SENSORY METHODS

Sensory Evaluation

Sensory evaluation is defined as the scientific discipline used to evoke, measure, analyze and interpret reactions to characteristics of food as perceived through the senses of sight, smell, taste, touch and hearing. In sensory analysis, appearance, odour, flavour and texture are evaluated using the human senses. Variations among individuals in the response of the same level of stimuli can vary and can contribute to a non-conclusive answer of the test. Thus, it is important to be aware of these differences when selecting and training judges for sensory analysis. Selected respondents are usually trained in interpretation of the stimulus and response in order to receive objective responses which describe features of the fish being evaluated. It is also easy to give an objective answer to a questions e. g. is the fish in rigor (completely stiff)?, but more training is needed if the assessor has to decide whether the fish is *post* or pre-rigor.

Subjective assessment, where the response is based on the assessor's preference for a product, can be applied in the fields like market research and product development where the reaction of the consumer is needed. Assessment in quality control must be objective.

Fish Preservation

Fish preservation refers specifically to the techniques used to keep fish from spoiling and to elongate its shelflife. Preservation is seen as a way of storing excess fishes that are abundantly available at certain times of the year, so that they can be consumed in times when fish is scarce. Fish preservation traditionally has three goals: the preservation of nutritional characteristics, preservation of appearance, and a prolongation of the time that the fish can be stored.

Traditional methods of preservation usually aim to exclude air, moisture, and microorganisms, or to provide environments in which spoilage organisms cannot survive. The principle of fish preservation thus involves the alteration of certain attributes that support microbial growth such as moisture content, water activity, temperature and pH.

Although consumers prefer fish in the fresh form, fresh fish is only available in the coastal areas. This is due to the unavailability of adequate supplies of ice coupled with poor transportation and distribution facilities to inland areas. Depending upon the variety and locality, fish becomes available during a peak season extending for one to three months and coinciding with the rainy season.

The aim of fish preservation is to prevent undesirable changes in the wholesome quality, nutritive value and/or sensory quality of fish; and to reduce chemical, physical and physiological changes of an undesirable nature and obviate contamination.

With the ever growing world population and the need to store and transport fish from one place to another where it is needed, fish preservation becomes necessary in order to increase its shelf life and maintain its nutritional value, texture and flavour.

Historically salting, drying, smoking, fermentation and canning were the methods used to prevent fish spoilage and extend its shelf life. In response to consumer demand for texture, appearance and taste, new methods were developed including: Cooling, freezing and chemical preservation.

Fish Preservation and Food Security

The Food and Agriculture Organization of the United Nations (FAO, 2000) defines food security as a **"situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life".** The process to attain food security must therefore be sustainable coupled with the maintenance of infra- structure and the environment.

Preservation of fish has a beneficial role in food security; as preserved fish has longer shelf life. In the tropical regions high temperatures and humidity induce accelerated deterioration of fresh fish. This accelerated deterioration is responsible for post harvest loses estimated to be as high as 30%. Preservation of fish could significantly reduce the post harvest loses, consequently reducing the food insecurity.

Fish Preservation and Food Safety

The nutritional quality of fish is high. Therefore, its availability in many developing countries should enable fish to contribute significantly to the provision of a healthy and balanced diet in these countries. It is estimated that around 60 percent of the population in many developing countries derive over 30 percent of their animal protein supplies from fish, while almost 80 percent of the population in most developed countries obtain less than 20 percent of their animal protein supplies from fish.

Preserving fish to extend its shelf-life, while ensuring its safety and quality, is a central preoccupation of the food industry. When harvested in a clean environment and handled hygienically until consumption, fish is very safe. Unfortunately, unhygienic practices, insufficient refrigeration and sub-standard manufacturing practices can lead to outbreaks of fishborne
illnesses and even death.

According to the World Health Organization (WHO), the estimated annual mortality from food and water-borne infectious diseases in developing countries amounts to as high as 2.1 million deaths, mainly of infants and children. In industrial countries, microbiological food borne illnesses affect up to 30 percent of the population. Every year, 20 out of every million inhabitants die from food borne disease. Unwholesome fish and fishery products cause up to 30 percent of the food-borne illnesses.

Around 40 million people in Asia are affected by fish and water borne parasitic diseases, especially trematodes. In addition to the economic losses incurred because of fish spoilage, fishborne
illnesses can have costly adverse health effects, the loss of productivity, medical expenses and the adverse publicity to fishing companies. Additional costs in international trade include the cost of rejections, detention of products, recalls and the resulting adverse publicity to the industry and even to the country.

