1.0 Introduction...
Global fish and shrimp production has been in a steadily increasing trend over the last decade and this trend is expected to continue. Of the estimated 131 million tonnes of fish produced in the year 2000 in the World, nearly 74% (97 million tonnes) was used for direct human consumption. The remainder (about 26%) was utilized for various non-food products, mostly for reduction to meal and oil. As a highly perishable commodity, fish has a significant requirement for processing. In 2000, more than 60% of total world fisheries production underwent some form of processing (FAO, 2002). An important waste reduction strategy for the industry is the recovery of marketable byproducts from fish wastes. Hydrolyzed fish wastes can be used for fish or pig meal as well as fertilizer components (www.earthprint.com). The three most common methods for utilization of aquatic waste (either from aquaculture or wild stock) are the manufacture of fishmeal/oil, the production of silage and the use of waste in the manufacture of organic fertilizer (www.fao.org). The utilization of byproducts is an important cleaner production opportunity for the industry, as it can potentially generate additional revenue as well as reduce disposal costs for these materials. The transportation of fish residues and offal without the use of water is an important factor for the effective collection and utilization of these byproducts.

Of the total world fish production of 132.9 million tons, more than 75% is utilized for human consumption and the rest is used for other purposes. Out of the 32.25 million tons used for other purposes, 78% is used for reduction and remaining for miscellaneous purposes (FAO, 2002). The fish landing in India is around 6 million tons in 2005 of which the marine sector is contributing about 2.9 million tons, against the estimated potential of 3.9 million tons (Anon. 2006).

The fish processing industry in India by and large depends on the shrimp which constitutes about 20% of the total landings. The trawling operations for prawn results in the landings of many low value varieties of fish, most of which are thrown back to the sea. The bycatch from Indian seas is mostly composed of jew fish, perches, sole, barracuda, lizard fish, anchovies, lactarius, crab, bulls eye, threadfin breams etc. Industrial fish processing for human consumption yields only 40% edible flesh and the remaining 60% is thrown away as waste (Raa & Gildberg, 1982). Annual discard from the world
fisheries were estimated to be approximately 20 million tonnes (25%) per year. This includes “waste” or byproducts also. Only 36000 tons of the byproducts were used for human consumption, which amounts to about 15.5% of the total (Rubin, 2001). Presently, the world export trade of fish waste is 6,75,970 tons in different forms worth US $205.4 million. The import figures are 1,23,3602 tons (value 328.1 million dollars). In India the export figure of the fish waste for the year 2002 is 2016 tons worth 11.03 million US dollars (FAO 2002).

Processing of fish leads to enormous amounts of waste. It is estimated that fish processing waste after filleting accounts for approximately 75% of the total fish weight and 30% of the waste is in the form of bones and skins (Gomez-Guillen et al., 2002). About 30% of the total fish weight remains as waste in the form of skins and bones during preparation of fish fillets (Shahidi, 1994). This waste is an excellent raw material for the preparation of high value products including protein foods. The utilization of fish wastes helps to eliminate harmful environmental aspects and improve quality in fish processing.

With a view to utilize the by catch and processing waste, efforts have been made to develop methods for converting them into products for human consumption, animal nutrients and products of commercial importance. Among the most prominent current uses for fish waste are fishmeal production, extraction of collagen and antioxidants, isolation of cosmetics, biogas/biodiesel, production of chitin and chitosan, food packaging (gelatin, chitosan) and enzyme isolation (proteases).

The fish skins and bones can be processed into gelatin, thus solving the problem of fish waste disposal in addition to creating value-added products. Gelatin is a substantially pure protein food ingredient, obtained by the thermal denaturation of collagen, which is the structural mainstay and most common protein in the animal kingdom. It is one of the most versatile gelling agents in food applications due to its special texture and the ‘melt-in-mouth’ perception. In addition to foodstuffs, gelatin has found a variety of applications in the pharmaceutical and photographic industry. Generally, gelatin is produced from skin and bone collagen by acid or alkali treatment to give type A and type B gelatins, respectively (Veis, 1964; Ward & Courts,
The World production of gelatin is currently pegged at 315,000MT of which 45.8% is produced from pigskin, 52.6% from bovine hides and bones and 1.6% from other sources (GME, 2007).

Gelatin forms thermally reversible gels with water, and the gel melting temperature (<35°C) is below body temperature, which gives gelatin products with unique organoleptic and flavour releasing properties. The disadvantage of gelatin is that it is derived from animal hide and bones hence there are problems with regard to kosher and Halal status and vegetarians also have objections to its use. Competitive gelling agents like starch, alginate, pectin, agar, carrageenan etc. are all carbohydrates from vegetable sources, but their gels lack the melt in the mouth and elastic properties of gelatin gels.

