CHAPTER 1
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1.1. GENERAL

Proteins occupy a unique status among the constituents of biological matter by virtue of their relatively large size, complex, multifaceted and multi reactive structure. These properties give them a superb characteristic for functioning in biological systems in many different ways. But these characteristics also make proteins susceptible to environmental stress. Proteins are also easily attacked by variety of chemicals and are subjected to many deteriorative reactions during processing. Apart from contributing to the nutritional quality, proteins along with other biological constituents also contribute greatly to the textural properties.

Fish muscle is an important food item for man in view of its high protein content, vitamins and polyunsaturated fatty acids. World fish productions from capture fisheries are more or less stagnant at around 100 million tones. For feeding the population at the present level of consumption it is estimated that by 2020 A. D. another 20 – 30 million tones of fish has to be added to the present availability. Another problem of serious threat is that on an average around 20% of the landed fish is wasted due to various reasons. The fishery wealth of the vast expanse of the Exclusive Economic Zone of India remains practically untapped and under – utilized. The augmentation of the present level of catch by adopting need-based technological and infrastructure inputs being the need on one side, the optimum utilization of the landed catch by developing appropriate technologies for their preservation and processing is another priority of equal importance.

Fish muscle proteins depending on their anatomical location and activity, exhibit structural differences that lead to different functional properties and processing abilities. Both intrinsic and extrinsic factors of muscle tissue affect the rheological characteristics. Myofibrillar protein and collagen that comprise 70 – 80% of the total protein content control the structure and the specific rheological properties of the muscle tissue. Post mortem textural changes are caused directly and indirectly by physiochemical changes in the myofibrillar proteins and the collagen of the extra cellular spaces between the fibers. Several scientists have already studied the role of myofibrillar protein in texture. But information regarding the distribution and functional properties of collagen in effecting the textural
properties of fish and fishery products are scarce. Texture is also affected by the structural components of muscle tissue, their pattern of arrangement and the processing techniques employed. Time – temperature profile also plays a significant role in affecting the rheological characteristics of the muscle tissue.

Rohu (Labeo rohita), squid (Loligo duvaucelli) and shark (Scoliodon sorrokawah) belong to three diverse classes. Rohu is a fresh water carp, Squid belongs to cephalopods (molluscs) and Shark is an elasmobranch. The research work carried out earlier suggests that these three species differ in their collagen content and on that basis these three species are selected for the present study.

1.2. MORPHOLOGY

1.2.1. Rohu (Labeo rohita, Hamilton) – Plate 1.1

Rohu (Labeo rohita) is a freshwater carp and is highly commercial. It is a hot favorite and is commonly preferred in Southeast Asia. And in India it is commonly found in the, Maharashtra, Kerala, Meenachil, Manimala, Chilka Lake and Pampa rivers. The fish is commonly distributed in Pakistan, India, Bangladesh, Myanmar and Nepal.

It grows to a maximum size of 200 cm in length and 45 kg in weight with a life span of 10 yrs. The upper body has dark scales. The lower body and the belly is golden brown. Dorsal fin and tail are dark brown in color. The pelvic, pectoral and anal fins have a red tint. The dorsal fin has 12 to 13 branched rays. The body is more linear than Catla. Rohu is considered as tastiest of the Indian carps. Its relatively small pointed head, almost terminal mouth with fringed lower lip and dull reddish scales on the sides easily distinguish it. It grows quickly. The bigger the size of the fish the tastier it is. It is procured, processed and exported to the global market as both whole gutted and also as block frozen steaks.

All landings of this Indian major carp are from aquaculture. Almost all of the rohu production comes from India but in recent years a growing, albeit small proportion is cultured in Myanmar, Thailand and Laos. Currently rohu is the most widely cultured species outside India and Myanmar is the largest non – Indian producer.
Plate 1.1 - *Labeo rohita* (Rohu)
1.2.2. Squid (*Loligo duvaucelli*, Orbigny) – Plate 1.2

Squid is a commercially important cephalopod. They are exclusively marine molluscs and there are about 660 species in the world ocean, of which less than 100 species are commercially important. They are diverse in form, size and nature. In India, cephalopod fishery are found in Bombay, Cochin, Mangalore, Rameshwaram, Mandapam, Kilkara, Madras, Kakinada, Waltair, Portnova and Vizhinam. It is mostly preferred as raw and in processed forms in Japan and other European Countries. Recently their contribution to the export market has shown an increase from the past. Export of frozen squid in 2004 – 05 has registered a substantial growth of 27.21% in quantity, 27.98% in rupee value and 31.64% in US$ terms. There was also a marginal increase in unit value realization.

