13

Nutritional Significance of Fish and Food Safety Issues

Dr. T.V. Sankar
Principal Scientist & Head
Quality Assurance & Management Division
Central Institute of Fisheries Technology, Cochin - 682029
E mail: sankartv@sify.com

Fish plays a major role in human nutrition. Importance of fish as a source of high quality, balanced and easily digestible protein is now well understood. Besides, it is also a well-known source of several other nutrients and is being accepted as a healthy food. A health food should contain all the essential constituents' viz., carbohydrates, proteins, fats and minerals and vitamins in correct proportion. In this modern era of health conscientious people often presence of one component or other like cholesterol is not appreciated in the diet. In this context, fish assumes significance and fish caters the needs of the consumer besides contributing to significantly to nutrition. No doubt the per capita consumption of fish is increasing considerably world over.

Fish are highly heterogeneous group with over 25000 species. Fish are available from marine, freshwater and brackish water environments. The composition of fish living in marine environment is different in certain aspects from that of freshwater and brackish water environments. The water conditions like temperature salinity, pressure, seasonality and feeding habits contribute to the changes in the composition. Within the species the changes in composition are noticed depending on the season.

Composition

Like any other meat, water, protein, lipid and ash (mainly minerals) constitute the four basic constituents of fish meat (Table 1 & 2). The quantity of different constituents of meat viz. water, protein, fat and minerals represents the composition of meat. The composition depends on the type and species of fish. The variation in the chemical composition of fish is closely related to feed intake, migratory swimming and sexual changes in connection with spawning.

Table 1: Proximate composition of edible portion fish

Moisture	:	65-90%
Protein	:	16-21%
Lipid	:	0.2-25%
Ash	:	0.5-5.0%

Carbohydrates, vitamins, nucleotides and other non-protein nitrogenous constituents are present in minor quantities even though some of them are playing a vital role in maintaining the system and thus essential for growth and development if the organism.

Table 2: Typical compositions of selected fish, g/100g

Type of Seafood (raw)	Water	Protein	Lipid	Ash	Energy kcal
Common carp	74.84	20.84	3.15	1.17	111.71
Pearl spot	75.30	22.50	2.40	0.90	111.6
Milk fish	70.90	23.50	3.60	1.40	126.4
Mackerel	71.19	21.21	7.51	1.33	152.43
Oil sardine	67.01	19.38	11.70	1.73	182.82
Tuna	74.30	18.90	4.50	1.30	116.1
Cuttle fish	73.10	20.10	0.35	0.51	83.55
Freshwater prawn	78.29	21.17	0.27	0.37	87.11

Source: Biochemical composition of fish & shellfish, P.G.Viswanathan Nair, CIFT Advisory Series, 2000.

Water

Water is the most abundant substance in living systems, making up 70% or more of the weight of most organisms. Water pervades all portions of every cell and is the medium in which the transport of nutrients, cytoplasmic reactions for the maintenance of cells and the transfer of chemical energy occur. All aspects of cell structure and function are adapted to the physical and chemical properties of water. The water molecule and its ionization products, H^+ and OH^-, profoundly influence the structure and properties of all cellular components, including enzymes and other proteins, nucleic acids and lipids.

The proportion of water in fish varies widely between 65-90%, although it is normally in the range of 70-75%. There exists an inverse relationship between water and fat contents. Low water content is usually associated with relatively high fat content and vice versa. An example of a species with high water content is Bombay duck (*Harpodon nehereus*), with about 90% water in the flesh.

Protein

Proteins are perhaps the most important biomolecules and made up of amino acids, joined together by peptide bonds and have versatile role in the living system. Protein content of the fish muscle ranges between 16-21%. A protein content of below 15% signifies the food as low protein food. The protein content varies with the type of muscle and dark muscles usually contain low levels of moisture and protein compared to light muscle.

