INTRODUCTION
1. INTRODUCTION

"Give a man a fish
He will eat only once
Teach him fish culture
He will eat through out his life."

FAO, 1980.

Modern life-style demands a consistent food supply with high quality that is convenient as well as affordable. There are several animal and plant food sources available worldwide. Among them, the most important animal protein source that caters to the human needs comes from the aquaculture. Aquaculture is one of the fastest growing food producing industries in the world and is considered as a way to provide enormous quantities of protein rich food. Aquaculture, the art and science of culturing aquatic organisms, has been practiced for a very long time. The Chinese initiated aquaculture practices between 3500 and 4500 years ago. The first known record describing aquaculture and its benefits was written by Fan Li in 460 BC in Chinese.

The world’s population continuing to increase each year will exceed 10 billion by the year 2050 (FAO, 1999). India being the second
largest and most densely populated country, the pressure on population explosion is greater and hence, an average Indian could not get really nutritious food. A survey taken up by I.C.M.R (Anon., 1989) clearly indicates that majority of children do not get sufficient calories to fulfil their maximum nutritional requirement. It is also estimated that about 10 million people die every year in the world either by starvation or by malnutrition.

Generally fish is considered as a highly protein rich food in relation to vegetable and other animal foods. It is a fact that millions of people in developing countries are suffering from malnutrition, for want of protein rich food. It has been accepted by the scientists and nutritionists that the only way to overcome such problem is to rely more on the fish and fishery products than on any other sources. Another important reason is that only these fish and fishery products are available at cheaper rate to the common man compared to other animal products. Fish and fish products contribute an important segment of dietary requirement and could play a vital role as a supplementary food to the generally ill balanced diets. Global food shortage may be got over by enhancing fish production.

Fish can play an important role as a source of protein of high digestibility, minerals especially calcium and iron and vitamins. Small fish is as good as milk as a calcium source. Fish has an enhancing effect on the bioavailability of iron from other foods in a meal. Fish supplies abundant amount of essential amino acids. Marine food is a heart healthy food since most varieties are low in fat. When such food is consumed
regularly without the addition of extra fat, it can help to lower overall fat intake. Nearly all seafood is low in cholesterol and calories but rich in unsaturated fatty acids and omega-3 fatty acids. Dietary fish oil lowers blood cholesterol and plasma lipids without increasing blood sugar and limits the chance of heart disease.Trimming the skin before eating will remove most of the fat underlying the skin.

Current world fish catch from freshwater and marine sources amounts to more than 110 million metric tonnes per year (Anon., 1997). India’s total fish catch in 1997-98 was estimated to be more than 5.3 million metric tonnes from both marine and freshwater resources whereas Tamilnadu’s share is only 0.38 million metric tonnes (Jayashree and Arunachalam, 2000). India has the seventh largest marine landing in the world with an immense potential for aquaculture development. Since 1993 India has maintained a sustained level of production from aquaculture with an average annual rate of over 6% and in some states like Punjab with the production rate of over 13 percent (Gopakumar, 2001). Hence, the value of marine products export from India substantially increased from 25 million rupees to 50,000 million rupees in 1997-98 (FAO, 1998). It is pertinent to mention that fishery sector plays an important role in the economy of India. It helps in augmenting food supplies, supplements protein deficiencies, generates employment, raises nutritional level and earns valuable foreign exchange (Jayashree and Arunachalam, 2000).

India has a long tradition of both freshwater and brackish water aquaculture. Freshwater fish culture of carps has been a long tradition in
eastern states like Bengal. In India, 70% of the total inland fish production is contributed by freshwater aqua farming (Dehadrai, 1997), mainly contributed by carps (Ayyappan and Jena, 1997). At present, fisheries practices are mainly oriented towards the selected species having remarkable culture potential with maximum utilization of water and human resources. Among these cultivable species, carps, the freshwater fish is being given due consideration because of its high nutritive value, faster growth rate, good taste, easy cultivability and ready availability throughout the year. Carp is not only valuable human food but also an angling fish. Worldwide, carp culture production accounted for about 65% of total finfish and crustacean aquaculture production in 1995. Among the top ten items cultured today, common carp, *Cyprinus carpio* occupies the fifth place (Gopakumar, 2001). China is the major producer of common carp.