Squid has practically a cone shaped sack consisting of several layers of tissue that envelop the organs. The head with 8 – 10 tentacles sprouting around the mouth is loosely attached to the body. There are no bones to support the muscle. Squid refer to those cephalopods having ten circum oral arms, eight of which are short and two slender and tentacular. The suckers of the arms and tentacles are stalked and equipped with armature. The tentacles are slender and long with expanded clubs. Club suckers are arranged in four rows. The suckers on the manus of the club are the largest and the median ones being more enlarged than the marginal ones. The large manus sucker bear about 14 – 17 pointed teeth on the rings. Squid has a chitinous internal shell. The mantle is cylindrically elongate and tubular with almost parallel sides up to the point where fins originate, then tapers to a blunt posterior point. The mid dorsal projection of the anterior margin of mantle is rounded. The fins are either terminal or marginal in position and unite at the apex of the mantle. The fins are small and short and occupy about 50 – 55% of mantle length being ad rhombic in outline. They are broadest near the middle, the anterior margin is nearly straight or slightly convex and the posterior margin is concave. In fresh condition immediately upon capture the squid is colorless and mantle is transparent showing the internal visceral organs. There are numerous light brown chromatophores scattered all over the mantle, fins, head and arms. On the ventral side chromatophores are less dense and appear whitish.
Plate 1.2 - Loligo duvaucelli (Squid)
1.2.3. Shark (*Scoliodon sorokawah*) – Plate 1.3

The annual production of elasmobranchs in India is around 70,000 tones, over 4% of total marine fish landings. Sharks account for between 60 and 70% of this. Tamil Nadu, Gujarat, Maharashtra, Kerala, Karnataka and Andra Pradesh supply around 85% of the shark landings in India. 65 species of shark have been sighted in Indian waters and over 20 of these contribute to the fishery. In India the present annual shark production is around 45,500 tones obtained as a by – catch from a variety of gears. Despite the commercial importance, no serious attempts have so far been made at any targeted exploitation of this valuable resource. Information on the composition of the species of shark landings is very scarce apart from the gross catch statistics.

The sharks are generally large, long and very powerful fish. It is viviparous. Foremost part of the shark is head and comprises of skull and face. First dorsal fin is the first locomotive limb on the back of the body. Second dorsal fin is the rear locomotive limb on the back. The caudal fin is the locomotive limb at the end. Locomotive limb beneath the pelvic girdle is the pelvic fin. Belly is located at the lower part of the trunk of the body. Pectoral fin is the locomotive limb on the chest. Caudal keel is a flattened area that increases forward thrust and speed of swimming. There are 5 to 7 gill openings on either side of the body near to pectoral fin. Mouth is located at the anterior end. Sharks do not have swim bladders. They have large oil – rich livers. The intestines of shark are very compact and take the form of a spiral. Snout is very sensitive and has the nostrils that are extremely sensitive. The snout is also dotted with the *ampullae of lorenzi* organs that can detect electrical signals in the water. Eyes located on either side of the head have a large number of rods that gives them good night vision. In addition to this *tapetum lucidum* in the eyes that lies beneath the retina help in reflecting the light back through the retina thus increasing the light received by the receptive cells.

The fins of sharks are highly valued for the shark fin soup industry, and it is estimated that more than 100 million sharks are killed every year with the trade being driven by the demand for shark fins.
Plate 1.3 - Scoliodon sorrokwah (Shark)
1.3. BACKGROUND OF THE WORK

Collagen is an extracellular matrix protein and is an essential component of muscle connective tissue in multicellular animals. The word collagen has been derived from the Greek words “kolla” and “genos" meaning “glue” and “formation” respectively. The basic unit of collagen, tropocollagen occurs in three polypeptide units (α chain) which together form a triple helical structure. On hydrolysis, the collagen is converted to gelatin that finds great commercial importance. In the muscle tissue, the myocommata covering muscle segments and the basement membrane covering muscle fibers are made up of connective tissue and collagen forms its major part. In fish, the largest concentration of collagen is found in the skeleton, fins, skin and air bladder. Mechanical strength, integrity and rheological properties of the muscle tissue, water holding and gel forming capacity of the fish and cooked fishery products and the flow properties of the fishery by – products are some of the attributes of fish protein where collagen has a major functional role. Collagen in fish contributes about one – tenth of total proteins or less. Fish collagen has high biological value, high essential amino acid content and lower content of hydroxyproline. Collagen has great significance in the fish muscle. Belly bursting and gaping are two characteristics found in fish and fishery products that have direct impact of collagen. Collagen is of great technological importance in that it holds fillet together. Recently collagen has received increased attention as an important protein component contributing greatly to the texture of raw material. Tenderization and thermal stability of the muscle products and the toughening are two dual purposes, dependent upon the conversion of collagen to gelatin and heat coagulation of the myofibrillar proteins. Hence, it is necessary to investigate more about the content and properties of collagen so as to optimize the processing conditions for production of quality fish products.
1.4. OBJECTIVES OF THE STUDY

- To study the physical and biochemical composition of Rohu (*Labeo rohita*), Squid (*Loligo duvaucelli*) and Shark (*Scoliodon sorrokawah*) highlighting their nutritional importance.

- To study the changes in the protein fractions during frozen storage and heat setting at different temperatures.

- To characterize the protein fractions using SDS – polyacrylamide gel electrophoresis.

- To study instrumentally and organoleptically the textural parameters of the meat and correlate these parameters with collagen content.

- To study the musculature differences in the three species by histochemical analysis during cooking of samples kept under frozen storage.

- To analyze and characterize the collagen of the squid skin, tentacle and mantle.

- To analyze and characterize the glycoproteins of the squid skin, tentacle and mantle.