Proteins are complex molecules and are generally classified based on the shape, solubility and chemical structure. Based on the solubility in salt solutions, proteins are classified in to three groups viz. sarcoplasmic proteins, myofibrillar protein and stroma. Sarcoplasmic proteins (albumin and globulin) are soluble in salt solutions of low ionic strength (<0.15 M). In fish meat this fraction constitutes 25-30 % of the protein. In comparison, mammalian meat contains about 35 - 40% sarcoplasmic proteins. Among fish, pelagic fish (sardines, mackerel etc.) have higher content of sarcoplasmic proteins while demersal fish (flat fishes, scienids etc.) have lower content. The sarcoplasmic proteins fraction contains the metabolic enzymes localized inside the cytoplasm or inside cell organelles like endoplasmic reticulum, mitochondria and lysosomes. As there is uniqueness associated with sarcoplasmic proteins from different species, the electrophoretic patterns of these fractions can be used for species identification.

The myofibrillar proteins are (actin, myosin, tropomyosin and troponin) structural proteins, which constitute 65-70 % of the total protein (compared with 40 % in mammals). These proteins are soluble in neutral salt solutions of fairly high ionic strength (0.5 M). The structural proteins make up the contractile apparatus responsible for the muscle movement. The amino acid composition is approximately the same as for the corresponding proteins in mammalian muscle, although the physical properties may be slightly different. Changes in the environment alter the nature of these fish proteins. Treatment with high salt concentrations or heat may lead to denaturation, irreversibly changing the native protein. Some of these changes have beneficial effects in the processing of fish for product development. The rheological and functional properties of the fish proteins are associated with these proteins and play significant role in the preparation of surimi based products.

Connective tissue proteins (also called stroma proteins) constitute approximately 3 % of the protein in teleosts and about 10 % in elasmobranches (compared with about 17 % in mammals). It is this low content of collagen that gives the soft texture to fish meat. Stroma proteins are insoluble in neutral salt solution or in dilute acids or alkalis. Collagen is the major connective tissue protein in fish and is very similar to that present in mammals. However, fish collagen is much more thermolabile and contains fewer but more labile cross-links than collagen from warm-blooded vertebrates. The hydroxyproline content is in general lower in fish than in other animals. Different fish species contain varying amounts of collagen in the body tissues and may be related to the swimming behaviour of the species. Further, the varying amounts and varying types of collagen in different fishes may indicate the differences in the textural properties of fish muscle.

Table 3: Essential Amino Acid content in various protein sources (g/100g)

Amino acid	Fish	Milk	Eggs	Beef
Lysine	8.8	8.1	6.8	9.3
Tryptophan	1.0	1.6	1.9	1.1
Histidine	2.0	2.6	2.2	3.8
Phenylalanine	3.9	5.3	5.4	4.5
Leucine	8.4	10.2	8.4	8.2
Isoleucine	6.0	7.2	7.1	5.2
Threonine	4.6	4.4	5.5	4.2
Methionine-cysteine	4.0	4.3	3.3	2.9
Valine	6.0	7.6	8.1	5.0

Source: Lahsen Ababouch, 2000. Fish Utilisation and Marketing Service

Fish proteins contain all the essential amino acids (not synthesized and need to be provided in the diet) in the required proportion and hence have a high nutritional value, which contribute to their high biological value. Cereal proteins are usually low in lysine and/or the sulphur-containing amino acids like methionine and cysteine, whereas fish protein is an excellent source of these amino acids. In diets based mainly on cereals, a supplement of fish can, therefore, raise the biological value significantly. The chemical score or amino acid score of fish protein (70) compares well with that of whole egg protein (69), which is considered a standard protein source, and slightly more than that of cow's milk (60). Similarly the protein efficiency ratio of fish proteins is 3.5 against that of egg protein (3.92), beef (2.3) and milk protein (2.5). Fish is also rich in a non-protein amino acid taurine which has a unique role in neurotransmission.

Lipids

Lipids are heterogeneous group of compounds extracted with solvents of low polarity. Glycerides, fatty acids, phosphoglycerides, sphingolipids, aliphatic alcohol and waxes, steroids and several lipoproteins are the important components belonging to this group. The terms fat or oil are often used to represent this group of compounds.

