Shark fillet

Usually sharks of more than 60 cm length were used for the production of fillets. The sharks were landed either in the frozen or in the iced form and were weighed before starting the filleting process. The fins of large oceanic sharks (more than 100 cm) were removed first and the carcass was vertically sliced into chunks of 20 to 25 cm size using a power cutter or a hand-saw. Afterwards these pieces or the whole sharks were taken to the filleting tables and the meat was filleted out from both the sides of the backbone, carefully (plate-2B). Deskinning of the fillets were done either manually or using a deskinning machine. The thickness of the fillets were made between 2-3 cm (maximum 3 cm). The fillets were kept in ice water for 3 to 4 hours in the ratio 1:3. The fillets were drained for 7 mts, weighed, wrapped in polythene paper and packed in duplex carton. The packed product was made frozen using a plate freezer and stored at -20°C or below. (Flow sheet given in page 59)

2.3 Battered and breaded fillets

Most of the fish fillets are consumed as battered and breaded form of different sizes and shapes in the European countries. This product is not introduced in our country till
now and there will be a good market for this product because now-a-days the fast foods are getting more popularity in our country.

Fillets block of weighing 3 kgs was made into thin slices of about 60-70 gm using a slicing machine. These slices were given battering by dipping a batter made by mixing wheat powder and ice water. Afterwards it was breaded using uniform size of breading and spread in trays. These battered and breaded fillets were made IQF and packed in polythene bags and stored at -20°C or below. (Flow sheet given in page 60)

2.4 Minced meat

Smaller sharks less than 70 cm were utilized for making minced meat. These sharks were dressed as in the case of dressed shark and split open longitudinally from the dorsal side. Afterwards deep scores were made from tail to head without breaking the skin. These dressed sharks were dipped in ice water for 3 to 4 hrs. in the ratio 1:3 (fish:water), drained for about 10 mts. and minced by using a bone separator (Plate-6A). The minced meat was then packed using polythene and duplex cartons as ½ kg unit (plate-6B) and transferred to plate freezer. It is master cartoned after freezing and stored at -20°C or below. (Flow sheet given in page 61)

2.5 Fish cake

Minced meat was blended with salt, starch powder, spices and vegetable oil for about 10 minutes using a mechanical grinder. Then it was moulded into regular shape with thickness less
than 1 cm (plate-7A). They were then battered and breaded mechanically or manually and made frozen, wrapped in polythene lining and packed in duplex cartons. The packed cakes were stored at -20°C or below. (Flow sheet given in page 61)

2.6 Fish balls

Fish balls were also made from the minced meat. Minced meat was pulvarised and blended with salt, milk, spices, starch and vegetable fat or oil for 12 to 15 minutes at a temperature below 10°C. The ground mixture was then made into balls of 2 to 3 cm diameter either mechanically or manually and cooked in 1.5% brine at 90°C. The cooked fish balls were frozen either as blocks or as IQF product and stored at -20°C or below. (Flow sheet given in page 61)

2.7 Pickles

Shark pickles were mainly made from the shark fillets or from the minced meat. The meat was mixed with spices like chilly powder, ground pepper, turmeric powder, salt etc. and kept for a few hours. Half portion of green ginger, peeled garlic, curry leaves, green chillies etc. were well ground into a slurry and kept. The meat along with spices were then fried in refined oil till a golden colour appeared. The second part of the green spices were made into slices and semi-fried in the remaining oil, followed by the ground spice mixture. Fried fish was mixed and boiled. Afterwards venigar was added and boiled for a few minutes and kept for curing for 3 to 4 days. Afterwards it was weighed, bottled and stored. (Flow sheet given in page 61)
2.8 **Smoked shark fillets and minced meat**

Shark fillets of thickness less than 2 cm were made and brined in saturated brine for 15 minutes. The fillets were hanged or spread in the smoking chamber using metallic rods. Then it was drained for 30 mts. and smoked for 4 to 10 hours with a temperature variation of 40° to 70°C. After smoking the products were cooled, packed and stored.

