STUDIES ON THE UTILIZATION OF SELECTED SPECIES OF SHARKS

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CERTIFICATE

This is to certify that this thesis is an authentic record of the work carried out by Shri. M.K. VENU under my supervision and guidance and that no part thereof has been submitted for any other Degree.

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DECLARATION

I hereby declare that the findings provided in the thesis were not previously formed the basis of the award of any degree, diploma, associateship, fellowship or other similar title of recognition in any University or Institution.

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C O N T E N T S

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1. INTRODUCTION

Sharks, skates and rays belonging to the group elasmobranchs, constitute about 4% of the total marine fish landings of India. Sharks, the main constituent of this fishery, are widely distributed in all oceans and richest shark faunas occur in the Indo-west Pacific from South Africa and Red sea to Australia and Japan. The shark is the largest fish in the world, the size varies from 15 cm (dwarf species of Squlidae) to 12.1 meter (Rhiniodon typus, Whale Shark) in length, and weight varies from 10 gm to several metric tons (FAO 1984).

The outstanding feature of shark is that the entire portion of the animal can be utilized; the meat, fins, skin, liver, teeth and even offal have high commercial value. At present the shark resource is not getting much attention from the fishing industry. High priced products could be made, if proper methodology is adopted. In early forties only the liver was considered as the valuable portion. Afterwards a trend was observed to utilize shark resource as fully as possible and included its meat in the diet in several parts of the world. Unfortunately a well organised effort for the utilization of this commercially important resource is not available in our country. In a highly populated country like India, where protein deficiency is high, should utilize all available animal protein for the prevention of malnutrition among the people.

Even though the world wide distribution of shark is not fully known, the existing report of Fischer and Bianchi (1984) indicate that there are 30 families, 96 genera and 350 species; of which 23 families, 62 genera and 115 species are available in Indian Ocean and Red sea. According to FAO Statistics (FAO 1976), the world shark catch was recorded as 307,000 tons in the year 1976 of which 56.6% was contributed by the North Pacific (Area 61), North East Atlantic (Area 27) and Western Indian Ocean (Area 51 & 57). The major species of the world catch belong to Carcharinidae and Squalidae. Springer (1965) collected information on the behaviour and distribution of sharks. Aubrey (1965) made a study on the shark of east coast of Africa, and Budker (1971) classified the different shark families with illustrations. The distribution and abundance of pelagic sharks in the Central Pacific Ocean was studied by Straslung (1958). The migration and growth of sharks in the Australia and Greenland waters were studied by Olsen (1953) and Hansen (1963) respectively using tagging methods.

As such, literatures regarding the shark and its utilization are very less compared to other groups of fishes. According to Krishnamoorthi and Jagdis (1986) there are about seventy seven publications on elasmobranchs available in India, and most of them are dealing with the systamatic position of this group. James (1973) studied elasmobranchs as a potential fishery resources of the east coast of India. The potential yield of elasmobranchs was estimated to be 170,000 tons in the Indian waters (James (1986). Devadoss (1978a, 1978b, 1979 and 1984)

made a study of this group especially on aspects of biology and fishery of few species of shark of the Indian coasts. The occurance of Centrophorus granulosus (Spiny shark) along the south west coast was observed by Premalatha (1986). Manoharan (1988) studied the biology and fishery of this group along the coast of Kerala.

Devanesan and Chidambaram (1948) studied the shark around Madras and Pondicherry. Besides this James (1973) made a study about the shark fishery along the Indian coasts. Appukuttan (1978) studied the developmental stages of hammer headed shark from the Gulf of Mannar. Devaraj (1983) estimated the growth parameters of five species of shark. Appukuttan and Nair (1984) made some biological studies of a few species of shark.

According to Talwar and Kacker (1984) 35 species of sharks are known to occur in Indian waters, about 20 species constitute the shark fishery of which only seven species accounts for the bulk landing.

Sharks are widely distributed in the coastal and oceanic region of the seas around India. Even though the sharks are distributed along the east and west coasts, the major percentage is landed in the west coast. According to Devadoss (1989) 70% of the shark landing of India are contributed by the west coast. Moreover 70-75% of the catch are composed of smaller sizes belonging to Scoliodon sp. Nair et. al. (1974) have made some systematic study on the pelagic sharks belonging to Carcharhinidae.

Generally sharks are caught by trawling, long lining, gill netting etc. as by-catches. Devadoss (1989) observed that 80%

of the catch is obtained by trawling, 19% by gill netting and 1% byother methods.

The main fishing area are the regions along North west (Gujarat and Maharashtra), South West (Karnataka, Kerala and Goa) and South east (Tamilnadu, Pondicherry and Andhra Pradesh) coasts of India. The main landing centres are Veravel, Mangalore, Calicut, Cochin, Quilon, Tuticorin and Madras.

As already stated, the shark is a totally usable fish, although the usage pattern differs. Shark meat is not considered palatable comparing to other fish meat, even though it contains almost equal percentage of protein with very low fat content. Tishin (1969) studied the uses of shark as a food for human consumption and animal feed. Gordievskaya (1971) estimated the chemical composition of shark meat of different species. Kreuzer and Ahmed (1978) provided information and guide lines on the development of this industry.

Shark meat contains a high percentage of urea which gives a bitter taste to the meat. This varies according to the species and age. Gordievskaya (1971) estimated the urea content in different shark species and found low in the spiny shark (1570 mg%) and highest in the hammerhead shark (2330 mg%). In Soviet Union chemical and nutritive analysis were carried out in government laboratories and various products were developed prior to the introduction of shark meat to the public (Kreuzer and Ahmed 1978). In the shark utilization, by-products like, liver oil, fins, fin-rays and hides are more valuable and important. Kulikov (1971)

gives a guide line to the production of shark liver oil with high content of vitamin A. Gordievskaya (1971) studied the squalene content of the liver oils of different shark species. According to Budker (1971) sharks of high squalene content tends to have proportionately lower vitamin A content in their liver oils. Buranudeen et. al (1986) studied the extraction of squalene from the liver oils of deep sea shark. Cormick (1964) and Maxwell (1953) had tried to study the economics of leather production.

Gajar and Sreenivasaya (1945) has given a short description of the utilization of shark. Afterwards Biswas (1990) explained the utilization of shark in general. Shark meat is consumed in the southern states of India in salted and dried form. Ramachandran and Solanki (1988) studied the processing and storage of semi-dried shark. Ramachandran (1989) explained the curing and marketing of shark in Veravel area. Mathew and Balachandran (1990) briefly explained the utilization of shark giving more importance to its by-products. Thankappan and Gopakumar (1991) detailed a rapid method for the separation and estimation of squalene from shark liver oil using Iatroscan Analyser.

As stated earlier, the elasmobranchs was about 4% in the marine fish landings of India and about 60% of the elasmobranchs was constituted by sharks, 35% by rays and rest 5% by skates. On studying the marine landings of India from the year 1983 to 1988 an average landing was found as 1,164,000 tons of which elasmobranchs constituted 58,000 tons (3.54%) and the contribution of shark was 35,000 tons (2.1%) (Table-1)

Of the total elasmobranchs landing 56.50% was landed along the west coast and 43.50% along the east coast and 70% of the sharks were landed in the west coast (Table-2)

Though Tamilnadu comes first in the landings of elasmobranchs (about 25%) in India, it ranks only fifth place in the landings of shark (Table-1).

The present status of this fishery is still in its primitive stage. At present the shark is handled and processed in an unhygenic condition mainly in the shore and marketed in the salted and cured form. A brief study on the processing of sharks along the coasts of Karnataka, Kerala and Orissa were carried out during the present observation.

In Karnataka coast the coastal shark are split open without removing head and fins. It is mixed with crystal salt and kept for a few weeks in the beach itself in heaps with or without a shelter. Afterwards the sharks are removed from the salt and packed in gunny bags and sent to the market. Sometime the salted sharks are dried for a day by spreading directly on the sandy beach.

In Kerala the sharks are cured in two methods. One method is called 'chappa' where the sharks are split opened without removing the fins and head and put in concrete curing tanks with alternate layers of salt and shark. In the case of bigger shark, it is made into chunks of about 5 kg and salted. Crystal salt is used in the ratio about 5:3. The oozing water from the fish is drained through the holes provided in the bottom

of the tanks. The material is kept in the tank for about 3 to 5 weeks and packed in gunny bags after removing excess salt and marketed.

In the other method the salting time is limited to about 24 hours. After salting the material are spread over the bamboo mats kept in the hot beach and dried for about one or two days. Afterwards the sharks are collected and packed in gunny bags and sent to markets.

In Orissa, since the local population is reluctant to touch the shark, people settled from other states are engaged in the processing of shark. Sharks are split open and mixed with crystal salt in the open sea shore for a few weeks and dried in the sandy beach, packed in gunny bags and sent to Kerala markets.

By observing the different methods of curing of shark in different parts of the country, it is evident that the processing of this resource is not getting enough attention. Because of unhygenic processing methods, the cured/dried shark available in the market is inferior in quality, with the smell of ammonia, the product is not favoured by the consumers. Another factor is that due to the high percentage of moisture content the shelf life of the product is shortened, to two to four weeks. Hence the producers are compelled to sell their products within the limited period at a very low price. Hence it is high time to introduce new techniques for the production of dried products of shark to get a good market.

Eventhough a number of valuable products both for domestic and export market can be made from shark, this fishery is getting very little attention in India. Fishermen in different parts of our country are not fully aware that shark meat is edible with high protein content. If proper attention is given to this fishery, a lot of value added diversified products can be made economically. This is one of the main reasons for the initiation of the present study. For example the small sized sharks - the major percentage of the shark landing - is now used for salting and drying; but it can be converted into 'consumer pack products' like dressed shark, fillets, minced meat etc. Fish cakes and fish pickles can also be made easily from the minced meat. The meat of the smaller sharks are more palatable when compared with the bigger species. In the case of larger shark the fins are more valuable, but the meat can be salted and dried. Another commercially important part of the bigger sharks are its hide which is now discarded in our country, but it can be exported to countries like U.S.A, U.K, Germany, France etc. where it has a good demand. The liver oil of spiny dog fish, which is also available in the deep waters of India, contains squalene which has high demand in Japan where it is used in the cosmetic industry. Besides these the offal obtained in the shark processing can easily be made into silage with very low investment.

The present study is conducted using the landing of sharks in the Integrated Fisheries Project, Cochin. A number of species were landed at the Project of which Scoliodon palasorra (Blecker 1953, Greyshark), Plate-1A, Characharhinus limbatus (Valenciennes,

1939, black tip shark) Plate-1B were selected for this study. The S. palasorra forms the major percentage of the trawl catches of the shallow water and C. limbatus is abundant in the long line catches in the oceanic region. Hence these species are selected for study. Being an occasional member of the catch and considering the commercial importance of its liver oil, Centrophorus granulosus (Bloch and Schneider 1801) Plate-2A, was also included in this study. Sharks are available almost round the year and in many parts of the country, this resource is not handled properly or hygienically. Through proper training, even the fishermen can produce different fishery products like dried meat, shark fin-rays etc. without much investment. Hence the main aim of this study is to give momentum to the utilization of this resources, adopting different simple methods for processing the entire portion of the shark converting into diversified products for the benefit of the fishermen industry and consumers.

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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, Sphyrna zygaena, Galeocerdo cuvieri and Alopias vulpinus. Centrophorus granulosus was brought occassionally 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 back bone, 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° 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. palasorra 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 sun-light 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. Other-wise 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 collogen 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, cartelagenous 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)

3. OBSERVATIONS AND RESULTS

The marine fish landing in India for the period from 1983 to 1988 was studied to find out the general availability of sharks. During this period a total of 98,44,285 ton of marine fish were landed along the Indian coast of which 3,48,765 ton were contributed by elasmobranchs. Among the elasmobranchs landing 207,353 ton was contributed by sharks (59.47% of the elasmobranchs) which comes to about 2.10% of the total marine fish landing (Table-1). The year-wise landings of elasmobranchs and sharks during the period 1983 to 1988 are shown in Fig.1. The percentage of elasmobranchs landing varied from 3.14 to 4.52% while the shark contribution varied from 1.84 to 2.54%.

The State-wise landings of sharks for the period is shown in Fig.2. On observing the year-wise landing from 1983 to 1988, Gujarat stood the first by landing 47,282 ton of sharks which was 22.79% of the total shark landings of India during 1983 to 1988. Maharashtra ranked second with 45,356 ton (21.86%) and Andhra Pradesh was in the third position with 33,921 ton (16.36%). Kerala came in the fourth position with 31,835 ton (15.34%) and Tamilnadu in the fifth position with 20,135 ton (9.71%), followed by Karnataka and Orissa with 11,904 ton (5.74%) and 9,550 ton (4.61%) respectively. West Bengal contributed a desimal 0.44% of the catch with 905 ton while the contribution by Goa was 2,397 ton which formed 1.16% of the total shark landings in India. The Union Territory of Pondicherry, Andaman

and Nicobar Islands and Lakshadweep together contributed, 3891 ton with 0.40%, 0.96% and 0.52% respectively of the all India shark landing.

The shark landings along the east and west coasts during the above period was also observed and tabulated in Table-2. Out of the 207,353 ton landed, 139,970 ton were from the west coast (67.50%) and the remaining 67,383 ton from the east coast (32.50%). 237 ton was landed by deep sea trawlers operated on both coasts.

Shark landings in the Integrated Fisheries Project was studied for a period of five years from April 1983 to March 1988 (Table-3). The sharks obtained were grouped into coastal shark, oceanic sharks and deep sea shark according to the area from where they were caught (Fig.3). A total of 280,107 kg. sharks were landed during the above five years, 6.95% of the total landings received at Integrated Fisheries Project, of which 216,378 kg. (77.25%) was oceanic shark, 63,513 kg. (22.67%) was coastal sharks and the reamining 216 kg (0.08%) was deep sea sharks. The data related to the shark landing in Integrated Fisheries Project is shown in Table-3.

The month-wise variation in the landings of oceanic shark is shown in Fig.4. A peak was observed in March with a landing of 45 ton and the minimum landing was observed in August.

Month-wise variation in the landings of coastal shark were also studied and the result is presented in Fig.5. According to the present study, the peak season for the coastal sharks was observed from December to March.

During the study period 255,942 kg of shark was utilized for the production of different products in Integrated Fisheries Project (Table-4). The year-wise utilization was shown in Fig.6. Out of the total quantity, 12,766 kg (4.99%) was marketed in the whole round frozen form, 24,860 kg (9.71%) was converted into dressed shark, 92,670 kg (36.21%) was made into fillets and 1,25,646 kg (49.09%) was converted into dried form. In the year 1983-84 out of the 49,266 kg of shark, only 1820 kg was used for producing dressed shark, 31,337 kg converted into fillets and the remaining 16,109 kg. was processed into dried form. A total of 58,822 kg. of shark was utilized in the next year, 1984-85, of which 1082 kg marketed in the whole form, 7,690 kg used for dressed shark, 17,327 kg filleted and 32,723 kg was dried. In 1985-86 year, the quantity utilized was reduced to 52,884 kg of which 2,450 kg sold in the frozen form, 4,570 kg converted into dressed shark, 11,010 kg filleted and 34,854 kg was used for the production of dried shark. The maximum quantity of shark utilized in the year 1986-87 with 62,821 kg out of which 2,057 kg in the frozen form, 6,450 kg used for the dressing, 21,074 kg converted into fillet and 33,240 kg used for drying. The lowest quantity utilized was in the year 1987-88 which was only 32,149 kg. of which 7,177 kg marketed in the frozen form, 4,330 kg in the dressed form, 11,922 kg filleted and 8,720 kg converted into dried form. The major quantity of shark used for filleting was in the years 1983-84 and 1987-88 and the percentage contribution during these years were 63.61 and 37.08% respectively. In the remaining three years ie. 1984-85, 1985-86 and 1986-87, the major quantity was used for drying with 55.60, 65.90 and 52.91% respectively.

The observations and results regarding to each product is presented below.

3.1 Dressed shark

Dressed shark can be defined as the carcass without head, gut and fins. If freezing facilities are available it is the simplest product made from smaller shark with a good consumer appeal. The meat of the smaller sharks are more palatable, because of low urea content.

A total of 24,860 kg of sharks was used for the production of 15,112 kg of dressed shark during this study period, giving an average yield percentage of 60.78. The year-wise observations on raw materials taken, products produced and their yield percentage are shown in Table-5. The product was marketed as one kg frozen block with polythene lining. Dressed shark production was lowest in the year 1983-84, which was only 1092 kg processed from 1820 kg of raw material giving an yield of 60%. From the Fig.7 it is clear that the product in the year 1984-85 was maximum with 4,613 kg from 7,690 kg of raw material giving the lowest yield percentage of 59.98. In the next two years 2,788 kg and 3,934 kg of dressed shark was produced from 4,570 and 6,450 kg of shark respectively giving a yield percentage of 61.00 and 60.99 respectively. In the year 1987-88 the yield percentage was maximum (62.00) by giving a production of 2,685 kg of dressed shark using 4330 kg of shark. Year-wise fluctuation in the production of dressed shark was shown in Fig.7

The S. palasorra being the predominent species among the coastal shark as stated earlier was mainly used for the production

of dressed shark and the results are tabulated in Table-6. The S. palasorra was graded to seven groups according to their size ie. 40-45 cm, 46-50 cm, 51-55 cm, 56-60 cm, 61-70 cm, 71-80 cm and 81-90 cm respectively. Their weight ranged from 250 to 5000 gm. The yield varied from 62.00 to 66.80%. The relation between the size range and yield percentage was presented in Fig.8. The figure showed that the yield percentage was maximum for the size group 56-60 cm. The Fig.8 further shows that the yield of dressed shark is increasing upto a length of 70 cm and decreased afterwards.

The colour and texture of the above products were also studied. The dressed shark produced from lower size group, from 40 to 60 cm was slightly red in colour and it was increasing as the size increased. The meat was also found to be softer in the lower size group.

The important draw back initially observed for the product was the difficulty in removing the skin. But through later study it was found easy to remove the skin by dipping the dressed shark in hot water (around 90°C) for about two to three minutes.

In this product the maximum meat is preserved and have the high yield percentage when compared to other shark products like fillets, minced meat or dried form. Besides this the urea content is very low in the smaller sharks.

Through the present study it can be recommended that the best way to utilize the small size shark of less than 60 cm is the dressed form and which can be considered as a semi processed product.

3.2 Shark fillets

Fillet is defined as strip of meat removed from the carcass by making parallel cut to the back bone. It is the best presentable form of product to the consumer in the frozen form because the entire portion can directly be used for the homely preparation.

During the study period 38,194 kg of shark fillets was produced from 92,670 kg of both oceanic and coastal sharks (above 60 cm. size) giving an yield of 37.94%. The entire product was marketed in the frozen form of ½ kg consumer pack with polythene lining. The quantity of shark fillet produced and raw material used are tabulated in Table-7. In the year 1983-84 maximum shark fillets was produced ie. 11,134 kg from 31,337 kg of shark which gave 35.52% yield, which was less compared to other years because the major part of shark taken for filleting was coastal shark and for this group the yield percentage is lesser than oceanic sharks. In the year 1984-85, 6,202 kg fillet was made using 17,327 kg of shark with almost the same yield percentage of the previous year. In 1985-86 the quantity produced was less, only 4,234.5 kg from 11,010 kg with 38.46% of yield. The maximum yield percentage was recorded in the year 1986-87 with 41.08 by producing 8,658.5 kg of fillets from 21,074 kg of shark. In the last year of study 1987-88, 7,965 kg of fillet was made from 11,922 kg of the shark giving an yield of 39.98%. The high yield percentage for these two years were mainly because of the utilization of more oceanic sharks for filleting. The year-wise production is shown in Figure.9.

A detailed study on filleting of all the three selected species of different sizes were carried out (Plate-2B). Table-8 and Fig.10 gives the details of the observation collected from the study of the S. palasorra. The species was grouped as in the case of dressed shark into seven. The yield percentages for these groups with skin and without skin were observed. The yield varied from 41.00% to 48.80% for the skin on fillets (plate-3A) whereas it was between 38.00 to 44.00% in the case of deskinned fillet (Plate-3B). In the size group 40 to 45 cm. the yield percentage of fillet was 38.00%. It was increased in the next sizes group to 39%. The yield percentage was 41% in the group 51-56 cm and it was 42% for the next group. The size group 61-70 cm gave an yield percentage of 43.25% and the maximum yield percentage was observed for the group 71- 80cm with 44%.

From the Fig.10 it is clear that the yield percentage of fillets in the S. palasorra was slowly increasing from the size range 40 to 80 cm and afterwards shows a decreasing trend.

The filleting was also carried out with different size groups of C. limbatus species. The sharks having a length range of 110 to 210 cm was grouped into seven like 110-120 cm; 121-130 cm; 131-140 cm; 141-150 cm; 151-170 cm; 171-190 cm and 191-210 cm respectively. The weight varied from 10 to 58.80 kg. Even though the yield perscentage was maximum in this species, the variation in the yield percentage according to size range was negligible. The yield percentage of different groups are tabulated in Table-9 Only 2% variation in the different size group was noticed whereas in the case of S. palasorra it was 6%. The maximum yield percentage was observed in the size range of 141 to 150 cm and lowest for the group ranging 171 to 190 cm.

During the study period the availability of the species C. granulosus was less compared to other species. Filleting experiments were carried out even though there was not much difference in the length range (90-96 cm). The yield of fillet was found to be between 22.30 to 26.32%.

The colour and texture of the fillets from the three species were studied. The colour of the fillet from S. palasorra was light red. Bright red coloured fillets were obtained from C. limbatus and for the C. granulosus the fillets were white in colour which was very similar to the fillets of lean fishes like perch or as in flat fishes. The fillets of the three species were analysed organoleptically and found the meat of C. granulosus was very soft, the fillet of S. palasorra was less soft and the fillet of C. limbatus was found little hard.

The odour of the three products were also studied. The fillets of C. granulosus was similar to other lean fish meat but S. palasorra gave a little punchant odour whereas the fillets from C. limbatus found more punchant because of the high percentage of urea.

In order to reduce the percentage of urea content of the fillets, washing with different solutions like ice water, brine solution, acetic acid and lactic acid were carried out. Out of the four methods, ice water washing was found to be more suitable because the other three methods affect the taste of the meat. The fillets of size 3 cm in thickness, washed in ice water for about 3 to 4 hours, reduced the urea content to less than 1500 mg%.

The removal of dark coloured red meat from the fillets of C. limbatus was found helpful to increase the appearance and the consumer's appeal. Red meat found in the S. palasorra was not removed as it did not affect the appearance. The shark fillets were quick frozen as block of ½ kg. size.

When shark is filleted, the quantity is reduced to less than 50%, so the storing space also can be saved. So it is better to store in the form of fillets than as the whole shark. The fillets are a blessing to the housewives since it is in the fully processed and ready to prepare form.

From the present study on the shark filleting, it can be suggested that the shark of size longer than 60 cm can be better processed to fillets and marketed as ½ kg consumable packet.

3.3 Battered and breaded fillets

Fillets made from the S. palasorra was used for the production of battered and breaded fillets. The rectangular fillet weighing 3 kg (plate-4A) of size 30 x 18 x 5 cm made into slices (plate -4B) Battered and breaded fillets (plate-5A) were made from the slices of thickness ranging from 0.5 to 1.5 cm. The products were fried in hot oil and organoleptically analysed. The results showed that the maaximum thickness of the frozen slices must be less than 1 cm, otherwise the inner portions of the product will not get cooked well. Frying time must be limited to 45-60 seconds at an oil temp. of around 220°C or till a golden colour appears (Plate-5B).

(Recipe given in page 54)

The battering was made by mixing wheat powder with water at different ratio and the best result got for the ratio 1:1. The batter is mixed with 1.5% of salt and 0.5% of spices like pepper, ginger etc. In the process of battering, the temperature of batter must be around 5°C otherwise the slices of fillets may disintegrated due to thawing.

In order to get uniformity of the product breading of same size must be used. The maximum size of the breading was limited to 1 mm size.

On observing the results of battered and breaded fillets it was found that, this product would get a good consumable appeal especially in the cities. Though the colour of the shark fillet was not pleasant, (Plate-4B) the problem of this unpleasant colour can be avoided by the battering and breading (Plate-5A).

3.4 Minced meat

Even though minced meat from shark was not produced and marketed in India, experimental production of minced meat was carried out from the three selected species. Minced meat had a vital role in the frozen fishery products especially in making various ready to cook products like cutlets, fish cakes, fish fingers, pickles etc.

Minced meat was produced mainly from the cheaper and lean varieties of fishes like pink perch, lizard fish, crokers etc. and marketed internally as 1 lb consumable packets. During the study period experiments were conducted with the minced meat

of S. palasorra of different size groups as in the case of shark fillets (plate-6A). The results are tabulated in Table-11. The yield percentage of minced meat from size group 40-45 cm was 44% and in the 46-50 cm size group the yield was increased to 46.50%. 47.5% of yield was observed for the 51-55 cm size group and found almost the same yield for the 56-60 cm group. The yield percentage was again 47.50% for the size group 61-70 cm and which decreased slowly as size increased. From the Fig.11 it is clear that the yield percentage of the minced meat is increasing as the size increases

Minced meat was also made from C. limbatus. Since these fishes are larger in size it was first filleted and then minced. The result showed that the yield was below 37%.

Even though the landing of C. granulosus was negligible the minced meat produced from this species showed only 21.53% yield.

Minced meat produced from the three species were studied organoleptically. The colour of the minced meat produced from the small sized S. palasorra, less than 70 cm, was bright and lightly red coloured. Whereas the meat produced from the large sized was more reddish in colour. The colour of the meat prepared from C. limbatus was dull and reddish, but the minced meat from the C. granulosus was white in colour as in the case of the other lean fish meat.