Fish production alone does not ensure the availability of protein to all unless it is effected in a systematic manner. Hence, comprehensive viable technology packages have become inevitable. Fish is a highly perishable commodity. Quality loss in fishery products may be attributed to three main causes namely catalytic, enzymatic and bacterial actions, spoilage of fish begins as soon as the fish dies. The spoilage rate may be reduced by good handling practices and effective temperature control. Storage at low temperature is required to suppress the microbial spoilage of fish. When the supplies of fish are increased further processing is necessary in order to improve the shelf life.
Fish reaches the consumers either in fresh or processed condition. The advantage of preservation is to reduce wastage of fresh products, extend the shelf life, develop value added products, and to provide convenient and preferable forms to the consumer. Processing carp can open up new markets, attracting new categories of consumers such as those looking for convenience foods and those who dislike fresh fish. It also enables new approaches to mass markets (Vallod, 1995). In addition, it provides employment opportunities and foreign exchange earnings from the export of processed foods thereby improve our national economy. These technologies also help year round availability of fish by suppressing the microbial and enzymatic spoilage. Health hazards due to consumption of unwholesome fish products containing microbial pathogens can also be eradicated.

Centuries before the advent of electricity and modern refrigeration, people developed methods for preserving muscle foods. These methods include drying, smoking, sausage making, salting and using ice or low temperatures. Later the role of microorganisms in spoilage was demonstrated and the effect of cooling on prolonging the shelf life was explained. The rapid spoilage of fish at high ambient temperature in the tropics is a well-known phenomenon. Fish spoil within a few hours of catch unless some form of preservation is applied. It has been estimated that as much as 20% of the total fish production is wasted by spoilage. At today’s price this has serious economic implications as well as inexcusable loss of animal protein in a food shortage world (Liston, 1980).
Although considerable knowledge has been accumulated through several investigations on the biochemistry and processing technology of other freshwater and marine fish, the role of native microbes on spoilage of common carp at ambient temperature in unprocessed condition is not clearly understood. Many attempts have been made for extending the shelf life of fresh fish. One such method is the refrigeration, which prolongs the shelf life of any perishable food and is effective in retaining high quality and flavour. High quality fish can be stored at home for short periods, if the conditions are good. Unlike frozen fish, refrigerated storage of fresh fishery products results in a shelf life of 5-10 days (Reddy et al. 1995). Whole fish, steaks, chunks, fillets and several value added products could be conveniently packed and stored.

Filleting is one of the methods of improving the consumer appeal. As the major freshwater fish grow to a fairly big size, and are costly, their storage as fillets will be of interest for their commercial marketing. However, the fish fillets being attractive by nature will catch up consumer preference and help in boosting up the sale. In the domestic trade, no attempt has been made so far in evaluating the quality and shelf life of freshwater fish fillets. Fish fillets have no waste, because the edible yield is high with filleted fish, a promotion emphasizing, "great taste, no waste" implies superb value. Fillets are simple to use and can be cooked easily as whole or sliced in minutes.

Another way to delay the aerobic bacterial spoilage in refrigerated stored fish is by using food additives and biopreservatives.
(Gilliland and Ewell, 1983). It is evident that no single storage technique can ensure prolonged shelf life in fish. Many works have recommended the combination of physical and chemical preservation methods. The combination of low temperature with permitted additives such as sodium chloride, sodium acetate / potassium sorbate is recommended by Kim et al. (1995).

Literatures on various quality aspects like biochemical and sensory characteristics of common carp from tropical region under refrigerated storage are found to be scarce. Only very little information are available on microbiological quality of the freshwater fish, *Cyprinus carpio* (Viswanath and Lilabati, 1995 and Lilabati and Viswanath, 1996). Most of the sensory and biochemical indices are the reflection of the extent of microbial spoilage. Based on this back drop, an investigation has been meticulously planned to study the detailed role of native bacteria during the process of spoilage of *Cyprinus carpio* stored in three forms viz. raw whole fish immediately after catch, untreated fish fillets and preservatives treated fish fillets. The study also aims to delineate the impact of various physical and chemical preservation techniques on the micro flora.

Critically reviewing the above points the present study was taken up with the following objectives:

i) To assess the natural sequence of changes occurring during spoilage of raw whole fish, fillets and preservatives added fillets of *C. carpio* during storage at ambient (28 ± 2°C) and refrigeration (4 ± 1°C)
temperatures. This includes organoleptic characters, microbiological changes such as total heterotrophic, psychrophilic and hydrogen sulphide producing bacterial population and the biochemical changes such as accumulation of total volatile bases, trimethylamine, ammonia, alpha amino nitrogen, free fatty acids, peroxide value at various time intervals.

ii) To find out the changes in the proximate composition (protein, carbohydrate, lipid and moisture) of the carp during storage at various temperatures by estimating the contents at different time intervals along with spoilage assessment.

iii) To study the innate and extraneous role of various bacterial genera which form the component of spoilage flora during storage.

iv) To determine the distribution of various hydrolytic enzyme producing bacteria by evaluating their ability to produce enzymes such as amylase, gelatinase, caseinase and lipase.

v) To evaluate the effect of chemical preservatives on the quality of fish fillets when stored at low temperature.

vi) To compare statistically the freshness parameters of fish stored under different conditions.