a. Chilling of fish:

Fish is a highly perishable food commodity and it spoils at a rapid rate at room temperature. Chilling is an effective method of maintaining the freshness of fish products. This normally involves keeping the harvested fish in sufficient quantity of ice to maintain the temperature of fish at around 1-4ºC, which delays the enzymatic action and retards microbial activity, thereby extending the shelf life of the fish and fish products. The fish processors have to remember that the core temperature i.e., the temperature of fish meat that is close to the central bone, must reach a temperature of less than 4°C. To achieve this core temperature under tropical conditions, one kg of ice is required to chill one kg of fish (1:1 ratio). Traditionally, chilling is carried out using flake ice or crushed block ice. Icing is usually done in insulated ice-boxes which are effective. Ice-boxes are made from food grade polyethylene materials in double wall construction, leak proof, rust proof and corrosion free, strong and durable with different storage capacities. Chilling of fish is performed in layers. One layer of ice is laid which is followed by a layer of fish. Weigh the fish and calculate the quantity of ice required for icing. Place one layer of ice at the bottom of the ice box. Place one layer of fish above this ice layer in the box. Cover this fish layer with another layer of ice. Repeat the process till you reach to the top of the ice box. Ensure that the top most layer of fish is covered with ice. Close the lid of the ice-box tightly. The storage life of fish in chilled condition varies with the fish species. For example, shelf life of 12-15 days has been achieved for seer fish and black pomfret. Indian Mackerel and Indian oil sardine have very short shelf life in ice (3-7 days), due to rancidity and belly bursting.

b. Chilled fish products

The modern food habits along with the fast life have created an enormous demand for ready to make food products, especially in urban areas. There are viable opportunities in cities for marketing ready to cook forms of fish products to meet the consumer demands. Improved market forms are one kind of value addition to fish and shell fish, through which the consumers can reduce the time required for further preparation of the product. A brief detail on value added chilled fish styles are given below.

1. Dressed and gutted fish

The purpose of gutting is to remove the viscera, gonads and sometimes the swim bladder. Hygienically gutted fish fetches higher price in the retail as well as export markets. Also, gutting process delays the spoilage in fish. Extreme care has to be taken while gutting to avoid bruises or cut in the fish flesh as it will reduce the market value. This procedure is performed on a table made of special material which is hard, easy to wash and does not absorb fluids. Yield of gutted fish ranges from 75-80%. Dressed and washed fish can be distributed in consumer packs in ice. Vacuum packaging and active packaging further improve the shelf life of the products.

2. Fish steaks

Steaks are the most convenient ready to cook form preferred by consumers. Steak is a section of fish removed by cutting approximately at right angles to the back bone of fish. Slicing of beheaded whole fish into steaks of 2.5-3.5 cm with a cut perpendicular to the animal's backbone is a very common fish processing method. Larger fish, particularly cyprinids, which have a massive and more solid backbone, need slicing mechanically. Most of the mechanical slicer utilize multiple rotating circular saws attached to the drive. The distance between the saws aswellas the elements moving the fish along the line can be adjusted. A mechanized cutter can process 20-40 fishes/minute, depending on the fish size. The steaks are packed in consumer packets and kept in chilled condition. The shelf life of steaks can be improved by vacuum packaging, modified atmosphere and active packaging techniques.

3. Fish fillet

Fish fillet is a skinless, boneless fish loin cut parallel to the central bone frame and trimmed free of loose or hanging meat. Filleting can be done manually or mechanically. Filleting efficiency depends upon fish species, its sex, size, freshness and nutritional condition. Manual filleting is very labour-intensive and largely depends on the skills of the workers. A sharp knife and flat board made up of metal or plastics are required for manual filleting. The fillet is placed on the board skin down, the meat is grasped in the left hand and the knife is drawn between the skin and meat. Manual filleting is time consuming; however, it gives better yield than mechanical filleting. Fillets with low fat and minimum fat content are preferred by the consumers. Average yield of skinless fillet is 40-45%. Skinless fillet can be used as a raw material for the production of a variety of value added products.