The quality of the cooked products was analysed and the meat of the C. limbatus was found bitter in taste and meat from S. palasorra was free from bitter taste and the meat from C. granulosus was found better in quality.

The bitter taste noticed was due to the presence of high urea content. The percentage of urea can be reduced by proper washing of dressed sharks before mincing. In the case of S. palasorra the dressed material was deeply scored without breaking the skin. The scored sharks were washed using ice water for about 3 to 4 hours. After this it was drained and minced. The minced meat thus obtained was good in colour with moderate taste. In the case of minced meat from C. limbatus, thin fillets were made first without red meat and washed for three to four times before mincing. The resulting product was not up to the standard in colour and taste.

It is understood from the study that the yield percentage of the minced meat from the S. palasorra, above 70 cm was less. This was mainly because of the presence of strong connective tissues and due to meat adhered to the skin.

The study pointed towards the facts that the coastal sharks having less than 70 cm in size are more suitable for mincing and the product gave better colour, flavour and odour.

3.5 Fish cakes

Fish cakes made from the minced meat of S. palasorra was organoleptically analysed and the result was not encouraging. The fish cakes made from the shark meat was inferior in quality when compared with fish cakes made from other lean fish meat.

Hence the minced meat of shark was mixed homogenically

with the minced meat of pink perch in different percentage and fish cakes were made. The mixing ratio of shark meat with the meat of other lean fishes is shown in Table-12.

Among the various percentage, the fish cakes made from the minced meat mixed in the ratio 1:1 was found satisfactory when organoleptically analysed (Recipe given in page 55). Other factors like the colour and texture of the products were also compared with the other standard products and the results were favourable (Plate-7A & 7B). From the experiments it can be suggested that the minced meat of shark can be mixed upto 50% with other minced meat for the production of quality fish cakes.

3.6 Fish balls

Fish balls were also produced from the minced meat of S. palasorra as a ready to cook product (recipe given in page 56) and analysed organoleptically. The colour and texture of the product being inferior, the experiements were repeated by mixing the shark meat in the various ratio as in the case of fish cake. The product made by mixing the shark meat and other lean fish meat in the ratio 2:3 was recommended by the taste pannel. The results of the experiments conducted in the fish ball preparation showed that the minced meat of shark can be mixed to a maximum of 40% with minced meat of other lean fishes and used for the production of quality fish balls.

3.7 Pickles

Even though pickles from vegetables and prawns are

available in the Indian market, fish pickles are rare. Now a days fish pickles are available in some cities and popularity for this product is gradually increasing.

Shark fillets from S. palasorra were used for the pickle production. The fillets were made into small pieces and fried in oil. Since the colour of the fillets was dull and also the meat was more hard and chewy after frying, the meat from C. limbatus was not utilized for pickling.

Pickles were made from the shark fillets and minced meat (Plate-8A) according to the Indian taste (recipe given in page 57). The pickles were organoleptically analysed at an interval of one month and the shelf life and texture of the products were studied.

The shelf life of the shark pickle was found to be more than one year, when compared with other fish pickle it is more and almost double.

Since the fat content in the shark meat is negligible (less than 0.3%), the rancidity will not occur in the shark meat preparations especially in the pickles which is the main reason for the longer shelf life.

The pickles made from the fillets and minced meat of the species S. palasorra was found in good quality and bulk production was made and packed in glass bottles of 350 gm consumable unit and marketed. Consumer's reaction for this product was much favourable and a lot of enquiries for the supply of pickles are coming from different parts of the country.

3.8 Smoked shark meat

Even though smoked products are not popular in our country, a number of smoking experiements were conducted using the meat of S. palasorra. The results of the experiments conducted using the fillets was tabulated in Table-14.

Individual fillets of different size were made from the S. palasorra. The fillets weighing from 100 gm to 800 gm were used for smoking. They were brined using saturated brine for 15 minutes. The salt content after brining was estimated by volumetric method. It varied from 3.0 to 2.3% depending on the thickness of the fillets (Fig. 19). The fillets were grouped into seven according to their weight ie. 100-150 gm; 150 to 200 gm; 200-300; 300-400 gm; 400-600 gm; and 600-800 gm. The percentage of salt absorbed in fillet after 15 minutes of brining was 3.00% 2.85%, 2.72%, 2.58%, 2.34% and 2.30% respectively. It is very clear that the absorbance of salt is decreasing according to the thickness of the fillets (Fig.19).

The smoking time varied from 4 hours to 10 hours depending on the thickness of the fillets. For example fillets of weight ranging from 100 to 150 gm, had given only 4 hours smoking whereas fillets of size ranging from 600 to 800 gm, were given 10 hours smoking. The smoking temperature varied from 40°C to 70°C and the yield percentages was studied. The yield percentage of the products varied from 37.50% to 48.80% according to the increase of the thickness of the fillets.

The colour, texture and flavour was good for the smoked fillets of S. palasorra. The reddish brown colour with a glossy surface favours the product to a great extent. Hence, the fillets of S. palasorra of size less than 70 cm. are recommended for making smoked products.

Smoking of minced meat of shark was also studied and the minced meat from S. palasorra was used for this purpose.

The colour, texture and flavour of the products before and after smoking were studied. Plate-8B shows the initial stage and 9A the final stage of smoking. The colour change of the products is clearly visible from the above plates. The colour was very dark brown and the flavour was not favourable for the smoked minced meat and hence the minced meat cannot be recommended for making smoked products (plate-9B).

3.9 Canned product

The canned products made from the shark meat (five nos.) was analysed after two weeks (incubation period), three months, six months and one year. The results are shown in Table-15 to 19.

The analysis of shark fillets in brine (Table-15) showed that the product was inferior in colour, texture and flavour. One spot of sulphide blackening was noticed in the bottom of the can after one year. The brine solution was not clear and found milky. The product was below average even soon after the incubation period.

Table-16 gives a clear report of the canned fillets in tomato sauce. Though the colour of the product was better, the taste of the meat was inferior. Also the sauce was found more sticky (see Plate-10A(1). Two spots of sulphide blackening was noticed after one year and the product was found fair after incubation period, but the quality decreased after 3 months and found inferior after one year.

The result of the analysis of smoked fillets in oil was tabulated in Table-17. The appearance colour, and flavour was found very good for the above product (plate-10A(2). The texture of the meat was found little bit hard because of smoking. The colour of the oil was clear and transparent. No sulphide blackening was noticed even after one year. The product was very good after one year and recommends for production.

Fish ball was canned in brine and tomato sauce and the results were shown in Table-18 and 19 respectively. The colour and texture was good in the brine packing and the brine solution was turbid. The product was found fair after one year. The fish balls packed in tomato sauce was found very good in colour, flavour and texture after one year (plate-10A(3). Sulphide blackening was not noticed after one year. This product was found very good and can be recommended for the production.

3.10 Dried shark

As stated earlier, most of the sharks are converted into salted and cured form and marketed in our country.

The year-wise utilization of shark for drying and the quantity and yield percentage of dried product produced during the study period is shown in Table-20 and Fig. 12 respectively. Totally 125,646 kg of shark was used for the production of 28,118.5 kg of dried shark by giving an yield of 22.37%. The dried product was packed as ½ kg consumable packet in printed polythene bags, and marketed in Kerala and in major cities like Delhi, Bombay, Madras etc. In the year 1983-84, 16,109 kg of shark was used for producing 3317.5 kg dried shark giving an yield percentage of 20.59. In the next year the quantity of raw material was increased to 32,723 kg and product was 7,258 kg showing a yield percentage of 22.18%. The maximum quantity of shark used and the production of dried shark was in the year 1985-86 with 34,854 kg and 8,188 kg respectively giving a yield of 23.49%. In the year 1986-87 the quantity of shark was 33,240 kg and the dried product was 7,265 kg. The lowest quantity used and dried product made was in the year 1987-88 with 8,720 kg and 2,090 kg respectively.

Dried shark meat were made from the three selected species. The samples of dried shark is shown in Plate -11A.

The shark meat prepared for drying was salted after making deep score without breaking the skin. This helped easy penetration of salt and expellsion of urea.

Crystal salt of ordinary size, semi-crystal salt of 1 to 1.5 mm size and powdered salt in different percentages were used for salting and the results showed that the semi-crystal salt is most suitable for salting shark when compared

to crystal and powder salt. The percentage of salt used was 25 to 30% of the fish.

The salting time was also studied. Different experiments were conducted giving salting time from one day to 100 days. The study showed that saturation was completed within 2 days and there was no markable difference by prolonged salting. But in rainy season the dressed shark can be kept under salt for two months.

The salted fish taken out of the tank was given 2 to 3 washing to remove excess salt in each washing the fish was dipped in water for at least one hour. The result showed that the washing helped to improve the colour of the dried product.

The drying of the fish was carried out by using mechanical drier. The dried products were made at different temperature from 40°C to 70°C, when the temperature increased the time of drying was reduced but the product was inferior in quality because of the denaturation of protein at higher temperature and the resulting product become very hard and chewy. The study showed that the best product could be obtained by drying the fish between 42 to 44 °C with a duration of 15 to 24 hours, depending on the thickness of the fish.

The dried product was packed in printed polythene bags. The shelf life of the product was also studied and it was found between 4 to 6 months depending on the moisture content of the product.

The moisture content and yield percentage of the dried shark is shown in Fig.13. The yield percentage increases according to the increase in moisture content. At 45% moisture the yield percentage was 43% and at 30% moisture the yield was 37% and at 20% moisture the yield decreased to 21% and at 15% the yield was found only 16%.

3.11 Shark liver oil

Shark liver of the three selected species of different size were collected and studied. The size of the liver varied according to species, sex and season.

Liver from different size of S. palasorra ranging from 300 gm to 4,800 gm were collected and the yield percentage varied from 2.75% to 8.18% by weight of the shark.

The liver of C. limbatus weighing from 15 kg to 47 kg were separated and weighed. The yield of liver showed a variation from 4.06 to 9.16%.

For C. granulosus the variation in size and weight was within narrow range. The liver percentage was in the range from 19.56% to 26.92%. On an average the weight of the liver was observed as 23.59% of the body weight.

The yield of liver from male and female sharks were observed separately but the result showed no markable difference in these species.

Liver oil, is extracted from C. granulosus by exposing

it to the sunlight for about 8 hours (82.35% by weight of liver). It was collected in three stages. When the belly was cut opened the oil oozed out from the liver and out of the 82.35% oil the major percentage of the oil (55%) was collected within the first 2 hours, 20% of the oil was got after four hours and the remaining portion 7.35% was collected after eight hours. Some traces of water was also collected with the last portion of oil. The percentage of the oil was observed as 19.44% by weight of the shark. The colour of the oil collected from three stages were studied. The first stage oil was light yellow in colour and clear (Plate-11B (3). The second stage oil was bright yellow in colour (Plate II B(2) and the oil collected in the final stage was dark yellow with brownish tinge in colour (Plate-11B(1).

The squalene content of the oil was estimated and the result showed it was about 70%.

At this stage it is suggested that further studies must be carried out on the availability of this species in Indian waters so that this resource can be used in the proper way, giving more importance to its valuable liver oil.

3.12 Dried shark fins

The most valuable portion of the shark, larger than one meter size, is their fins. The fins of most of the shark except a few ie. nurse shark contains the valuable collogen fibres called shark fin rays.

The preparation of dried shark fins is very simple, but care should be taken to satisfy the buyers because they

The quantity and value of dried shark fins exported from India is shown in Fig.14. From the year 1979 to 1981 the quantity of shark fins exported showed an increasing trend. The highest quantity was exported from India in the year 1981. But the value-wise return was observed in its maximum in the year 1988 (Fig. 14) which was Rs. 30.11 million.

The shark fins were collected from C. limbatus of different size and the results are tabulated in the Table-22. The yield of the fins after cutting from the fish was calculated (Table-22). The pectoral fins, the dorsal fin and the lower of lobe of the caudal fins were separated and the yield percentage of the total fins were again calculated. These fins were dried till the moisture reduced to 10% and the yield percentage was again estimated.

The fins of C. limbatus of size 10-20 kg was found 3.75% before cutting, 1.89% after cutting and 0.90% after drying to the body weight. The yield was in the order of to 3.81% before cutting, 1.91% after cutting and 0.91% after drying for the weight range of shark from 10 to 20 kg. In the next group weighing 20-30 kg. the percentage was found 4.02, 1.94 and 0.92 respectively before cutting after cutting and drying respectively.

The yield. percentage of fins showed an increase according to the increase in body weight. Sharks were grouped into five groups based on its weight ie. 10-20 kg, 20-30 kg, 30-40 kg, 40-50 kg and above 50 kg. The yield percentage of the fins before cutting, after cutting and after drying were studied.

The present study helped to give the following suggestions for the best quality product. Before drying it is better to give a dip in mild brine (2%). Before brining the fins should be brushed properly in order to improve the colour of the fins. The flesh sticking to the fins especially in the pectoral fins must be carefully removed with a half moon shape and sprinkling of quick lime on the cut portion is also necessary to improve the quality of the product. For drying, the fins should be hanged in order to avoid the mixing sand with the product.

3.13 Shark fin rays

Shark fin rays, one of the most important marine product from shark is mainly marketed to Hongkong and Singapore, where it is used for making shark fin soup which is an internationally accepted marine delicacy.

The quantity of shark fin rays produced and marketed in the study period is shown in Table-21. In this study period 289.25 kg shark fin rays produced of which 215 kg (74.33%) was exported to Kuwait and the rest 74.25 kg (25.67%) were marketed in the cities like Cochin, Bombay, Bangalore, Madras etc. In the year 1983-84, 66.72 kg shark fin rays was produced of which only 4.70 kg was marketed internally. In the year 1984-85 the production was increased to 71.38 kg and same year 80 kg. of fin rays was exported and 18.50 kg was internally marketed. In the next year the production, export and internal consumption were lowered to 50.15 kg, 35.00 kg and 15.30 kg respectively. Next year even though the production showed a slight decline

to 46.00 kg the export was increased to 50.00 and 16.50 kg. was marketed domestically. In the year 1987-88 the production had increased to 55.00 kg, whereas the quantity of export was the same as in the previous year and internal consumption increased to 19.25 kg. (Fig.15).

Shark fin rays were made by hot process from the different sized groups at C. limbatus according to the weight as in the case of shark fins and the yield percentage was studied (Table.22). The yield percentage was 0.20% to the weight of for shark weighing 10 to 20 kg, which was increased to 0.208% in the case of 20 to 30 kg group. The yield was found 0.212% for the next size ranging from 30-40 kg and for the following group of 40-50 kg the yield was 0.216%. The yield percentage of species above 50 kg was found 0.220%.

When experiments were conducted using fins of C. limbatus, the yield percentage of shark fin rays was found varying for caudal fin and other fins. Hence a detailed study of the shark fin rays using different sizes of the caudal fins and other fins which were in wet or dried form were carried out and the results are shown in Table-23 and 24.

The shark fins from C. limbatus were collected and caudal fins and other fins were grouped separately after cutting (Table.22). These fins were again graded into six groups according to the size $<$ 10 cm; 11-20 cm; 21-30 cm; 31-40 cm; 41-50 cm; above 50 cm.

The yield percentage of the shark fin rays in the fresh caudal fin (lower lobe) varied from 14% to 20% according to the increase size of the fin (Table-23). Maximum length of caudal fin obtained from C. limbatus during the period of study was 40 cm.

The pectoral and dorsal fins were combined and graded according to their size in the fresh condition. The yield percentage of shark fin rays obtained from the pectoral and dorsal fins showed an increasing trend, ie. from 5.50 to 9.80%, according to increase in size (Fig.17).

The above experiments were repeated with the same grades of dried fins.

The results of the experiment was tabulated in the Table-24 and the yield variation is shown in Fig.18.

As in the case of fresh pectoral and dorsal fin the dried fins of the same were grouped into five and the yield of fin rays showed an increasing trend according to the increase in size of the fin, the minimum yield was 11.5% for the fins less than 10 cm and the highest (22.00%) for the above 50 cm group.

The results of the yield percentage obtained for the dried caudal fin is shown in Table-24. Here also the yield variation showed an increasing trend accordig to the increase as in the case of fresh caudal fin (Fig.18).

Shark fin rays were extracted using two methods called cold method and hot method and quality of the product was studied. The rays made by cold method was more flexible, but the colour was not bright golden. The product obtained from the hot process though the colour was bright golden, the rays were hard and brittle (Plate-13A).

The shark fin rays extracted in the hot process by heating the fin at different temperature from 60°C to 100°C and the product obtained was analysed. The product obtained by heating at higher than 70°C was found inferior in quality.

Combination of both method of cold and hot process was found better to extract quality fin rays. The fins were soaked in 10% Acetic acid for one day. The skin will become soft by this time and it can be scrapped off then the fin rays were separated using the hot process. The product obtained by this method was superior in quality especially in colour.

In case of fresh fins, the cold process is better, but for the dried fin it will take about 5 days for the easy separatio of fin rays. Hence cold process can be called a long process whereas in the hot process it will take only few hours (maximum 5 hours) hence it can be called as short process. But it need heating facility and acid resistant metallic vessels (eg. stainless steel) were needed for the hot process.

Based on the present study on shark fin-rays it can be recommended that instead of exporting dried fins, it is better to export it as fin rays because the processing method is simple·

3.14 Shark hides

Good quality hides can be produced from the larger species of sharks. In early days the rough leather made from shark called 'Shagreen' was used for grasping and polishing. Now technology have developed to produce beautifully textured leather using for the production of pouches, wallets, ladies bags, shoes, watch strap etc. The most expensive leather in the world 'Boraso' is made from the small Morocco shark.

In our country about 20% of shark landing consists of species with size more than one meter. The skin of these sharks are at present not utilized. If the hide is separated in proper time and processed in proper way it can earn more foreign exchange through its export.

The hide of the C. limbatus separated carefully without damage by opening from the dorsal sides and flesh was removed carefully, salted and sent to a tannery in Madras for tanning. Durability and colour of the tanned leather was studied. Even after five years of storage the quality of the tanned skin remained unchanged, especially the colour (plate-13B). Even though the skin of C. granulosus was small in size (less than 90 cm) the leather obtained seems to be best in quality.

The quality of the skin will be inferior if the skin is separated after the freezing or icing. Hence the skin must be removed and salted immediately after the catch. A major portion of the oceanic sharks caught by gill nets are landed ashore without icing which give a good potential for the utilization of shark skin.

3.15 Fish silage from shark

Generally in the fish processing plants the offals are not utilized but discarded as waste. In the shark processing plants about 30 to 40% will be waste. An attempt was made to utilize this waste for the production of fish silage. Trials of fish silage was made in PVC buckets using formic acid and the quality and shelf life of the product was studied. All trials showed that the silage made from the offals of shark were good in quality and the shelf life extended for more than one year without spoilage in our tropical condition. The only thing observed was that the skin should be avoided in the preparation of silage since the disintegration of skin is difficult. The study also indicated that the production of silage could be done with the minimum quantity ie. from one kilogram to several tons of offal and it could be easily mixed with other suitable ingredients and used for feeding poultry or piggery.

3.16 Chemical composition of shark meat in the three selected species

The result of the chemical analysis of shark meat before and after processing the three species was tabulated in Table.10. According to this table the moisture content varied from 77.50 to 79.00% for S. palasorra before processing (raw material). It has increased into 79.00 to 79.50% after processing (product - shark fillet after ice water washing). Protein content in the same species varied from 21.60 to 23.00% before processing and of 18.80 to 20.10% after processing. Fat content was in the range of 0.15 to 0.20% before processing which was almost negligible after processing.

The moisture content was in between 77.00 to 77.80% for the fresh meat of C. limbatus (before processing) which increased to 78.80 to 79.20% for fillets after washing in ice water. The protein percentage was found high in this species ie. from 21.90 to 23.80% which was reduced after washing to the range 19.00 to 20.50%. In the case of fat content it was found in between 0.10 to 0.15% which was found negligible after washing.

In the case of C. granulosus, the moisture content was found in between 77.80 to 78.90% for the raw material (fresh meat before processing) which increased to 79.10 to 79.40 after washing (processing). Protein percentage was found in between 20.10 to 22.00% for the raw material which decreased to 18.40 to 19.40 for the product (fillets) and the fat content was initially in the range of 0.22 to 0.30% which had found negligible after washing in ice water.

From the above analysis it is clear that the protein content is reduced by the washing of shark meat in ice water.

The decrease in the urea content after ice water washing of shark meat of three species was observed and the results was shown in Table-13. The urea content was in the range of 1600 to 1800 mg% in S. palasorra, which reduced to 1300-1500 mg% after ice water washing for 4 hours in the ratio 1:3 (fish:water). In the case of C. limbatus the urea content was found high ie. 1800-2100 mg% which reduced to 1500-1800 mg% after ice water washing as in the case of S. palasorra. The urea content was found lowest in C. granulosus (1200 - 1300 mg%) which was decreased to less than 1200 mg% after washing. Hence it is clear that ice water washing will reduce the urea content to some extent.

3.17 COMMERCIAL FEASIBILITY OF TAKING UP INDUSTRIAL PRODUCTION OF SHARK PRODUCTS BASED ON THE PRESENT STUDY

Raw Material **SHARK**

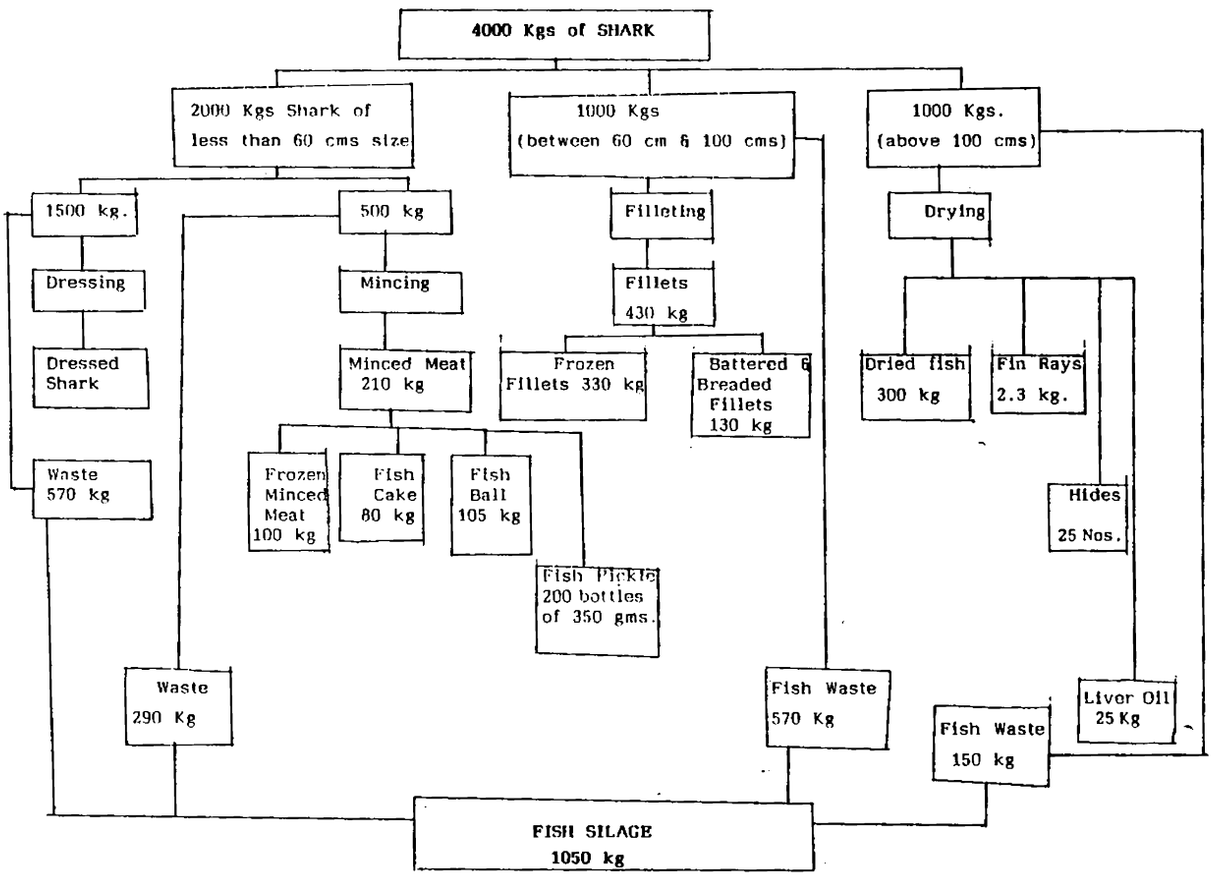
Average daily raw material utilisation : 4000 kgs

Size ranges : below 60 cms - 2000 kg - Rs. 6/kg

between 60 cms and 100 cms - 1000 kg - Rs. 8/kg

Above 100 cms - 1000 kg - Rs. 10/kg

PRODUCTION PATTERN



COSTS OF PRODUCTION

		Costs in Rs.
I. CAPITAL COSTS		
1) Land & buildings, plant etc.		15,00,000
2) Cold storage facility		
a) Chill room 10 tonne		
b) Cold store - 50 tons		53,00,000
c) Plate freezer 600 kg/charge 90 mts		
3) Mincing machine	2,00,000	
4) Dressing filleting tables 2 nos.		20,000
5) Knife, trays, handling boxes		50,000
6) Sun-drying platforms, racks etc.		50,000
7) Salting tanks		30,000
8) Store for dried fish		2,00,000
9) Other equipments etc.		4,00,000
10) Boiler, moulding tanks, moulds etc.		1,00,000
Total		78,50,000
II. OPERATING COSTS		
1) Raw material (fish) 4000 kgs.x 240 days		72,00,000
2) Ice 2 x 240 tons x 200		96,000
3) Packing materials		9,00,000
4) Strapling, sealing machines		8,000
5) Acetic acid & formic acid		3,60,000
6) Additives for cakes, fish balls, pickles		7,26,000
7) Water, electricity		2,00,000
8) Workers 55 x 600/- x 12		3,96,000
9) Staff - 10 members		1,80,000
10) Accumulated benefits to staff & workers		1,44,000
11) Repairs, maintenance 5% of the Capital Cost		3,92,500
Total		10,602,500

FINANCIAL STATEMENT OF THE OPERATION OF THE PLANT

1. Capital Costs		Rs. 78,50,000
Depreciation at 10 year life		7,85,000
Operating costs		106,02,500
Interest on capital investment at 20%		15,70,000
Interest on working capital at 20% (working capital to run the plant for one month	)	1,70,200
Total costs		13,127,700
Total Revenue		155,85,000
Net profit		24,57,300

	Year 0	Year 1	Year 2	Year 3	Year 4
1) Capital Costs	78,50,000	---	---	---	--
2) Working capital	8,51,000	---	---	---	8,51,000
Operating Costs	53,05,000	106,02,500	106,02,500	106,02,500	106,02,500
Total costs	140,06,000	106,02,500	106,02,500	106,02,500	106,02,500
Revenue	77,92,500	155,85,000	155,85,000	155,85,000	155,85,000
Profit	– 62,13,500	49,82,500	49,82,500	49,82,500	57,79,500
Discount Rate 20%					
Present value	– 62,13,500	41,52,083	34,60,069	28,83,391	27,87,181
Net present value	+ 70,69,224				
Internal Rate of Return 72%					

III. REVENUE

Products

1) Dressed Shark 930 x 240 x 18/-	40,17,600
2) Fillets - frozen 330 x 240 x 25/-	19,80,000
3) Kheema frozen 100 x 240 x 25/-	6,00,000
4) Fish cakes & balls 185 x 240 x 30/-	13,32,000
5) Pickles 200 bottles x 240 x 25/-	11,04,000
6) Battered & Breaded fillets 130x240 x 27/-	8,42,400
7) Dried shark 300 x 240 x 30/-	21,60,000
8) Fin ray 2.3 x 240 x 3000/-	16,56,000
9) Shark hide 25 x 240 x 50/-	3,00,000
10) Liver oil 25 x 240 x 12/-	72,000
11) Silage 1050 kg x 240 x 6/-	15,12,000
Total	155,85,000

SENSITIVITY

Assumptions:

1) The Capital Costs increases by 20%
   IRR 53.5%

2) The raw material price increases by 30%
   IRR 23%

3) The operating Costs other than raw material costs increases by 20%
   IRR 57%

4) The revenue decreases by 10%
   IRR 34%

5) The production is reduced by 20%
   IRR 37%

Going through the net present value of the cash flows of the production system under assumptions of production costs and revenue levels as detailed in the list the production unit is a viable scheme. The internal rate of return (IRR) under these assumptions comes to 72%. The sensitivities worked out for various assumption's as given above shows that the production scheme allows a considerable flexibility in many aspects, hence feasible.