Smoking of minced meat was done by mixing 3% powdered salt homogenously instead of using brine solution. (Flow sheet given in page 62)

2.9 **Canned shark**

Shark fillets were made from *S. palasorrra* and packed in ½ Hanza aluminium can of 200 gm. capacity. It was steam cooked for 20 minutes and filled with 3% brine solution and sterilized for 70 minutes under 15 lb pressure. The shark fillets were packed with the tomato sauce in the above method. Smoked shark fillets were made and packed in the same type of can and filled with double refined groundnut oil and sterilized for 60 minutes under 15 lb pressure. The fish balls were made from minced meat and canned with brine and tomato sauce. The sterilization time was reduced to 50 mts. under 10 lb pressure for the fish balls. (Flow sheet given in page 63)

2.10 **Dried shark**

The larger sharks were sliced as in the case of fillets and split open with deep scoring (2 cm width) for easy salt
penetration. In the case of smaller sharks, it was dressed as in the case of mincing, washed and drained. Afterwards the fishes were rubbed with salt especially inside the scoring and this salted sharks were arranged in salting tank in alternative layers of salt and kept for about 48 hrs. for saturation. Care was taken to avoid draining of brine from the salting tank. Afterwards it was taken out, washed in potable water to remove excess salt, spread in aluminium trays or webbing and dried in sunlight or in a mechanical drier. The dried sharks (plate-10B) were packed as consumable pack of ½ kg unit in polythene bags, sealed and stored. (Flow sheet given in page 64)

2.11 Shark liver oil

Among the three species, only the liver oil of C. granulosus was taken for the present study. The liver of C. granulosus was removed immediately after receiving the catch. The entire oil oozed out without much external effort when the liver was exposed to air and to sunlight for a few hours. Otherwise it was separated by heating the liver in a water bath with a temperature around 40°C. The oil was filtered and made moisture free using unhydrous sodium sulphate and bottled in brown coloured bottles.

2.12 Dried shark fins

Usually the pectoral fins, the first dorsal fin (also the second dorsal fin in the case of bigger sharks) and the lower lobe of the caudal fin were collected and the adhering flesh was carefully removed from the fins. These fins were brushed,
washed and soaked in mild brine (2\%) for 30 minutes and dried after spreading a little amount of quicklime on the cut portion till moisture content reduced to less than 10% and then packed either as grade or as set (plate-12A).(Flow sheet given in page 65)

2.13 Shark fin rays

The sharks fin-rays, the golden coloured collagen fibrers, can easily be separated from the fins, used in the preparation of shark fin soup, is one of the most valuable marine products in the world.

Shark fin rays were separated by two simple methods called: cold process (long process) and hot process (quick process). In cold process the fins (fresh or dried) were dipped in 10\% glacial acetic acid for one day and the skin was removed by scrapping. Afterwards it was kept in the same acid solution for two to five days, depending on the thickness of the fins. The fins become soft and the rays, were separated manually. These rays were washed till free from acid and dried at a temperature below 50°C till the moisture content was reduced to less than 10\%, packed in polythene bags and sealed (Plate-13A).

In the hot process the fins were soaked in 10\% glacial acetic acid in a stainless steel boiling kettle and heated upto 70°C for two to five hours depending on the thickness of fins. The fin-rays were separated, washed, dried and packed as explained earlier. (Flow sheet given in page 66)
2.14 **Shark hides**

The skin of the oceanic sharks was removed from the meat carefully without damage, cutting from the dorsal side. The adhering meat was removed by using a PVC brush and washed well. These hides were salted and rolled and sent to Madras for tanning. The tanned hides were of superior quality and found durable.

2.15 **Fish silage**

The offal or waste accumulated during processing composed of mainly gut, cartilagenous bones etc. were chopped, size less than 2 mm, or ground mechanically or manually and the slurry was homogenously mixed with commercial grade formic acid (3.5% by weight of offal used) in PVC tanks or buckets. The pH of the mixture was checked every day in order to keep the pH less than 4.0. The mixture liquifies completely with a peculiar aroma within three weeks. The silage was then stored for further utilization. (Flow sheet given in page 67)