Lipid is the third major constituent, quantity wise, in fish muscle. Variation in the fat content is much wider than that of protein. Fat content varies between species as also within the species between different organs. Fish with fat content as low as 0.5% and as high as 18-20% are common. In many species there is a buildup of fat during feeding season and its proportion decreases substantially after spawning. As far as the type of lipid in fish muscle is concerned, triacyl glycerol and phosphoglycerides both containing long chain fatty acids

are the major component. Squalene and wax esters are other components found in unusually high concentrations in certain fish meat.

Some tropical fish also show a marked seasonal variation in fat content. West African shad *(Ethmalosa dorsalis)* shows a range in fat content of 2-7 % (wet weight) over the year with a maximum in July. Similarly the Indian sardines (*Sardinella longiceps*) show high variations in fat content and during seasons the content go up to 18%. Based on these variations in fat content, fish are broadly classed as lean (fish that store lipids only to a limited extent) and fatty fishes (fish storing lipids in fat cells distributed in the body tissues). Typical lean species are the bottom-dwelling ground fish like cod, saithe and hake. Fatty species include the pelagics like sardines, herring, mackerel and sprat. The main role of fat is as a source of stored energy. The storage sites for fat (fat depot) are different for different species. Liver, adipose tissues etc. are the common sites where fat is stored in fish. In a great majority of cases, the depot fat is mainly triglycerides. The white muscle of a typical lean fish (cod) contains less than 1 % lipids.

Lipids of fish and other aquatic animals contain high proportion of highly unsaturated long chain fatty acids (Table 3). Fatty acids with carbon chain varying from 10 to 22 and unsaturation varying from 0 - 6 double bonds are common. Among the saturated acids palmitic and stearic acids are the important ones and in the monounsaturated group, palmitoleic and oleic acids are the major constituents. Among the polyunsaturated acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are the major components. The percentage of polyunsaturated fatty acids with four, five or six double bonds is slightly lower in the lipids from freshwater fish than in the lipids from marine fish. However, the composition of the lipids can vary with the feed intake and season and many other factors.

Table 4: Omega-3 Polyunsaturated fatty acids (g/100g edible portion) in Selected Fish and Shellfish

Type of Fish (raw)	Lipid Content	20:5 w-3	22:5 w-3	22:6 w-3	Total w-3
Oyster	1.3	0.2	tr	0.2	0.5
Squid	1.7	0.1	tr	0.3	0.5
Lobster	1.6	0.2	tr	0.1	0.3
Crab	5.5	0.5	0.1	0.5	1.2
Herring	13.2	0.8	0.1	1.0	2.0
Mackerel	16.1	0.7	0.1	1.1	2.0
Pilchard/Sardine	9.2	0.9	0.1	1.1	2.2
Tuna	4.6	0.3	0.1	1.1	1.6
Salmon	11.0	0.5	0.4	1.3	2.3

The biological significance of fish oils is mainly due to the presence of polyunsaturated fatty acids. In human nutrition fatty acids such as linoleic and linolenic acid and arachidonic acid are regarded as essential since they cannot be synthesized in the system. In marine fish, these fatty acids are present at a relatively low level. However, presence of other polyunsaturated fatty acids gives importance to fish oils compared to vegetable oils. These acids, eicosapentaenoic acid (C20:5 w3) and decosahexaenoic acid (22:6 w3) are reported to play important role in the development of nerve cells in growing children, besides having proven effects in atherosclerosis and as antithrombotic factor.