RECIPE FOR BATTERED AND BREADED FILLETS

Raw material

Shark fillet blocks	30.00 kg.
Wheat powder	8.000 "
Bread powder	8.000 "
Salt	1.500 "
Spices (pepper powder, ginger powder etc.)	0.500 "

Procedure

The blocked fillets were sliced into thin slices of size 6x5x1 cm weighing from 60-70 gm (Plate-4B). These were spread over trays and dipped in the batter for a few seconds and bread powder was spread over uniformly on all sides. Afterwards it was spread in the trays and made frozen using an IQF (Plate-5B). The frozen battered and breaded fillets were packed in the polythene bags and stored at -20°C or below. The frozen product can be fried in hot oil till golden colour attains and served in the hot condition (Plate-5B)

Product:

100 gm battered and breaded fillets - 400 Nos.

RECIPE FOR FISH CAKE

Raw material

Mixture of minced meat of shark and pink perch in the ratio (1:1)	10.000 kg
Starch (Wheat powder or Tapiocca powder)	1.250 "
Vegetable oil or Fat	0.700 "
Salt	0.150 "
Pepper powder	0.050 "
Carlic (peeled)	0.050 "
Mint leaves	0.050 "
Green chillies	0.100 "
Batter (wheat powder or starch)	1.000 "
Bread	1.200 "

Procedure

Minced meat is ground in a silent cutter with salt, starch powder and spices for 8 to 10 minutes. Then it is moulded in metallic or wooden moulds of different shapes. The thickness must not exceed 1 cm. Then the moulded fish cakes are cooled in a freezer till it becomes semifrozen.

The Batter is made by mixing wheat powder or starch with chilled water in the ratio 1:1. Breading is made by powdering dried bread. First the semi frozen fish cake is dipped in the batter and bread powder is uniformly spread over it. Then the battered and breaded fish cakes are quick frozen.

The frozen fish cakes can be fried in hot oil (without thawing) till golden yellow colour attain.

Product: 50 gm fish cake - 280 Nos.

RECIPE FOR FISH BALLS

Raw material

Mixture of Minced meat of shark and pink perch in the ratio 2:3	10.000 kg.
Wheat powder	1.000 "
Milk	6 litre
Salt	0.300 Kg
Vegetable fat	0.400 "
Pepper powder/spices	0.200 "
Ice water	0.500 "

Procedure

The meat ~~fillets~~ is ground using a wet grinder with salt and half part of the milk for two minutes. Afterwards it is mixed well with starch, spices, ice water, vegetable fat and finally the second part of milk and the entire process is completed within 12 minutes. Keep the temperature of ground material around +10°C.

The materials are made into balls of size 2-3 cm diameter and cooked in 1.5% brine at 90°C. The cooked balls will float on the surface of brine which can be separated using a perforated spatula and then cooled and packed in polythene bags or canned.

Product : Fish balls = 12.00 kg

RECIPE FOR FISH PICKLE

Raw material

Shark Meat (Minced/Fillets made into smaller pieces)	10.000 kg.
Oil	2.300 "
Green chillies	1.000 "
Ginger	0.500 "
Garlic	1.000 "
Curry leaves	0.200 "
Mustard seeds	0.500 "
Chilly powder	1.500 "
Turmeric powder	0.500 "
Salt	1.500 "
Pepper powder	0.300 "
Veneger	7000 ml
Fenugrek	0.200 kg

Procedure

Fish meat is mixed with pepper powder, salt and turmeric powder etc. for 1 hour. Chilly powder, one part of turmeric powder, one part of garlic and ginger were ground and kept. Minced meat is then fried in oil and taken out. The remaining part of the garlic, curry leaves,s green chillies (cut into pieces) ginger and mustard seeds are semifried and mixed in the ground masala and again fry. Then it is mixed with venegar. Then it is mixed with fried fish and just boil. It is bottled after keeping 3 - 4 days for curing.

Product : 350 gm bottle fish pickle : 40 nos.

FLOW SHEET FOR DRESSED SHARK

Shark (Raw material)

↓

Grading (less than 60 cm)

↓

Weighing

↓

Removal of head, fins and gut

↓

Cleaning the belly portion with potable water

↓

Dipping in ice water for 3 - 4 hrs.
(Fish : Water = 1:3)

↓

Draining for 5 minutes

↓

Weighing and packing as one kg. block
using polythene wrapping

↓

Plate Freezing

↓

Removal from the plate freezer

↓

Packing in Master carton

↓

Storing at - 20°C or below

FLOW SHEET FOR SHARK FILLET

Shark (Raw material)

↓

Grading (above 60 cm)

↓

Weighing

↓

Removal of Fins by cutting (above one meter)

↓

Slicing as 20 - 25 cm chunks (bigger ones)

↓

Hand Filleting

↓

Deskinning manually or mechanically

↓

Removal of red Meat

↓

Making into fillets of thickness maximum 3 cm.

↓

Washing in potable water

↓

Dipping in ice water for 3 to 4 hrs.
(Fish : Water = 1:3)

↓

Draining for 7 minutes

↓

Weighing

↓

Packing as ½ Kg. block with polythene and duplex carton

↓

Plate Freezing

↓

Removal from the Plate freezer

↓

Packing in Master cartons

↓

Storing at - 20°C or below

FLOW SHEET OF BATTERED AND BREADED FILLET

Shark fillet block of size 30 x 18 x 5 cm (3 kg.)

↓

Made into thin slice of size (6x5x1 cm) (60 - 70 gm)

↓

Spreading on the trays

↓

Batter mixing (Wheat powder : Ice water 1:1)

↓

Battering (about 15 - 20%)

↓

Breading (about 15 - 20%)

↓

Spreading in trays

↓

I.Q.F

↓

Packing in polythene cover

↓

Storing at - 20°C or below

FLOW SHEET OF MINCED MEAT, FISH CAKE, FISH BALLS & PICKLES

Shark (Raw material)

↓

Grading (less than 70 cm)

↓

Weighing

↓

Dressed, splitted with deep scoring of 2 cm. width

↓

Washing with potable water

↓

Dipping in ice water for 3 - 4 hrs.(Fish:Water= 1:3)

↓

Draining for 10 minutes

↓

Mincing

Frozen Minced meat	Fish cake	Fish Balls	Fish pickles
Keep for draining excess water for 10 minutes	Blending with minced meat of lean fishes in the ratio (1:1)	Blending with minced meat of lean fishes in the ratio(2:3)	Mixing with salt and spices powder
↓	↓	↓	↓
Weighing	Homogenous mixing of other ingradients like starch, spices salt, oil etc.	Pulvarising using a colloid mill or wet grinder with other ingradidents	Keeping for one hr. & frying till golden yellow colour appears.
↓	↓	↓	↓
Packing as ½ kg block using polythene and duplex carton	Moulding in regular shape (maximum one cm. thickness)	Cooking in 1.5% brine at 90°C for 4 - 5 Mts.	Spreading for cooling
↓	↓	↓	↓
Plate freezing	Battering (below 5°C)	Collecting from the brine	Frying the green spices made into slices
↓	↓	↓	↓
Removal from the Plate freezer	Breadding	Cooling	Mixing the fried spices with meat
↓	↓	↓	↓
Packing in master carton	IQF	Canning	Vinegar adding
↓	↓	↓	↓
Store at -20°C or below	Packing		Boil for a few Mts.
	↓		↓
	Store at -20°C or below		Curing for 3 - 4 days
			↓
			Bottling
			↓
			Storing

FLOW SHEET OF SMOKED FILLETS

Fillets

↓

Brining in saturated brine for 15 minutes

↓

Hanging in the Smoking chamber using rods

↓

Draining for 30 minutes

↓

Smoking for 4 - 10 hrs. at temperature range 40 - 70°C (depending on the thickeness of Fillets)

↓

Cooling

↓

Canning

↓

FLOW SHEET OF CANNED SHARK PRODUCTS

(A) Smoked Fillets in oil	(B) Fish Balls in Tomato sauce
Smoked Fillets	Fish Balls
Cutting according to the can size	Packing in the can
Packing horizondally in the can (½ Hansa can of 200 gm size)	Weighing (70% of the net weight of the can)
Weighing the can (65% of the net wt. of the can)	Filling the media (freshly prepared tomato sauce in hot condition)
Filling the media (Hot double refined Groundnut oil)	Weighing
Weighing	Seaming
Exhausting	Sterlization for 50 Mts. at 10 lb pressure
Seaming using double seamer	Wiping and labelling
Sterilizing for 70 Mts. at 10 lb pressure	Storing
Wiping and labelling	
Storing	

FLOW SHEET OF DRIED SHARK

SHARK

Weighing

Remove the fins (for bigger fishes)

Cutting into chunks as 20-25 cm (for bigger fishes)

Dressing with deep scoring with 2 cm width

Washing in ice water

Salting (Rubbing with salt on the table)

Putting in the salting tank with salt & fish in alternative layers

Kept in the salting tank for saturation (Minimum 48 hrs.)

Washing the salted fish in fresh water (Three washing each - about 2 hrs. soaking in water)

Draining for 10 minutes

Spreading in Aluminium trays or on nylon webbing

Dried in the Artificial drier for 15-22 hrs. at 42-45°C depending on the thickness of fish till the moisture content reach less than 25%

Weighing

Packing as ½ kg. in polythene bags and sealing

Storing

FLOW SHEET OF DRIED SHARK FINS

SHARK

↓

Collecting pectoral, dorsal & caudal fins

↓

Half moon cutting of pectoral and dorsal fins

Parallel cutting of lower lobe of the caudal fin

↓

Brushing of the surface of fin with PVC brushes

↓

Soaking in mild brine (2%) for 30 minutes

↓

Sprinkling of quicklime in the cut portion

↓

Spreading or hanging of fins

↓

Drying till the moisture reaches less than 10%

↓

Grading according to size or set

↓

Packing

FLOW SHEET OF SHARK FIN RAYS

SHARK FINS

Cold process (Long process)

Fins (Wet/dried)

↓

SOAK IN 10% Commercial Acetic Acid for one day

↓

Remove the skin by scrapping using a knife from the fins

↓

Soak in the fins in 10% Acetic Acid in PVC or S.S. tank for 3 to 5 days

↓

Keep the pH below 3.0

↓

Fins are collected from the acid and put in water

↓

Separate the fin rays manually

↓

Washing the fin rays till free of acid

↓

Keep for draining for 30 Mts.

↓

Spread in thin layers in trays

↓

Dry till the moisture content reaches less than 10%

↓

Pack in polythene bags as 50 gm. packet

↓

Storing

Hot process (Short process)

Fins (Wet/dried)

↓

Soak in 10% Acetic Acid solution in S.S. Boiling Kettle

↓

Heat the solution upto 70°C and keep for 3 - 5 hrs.

↓

Separate from the Acid solution and cool it in water

↓

Separate the fin rays manually

↓

Washing till acid free

↓

Draining

↓

Spreading

↓

Drying

↓

Packing

↓

Storing

FLOW SHEET OF SILAGE

Offals

|

Chopping to size 1 to 1.5 mm. size
or pulvarising

|

Keeping in PVC tanks/buckets

|

Acidfication using Formic Acid
(3.5% Acid is added slowly with
homogeneous mixing)

|

Stirring for one hour

|

Keep the pH below 3.5

|

Liquifies completely within three weeks

|

Storing in PVC tank

|

Made into poultry/piggery feed using
other ingradients

TABLE-1

STATE-WISE LANDINGS OF SHARKS FROM 1983 to 1988

	1983	1984	1985	1986	1987	1988	Total Qty. (Tons)	% on the basis of total Shark landings
Gujarat	6,818	6,777	10,523	6,964	6,997	9,203	47,282	22.79
Maharastra	8,205	7,276	6,479	6,593	7,623	9,180	45,356	21.86
Goa	628	508	209	681	136	235	2,397	1.16
Karnataka	3,801	1,427	1,424	2,002	1,468	1,782	11,904	5.74
Kerala	7,747	6,229	4,953	4,660	3,095	5,151	31,835	15.34
Tamilnadu	3,095	2,395	1,661	3,547	5,129	4,308	20,135	9.71
Pondicherry	45	256	191	12	50	164	718	0.40
Andhra Pradesh	6,706	6,627	6,239	5,336	4,162	4,851	33,921	16.36
Orissa	1,408	1,247	1,364	3,077	1,120	1,374	9,590	4.61
West Bengal	223	265	97	140	136	44	905	0.44
Lakshadweep	256	198	157	98	183	185	1,077	0.52
A & N Islands	295	274	274	400	235	518	1,996	0.96
Others	127	110	--	--	--	--	237	0.11
Total	39,354	33,589	33,571	33,510	30,334	36,995	207,353	100.00
Elasmobranchs	70,046	57,757	52,804	53,743	56,768	57,647	348,765	
Total Marine Fish landings	1548,475	1630678	1534726	1707912	1647484	1775010	9844285	
Percentage of Shark	2.54	2.06	2.18	1.96	1.84	2.08	2.10	
Percentage of Elasmobranchs	4.52	3.54	3.44	3.14	3.44	3.24	3.54	

TABLE-2

DISTRIBUTION OF SHARK LANDINGS IN BOTH COASTS

FROM 1983 to 1988

Year	Shark landings (Tons)	West coast		East coast	
		Tons	%	Tons	%
1983	39,354	27,519	69.92	11,835	30.08
1984	33,589	22,470	66.93	11,119	33.07
1985	33,571	23,745	70.73	9,826	29.27
1986	33,510	20,998	62.66	12,512	37.34
1987	30,334	19,502	64.30	10,832	35.70
1988	36,995	25,736	69.56	11,259	30.44
Total	207,353	140,010	67.50	67,383	32.50

TABLE-3

SHARK LANDINGS IN THE INTEGRATED FISHERIES PROJECT DURING THE STUDY PERIOD FROM 1983-84 TO 1987-88

Year	Shark landing (Kg)	%	Coastal Shark		Oceanic Shark	
			(Kg)	%	(Kg)	%
1983-84	55,301	7.57	11,415	20.64	43,886	79.36
1984-85	62,664	6.85	14,314	28.84	48,350	77.16
1985-86	52,884	6.06	9,180	17.35	43,704	82.65
1986-87	69,209	7.69	16,837	24.33	52,372	75.67
1987-88	40,049	6.54	11,983	29.93	28,066	70.07
Total	280,107	6.95	63,513 + 216*	22.67 0.08	216378	77.25

* Deep sea Shark

TABLE-4

UTILIZATION OF SHARK FOR DIFFERENT FISHERY PRODUCTS

DURING THE STUDY PERIOD

Year	Total Qty. processed (Kg)	Round Frozen		For the production of Dressed shark		For the production of Fillet		For the production of Dried product	
		Qty. (Kg)	%	Qty.(Kg)	%	Qty.(Kg)	%	Qty.(Kg.)	%
1983-84	49,266	--	--	1,820	3.69	31,337	63.61	16,109	32.70
1984-85	58,822	1,082	1.80	7,690	13.07	17,327	29.45	32,723	55.60
1985-86	52,884	2,450	4.63	4,570	8.64	11,010	20.81	34,854	65.90
1986-87	62,821	2,057	3.27	6,450	10.26	21,074	33.54	33,240	52.91
1987-88	32,149	7,177	22.32	4,330	13.46	11,922	37.08	8,720	27.12
Total	255,942	12,766	4.99	24,860	9.71	92,670	36.21	125,646	49.09

TABLE-5

PRODUCTION OF DRESSED SHARK FROM THE YEAR 1984-85 TO 1987-88

Year	Qty. of Shark used (Kg)	Dressed shark produced	
		Qty. (Kg)	Yield %
1983-84	1,820	1,092	60.00
1984-85	7,690	4,613	59.98
1985-86	4,570	2,788	61.00
1986-87	6,450	3,934	60.99
1987-88	4,330	2,685	62.00
Total	24,860	15,112	60.78

TABLE-6

YIELD VARIATIONS ACCORDING TO SIZE RANGE IN THE PRODUCTION OF DRESSED SHARK USING S. PALASORRA

Size range (cm)			Weight range (gm)			Yield %
From		To	From		To	
40	-	45	250	-	325	62.00
46	-	50	325	-	500	62.70
51	-	55	500	-	850	64.50
56	-	60	850	-	1100	66.80
61	-	70	1100	-	1800	66.66
71	-	80	1800	-	3200	66.00
81	-	90	3200	-	5000	65.50

TABLE-7

PRODUCTION OF SHARK FILLET FROM 1983-84 TO 1987-88

Year	Qty. of Shark used (Kg)	Fillet produced Qty.(Kg)	Yield %
1983-84	31,337	11,134	35.52
1984-85	17,327	6,202	35.73
1985-86	11,010	4,234.5	38.46
1986-87	21,074	8,658.5	41.08
1987-88	11,922	7,965	39.98
Total	92,670	38,194	37.94

TABLE-8

YIELD VARIATION ACCORDING TO SIZE RANGE IN THE PRODUCTION OF FILLETS FROM S. PALASORRA

Size range(cm) From	To	Weight range (gm) From	To	Yield % of Fillets with skin	Yield % of Fillets Deskinned
40	45	250	325	41.00	38.00
46	50	325	500	42.50	39.00
51	55	500	850	44.75	41.00
56	60	850	1100	46.00	42.00
61	70	1100	1800	48.00	43.25
71	80	1800	3200	48.80	44.00
81	90	3200	5000	48.50	43.85

TABLE-9

YIELD VARIATION ACCORDING TO SIZE RANGE IN THE PRODUCTION OF FILLET FROM C. LIMBATUS

Size range (cm)			Weight range (kg)	Yield % of Fillet
110	-	120	10.00 to 13.00	47.55
121	-	130	13.00 to 16.50	47.00
131	-	140	16.50 to 19.00	48.10
141	-	150	19.00 to 21.80	48.80
151	-	170	21.80 to 30.00	47.70
171	-	190	30.00 to 44.00	46.80
191	-	210	44.00 to 58.80	47.50

TABLE - 10

ESTIMATION OF CHEMICAL COMPOSITION OF SHARK MEAT BEFORE AND AFTER PROCESSING IN THE SELECTED SPECIES

Species	Before processing (fresh meat)			After processing(fillets-after washing)		
	Moisture %	Protein %	Fat %	Moisture %	Protein %	Fat %
S. palasorra	77.50 - 79.00	21.60 - 23.00	0.15 - 0.20	79.00 - 79.50	18.80 - 20.10	Negligible
C. limbatus	77.00 - 77.80	21.90 - 23.80	0.10 - 0.15	78.80 - 79.20	19.00 - 20.50	Negligible
C. granulosus	77.80 - 78.90	20.10 - 22.00	0.22 - 0.30	79.10 - 79.40	18.40 - 19.40	Negligible

TABLE-11

YIELD VARIATIONS ACCORDING TO THE SIZE RANGES IN THE PRODUCTION OF MINCED MEAT FROM S. PALASORRA

Size range (cm)			Weight range (gm)			Yield %
From		To	From		To	
40	-	45	250	-	325	44.00
46	-	50	325	-	500	46.50
51	-	55	500	-	850	47.50
56	-	60	850	-	1100	47.45
61	-	70	1100	-	1800	47.50
71	-	80	1800	-	3200	46.50
81	-	90	3200	-	5000	46.00

TABLE -12

MIXING OF MINCED MEAT OF SHARK AND PINK PERCH IN DIFFERENT PERCENTAGES AND RESULT OF THE PRODUCTS (FISH CAKES AND FISH BALLS)

% of Minced meat from Shark	% of Minced meat from Pink perch	Fish cakes Texture	Fish cakes Taste	Fish Balls Colour	Fish Balls Texture	Fish Balls Taste
100	0	C+	C	B	C+	D+
90	10	C+	C+	B	C+	C
80	20	B	C+	B	B	C
70	30	B+	B	B+	B	C+
60	40	A	B+	A	B+	B
50	50	A	A	A	A	B+
40	60	A	A	A	A	A
30	70	A	A	A	A	A
20	80	A+	A	A	A	A
10	90	A+	A	B+	A+	A
0	100	A+	A	B+	A+	A+

A+ = Excellent
A = Very good
B+ = Good
B = Fair
C+ = Average
C = Below average
D+ = Poor
D = Very poor

TABLE -13

VARIATION OF UREA CONTENT IN SHARK MEAT BEFORE AND AFTER ICE WATER WASHING OF SELECTED SPECIES

Species	Before washing - fresh meat (mg %)		After washing in ice water for 4 hrs. (fish:water = 1:3) (mg %)	
	From	To	From	To
S. palasorra	1,600	1,800	1,300	1,500
C. limbatus	1,800	2,100	1,500	1,700
C. granulosus	1,200	1,300	less than 1200	

TABLE -14

SMOKING OF FILLETS MADE FROM S. PALASORRA

Weight range of individual Fillet (gm)		Time of brining in saturated brine	Temp. range of smoking °C		Time range for smoking (Hours)	Yield %
From	To		From	To		
100 -	150	15	40 -	70	4	37.50
150 -	200	"		"	5	38.50
200 -	300	"		"	6	40.10
300 -	400	"		"	7	42.00
400 -	600	"		"	8	45.00
600 -	800	"		"	10	48.80

TABLE - 15

ANALYTICAL REPORT OF THE CANNED SHARK PRODUCT

PRODUCT: Shark fillets in brine

SPECIES: S. Palasorra

Can used: ½ Hansa Aluminium can (SR. lacquered)

Sl.No	Details	Period of observation			
		After incubation period	After 3 months	After 6 months	After one year
1.	Can condition	Normal	Normal	Normal	Normal
2.	Std. Net. Wt.	200 gm	200 gm	200 gm	200 gm
3.	Std. Solid Wt.	145 gm	145 gm	145 gm	145 gm
4.	Gross Wt.	230	225	228	226
5.	Empty Can Wt.	27	27	27	27
6.	Solid + can Wt.	168	169	170	167
7.	Water/Liquid	62 ml	56 ml	58 ml	59 ml
8.	Net Wt.	141	142	143	140
9.	Solid Wt.	141	142	143	140
10.	± net wet.	- 4	- 3	- 2	- 5
11.	± Solid wt.	- 4	- 3	- 2	- 5
12.	Appearance	C+	C+	C	C
13.	Colour	C+	C+	C+	C+
14.	Flavour	D+	D+	D+	D
15.	Texture	C	C	C	C
16.	No. of pieces	2	2	2	2
17.	pH	6.0	6.2	6.5	6.3
18.	Sulphide blackening	--	--	--	one spot of sulphide blackening.- Normal
19.	Saltiness	Normal	Normal	Normal	
20.	Colour of brine	White	White	White	White
21.	Turbidity	Opaque	Opaque	Opaque	Opaque
22.	Brine strength	1.88%	1.75%	1.70%	1.68%
	Overall score	C	D+	D+	D

A+ = Excellent
A = Very good
B+ = Good
B = Fair
C+ = Average
C = Below average
D+ = Poor
D = Very poor

TABLE - 16

ANALYTICAL REPORT OF THE CANNED SHARK PRODUCT

PRODUCT: Shark Fillets in Tomato sauce

SPECIES: S. Palasorra

Can used: ½ Hansa Aluminium can (SR. lacquered)