4. Marinated fish

Fish steaks or fillet pieces can be marinated with salt and spices and packed in thermoformed trays. The fish is coated with a paste consisting of spices, salt, seasonings and allowed to remain for 6-12 hours or preferably overnight at chilled condition. This fish can be fried in oil or roasted before consumption. Ready to fry marinated fish/shell fish shrimp, mussel, oyster, squid, cuttle fish etc. can be stored up to 2 weeks at 4^0C. Cured product like mackerel is suitable for marinating with spices.

c. Packaging of chilled fish and fish products

Fresh fish is the most perishable among the foods. Proper packaging is an important requirement for maintaining hygiene and safety of fish products. Packaging also aims to reduce the post harvest losses in fisheries. In whole sale and local markets, fish is mostly sold without any packaging, but for retailing and on line marketing, packaging is of utmost importance.

1. Air packaging

Packaging materials for fresh fish should provide a barrier against oxygen to reduce fat oxidation, prevent dehydration, retard chemical and bacterial spoilage and permeation of external odours. The packaging material should be food grade, non-toxic and do not impart any undesirable odour to the packed fish. Plastic trays of Expanded Polystyrene (EPS) or Polyethylene Terephthalate (PET) are suitable for packing ready-to-cook products from shrimp and fish. Polyethylene films that meet the specifications of FSSAI can be used as the primary packaging for retail purpose. For bulk transportation, the container should be sturdy enough to withstand the rigors of transit and travel by different modes, should be of light weight, hygienic and easily cleanable and possess good insulation properties. High density polypropylene containers are commonly used for transportation of fish in the landing centres and fish markets.

2. Vacuum packaging

Vacuum packaging involves the removal of air from the package and the application of a hermetic seal. The air removal creates a vacuum inside the packs and lack of O_2 in packages may minimise the oxidative deteriorative reactions and aerobic bacterial growth. Vacuum packaging can considerably extend the viable shelf life of many cooked foods. The use of vacuum packaging, in gas impermeable and heat stable materials, has many advantages, which include; no or low risks of post pasteurization contamination, ease of handling, Inhibition of growth of aerobic spoilage organisms and inhibition or slowing of deleterious oxidative reactions in the food during storage due to oxygen barrier properties of the packaging material.

There are number of criteria required for the films used for vacuum packaging in large scale production methods. These requirements include: high durability, i.e. ability to withstand considerable mechanical stresses during packaging, handling and transport, retention of flexibility even at low temperatures (-2 to 4°C) to enable satisfactory handling in the packaging and refrigeration rooms, impermeability to liquids, including oils and fats and macromolecules,

impermeability to gases, in particular oxygen, so that oxidative deterioration of the packaged food stuffs is limited or inhibited, manufactured from non-toxic, food acceptable, odourless materials and must be able to create airtight durable heat seals to close packs. Many of these criteria have been met by a range of materials mostly multi-laminated plastics. Vacuum packed foods maintain their freshness and flavor 3-5 times longer than with conventional storage methods, because they don't come in contact with oxygen. Foods that are high in fats and oils won't become rancid, because there's no oxygen coming in contact with the fats, which causes the rancid taste and smell.

3. Modified Atmospheric packaging

Fresh fish is highly susceptible to spoilage from post mortem autolysis and microbial growth. The high ambient temperature of our country favours rapid growth of microorganisms. Presently ice and mechanical refrigeration are the most common means of retarding microbial and biochemical spoilage in freshly caught seafood during distribution and marketing. However, as ice melts it tends to contaminate fish accelerating spoilage and reduces shelf life. Modified atmosphere packaging, a technologically viable method has been developed as a supplement to ice or mechanical refrigeration to reduce the losses and extend the storage life of fresh seafood products. In modified atmosphere packaging air is replaced with different gas mixtures to regulate microbial activity and /or retard discolouration of the products. The proportion of each component gas is fixed when the mixture is introduced into the package; however, no control is exercised during storage. The composition of the gas