Fish oils have a positive cholesterol lowering effect by increasing the content of high density lipoprotein and lowering the LDL/HDL ratio. Evidences indicate the positive effect of PUFAs to reduce cardiac arrhythmias - the irregular electrical conductivity of heart muscle often leading to cardiac arrest. Presence of high levels of PUFA increases the membrane permeability and also has effect on blood pressure. Generally, approximately 50% of fatty acids in lean fish and 25% of fatty acids in fatty fish are PUFAs. Eicosapentaenoic acid (C20:5 w3) and decosahexaenoic acid

Table 5: Mineral Contents of Selected Fish and Shellfish

Type of Seafood	Sodium	Potassium	Calcium	Iron	Zinc	Iodine (mcg)	Selenium (mcg)
Cod	60	340	9	0.1	0.4	110	28
Herring	123	320	60	1.2	0.9	29	35
Mackerel	63	290	11	0.8	0.6	140	30
Pilchard/Sardine	120	360	84	1.4	1.0	29	34
Tuna	47	400	16	1.3	0.7	30	57
Mussel	290	320	38	5.8	2.5	140	51
Lobster(boiled)	330	260	62	0.8	2.5	100	130
Crab	420	250	n	1.6	5.5	n	17
Prawn	190	330	79	1.6	1.5	21	16

n= data not available

Source: : Holland, B., Brown, J., & Buss, D.H., 1993. Fish and Fish Products; the third supplement to McCance & Widdowson's The Composition of Foods (5th Edition), HMSO, London.

(22:6 w3) are the major PUFAs associated with fish oils. EPA and DHA are reported to reduce vasoconstrictor effect by competing with arachidonic acid which results in strong vasoconstriction through the formation of thromboxane A2, a strong vasoconstrictor. EPA are also reported to have antitumor effect through suppression of cell proliferation while DHA appears to induce apoptosis. Other clinical symptoms where PUFA plays key role include acute respiratory distress syndrome, multiple sclerosis. Alzheimer's diseases etc.In elasmobranches, such as sharks, a significant quantity of the lipid is stored in the liver and may consist of high molecular weight hydrocarbon like squalene. Some sharks may have liver oils with a high concentration (80%) of the lipid as unsaponifiable substance, mostly in the form of squalene.

Minerals

Fish is good source of almost all the minerals present in seawater (Table 4) and the total mineral content in wet fish meat range from 0.6 to 1.5%. Calcium and phosphorus account for more than 75% of the mineral in the skeleton. Besides forming a part of skeleton, phosphorous has a number of metabolic and physiological roles in fish. Element of special nutritional significance, iodine and fluorides are also present in fish. The iodine content in marine fishes ranges form 0-300 µg per kg fish. Sulfur is present in the form of amino acids as fish is good source of sulfur containing amino acids, cysteine and methionine. Copper and iron are associated with muscle tissues. Cobalt is present in the form of cyanocobalamin (Vitamin B_{12}). It should be noted that the sodium content of fish meat is relatively low which makes it suitable for low-sodium diets. Certain fishes like tuna are especially good sources of macro minerals like magnesium and trace elements like selenium.

Vitamins

Both water soluble and fat-soluble vitamins are present in fish. The content of fat soluble vitamins varies between fish and within fish with season. The hepatic reserve of vitamin A in aquatic animals is much greater compared to mammals and birds. The meat of fatty or semi-fatty fishes is an excellent source of vitamin D, the concentration of which varies from 500 to 3000 IU/100g. In fish flesh vitamin E occurs largely as α-tocopherol. The antihaemorrhage factor, vitamin K is also present in fish.

Table 6: Vitamin Content of Selected Fish and Shellfish

Type of Seafood	Vitamin A, mcg	Vitamin D, mcg	Vitamin E, mg	Vitamin B1, mg	Vitamin B2, mg	Vitamin B6, mg	Vitamin B12, mcg
Cod	2	tr	0.44	0.04	0.05	0.18	1
Herring	44	19	0.76	0.01	0.26	0.44	13
Mackerel	45	5	0.43	0.14	0.29	0.41	8
Pilchard/Sardine	n	11	0.29	tr	0.22	0.39	11
Tuna	26	7.2	n	0.10	0.13	0.38	4
Mussel	n	tr	0.74	tr	0.35	0.08	19
Lobster(boiled)	tr	tr	1.47	0.08	0.05	0.08	3
Crab	tr	tr	n	0.07	0.86	0.16	tr
Prawn	tr	tr	2.85	0.04	0.12	0.05	7