Sl.No	Details	Period of observation			
		After incubation period	After 3 months	After 6 months	After one year
1.	Can condition	Normal	Normal	Normal	Normal
2.	Std. Net. Wt.	200	200	200	200
3.	Std. Solid Wt.	145	145	145	145
4.	Gross Wt.	230	228	228	226
5.	Empty Can Wt.	27	27	27	27
6.	Solid + can Wt.	180	180	179	151
7.	Water/Liquid	50 ml	48 ml	49 ml	48 ml
8.	Net Wt.	153	153	152	151
9.	Solid Wt.	153	153	152	151
10.	± net wet.	+ 8	+ 8	+ 7	+ 6
11.	± Solid wt.	+ 8	+ 8	+ 7	+ 6
12.	Appearance	B^+	B^+	B	B
13.	Colour	A	A	B^+	B^+
14.	Flavour	C	C	D^+	D^+
15.	Texture	C^+	C^+	C	C
16.	No. of pieces	2	3	2	2
17.	pH	4.8	4.8	4.9	5.0
18.	Sulphide blackening	--	--	--	Two spotsof blackening
19.	Saltiness	Normal	Normal	Normal	Normal
20.	Colour of Tomato sauce	Reddish	Reddish	Reddish	Reddish
21.	Turbidity	Thicker	Thicker	Thicker	Thicker
22.	Brine strength	--	--	--	--
	Overall score	B	C^+	C^+	C

A +	= Excellent	C^+	= Average
A	= Very good	C	= Below average
B^+	= Good	D^+	= Poor
B	= Fair	D	= Very poor

TABLE - 17

ANALYTICAL REPORT OF THE CANNED SHARK PRODUCT

PRODUCT: Smoked Shark fillets in oil

SPECIES: S. Palasorra

Can used: ½ Hansa Aluminium can (SR. lacquered)

Sl.No	Details	Period of observation			
		After incubation period	After 3 months	After 6 months	After one year
1.	Can condition	Normal	Normal	Normal	Normal
2.	Std. Net. Wt.	200 gm	200 gm	200 gm	200 gm
3.	Std. Solid Wt.	140 gm	140 gm	140 gm	140 gm
4.	Gross Wt.	220	218	221	223
5.	Empty Can Wt.	27	27	27	27
6.	Solid + can Wt.	168	165	167	170
7.	Water/Liquid	0.2/61 ml	0.3/62 ml	0.1/61 ml	0.3/60 ml.
8.	Net Wt.	141	138	140	143
9.	Solid Wt.	141	138	140	143
10.	± net wet.	+ 1	- 2	+ 0	+ 3
11.	± Solid wt.	+ 1	- 2	+ 0	+ 3
12.	Appearance	A^+	A^+	A^+	A^+
13.	Colour	A	A	A	A
14.	Flavour	A	A	A	B^+
15.	Texture	B^+	B^+	B^+	B^+
16.	No. of pieces	5	4	4	4
17.	pH	6.0	5.9	5.9	5.9
18.	Sulphide blackening	--	--	--	--
19.	Saltiness	Normal	Normal	Normal	Normal
20.	Colour of Oil]	Yellow transparent	Deep yellow transparent	Deep yellow transparent	Deep yellow transparent
21.	Turbidity]				
22.	Brine strength]	--	--	--	--
	Overall score	A	A	A	A

A^+	= Excellent	C^+	= Average
A	= Very good	C	= Below average
B^+	= Good	D^+	= Poor
B	= Fair	D	= Very poor

TABLE - 18

ANALYTICAL REPORT OF THE CANNED SHARK PRODUCT

PRODUCT: Fish balls in brine

SPECIES: S. Palasorra

Can used: ½ Hansa Aluminium can (SR. lacquered)

Sl.No	Details	Period of observation			
		After incubation period	After 3 months	After 6 months	After one year
1.	Can condition	Normal	Normal	Normal	Normal
2.	Std. Net. Wt.	200	200	200	200
3.	Std. Solid Wt.	145	145	145	145
4.	Gross Wt.	228	227	228	227
5.	Empty Can Wt.	27	27	27	27
6.	Solid + can Wt.	172	170	174	171
7.	Water/Liquid	56	57	54	56
8.	Net Wt.	145	143	147	144
9.	Solid Wt.	145	143	147	144
10.	± net wet.	+ 0	- 2	+ 2	- 1
11.	± Solid wt.	+ 0	- 2	+ 2	- 1
12.	Appearance	A^+	A	A	A
13.	Colour	B^+	B^+	B	C^+
14.	Flavour	B^+	B	B	C^+
15.	Texture	A^+	A^+	A	A
16.	No. of pieces	16	17	15	15
17.	pH	6.2	6.1	6.1	6.1
18.	Sulphide blackening	--	--	- --	--
19.	Saltiness	Normal	Normal	Normal	Normal
20.	Colour of the brine	White	White	White	White
21.	Turbidity	Turbid	Turbid	Turbid	Turbid
22.	Brine strength	2.10	2.00	2.01	1.98
	Overall score	B^+	B^+	B	B

A^+	= Excellent	C^+	= Average
A	= Very good	C	= Below average
B^+	= Good	D^+	= Poor
B	= Fair	D	= Very poor

TABLE - 19

ANALYTICAL REPORT OF THE CANNED SHARK PRODUCT

PRODUCT: **Fish Balls in Tomato sauce**

SPECIES: S. Palasorra

Can used: ½ Hansa Aluminium can (SR. lacquered)

Sl.No	Details	Period of observation			
		After incubation period	After 3 months	After 6 months	After one year
1.	Can condition	Normal	Normal	Normal	Normal
2.	Std. Net. Wt.	200 gm	200 gm	200 gm	200 gm
3.	Std. Solid Wt.	145 gm	145 gm	145 gm	145 gm
4.	Gross Wt.	230	228	225	226
5.	Empty Can Wt.	27	27	27	27
6.	Solid + can Wt.	180	180	175	177
7.	Water/Liquid	50 ml	51 ml	50 ml	49 ml
8.	Net Wt.	153	150	148	150
9.	Solid Wt.	153	150	148	150
10.	± net wet.	+ 8	+ 5	+ 3	+ 5
11.	± Solid wt.	+ 8	+ 5	+ 3	+ 5
12.	Appearance	A^+	A^+	A^+	A^+
13.	Colour	A	A	A	B^+
14.	Flavour	A	A	A	A
15.	Texture	A^+	A^+	A	A
16.	No. of pieces	15	18	16	15
17.	pH	4.8	4.8	4.9	4.9
18.	Sulphide blackening	--	--	--	--
19.	Saltiness	Normal	Normal	Normal	Normal
20.	Colour of Tomato sauce	Reddish	Reddish	Reddish	Reddish
21.	Turbidity	Normal	Normal	Normal	Normal
22.	Brine strength	--	--	--	--
	Overall score	A	A	A	A

A^+	= Excellent	C^+	= Average
A	= Very good	C	= Below average
B^+	= Good	D^+	= Poor
B	= Fair	D	= Very poor

TABLE - 20

PRODUCTION OF DRIED SHARK FROM 1983-84 TO 1987-88

Year	Qty. of Shark used (Kg)	Qty. of Dried Shark produced (Kg)	Yield %
1983-84	16,109	3,317.5	20.59
1984-85	32,723	7,258.0	22.18
1985-86	34,854	8,188.0	23.49
1986-87	33,240	7,265.00	21.85
1987-88	8,720	2,090.0	23.96
Total	125,646	28,118.5	22.37

TABLE - 21

PRODUCTION OF SHARK-FIN-RAYS FROM 1983-84 TO 1987-88

Year	Production (Kg)	Exported (Kg)	Internally marketed(Kg)
1983-84	66.72	--	4.70
1984-85	71.38	80	18.50
1985-86	50.15	35	15.30
1986-87	46.00	50	16.50
1987-88	55.00	50	19.25
Total	289.25	215 74.33%	74.25 25.67%

TABLE - 22

STUDY OF THE YIELD % OF RAW SHARK FINS, DRIED FINS AND SHARK FIN-RAYS IN C. LIMBATUS

Weight range of Shark (Kg)	Fins % (A)	% of Fins after cutting (B)	% of Fins after drying (C)	% of Shark-fin-rays
10 - 20	3.75	1.89	0.90	0.200
21 - 30	3.81	1.91	0.91	0.208
31 - 40	4.02	1.94	0.92	0.212
41 - 50	4.10	1.99	0.94	0.216
above 50	4.08.	2.00	0.96	0.220

TABLE - 23

YIELD PERCENTAGE OF SHARK FIN-RAYS FROM CAUDAL FIN AND OTHER FINS OF DIFFERENT GRADES IN FRESH CONDITION

Grade (cm)	Pectroal & Dorsal Fins A	Caudal fin (after cutting) B
Less than 10	5.50	14.00
11 - 20	6.50	16.00
21 - 30	7.00	17.00
31 - 40	8.00	20.00
41 - 50	8.50	--
Above 50	9.80	--

TABLE - 24

YIELD PERCENTAGE OF SHARK-FIN-RAYS FROM CAUDAL AND OTHER FINS OF DIFFERENT GRADES IN DRIED CONDITION

Grade (cm)	Pectoral & Dorsal Fins C	Caudal fin (after cutting) D
Less than 10	11.50	26.00
11 - 20	14.20	31.00
21 - 30	16.50	35.00
31 - 40	18.00	37.00
41 - 50	19.50	--
Above 50	22.00	--

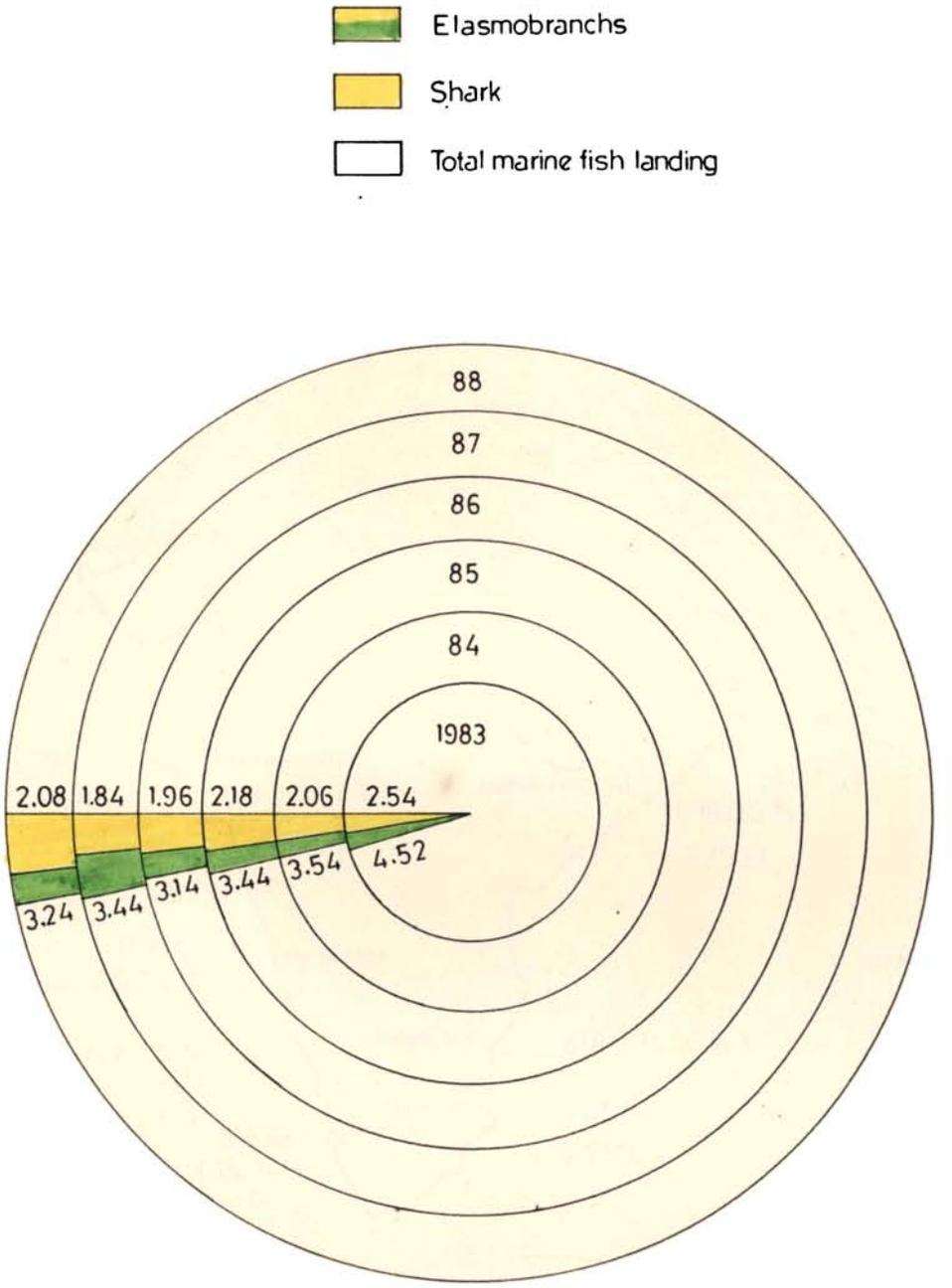


Fig-1 Yearwise landings (percentage) of Elasmobranchs and Sharks in the total marine fish landings of India from 1983 to 1988

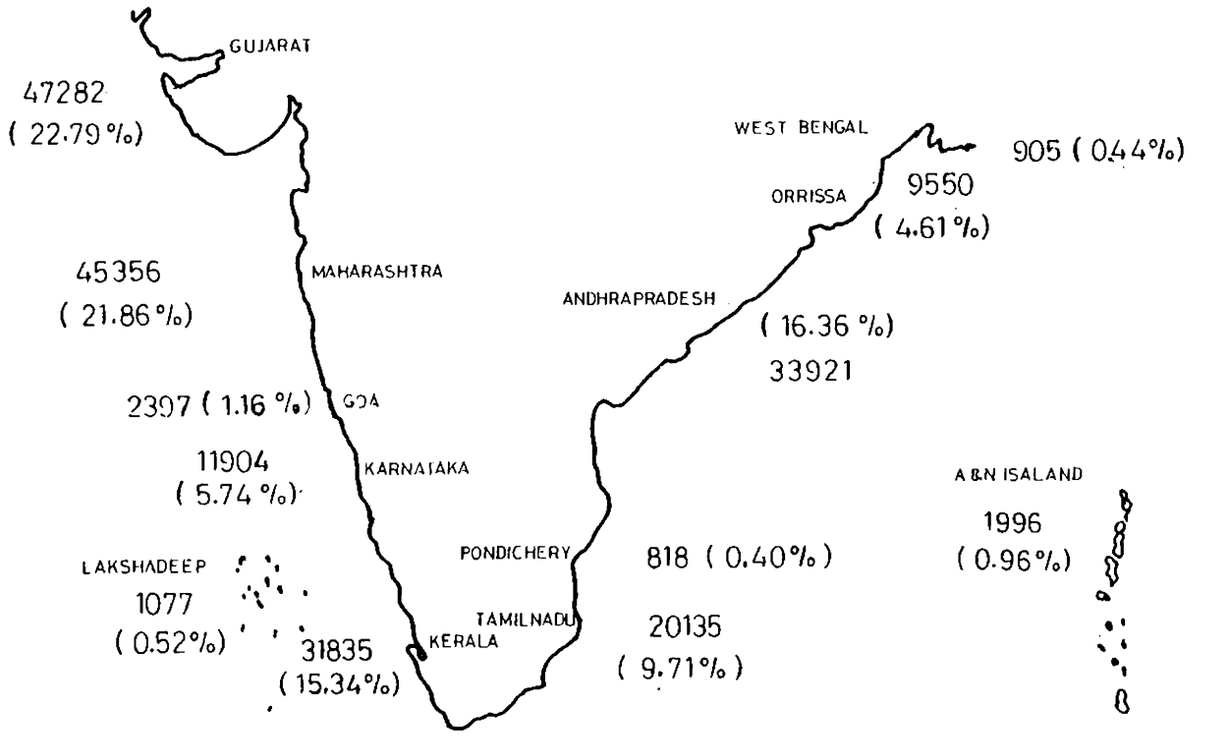


Fig 2 Statewise landings of shark from 1983 to 1988 in tons

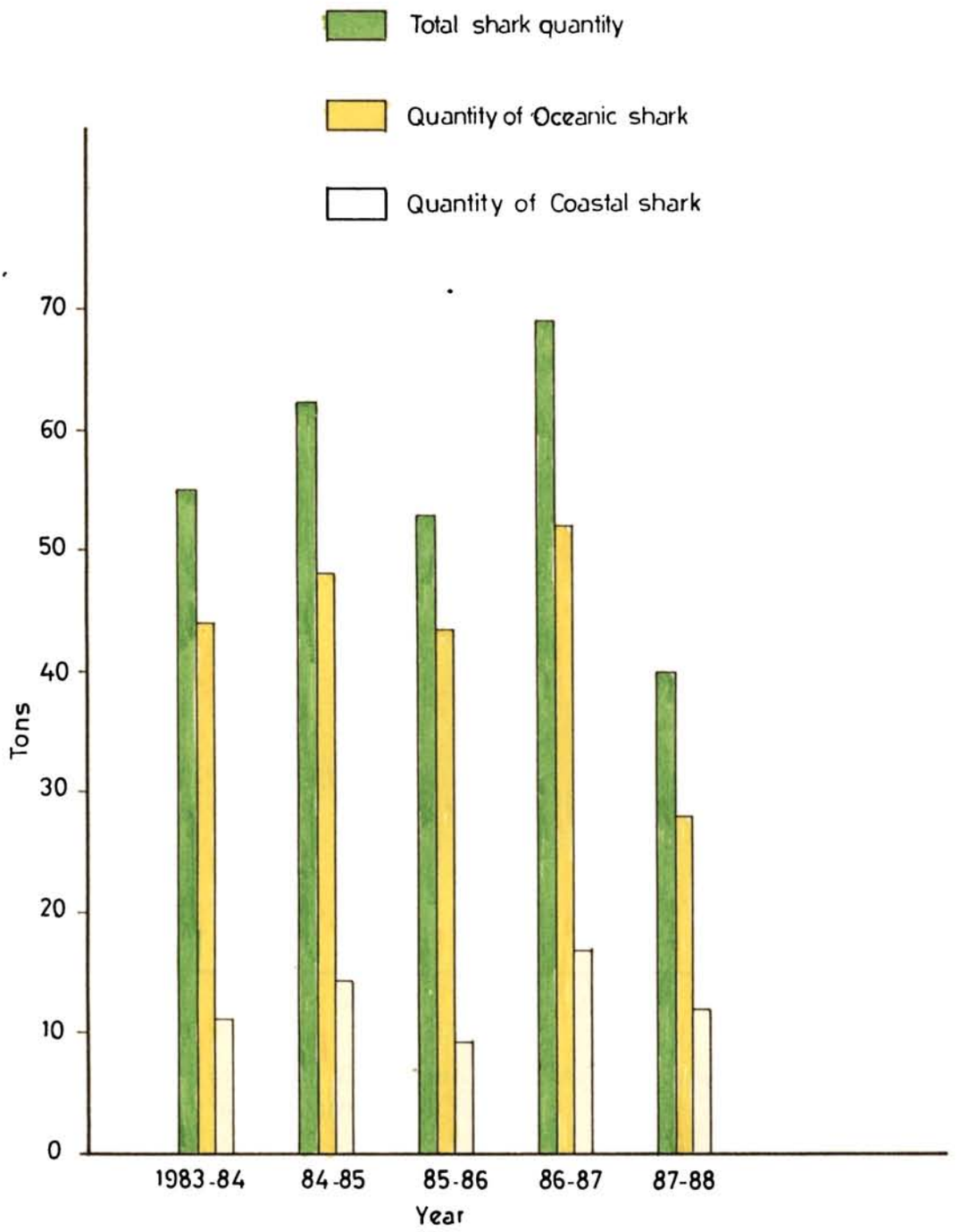


Fig-3 Shark landing in Integrated fisheries project, Cochin 16, during the study period

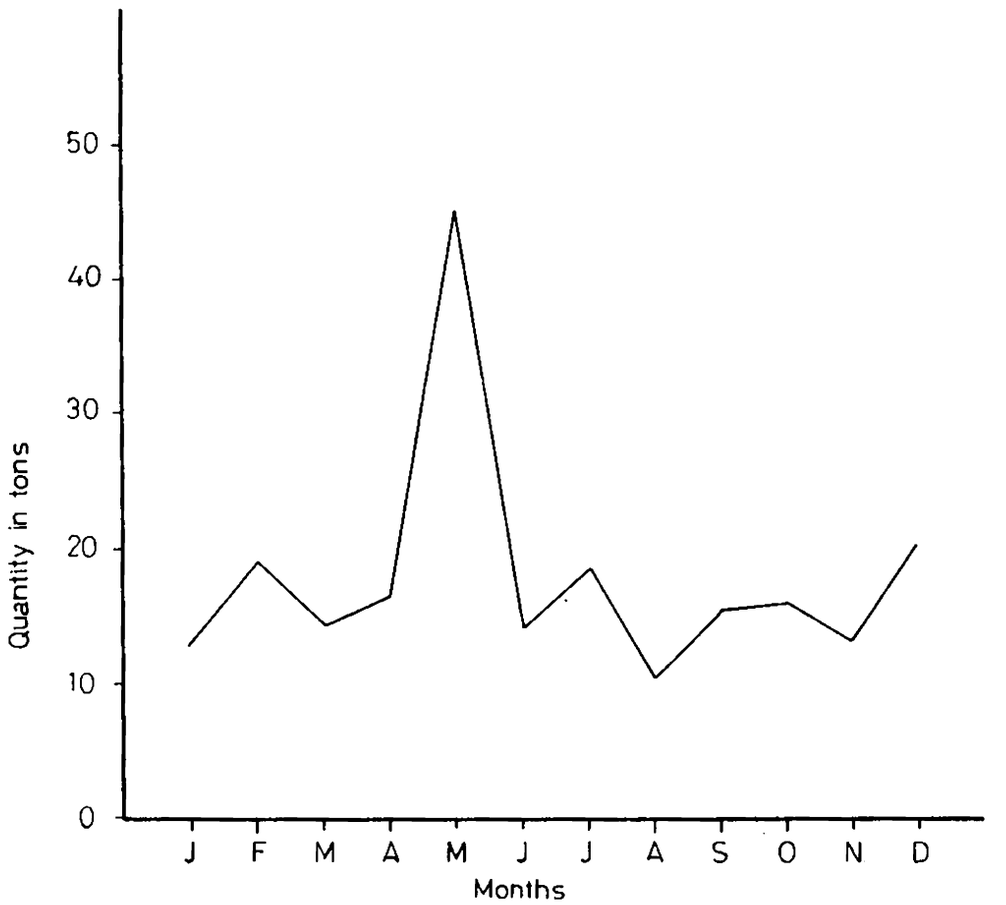


Fig-4 Monthwise landing of Oceanic shark in Integrated fisheries project pooled data from 1983 84 to 1987-88

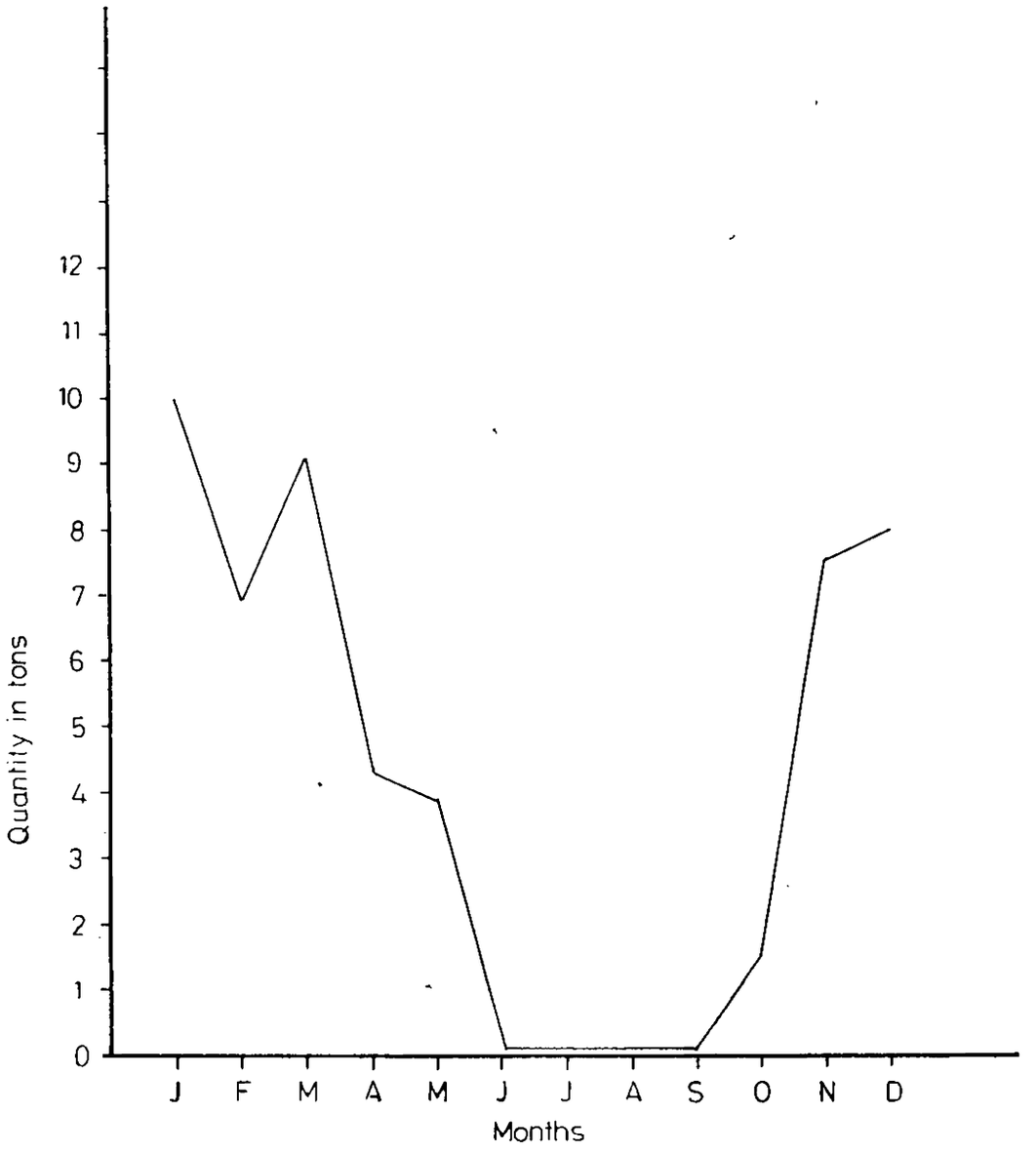


Fig-5 Monthwise landing of Coastal shark in Integrated fisheries project pooled data from 1983-84 to 1987-88