There are two main types of gelatin. Type A, with isoionic point of 7 to 9, is derived from collagen with exclusively acid pretreatment. Type B, with isoionic point of 4.8 to 5.2, is the result of an alkaline pretreatment of the collagen. However, gelatin is sold with a wide range of special properties like gel strength, to suit particular applications.

Gelatin is a gelling protein, which has widely been applied in the food and pharmaceutical industries. Most commercial gelatins are derived from mammalian sources, mainly pigskin and cowhide but for many socio-cultural reasons alternative sources are increasingly demanded. Among such reasons are religious proscription of Judaism and Islam, and diseases like Bovine Spongiform Encephalopathy (BSE). Byproducts of poultry and fish are rarely used as a resource of gelatin.

The amount of gelatin used in the worldwide food industry is increasing annually (Montero & Gomez-Guillen, 2000). However, frequent occurrences of BSE and foot/mouth diseases limited the utility of mammalian gelatins in processing of functional food, cosmetic and pharmaceutical products. Therefore, the significance of study of gelatin from fish by-products, such as skin and bone, has increased for the replacement of mammalian resources (Gudmundsson, 2002).
A few fish gelatins are available commercially, but fish gelatin is not commonly utilized because it is inferior to mammalian gelatin in rheological properties, which affect product quality (Choi & Regenstein, 2000). The fish gelatins available commercially are not well characterized. One of the most important differences between mammalian and fish gelatins are that the latter have normally low gelling and melting temperatures and also lower gel strength (Norland, 1990).

The use of byproducts from fish for gelatin production as an alternative to mammalian gelatin raises some practical problems. First, fish collagen is highly susceptible to deterioration when compared to mammalian collagen which is more stable. Second, the raw material for gelatin production from fish viz. skin can undergo rapid enzymatic and microbial damage when kept along with the rest of byproducts including gut contents causing wide variations in the quality of gelatins produced.

In order to be suitable for application in food and pharmaceutical industries, fish gelatin must possess the following characteristics. First, there should be a large quantity of fish processing waste to make the collection of sufficient quantity of skin and bones economical to run the production continuously. Secondly, gelatin from fish byproducts must have rheological properties (gel strength, gelling and melting points, etc.) at the level of mammalian gelatin. However, it is not easy for fish byproducts to satisfy the above two categories because of their typical physical properties.

Fish byproducts from freshwater are seldom used as a source of raw materials for gelatin extraction. They are mainly used for animal feed supplements due to their small size (Gildberg et al., 2002). However, some studies have ascertained that freshwater fish have vast amounts of waste after removal of useful edible parts and high gelatin yield is expected from them (Jamilah & Harvinder, 2002; Grossman & Bergman, 1992; Muyonga et al., 2004a). Additionally, most findings suggest that gelatin from tropical fish species has an advantage over those extracted from cold water species, the
former having better rheological properties nearly similar to mammalian
gelatins (Veis, 1964; Cho et al., 2005; Gilsenan & Ross-Murphy, 2000a).

India ranks second to China in the global aquaculture production. The
aquaculture production in the country was estimated to be 2.47 million tonnes
in 2004 which is more than 50% of the total fish production. Freshwater fin fish
contributed almost 97% of the total freshwater aquaculture. Among the
freshwater species Indian major carps (Catla - *Catla catla*, Rohu – *Labeo rohita* and Mrigal *Cirrhinus mrigala*) predominated with 85% of the total
landings. Generally the freshwater fish is consumed fresh in the country.
However with the change in consumer preferences and constant demand for
value added and convenience products, there is scope for the development of
organized fish processing units in the inland sector. With the establishment of
such units, there will be generation of significant quantity of fishery waste,
which, if not properly utilized can be a serious environmental hazard. In major
carps the skin accounts for almost 6% of the live weight. Fish skin forms a
major portion of the fishery waste, particularly in the case of production of
mince based and fillet based value added products.

The present study aims to evaluate the suitability of the skin of the
freshwater fish as a raw material for the production of gelatin. The objectives
of this study are:

- To study the suitability of the fish skin from selected species of Indian
  major carps and exotic carps for the production of gelatin

- To optimize the process condition for the extraction of gelatin from the
  skin of selected species of Indian major carps and exotic carps

- To study the physico-chemical properties of the gelatin prepared from
  the skin of selected species of Indian major carps and exotic carps
• To compare the physicochemical properties the gelatin prepared from the skin of selected species of Indian major carps and exotic carps with that of gelatin from mammalian sources

• To prepare and study the physical and mechanical properties of edible films fabricated with fish skin gelatin from the above species

• To formulate gel based edible products from fish skin gelatin and study their physical and sensory properties.