tr=trace amounts only; n= data not available

Fish meat is a good source of the B vitamins. The red meat has higher content of vitamin B than white meat. Fish liver, eggs, milt and skin are good sources of B1, riboflavin, pyridoxine, folic acid, biotin, and B12. The amount of vitamins and minerals is species-specific and can vary with season. The vitamin content is comparable to that of mammals except in the case of the A and D vitamins, which are found in large amounts in the meat of fatty species and in abundance in the liver of species such as cod and halibut. Liver oils from shark (13300 IU/ g oil) and tuna are rich in vitamin A. Large quantity of vitamin E, varying between 500 - 3000 IU per 100 g, is present in liver and body oils.

Non Protein Nitrogenous compounds

The water-soluble, low molecular weight, nitrogen- containing compounds of non-protein nature constitute 9 to 18% of the total nitrogen in teleosts. The major components in this fraction are: volatile bases such as ammonia and trimethylamine oxide (TMAO), creatine, free amino acids, nucleotides and purine bases, and, in the case of cartilaginous fish, urea. The composition varies from species to species and within the species depending on size, season and muscle sample.

TMAO constitutes a characteristic and important part of the NPN-fraction in marine species but is virtually absent in freshwater species and other terrestrial organisms. The amount of TMAO in the muscle tissue depends on the species, season, fishing ground, etc. In general, the higher content of TMAO is found in elasmobranches and squid (75-250 mg N/100 g) while flatfish and pelagic fish have comparatively lower content.

Quantitatively, the main component of the NPN-fraction is creatine. In resting fish, most of the creatine is phosphorylated and supplies energy for muscular contraction. The NPN-fraction also contains a fair amount of free amino acids. Taurine, alanine, glycine and imidazole-containing amino acids seem to dominate in most fish. Of the imidazole-containing amino acids, histidine has attracted much attention because it can be decarboxylated microbiologically to histamine. Active, dark-fleshed species such as tuna and mackerel have a high content of histidine. The amount of nucleotides and nucleotide fragments in dead fish depends on the state of the fish.

The major and the minor constituents undergo changes during processing and storage and their interactions with each other results in the formation of chemicals in the body. Some of the metabolites, like histamine, hypoxanthine are used as quality indices to evaluate the quality of the fish.

Food safety issues

Food safety is a discipline dealing with producing, storing and transportation of food in order to prevent food borne illness. Food facilitates growth not only for human beings but also for microorganisms and animals as well. If you provide a conducive environment for bacteria to grow in food, it becomes contaminated causing inconvenience to the consumers.

In the global context, produced in one part of the world is available in the other part and if sufficient precaution is not taken this may lead to epidemic level. Therefore food safety is viewed as a serious matter and has been taken as a priority agenda at the highest body of Food and Agricultural Organization. Codex Alimentarius Commission (CDC) of the FAO is body formed in 1962 to tackle the issues related to trade and consumers. This transportation of commodities from one corner of the world to the other also leads to food security issues as a result of transportation of the microorganisms of concern to the destination country along with food. As of now the CDC has about 165 member countries representing over 98% of the world population. The primary objective of the organization is to provide guidelines for hazards related to foods, code of practices for production,

transportation and distribution, harmonize food standards between countries and to protect health of consumers and ensure fair practices in food trade.

There are two aspects which need to be considered when factors affect the consumers are concerned. One is food quality which addresses the quality of food meant for consumption which is related to the characteristics of food affecting the sense of the consumers. In the same food standards are related to safety and hygiene, quality, packaging, labeling and handling and storage. The second is concerned with safety aspects namely the consequence of consuming a food. The poor quality food need not be unsafe and vise-versa. The food safety standards are related to the presence of additives, environmental contaminants, agricultural chemicals, radioactivity and micro-organisms and their toxins. It is not only the presence of these contaminants but also their quantity that is crucial as far as safety is concerned.