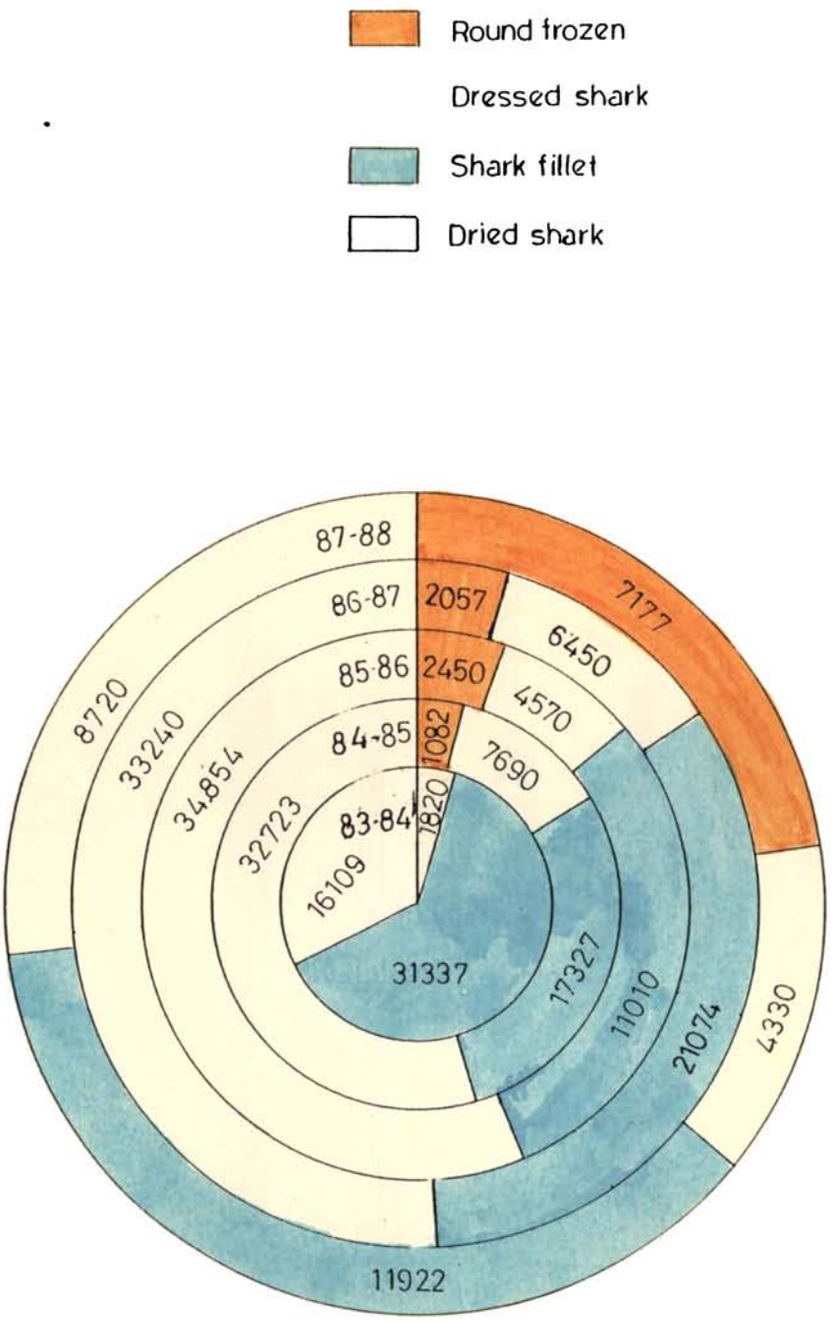


Fig-6. Yearwise utilization of shark for the production of different products in the study period

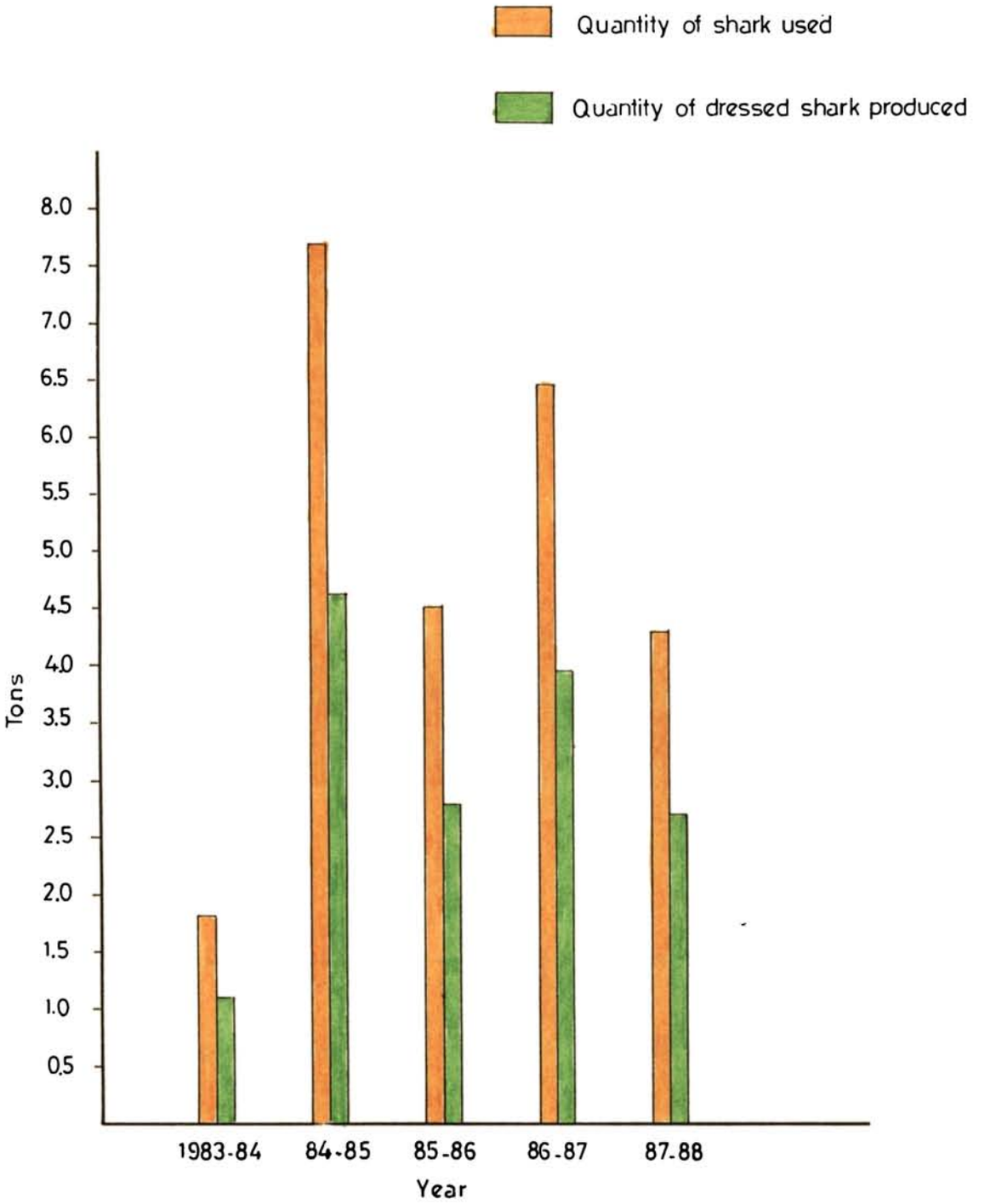


Fig-7 Production of dressed shark from 1983-84 to 1987-88

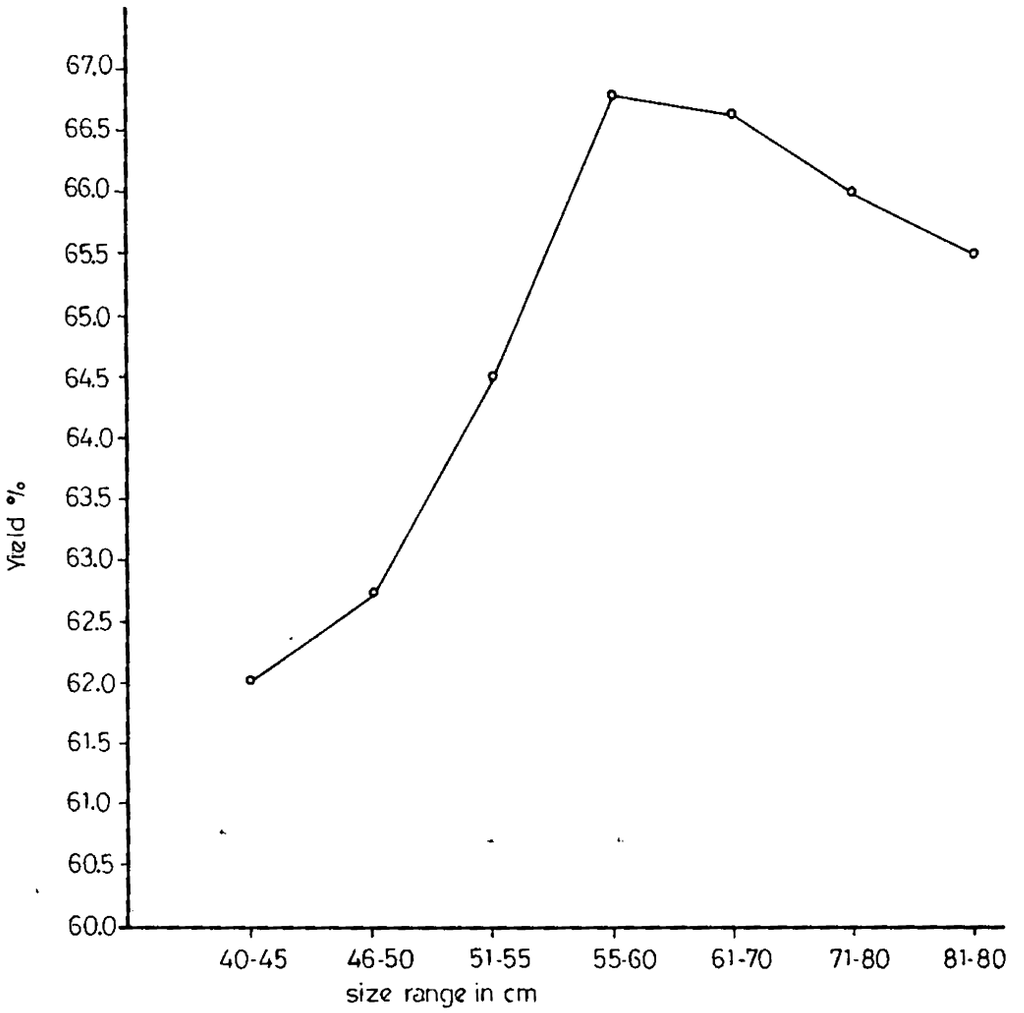


Fig 8 Yield variations according to size ranges in the production of dressed shark using S.Palasorra

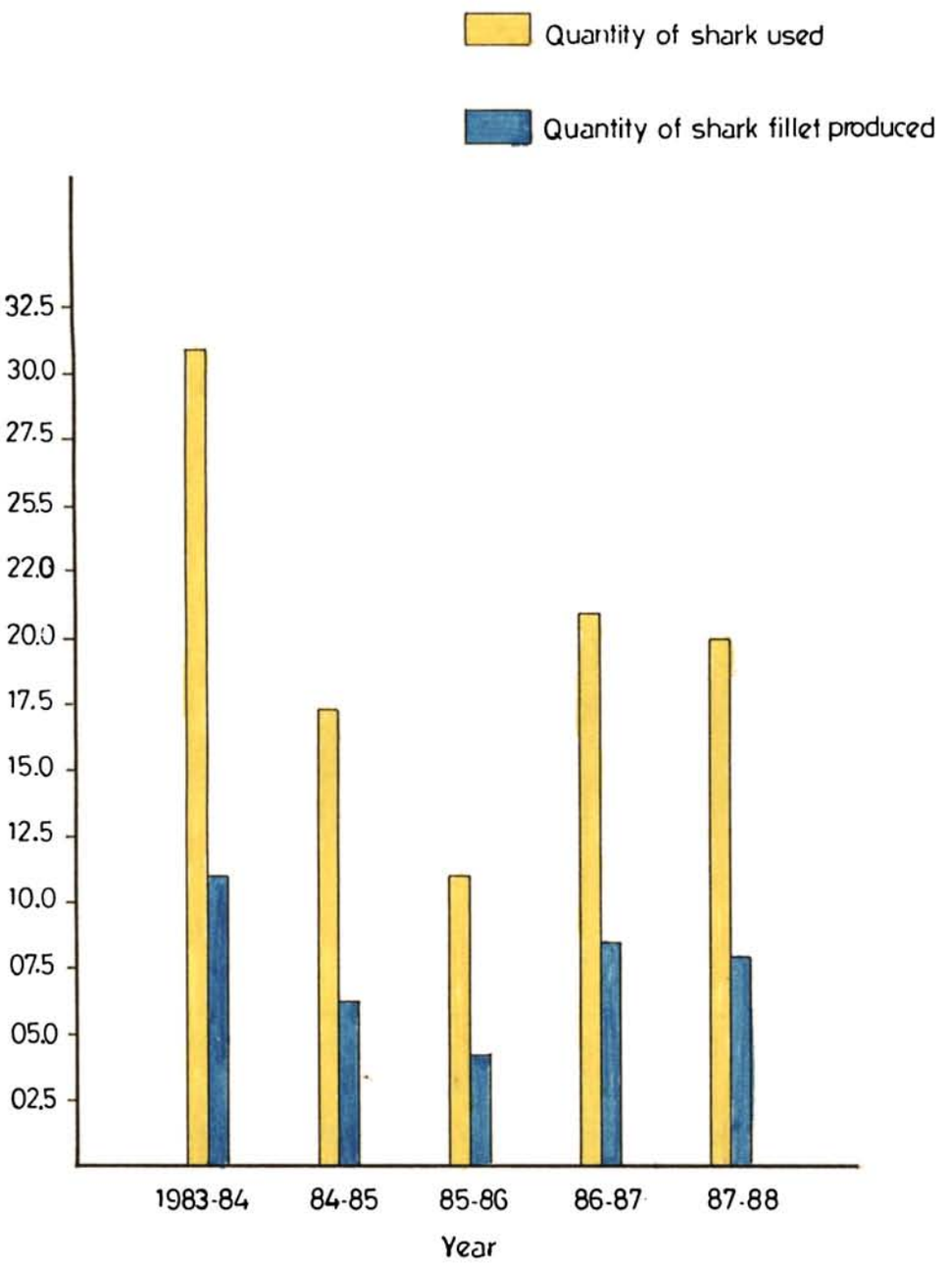


Fig-9 Production of shark fillets from 1983-1984 to 1987-1988

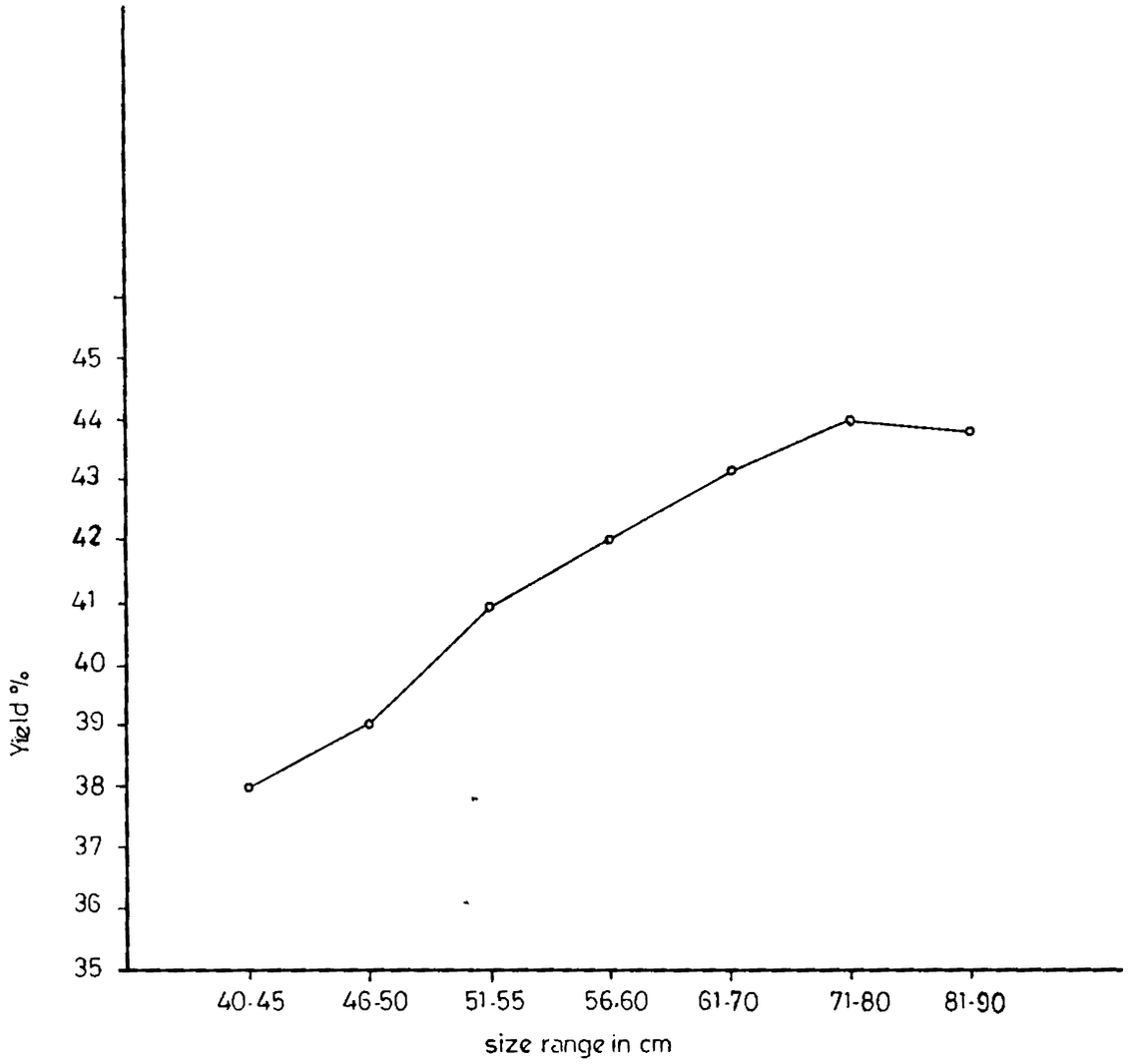


Fig.10 Yield variations according to size ranges in the production of shark fillets using S.Palasorra

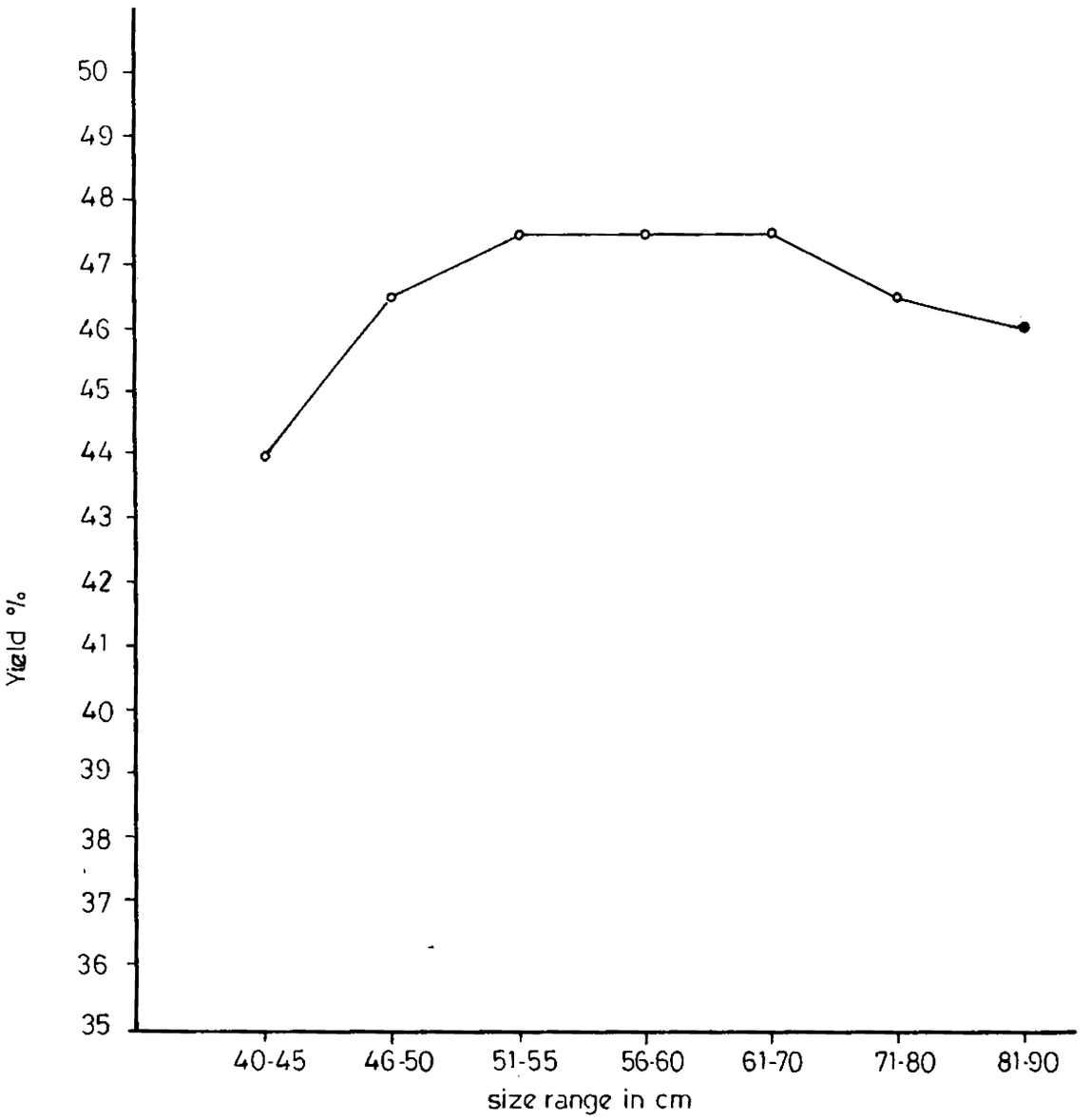


Fig.11 Yield variations according to size ranges in the production of minced meat from S. Palasorra