Fish Preservation Methods

Many techniques have been used to preserve fish quality and to increase their shelf life. They are designed to inhibit or reduce the metabolic changes that lead to fish spoilage by controlling specific parameters of the fish and/or its environment. Generally, they encompass a wide array of technologies used to decrease the fish temperature to levels where metabolic activities catalyzed by autolytic or microbial enzymes are reduced or completely stopped.

Preservation methods such as salting have declined in the developed world in preference to newer methods that are machinery based, technologically advanced and sometimes energy intensive. In the tropics however, preserving food based on low energy consumption, simpler machinery and storage at ambient temperatures, appears to be alternatives that are more economical. Methods such as drying, salting, smoking or in combinations like smoking with drying or salting with smoking and drying as well as the use of herbs and spices including fermentation are in common practice in the poorer regions of the world notably sub-Saharan Africa.

Low Temperature methods of preservation

Since mid of 19th century, the low temperature storage method have been used for the preservation of wide varieties of seafood. This method of preservation does not kill the microorganisms but reduces microbial activities responsible for spoilage. It has been observed that freezing and cold storage are efficient methods of fish preservation but they do not improve product quality.

Freezing operation for preservation cannot prevent amino acid losses. However, it surely impedes the physical and biochemical reactions which are responsible for spoilage of food. Survival of spoilage microorganisms during low temperature storage depends on the types of microorganisms and fish species, history of the fish, methods of catch and the handling and storage processes aboard the fishing vessel.

Salting

Salting as a method of fish preservation is an age old custom. Sodium chloride serves both as a chemical preservative and also binds available moisture in fish. This may, however, not affect the halophiles (salt loving microorganisms) which sometime cause discolouration during drying. The introduction of common salt (NaCl) produces an environment of high osmotic pressure that denies bacteria the aqueous surroundings they require to survive and reproduce. Unlike bacteria, molds can often withstand the effects of high salt or sugar concentrations in foods.

Most food poisoning bacteria cannot live in salty conditions and a concentration of 6-10 per cent salt in the fish tissue will prevent the activity of this class of microorganisms. However, a group of micro-organisms known as **'halophilic bacteria'** are salt-loving and will spoil salted fish even at a concentrations of 6-10 per cent thus further removal of the water by drying is needed to inhibit these bacteria. During salting or brining, two processes take place simultaneously: water moves from the fish into the solution outside and salt moves from the solution outside into the flesh of the fish.

Salting requires minimal equipment, but the method employed is important. Salt can be applied in many ways. **Traditional methods** involve rubbing crude rock salt into the flesh of the fish or making alternate layers of fish and salt (recommended levels of salt usage are 30-40 per cent of the prepared weight of the fish). There is often the problem, however, that the concentration of salt in the flesh is not sufficient to preserve the fish, as it has not been uniformly applied. A better technique is **brining** which involves immersing the fish into a pre-prepared solution of salt (36 per cent salt). The advantage is that the salt concentration can be more easily controlled, and salt penetration is more uniform. Brining is usually used in conjunction with drying. Ultimately the effectiveness of salting for preservation depends upon: uniform salt concentration in the fish flesh, concentration of salt, and time taken for salting and whether or not salting is combined with other preservation methods such as drying.

The salted fish are usually spread in the sun to dry for one to seven days depending on the weather. Platforms are made of sticks, split bamboo or palm branches. When dry, the fish takes on a white appearance due to the presence of salt particles on the surface.

Smoking

The preservative effect of the smoking process is due to drying and the deposition in the fish flesh of the natural chemicals of wood smoke. Smoke from the burning wood contains a number of compounds which inhibit bacteria. Heat from the fire causes drying, and if the temperature is high enough, the flesh becomes cooked. Both of these factors prevent bacterial growth and enzyme activity which may cause spoilage. Smoking is the preferred cheap method of preventing fish spoilage. This is carried out over smouldering wood, sawdust or other local source of energy using traditional kilns constructed with locally sourced materials. This has the effect of imparting

pleasant flavours to the product beside the preservative effect of the smoke itself. Different types of ovens which are completely open at the top to permit the arrangement of fish on the gills are employed. The smoking ovens are predominantly cylindrical or rectangular in shape with one or two openings made at the lower part. These openings serve as doorways for placing fuel into the fireplace which forms the base of the unit. The finished smoke dried fish are dark brown to black, tough and brittle.