Besides contributing to nutrition food also contribute to transmission of diseases. Though there are specific standards available for the preparation and transportation of standards, most often enough care is not taken leading to food safety issues. Water is one of the important agents which plays a major role in the transmission of food borne diseases. This highlights the importance of sanitation and hygiene in food producing establishments and WHO has given five key principles of food hygiene as follows:

1. Prevent contaminating food with pathogens spreading from people, pets, and pests.
2. Separate raw and cooked foods to prevent contaminating the cooked foods.
3. Cook foods for the appropriate length of time and at the appropriate temperature to kill pathogens.
4. Store food at the proper temperature.
5. Do use safe water and cooked materials.

Hazard and safety concerns

Any biological, chemical or physical agent that is reasonably likely to cause illness or injury in the absence of its control is called a hazard. Hazards profile is food is so extensive that it is difficult to qualify and quantify majority of them. However, as per the guidelines from the organizations concerned quite a few are notified as important and need to be addressed if it is meant for human consumption. As has been discussed we are aware that there are three major classes of hazards viz., biological, chemical and physical which make food unsafe for human consumption. These hazards are introduced in to the food along the food value chain at any point starting from harvesting, processing, transporting, preparing, storing and serving.

Contamination by microbiological hazard occurs when food becomes contaminated by microorganisms at any of the stages mentioned above from air, water, soil, animals and the human body. The microorganisms are ecosystem specific. The consortia of microorganism associated with terrestrial ecosystem are different from that of water. Generally the microbes associated with unpolluted water system or marine environment are nonpathogenic. Same is the case when an animal is alive - no external microbes can act on them. But once the animal dies other microorganisms act on them which most often may be a pathogen from human point of view. This mainly happen during handling operations,

either at the preprocessing or processing area. Microorganisms commonly associated with foodborne illnesses include bacteria, viruses and parasites.

In the same way the chemical hazard profile for product depends on the source of the commodity. The product from a particular soil retains the characteristics of the soil from where they are harvested. The vegetable or a fish harvested from a particular ecosystem are likely to possess all the chemical contaminants, particularly pesticide residues, polychlorobiphenyls, dioxins, heavy metals etc. from that source. Besides, chemical hazards can occur at any point during the handling stages, including storage, preparation and service.

These organisms can affect human health causing infection, intoxication and even death. Infection is the consequence of invasion by organisms followed by multiplication in the body. When the toxin produced by the organism affect the human then the condition is called intoxication. Some of the disease causing microorganisms which are pathogenic human beings are bacteria (Salmonella spp., Enterohaemorrhagic Escherichia coli, *Campylobacter jejuni, Yersinia enterocolitica, Listeria monocytogenes, Bacillus anthracis, Bacillus cereus, Staphlococcus aureus, Clostridium botulinum, Clostridium perfringens, Vibrio vulnificus, Vibrio parahaemolyticus*), viruses (hepatitis A virus, Norwalk iruses, rotavirus) and Parasites (*Toxoplasma gondii, Cryptosporidia, Giardia sp.,Trichinella spiralis, Taenia solium, Anisakis spp*)

There are a number of chemicals that are present in the ecosystem which enters the food it becomes a contaminant which ultimately a health hazard. Some of the contaminants are naturally present in the ecosystem such as heavy metals, some get in to ecosystem due to human involvement such as agricultural chemicals like pesticides and related compounds, industrial chemicals such as polychlorobiphenyls, dioxins etc., and some produced in the food due to spoilage during storage. The presence of residues in food may result from the application of a particular chemical during agricultural production, without the intention that the involved compound or its degradation products remain present in the agricultural commodity when it is transformed into food. In the same way lots of antibiotic residues which are used with purpose in animal husbandry activities get mixed up food and get exposed as food contaminant or hazard.