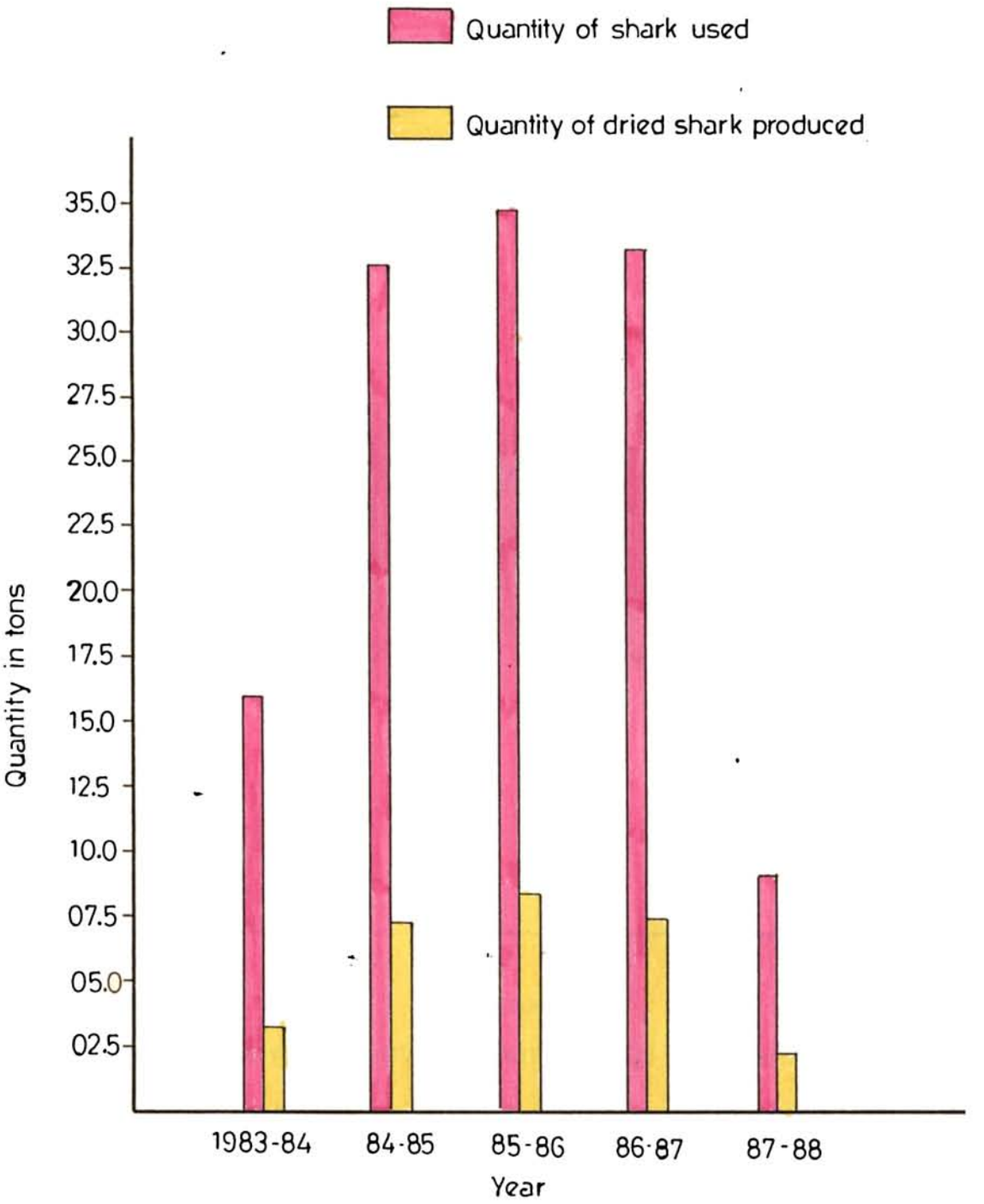


Fig - 12, Production of dried shark from 1983-84 to 1987-88

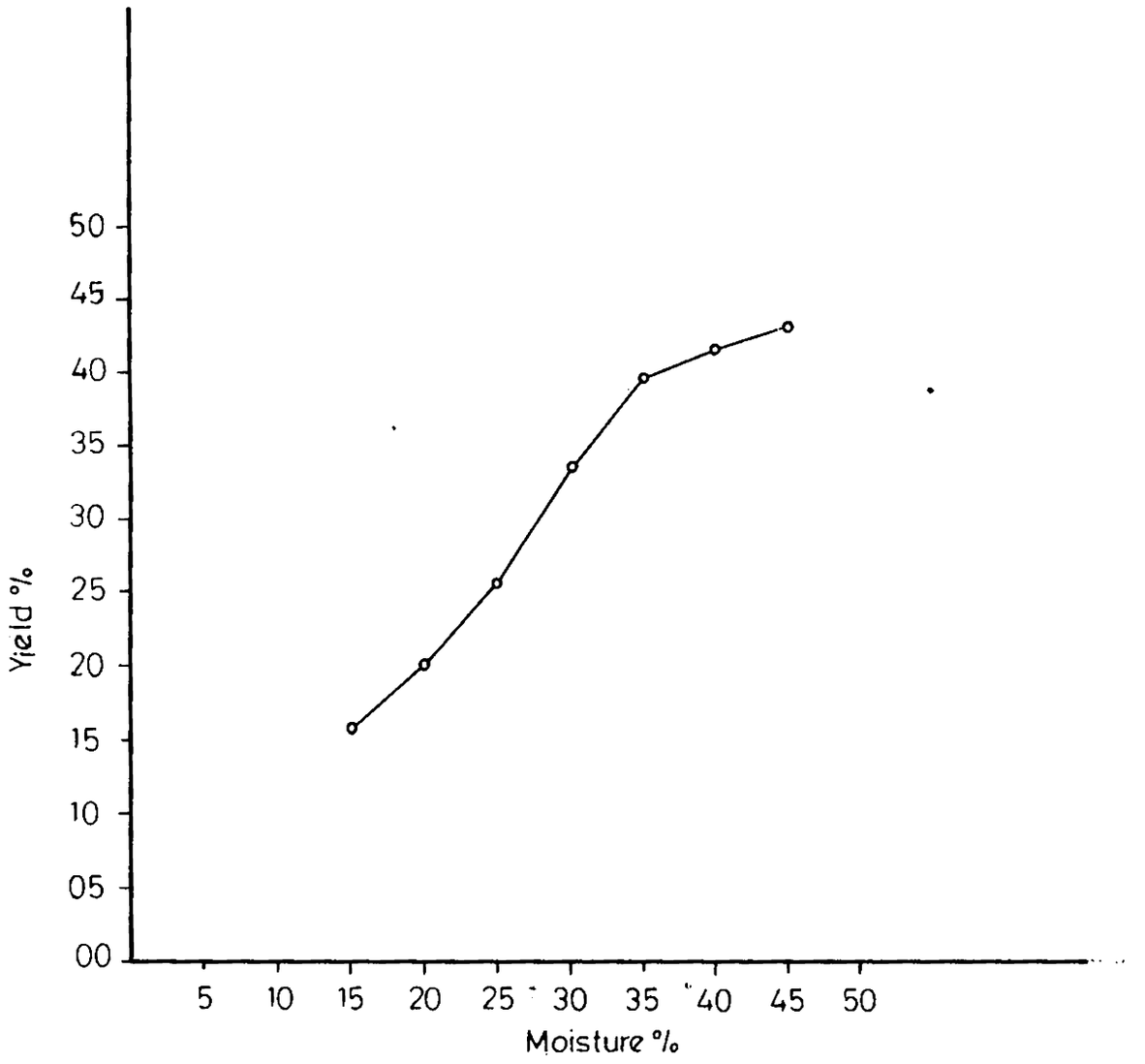


Fig-13, The relation between moisture content and yield percentage in dried shark

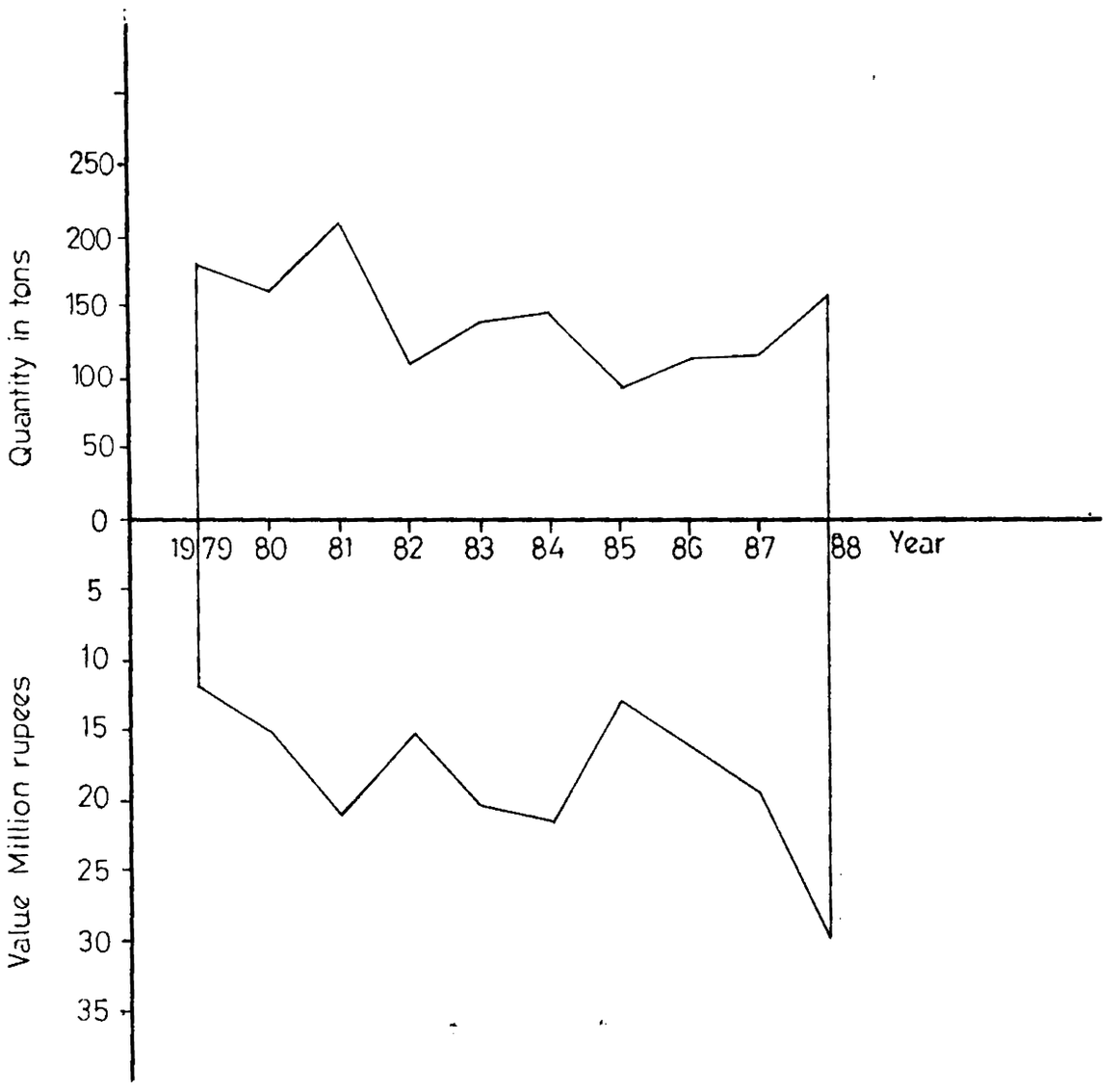


Fig-14 Quantitiwise and valuewise export of dried shark fins from India

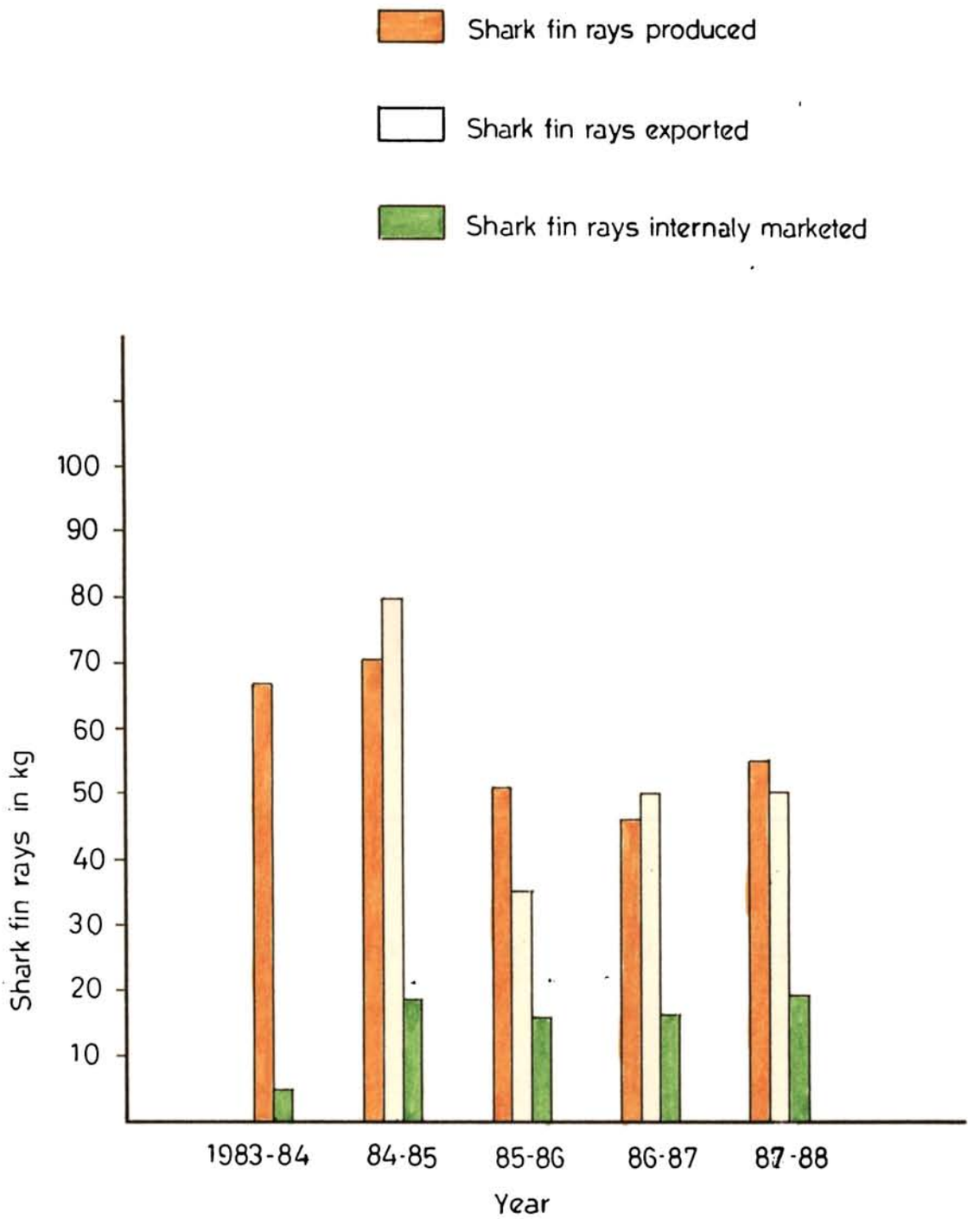


Fig.15 Production of shark fin rays from 1983-84 to 1987-88

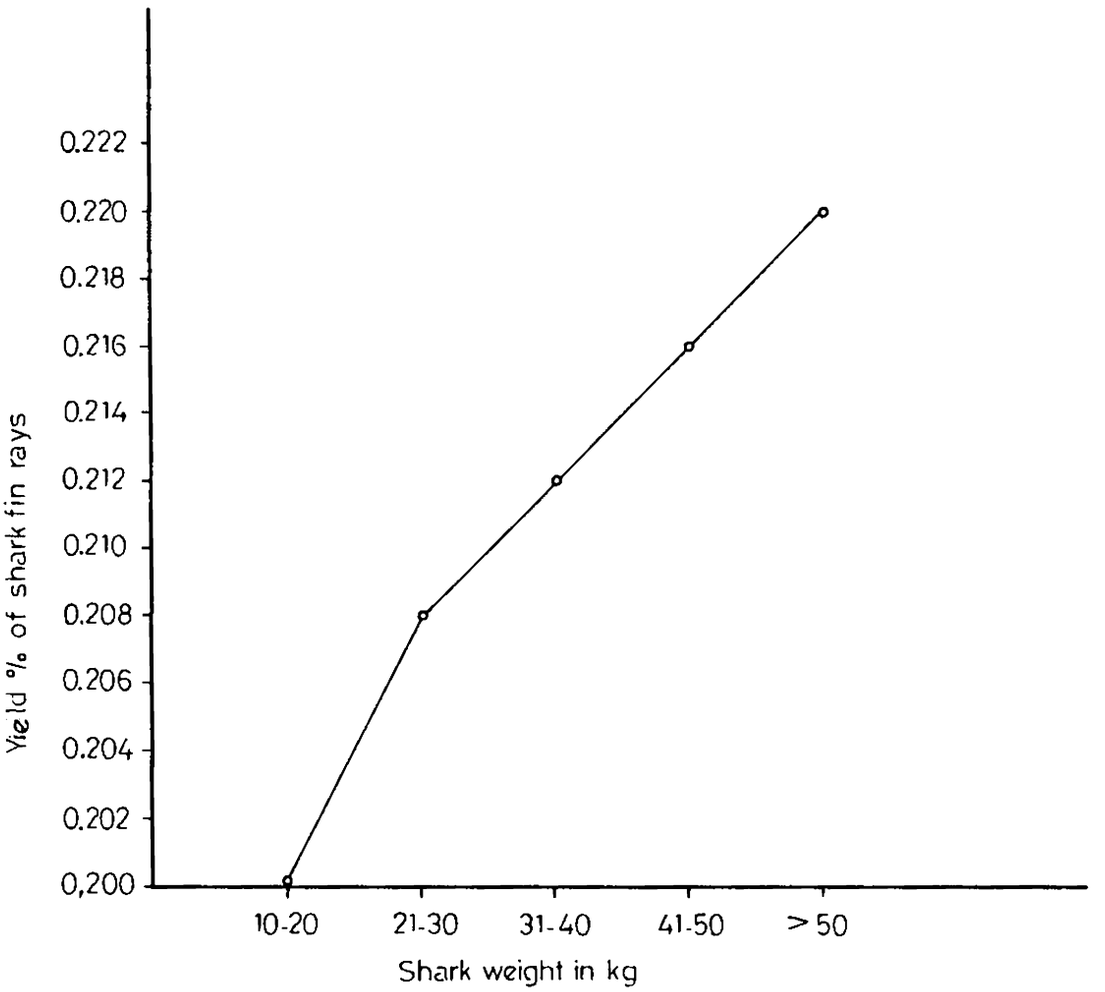


Fig -16 Yield percentage of shark fin rays from different size of C. limbatus

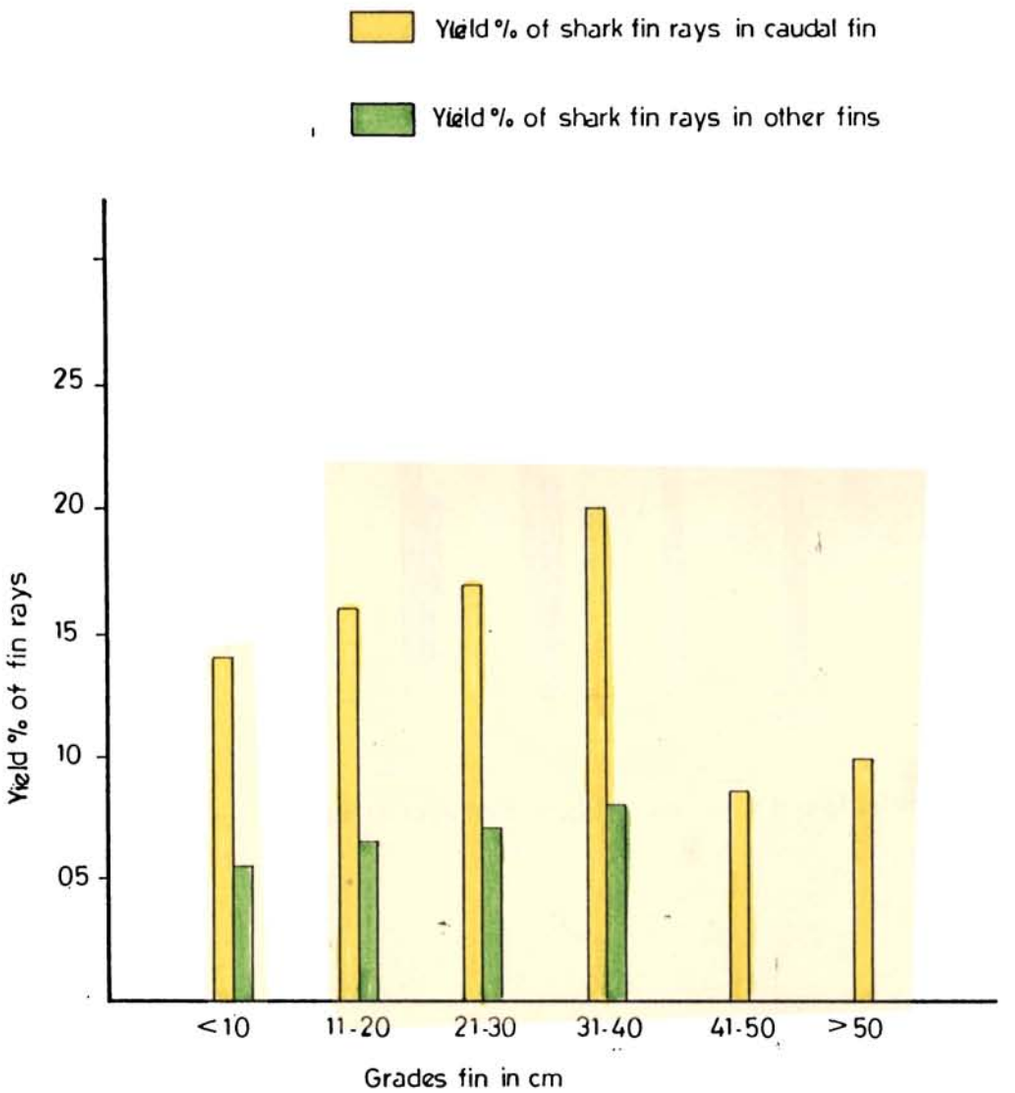


Fig-17 Yield percentage of shark fin rays from caudal fin and other fins of different grades in fresh condition

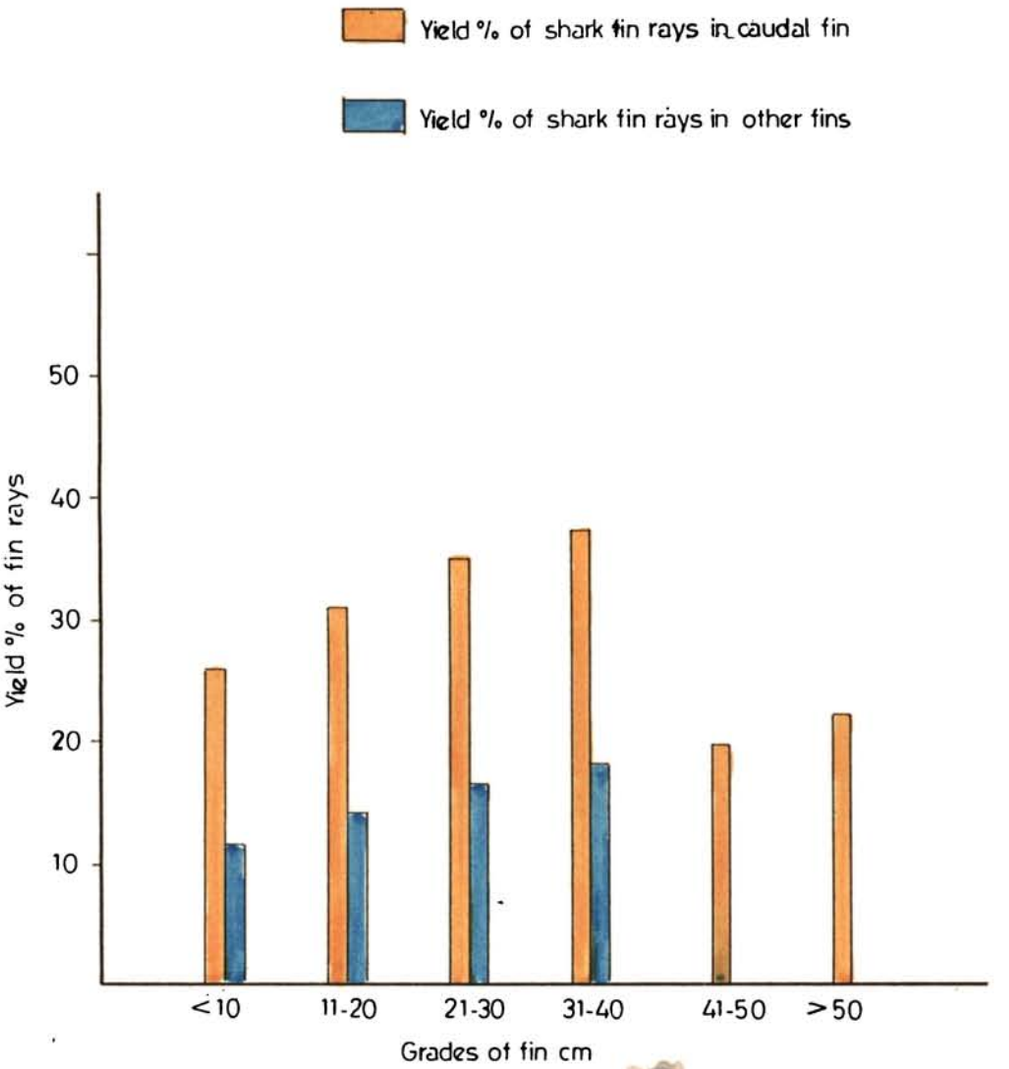


Fig.-18 Yield percentage of shark fin rays from caudal and other fins of different grades in dried condition

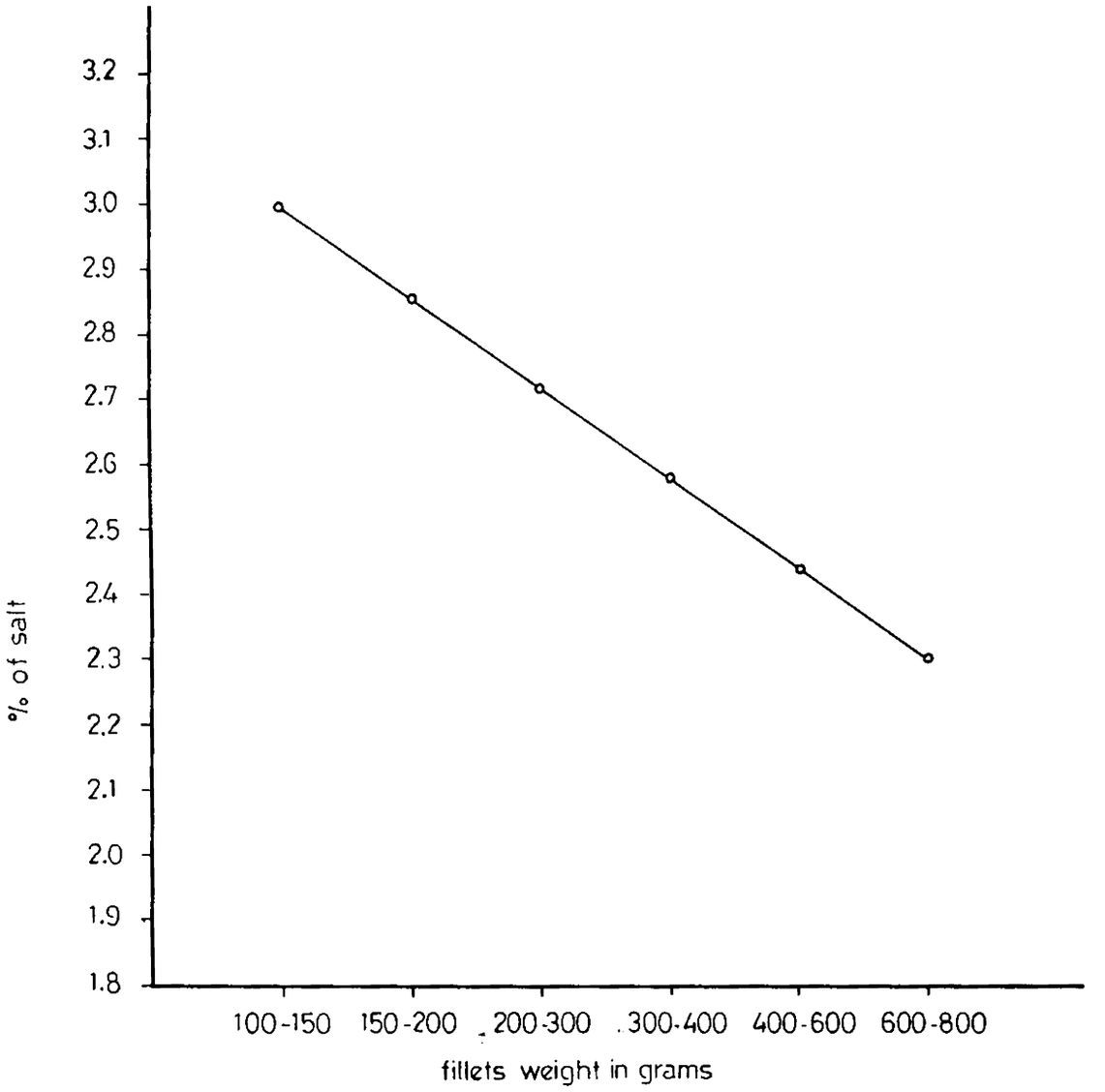


Fig.19 Percentage of salt absorbed in the fillets during brining 15mts in saturated brine for smoking

4. DISCUSSION

As mentioned earlier Shark is almost available in all parts of the world. According to Kreuzer and Ahmed(1978) some 60 to 70 years ago shark was familar to the inhabitants of the Pacific Islands, along the coasts of Africa, Latin America and Europe. In Japan salted, dried and smoked shark meat was the traditional food. What characterized the consumption pattern of this period was that relatively small quantities, which were utilized near the place of landing as heavily salted and smoked products. On these days sharks were not really commercially exploited. The commercial exploitation of shark began in the middle of forties. In this period smoked shark meat was introduced in Germany and frozen shark meat was introduced in U.K. In the early seventies market for shark meat was increased in Australia. Now-a-days most of shark meat is utilizing for the production of kamaboco and hampen in Japan.