mixture changes from its initial composition as a result of chemical, enzymatic and microbial activity of the product during storage. It is primarily the enrichment of Carbon dioxide in the storage atmosphere as a means of controlling microbial growth, which results in the extension of shelf life of products. Carbon dioxide lowers the intra and extracellular pH of tissues and possibly that of microorganisms. Further it may affect the membrane potential of microorganisms and influence on the equilibrium of decarboxylating enzymes of microorganisms. The gases normally employed are carbon dioxide, mixtures of carbon dioxide and nitrogen, carbon dioxide and oxygen and carbon dioxide, oxygen & nitrogen with the sole objective to extend the shelf life of the product beyond that obtained in conventional refrigerated storages. Inhibition by Carbon dioxide manifests in an increased lag phase and a slower rate of growth of microorganisms during logarithmic phase. Inhibition by Carbon dioxide was found to be more effective when the product was stored at the lowest range of refrigerated temperatures. Packaging materials generally employed for this purpose are flexible films of nylon/surylyn laminates, PVC moulded trays laminated with polythene, polyester/low density polythene film etc. The use of high barrier film along with MAP that contains CO_2 effectively inhibits bacterial growth during refrigerated storage of packaged fresh fishery products.

The composition of the gas mixtures used for MAP of fresh fish varies, depending upon whether the fish in the package is lean or oily fish. For lean fish, a ratio of 30 % Oxygen, 40% Carbon dioxide, 30% Nitrogen is recommended. Higher values of Carbon dioxide are used for fatty and oily fish with a comparable reduction in level of Oxygen in the mixture leading to 40-60% Nitrogen. By excluding oxygen, the development of oxidative rancidity in fatty fish is slowed. On the other hand, oxygen can inhibit the growth of strictly anaerobic bacteria like *Clostridium botulinum* although there is a very wide variation in the sensitivity of anaerobes to Oxygen. It is also seen that inclusion of only some Oxygen with Nitrogen or Carbon dioxide will not prevent botulism with absolute certainty.

d. Live Fishery Products

There is a great demand for live fish and shellfishes, the world over. These products fetch maximum price compared to all the other forms of value added products as it maintains the freshness. The candidate species for live transportation include high value species, cultured grouper, red snapper, seabreams, seabass, red tilapia, reef fish, air breathing fishes, shrimp,

crabs, lobster, clams, oyster and mussels. These are normally transported in air cargo maintained at low temperature in order to lessen the metabolic activities of the animals.

e. CIFT-Insulated Fish Bags

Temperature abuse is the single most important factor in loss of quality in fish and fishery products. Insulated fish bag is a simple intervention for hygienic handling of iced-fish by traditional fishermen, fish vendors and urban fish consumers. ICAR-Central Institute of Fisheries Technology, Visakhapatnam Research Centre has deigned insulated fish bags of different sizes with an objective to preserve the quality of the fish caught by the fishermen. Fish kept along with ice (1:1 ratio) preserves the quality of iced-fish for a period of 6 hours. The insulated fish bags are convenient and find use in the transportation of iced fish.

The back pack model is basically a cylindrical bag with straps for carrying the bag on the back while walking or riding on a motorcycle. The empty weight of the back pack model fish bag is 1.18 Kg. The volume of the bag is 50 litres and can easily hold 10 kg of iced-fish and fishery products. Apart from back pack model, Insulated fish bags of various shapes and sizes were made to suit the needs for different types of users (fishermen, fish retailers, fish consumers). Cylindrical model best suits for fisherwomen for easy transportation. These bags of 20 kg capacity have a round plastic support (covered with foam sheet and has Velcro sticker on one side is supplied along with the bag so to bear the weight of the material and for easy carrying. This design will be convenient for the fisherwomen for door step delivery of fish and fishery products. Medium and small sized insulated bags are designed for seafood consumers when they would like buy fish in larger quantities for household purposes.

f. Quality and safety requirements for chilled fish products

Food safety regulations have been laid by the Food Safety Standards Authority of India (FSSAI) for sale of chilled fish and chilled shrimp products in the domestic market.

Microbiological parameters for Chilled Finfish

	Sampling Plan		Limits		Action in case of unsatisfactory results
Hygiene Indicator Organisms					Improvement in hygiene; Time-Temperature Control along value chain
	n	c	m	M	
Aerobic Plate Count	5	3	$5x10^5$cfu /g	$1x10^7$ cfu/g	
Safety Indicator Organisms					
Escherichia coli	5	3	11 MPN/g	500 MPN/g	
Salmonella	5	0	Absent/25g		
Vibrio cholerae (O1 and O139)	5	0	Absent/25g		

Where,

n: Number of units comprising the sample

c: Maximum allowable number of defective sample units

m: Acceptable level in a sample

M: Specified level when exceeded in one or more samples would cause the lot to be rejected