The chemicals formed in the food can be controlled by appropriate preservation techniques while the other two categories cannot be controlled by any means. Lots are chemicals are used in food industry intentionally or unintentionally. Intentionally added chemicals are used to enhance their shelf life or keeping quality or to improve the texture of the product. Some are permitted by law for use in food but most used are not permitted chemicals. In the same way intentionally added chemicals are mostly permitted additives. According to European Union's Directive 89/107/EEC, a food additive id defined as" any substance not normally consumed as a food in itself and not normally used as a characteristic ingredient of food whether or not it has nutritive value, the intentional addition of which to food for a technological purpose in manufacture, processing, preparation, treatment, packaging, transport or storage of such food, results or may be

reasonably expected to result, in its or its by-product becoming directly or indirectly a component of such foods".

But often they are used beyond the recommended level posing problem to the consumers. These types of misuse of chemicals in food lead to allergic responses among the consumers in the milder sense to fatality in specific cases. Chemicals provoking food intoxications can be classified in various manners as e.g. food additives, residues, contaminants and endogenous substances. Unintentional contaminants are related to the sanitizers used for keeping hygiene in the processing establishment, grease or paints used in different machineries or elsewhere.

Physical hazards usually encountered in foods as a result of unintentional or accidental contamination and poor food handling practices. These are contaminants which are not normally present in food but causes injury to the consumer due to its presence. These are generally from three different categories viz., mineral comprising of sand, stones, dust, metals, glass, fibre, etc., plant materials such as weeds, leaves, stems, etc. and animal materials such as mites, insects, rodents, etc. which are likely to pose problem to the consumer needs to be considered while performing hazard analysis.

What are the options?

Controlling the hazards is possible only if identify them correctly. In that context, hazard analysis becomes an important area of food safety regime. The good management practices (GMP) are the immediate solution. GHP are the general practices that are intended to reduce microbial food safety hazards that include sorting, packing, storage and transportation operations.

Food quality control is necessary to ensure that food related supplies are safe, of good quality and in adequate amounts in appropriate time at affordable price. The idea is to ensure acceptable nutrition and health status to world population. The international guidelines and the good Manufacturing practices, Certification under an Internationally Accepted Standard (ISO 9000 series), Total Quality Management (TQM) and ISO offer a meaningful solution to address these issues. A **good manufacturing practice (GMP)** is a production and testing practice that helps to ensure a quality product. GMP regulations require a quality approach to manufacturing, enabling food producing establishments to minimize or eliminate and legal aspects. Hazard Analysis Critical Control Point (HACCP) is a systematic, science instances of contamination which in turn protects the consumer from purchasing a safe product. Therefore GMP ensures that products meet the requirements in terms of quality, safety based programme which can be part of GMP on order to attain the requirements of food safety.

HACCP is an important component of GMP, which was first established in 1960 for NASA for space programme and is a systematic hazard control programme which focuses on hazard prevention rather than hazard control. It is a systematic process control system which identifies hazards and implements control measures to eliminate of reduce the hazard to acceptable level. The effective implementation of HACCP requires in place certain pre-requisite programmes which are nothing but operational conditions providing basis for the HACCP system. A appropriate HACCP programme should cover all the major steps in the product starting from raw materials to production to packaging to transport to

distribution. The important sanitary conditions which are critical to implementation of HACCP and hence to food safety management systems include safe water, condition and cleanliness of food contact surfaces, prevention of cross contamination, personal hygiene (hand washing, hand sanitizing etc.), control on additives and prevention of adulterants, labeling, storage & use of toxic compounds, employees health condition, and exclusion of pests

Therefore, the cold chain plays a significant role in modern global trade in all food commodities. Increasingly, market demand has heightened the importance of uncompromised food safety and quality as it travels through sectors that include farming, food processing transportation/distribution, retailing and ultimately as it ends up in the foodservice industry or on the consumer's table. Control of the storage temperature is vital in maintaining the quality and safety of refrigerated foods throughout the chain. As a consequence, it is important that good chill/storage procedures are in place to ensure that such foods not only achieve their required shelf lives but are safe for consumption by the end user.

****