In our country shark is mainly handled for its fins. The carcass after cutting off the fins has not been utilized properly - it is observed that in many parts of India, fishermen throw off the reamining body of the shark after cutting of the fins to the sea itself. Another important observation is that in many parts of India, shark is sold at very low prices after removal of the fins. This point to the lack of awareness that the meat, hide, liver and even offal of shark can be effectively used to develop products which will have

a good consumer acceptance. Also the knowledge of preserving the products was lacking. The cured or sundried shark handled by the traditional fish curer gives a very low quality product because of the following reasons (a) the raw material used is not preserved and is inferior in quality (b) the method of processing is not hygienic and (c) the preservation of the product is not satisfactory.

During this study period diversified fishery products were made utilizing the entire portion of the shark.

Kreuzer and Ahmed (1978) explained a method for pulling away the skin of small species Squalus acanthias. This method was tried for the dressed shark made from S. palasorra and found that it is a failure because the meat is damaged when the skin is pulled out. So the method adopted in this study is found to be more effective for our species. It is also found that the size less than 60 cm is more palatable and maximum meat is retained in this product.

Shark fillet is a fully processed form and the consumer can prepare dishes without much effort. The fillet need only minimum space for storing and the transportation is more easy. Another advantage for the fillet is that the physical appearance of the product is entirely different from the whole shark. This will also favour easy marketing of the product. Hence it is suggested to process the coastal shark of larger than 60 cm into fillets. Kreuzer and Ahmed (1978) suggested a brine washing (5%) for the fillets before freezing. But in this study the fillets was given only ice water washing of 4 hours in the ratio 1:3 (fillet:water) and consumer's

appeal was pleasing for this product.

According to Kreuzer and Ahamed (1978) though Japan is the biggest shark catcher in the world, import sharks in the chilled and frozen condition. It is converted into minced meat and utilized for making of kamaboco, hampen, yoki-chukuwa etc. In the present study period coastal shark S. palasorra of size less than 70 cm used for minced meat production. The dressed and sufficiently scored sharks must be given ice water washing before mincing. This will help to improve the colour and reduce the urea content of the product.

Fish cakes and fish balls were developed for the first time in India from the minced meat of shark after mixing it with other fish meat like pink perch in the ratio 1:2 and 2:3 respectively during this study period.

The pickles made out of the shark meat is already proved its superiority among the consumers. Production of the above items can be suggested to the Women Welfare Societies as a cottage industry.

Mathew and Balachandran (1990) explained a method for producing smoked shark fillets. According to them the brined fillets after surface drying for about one or two hours in sun is smoked by burning saw dust. Smoking is carried out at a temperature of about 50°C for 2 to 3 hours. The method developed in the present study is quite different from the above method. Fillets of the coastal sharks (S. palasorra) are found to be suitable for smoking. Salting is given in a saturated brine for 15 minutes. Draining and smoking is carried

out inside the smoking chamber and the product is not at all dried in sunlight. If the product is dried in sun, there is every chance of contamination which will lower the quality of the product.

The procedure for the canning of shark meat is not mentioned so far by anybody in India. Smoked fillets and fish balls are canned and the analytical reports favours the products.

Most of the shark meat is converted into dried or cured form in our country. Kreuzer and Ahmed (1978) explained two methods namely kench and pickle curing. The product will be dried with a moisture content of about 35%. They also estimated that sun drying of fillets of 2 cm thickness will take 3-4 days. Mathew and Balachandran (1990) also explained the same methods for drying the shark. According to them the fish to salt is usually in the ratio 3:1.

Ramachandran (1989) discribed the typical method adopted for the production of semi-dried shark in Veravel area and also estimated the cost of production and marketing. Ramachandran and Solanki (1988) have suggested an improved method for the processing of semi-dried shark. They suggested filtered saturated brine for salting instead of using dry salt directly for curing. This will eliminate all dust and other foreign particles from the salt.

But the present study proved that washing of fish before salting and after salting give good appearance and eliminate the ammonia smell from the product. The washing of salted

fish before drying remove all unwanted material from the meat and also reduce the high percentage of salt content. The low percentage of salt will help easy drying and thus lowering the moisture content. The low moisture content (less than 25%) increase the shelf life of the product to about six months, so the processers are getting enough time for marketing their products in good condition. Normally it is already known that the demand for dried fish is reduced in the peak season of fresh fish landing. The present study the shark is dried until the moisture content reaches less than 25% and thus increasing the storage life. Though the yield percentage is a little bit lowered the advantage is that the product can be stored for larger period and can market the product at lean season when the prices of the dried fish is at its maximum.

Salting the meat using saturated brine solution and keeping it in the same solution is not recommended for our tropical condition because the water from the fish diffuses out which will reduce the brine concentration and increasing the chances of spoilage and also lowering the quality of the product. It is also suggested that the meat of larger oceanic sharks are processed into dried form because the meat is not palatable compared with coastal shark meat due to high percentage of urea content.

Shark liver oil containing high percentage of squalene has a good market. According to Kreuzer and Ahmed (1978) shark liver oil of high squalene content is used in cosmetic industry in Japan. The squalene is an emollient believed to rejuvenate the human skin and is found as unsaponifiable matter

in the liver of certain deep sea sharks.

Buranudeen and Rajadurai (1986) discribed the extraction of squalene from the liver. The liver have to be processed as soon as possible, preferably within 15 minutes after its death. As soon as the liver are taken out, they should immediately be chopped, placed over a wire mesh basket and heated below about 82°C in 2% caustic soda solution for 30-45 minutes. This process is called as alkali digestion method.

Shark liver oil of high squalene content was separated from C. granulosus species by simply exposing the liver to sunlight or air. The oil separated by the alkali digestion method as stated above was found more viscous and dark coloured. But the oil separated by exposing to sunlight was light coloured with a pleasant odour.

Thankappan and Gopakumar (1991) estimated the squalene content of the liver oil of four species using Iatroscan method. According to them the detection of squalene is found to be higher using Iatroscan compared to column Chromatography using alumina.

The processing of shark fins and fin-rays differs considerably from place to place. Mathew and Balachandran (1990) suggested a method for producing semi-prepared fins and fin rays. The fins are first soaked in 10% acetic acid over night. The shagreen present on the skin is scrapped off and the adhering scrap residues are washed away with water and further soaked in acetic acid (10%) in a separate tank until they become soft. In the case of

dryfins the soaking is done for 4-5 days or more. The softened gelatinous material is scrapped off and the rays are separated from cartilage frame while washing with water. They are then washed free of acid and dried at 50-60°C to a moisture content of nearly 10%.

The present study suggests two methods for the separation of shark fin rays namely cold and hot process. The cold process is similar to the above process which need only a few PVC buckets and commercial acetic acid. Hot process need heating facilities and more over a good acid resistant metallic container for heating to around 70°C. No yield variation is noticed in both process. The production of shark fin rays can be done by the fishermen as a cottage industry in a hygienic way, because the process is simple and getting a good price. The product is mainly exported and hence the quality must be of supreme nature.

Kreuzer and Ahmed (1978) explained the processing of shark skin in detail. The most important contribution of the large sharks in the market place, apart from the fins, is its uniquely strong skin. The recent techniques in processing can transform shark skins into superior quality leather making articles of distinctive beauty with unsuasl comfort and serviceability.

Since the shark hides are considered as the key revenue product in the shark fishery, it is appropriate to discuss the factors responsible for getting the good quality hides. The shark must be skinned as soon as possible and the skin should be thoroughly cleaned of flesh. The cleaned skins are to be salted immediately. Mathew and Balanchandran (1990) recommends that the mixture of pure salt using for salting of shark hide contains 0.5% Zinc

In this study the hides were separated from C. limbatus by split opening the dorsal side and separating the flesh and bone carefully using knives, because the pulling off skin was a failure. The tanned hides are superior in strength and colour even after five years. Hence it is suggested that the skin of the oceanic sharks of larger size which is now discarding in our country can be utilized for making good quality leather. Another factor noted in the study was that the hides separated from the frozen shark is inferior in quality compared to the hides of fresh shark (without icing and freezing).

Kreuzer and Ahmed (1978) suggested the conversion of shark offal into fish meal. But the present study shows that the fish silage production need only very low investment and the process is very simple. Another attractive factor is that even the fisherman can produce the silage from the daily waste using few PVC buckets. The silage produced can be utilized for feeding their poultry or cattles as such or by mixing with rice bran, topioca etc.

Gordievskaya (1971) estimated the chemical composition of meat of five species of shark namely Horn shark, White tipped shark, Hammer headed shark, Silky shark and Tiger shark. According to him protein content differs in different species. In the present study chemical composition of the meat of three selected species of shark was estimated and the result showed that the chemical composition varies according to species. Highest moisture content was noticed in the S. palasorra while protein was highest in C. limbatus and fat content was more in the C. granulosus.

The investigation of Gordievskaya (1971) and Mathew and Balachandran (1990) on the urea content of shark species have shown that it varies from 1600 mg% to 2300 mg%. Moreover it is noticed that 1200 mg% is the threshold value below which urea is not detected in shark meat; 1400 mg% of urea is not noticeable if the meat is prepared with ingredients which give a distinct flavour.

For reducing urea content they suggested soaking of shark meat in 5% brine solution or a mild solution (1.5%) of acids like citric, acetic or lactic acids etc.

It was found from the present study that the different species of shark have different percentages of urea content and this content is species characteristic; S. palasorra varied 1600 to 1800 mg%, C. limbatus varied 1800 to 2100 mg% and C. granulosus varied 1200 to 1300 mg%. In the study period the shark meat was given ice water washing of about 4 hours in the ratio 1:3 (fish:water) after making thin slices of maximum 3 cm thickness. The result showed that the urea content was reduced about 1500 mg% and by preparing shark meat with hot spices like red chillies, pepper, garlic etc. reduced the pungent odour (due to urea content) of the meat into undetectable level.

Based on the commercial feasibility study conducted in the present context supports the view that the shark fishery will be a profitable one even if the existing industry diversify their processing activities from shrimp to fishes.

Unless all parts of shark are used in the most remunerative way, utilization may not lead to commercial success. The present study concentrates on methods of preparing hygienic

and acceptable products from shark and attaining fullest utilization of shark. In order to over come the traditional consumer prejudice against shark meat, it will be ideal to conceal the physical nature of shark by developing products like fillets, minced meat and other value added products like fish cake, fish balls, battered and breaded fillets, fish pickles etc. which can easily introduced to the market. The product range allows selection of products to be adopted in large scale as well as small scale and cottage industries. The products can be prepared even in a house based system. Therefore, the product-line system can be adopted by the fish processing industry to develop a scale production or to develop as an alternative production system to utilize spare capacities in the existing plants. This can be adopted by the traditional fish processor and also by fisher women as a family business or as Women's Co-operatives. Such a production system can bring economic benefits to the fisherman community and also to the traditional as well as industrial fish processor.

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5. SUMMARY

Elasmobranchs constitute about 4% of the marine fish landings of India. Shark is the main constituent of this fishery. Sharks are widely distributed along the west and east coasts of India and are available in all seasons although a peak is observed during December - January. At present in India sharks are mainly used for making dried meat and dried fins. Presently an organised effort for the utilization of this resource is not available. A good number of people are still reluctant to include shark meat in their regular diet. If proper attention is given, valuable fishery products can be produced from shark. While comparing to other bony fishes, the main difference is that the entire shark can be utilized economically in one way or other.

The present study is the result of work carried out for 5 years, during the period from April, 1983 to March 1988. The materials were collected from the catches of the Government of India vessels, operated along the south west coast of India and landed in the Integrated Fisheries Project, Cochin-16. The sharks were caught by different types of gears such as bottom trawls, pelagic trawls, long line etc. A number of species of sharks were landed during this period and three species were selected for the present study namely Scoliodon palasorra (Bleeker 1853, Grey shark), Carcharhinus limbatus (Valenciennes 1839, black tip shark) and Centrophorus granulosus (Bloch and Schneider 1801, Spiny shark).

The entire catches of shark landed at Integrated Fisheries Project were utilized for the production of various diversified fishery products like Dressed shark, Shark fillets and Salted dried sharks for domestic market. Products like Dried shark fins and Shark fin rays were also produced for the export market. In addition to this a lot of products like Dressed shark, Shark fillets, Battered and breaded fillets, Minced meat, Frozen fish cakes, Fish balls, Fish pickles, Smoked shark fillets, Smoked minced meat, Canned cooked and smoked shark meat and fish balls, Salted and dried shark, Shark liver oil, Dried shark fins, Shark fin-rays, Shark leather and silage were made from the above selected species.

During this study period the quantity of shark utilized was 2,55,942 kg out of which 9.71% used for the production of Dressed shark; 36.21% for the production of Fillets; 49.09% converted into Dried shark and 4.99% was domestically marketed as whole form. Besides this 526 kg of dried shark fin and 289.25 kg of shark fin rays were produced.

Dressed shark was made from small sized sharks of the species S. palasorra and the yield percentage of the product varied from 60.93% to 66.66% and the product was mainly marketed in the frozen form. Shark fillets were made from all the three species and yield percentage of fillets varied according to the species and size. Battered and Breaded Fillet was produced during the study period. Production of minced meat was also carried out using a Bone separator.

Fish cakes and fish balls were made from the minced meat and marketed in frozen form. The minced meat from shark, mixed with other fish meat in different percentage for the production of both fish cakes and fish balls and the quality of the product was as good as the products made from other lean fishes. Pickles were made from the minced meat and the shelf life of the product was observed.

The effect of smoking of shark fillets and minced meat at different temperature were also studied during this period.

Canning of cooked shark meat, smoked fillets and fish balls were carried out in media like brine, vegetable oil, tomato sauce etc. The quality of smoked fillets in vegetable oil was found superior to other canned products from shark meat.

Dried shark meat were prepared from all the three species after salting. The yield varied depending on the size and moisture content in the final product. The yield percentage of shark liver oil was found highest for C. granulosus with high squalene content.

Fins collected from C. limbatus were dried and preserved. The dried fin as well as fin rays were marketed according to the demand of the products. Shark fin rays is one of the most important marine products from shark and is mainly exported to Singapore and Hongkong where it is used for making shark fin soup which is an internationally accepted marine delicacy.

Hides of C. limbatus separated from the meat, salted and tanned. The leather obtained were found superior to other animal leather. The hides can be properly processed instead of discarding them as practiced in India.

The offals obtained in the shark processing was easy to convert into fish silage and further processed into poultry or cattle feed after mixing it with rice bran, tapioca or other suitable ingredients. It need only very less investment comparing with fish meal production and the silage made by the fishermen can be used by themselves for feeding their poultry and cattles.

During this study an attempt was also made to evaluate the commercial processing of shark resources and found feasible.

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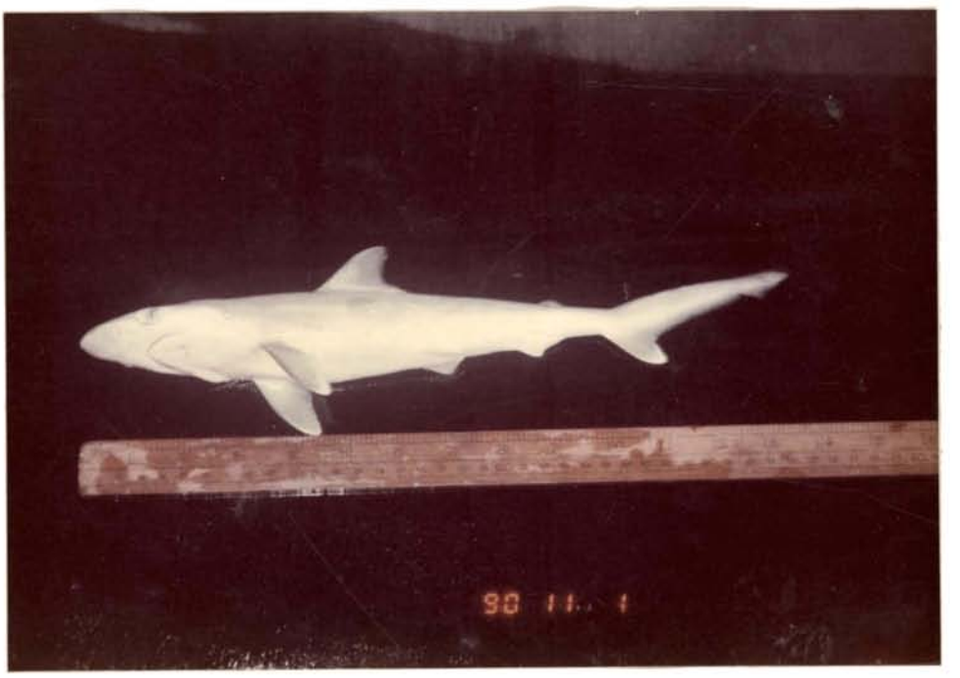