Drying

Much of the harvested fish in rural areas of the tropics (especially where ambient temperatures are high and relative humidity low) is preserved by sun drying. While the cost of sun drying is low, there are significant losses due to spoilage, contamination by dust and bacteria, and insect infestation, particularly when the fish are laid close to the ground. Toxins can also develop in such uncontrolled drying set-ups leading to degradation of quality beyond edibility. It is therefore more hygienic for fish to be dried on raised platforms or in solar driers. Solar drying in an enclosed system offers an indirect or direct approach to drying of harvested fishes with added advantages of hygiene, quality control and predictability. The use of simple enclosures that allow heat generation such as the flat plate collectors or other designs of solar heat collectors provide many advantages in the quality of dried products. Solar fish driers are simple and inexpensive and can eliminate much of the spoilage that occurs with traditional drying methods. These driers usually have a wood or bamboo-frame table, covered with plastic or glass to produce an enclosed chamber. The surface of the table can be covered with black plastic or paint to absorb the sun's heat. With openings at the top and bottom of the drier, air will be heated and flow around the fish. Fish exposed to this flow of heated air will rapidly lose moisture, reducing drying time by as much as half over open-air drying. Similar driers have been constructed in Bangladesh, Indonesia, Rwanda, the Philippines, and Papua New Guinea. Solar driers have a number of advantages over traditional drying methods. They exclude rain, insects, animals, and dirt, and can produce temperatures high enough to reduce the possibility of mould or bacteria spoilage. In an increasing hungry world, solar drying offers a cheap and hygienic way of preserving fish. Drying harvested fish is an energy intensive process, which may be expensive when fossil fuels are used but relatively cheap when the free sun’s heat is exploited.

Irradiation

Irradiation of food is the processing of food with ionizing radiation; either high-energy electrons or X-rays from accelerators, or by gamma rays (emitted from radioactive sources as Cobalt-60 or Caesium-137). The treatment has a range of effects, including the destruction of bacteria, molds and insect pests, reducing the ripening and spoiling of fruits, and at higher doses induction of sterility. The technology may be compared to pasteurization; it is sometimes called 'cold pasteurization' as the product is not heated. Irradiation is not effective against viruses or prions, and is only useful for food of high initial quality. The radiation process is unrelated to nuclear energy, but it may use the radiation emitted from radioactive nuclides produced in nuclear reactors. Ionizing radiation is hazardous to life; for this reason irradiation facilities have a heavily shielded irradiation room where the process takes place. Radiation safety procedures ensure that neither the workers in such facility nor the environment receive any radiation dose from the facility. Irradiated fish does not become radioactive, and national and international expert bodies have declared food irradiation as wholesome.

The irradiation of fish has the advantage of enabling food packaging and preparation in which there is less person-to-food contact, thus decreasing the possibility of contamination and decreasing the need for chemical preservatives, some of which may be harmful. The ionizing

radiation that is used to irradiate foods, wherein the foods are exposed to bursts of high-intensity x rays or streams of electrons, disrupts bacterial DNA. However, the wholesomeness of consuming such food is disputed by some opponents and consumer organizations. National and international expert bodies have declared food irradiation as 'wholesome'; UN-organizations such as WHO and FAO have endorsed the use irradiation technology in food preservation. International legislation on irradiation as a food preservation technique varies worldwide from ‘no regulation’ to ‘full banning’. It is estimated that about 500,000 tonnes of food items are irradiated yearly world-wide in over 40 countries. These are mainly spices and condiments with an increasing interest in the irradiation of fresh fruits.

Fermentation

Fish fermentation is an ancient technology practised especially in South East Asia, Africa and Latin America. Fermentation is described as the transformation of organic substances into simpler ones by enzymes or microorganisms. The addition of salt during fish fermentation plays a key role by suppressing the activity of microorganisms, thereby preventing putrefaction. Fermentation is a naturally occurring chemical reaction by which a natural food is converted into another form by pathogens. It is a process in which food spoils, but results in the formation of an edible product. Fish fermentation involves breaking down the protein in the fish by enzymatic action. It is also referred to as **hydrolization**. During fermentation, certain plants may be to fish in order to speed up the reaction. They release proteolytic enzymes such as Papain (present in leaves of papaya tree), Ficin (obtained from the latex of tropical fig tree) and Bromelin (found in fruit or stem of pineapple plant). In a normal process, fermentation may take up to 8 months. It may also take less than a month if pure salt is used and the temperature is increased from 37oC to
45oC.