Plate-1A - Selected species - (1) Scoliodon Palasorra

Plate-1B - Selected Species - (2) Carcharhinus limbatus

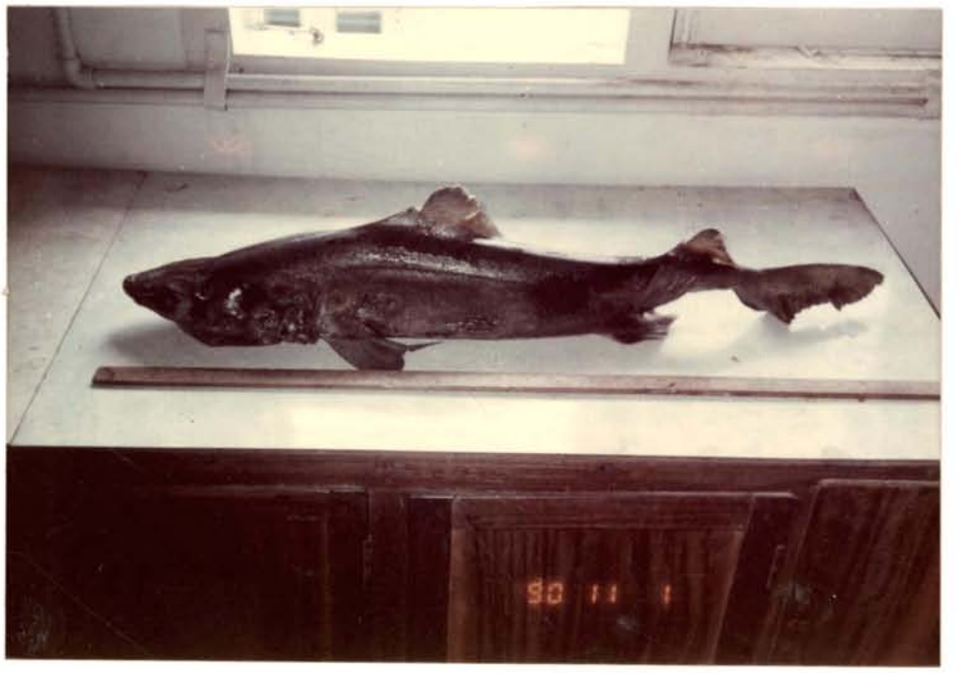

Plate-2A - Selected species (3) Centrophorus granulosus

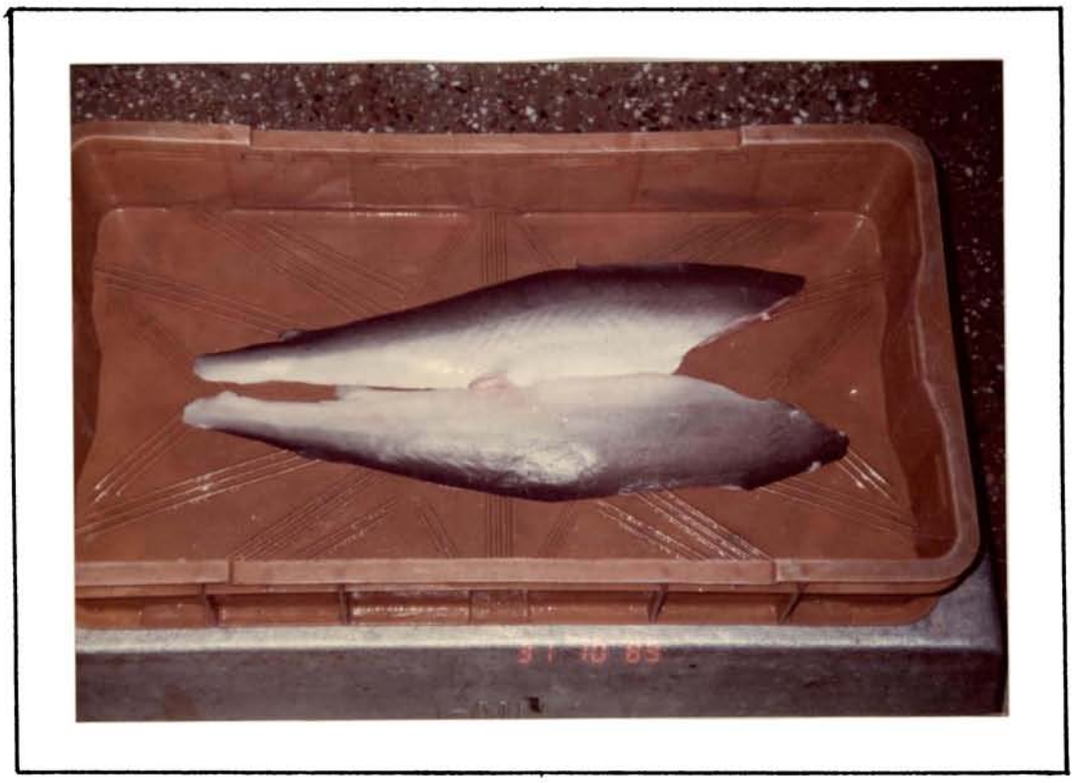

Plate-3A Skin on Fillets

Plate-3B Skinless Fillets

Plate-4A - Frozen fillet block

Plate-4B Fillets ready for battering and breading

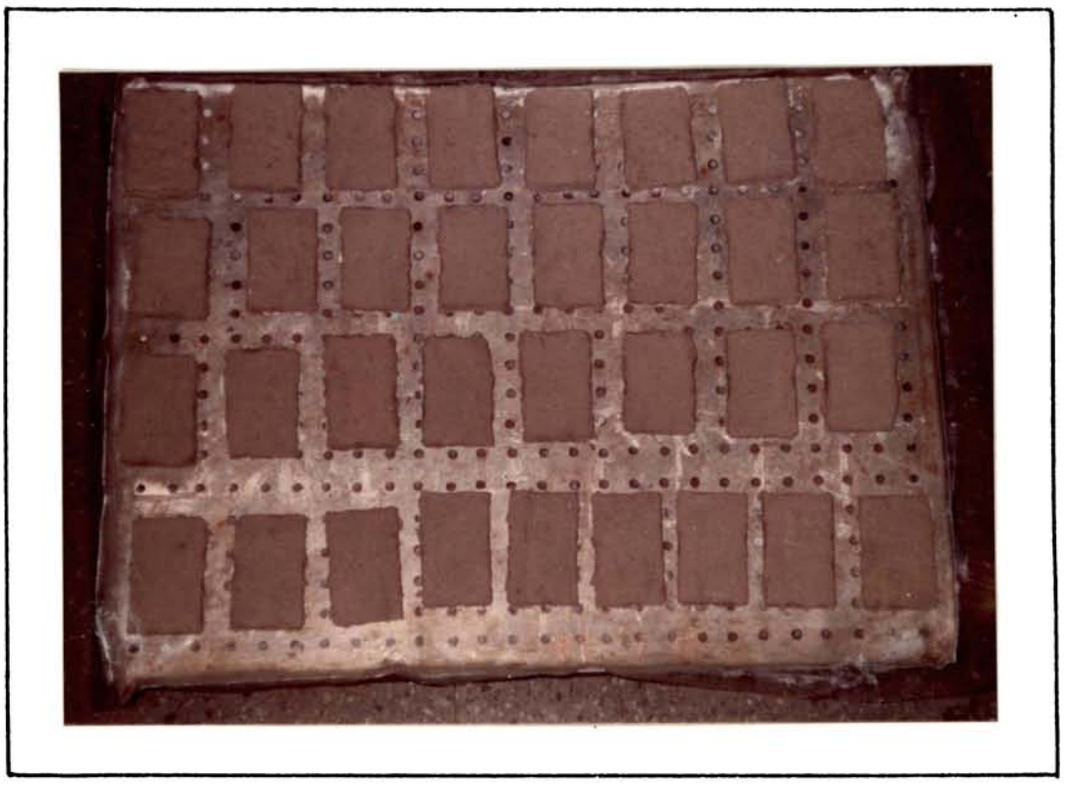

Plate-5A - Battered and breaded fillets

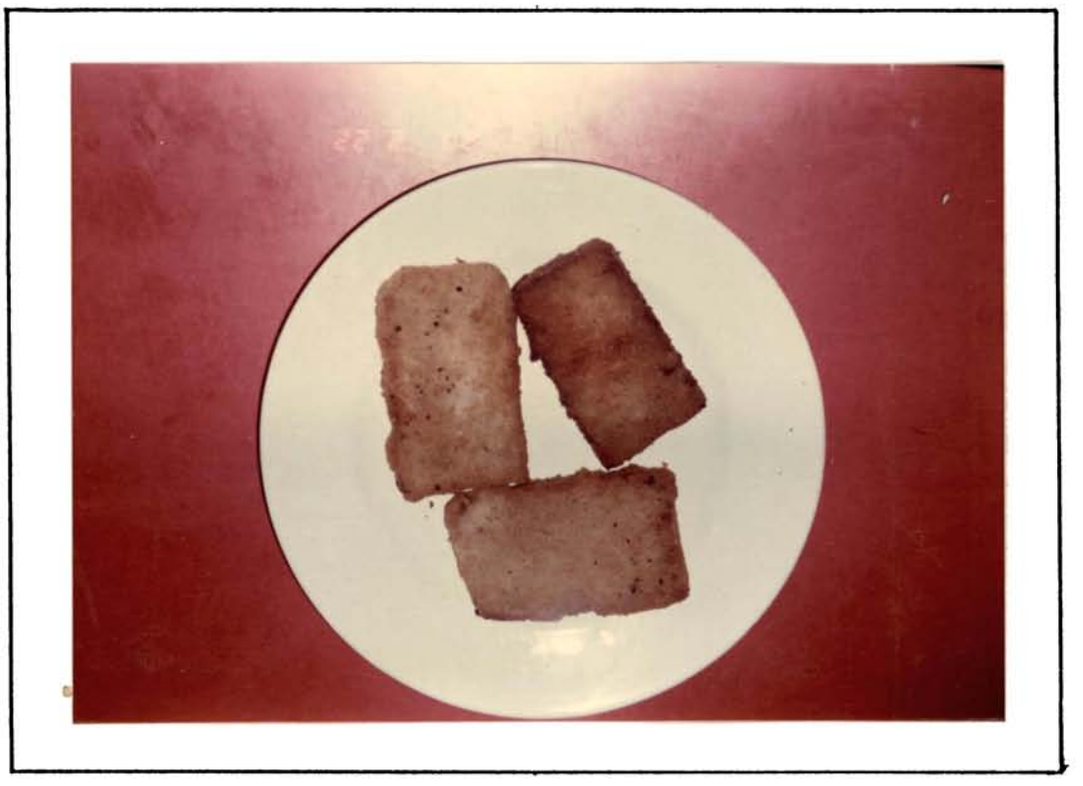

Plate-5B - Battered and breaded fillets after frying

Plate-6A - Mincing of shark in progress

Plate-6B - Frozen Minced meat block

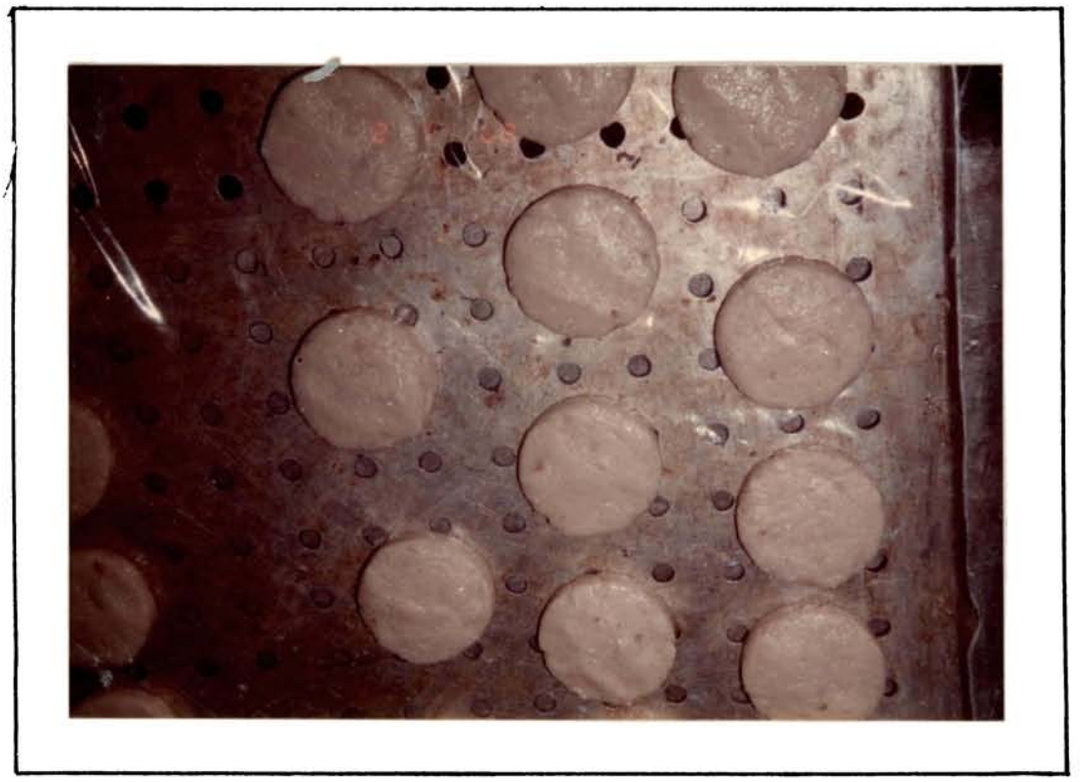

Plate-7A - Frozen fish cakes before frying

Plate-7B - Fish cakes after frying

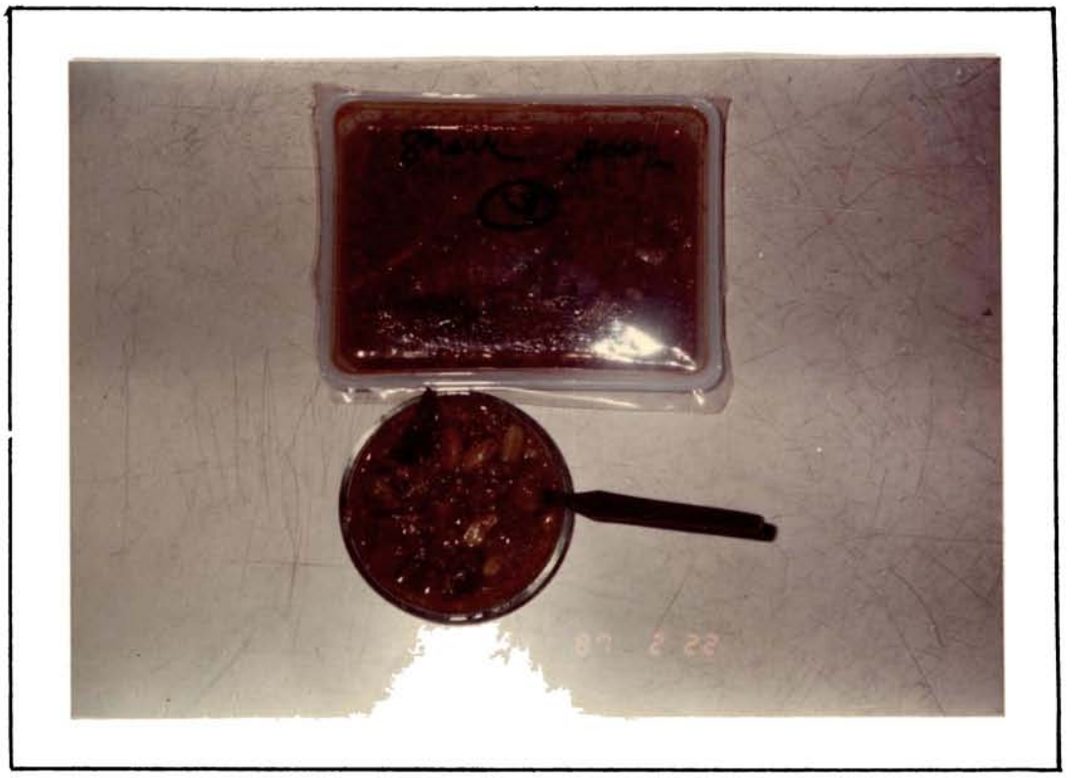

Plate-8A - Fish Pickle

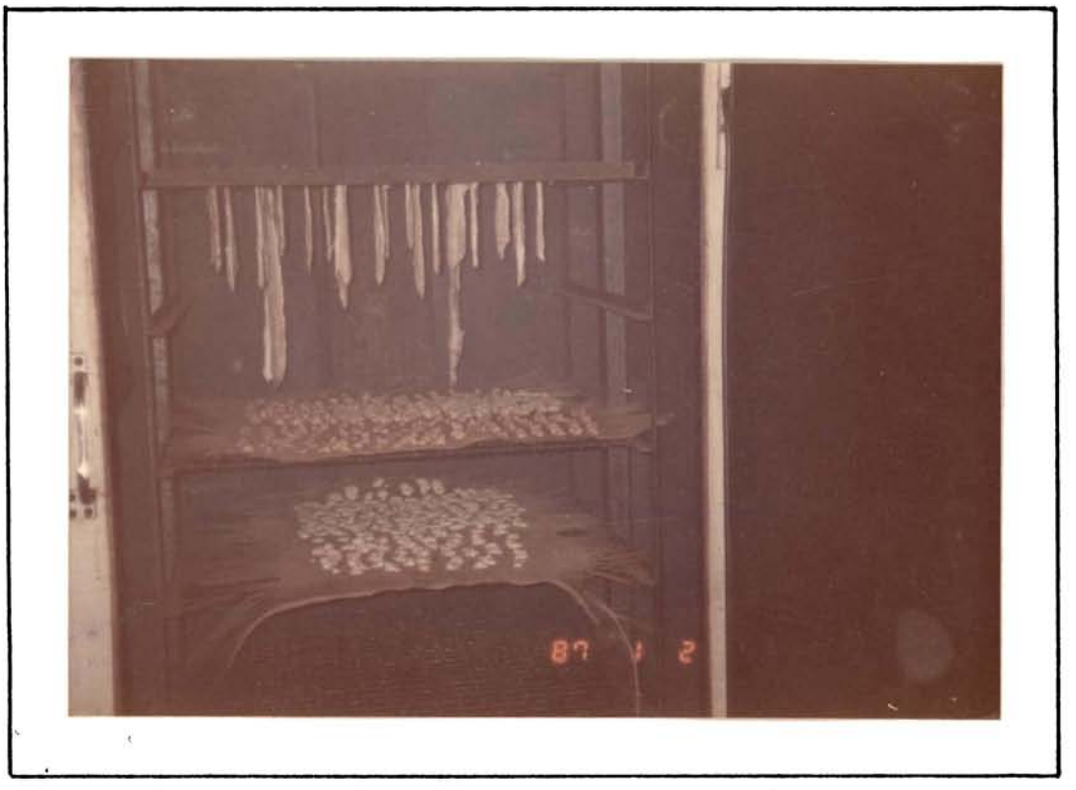

Plate-8B - Initial stage of smoking of shark fillets & Minced meat

Plate-9A - Final stage of smoking of shark fillets and minced meat

Plate-9B - Smoked products

Plate-10A - Canned products -
(1) Shark fillets in tomato sauce (2) Smoked fillets in oil
(3) Fish balls in tomato sauce

Plate-10B Dried Shark

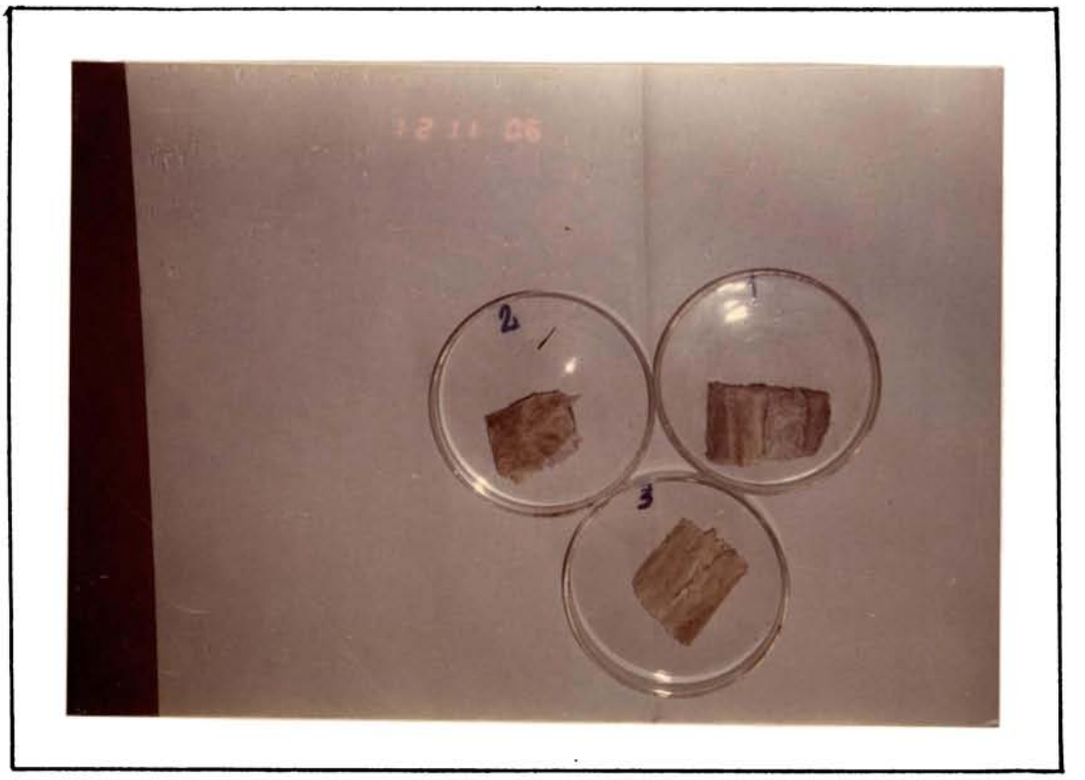

Plate - 11A - Dried sample from the selected species

(1) Scoliodon palasorra (2) Carcharhinus limbatus
(3) Centrophorus granulosus

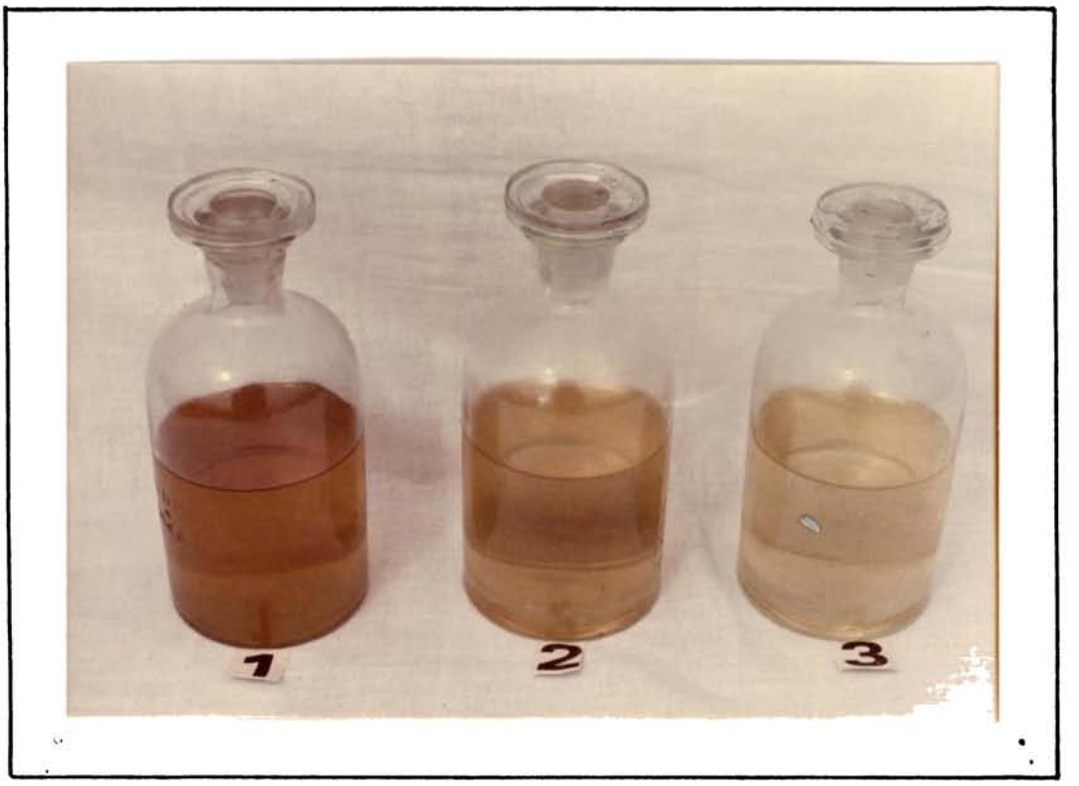

Plate - 11B - Shark liver oil from Centrophorus granulosus

(1) Oil collected after two hours (2) oil collected after 4 hrs.
(3) Oil collected after eight hours

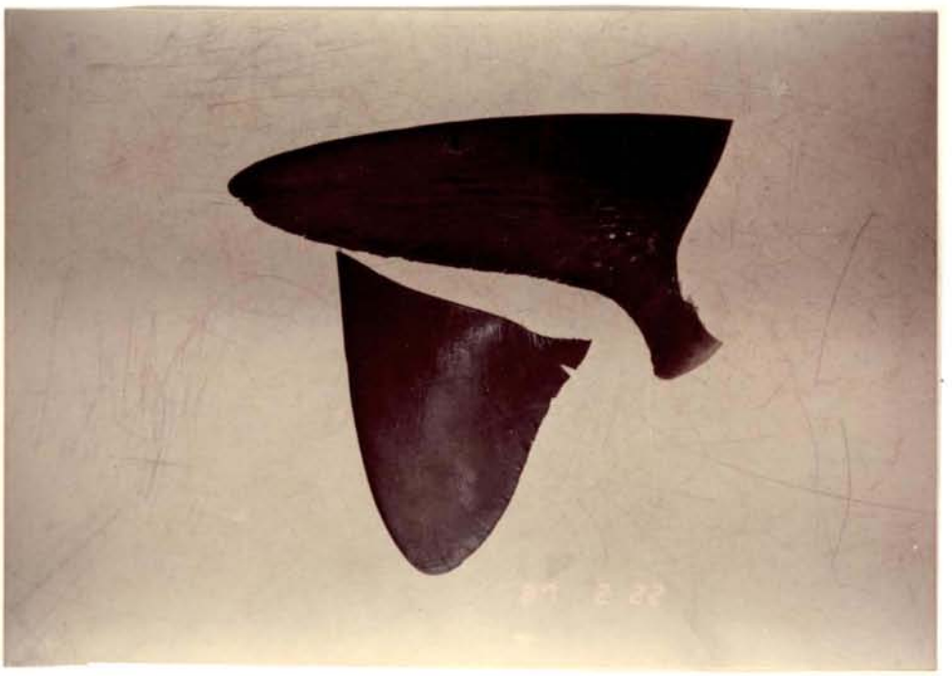

Plate-12A - Dried fins after Half-moon cut & parallel cut

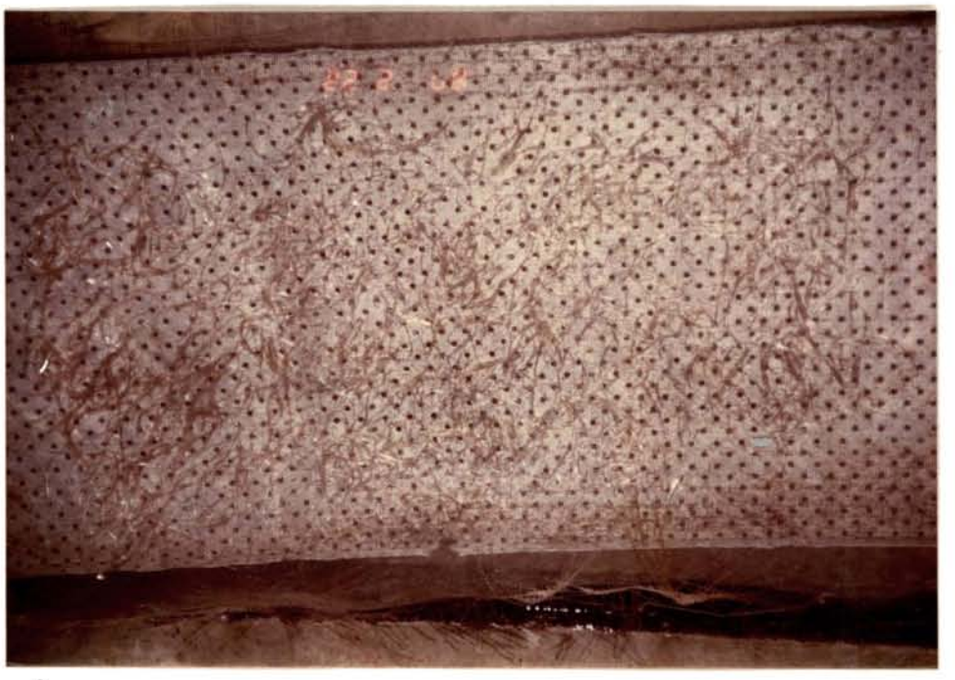

Plate-12B - Drying of Shark fin rays

Plate - 13A - Shark fin rays collected after cold process (light golden colour) and after Hot process (deep golden colour)

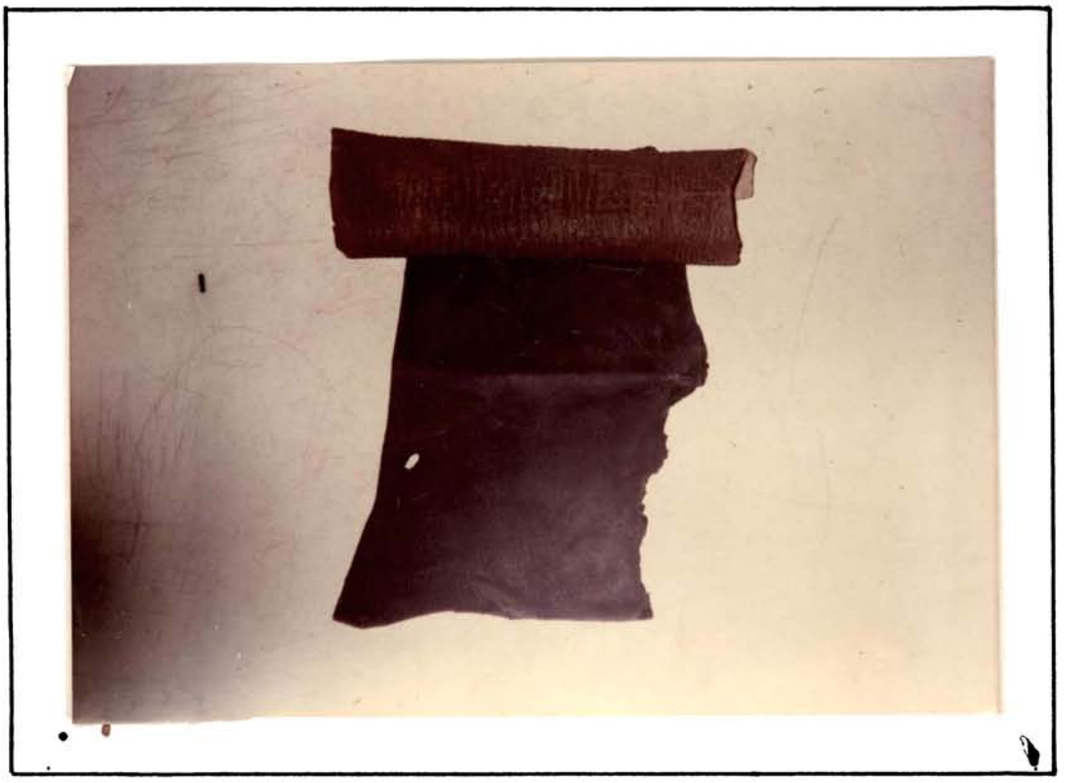

Plate- 13B Tanned shark leather