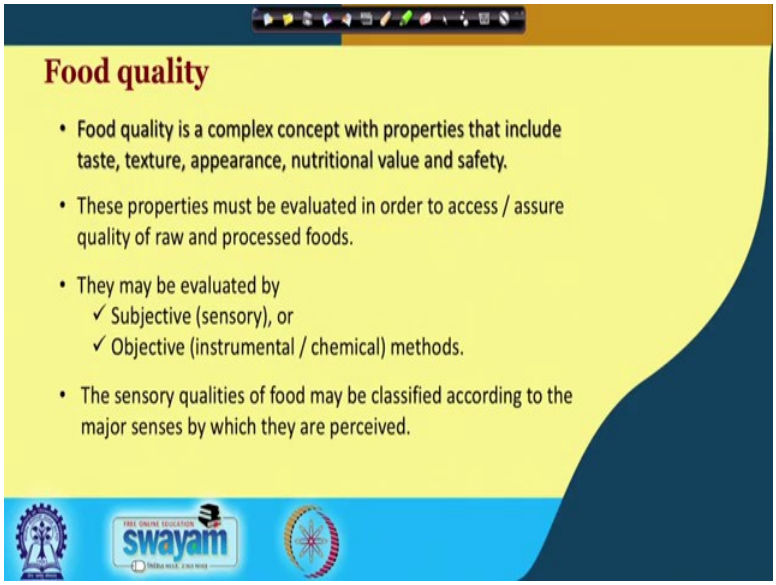
Novel Technologies for Food Processing and Shelf Life Extension

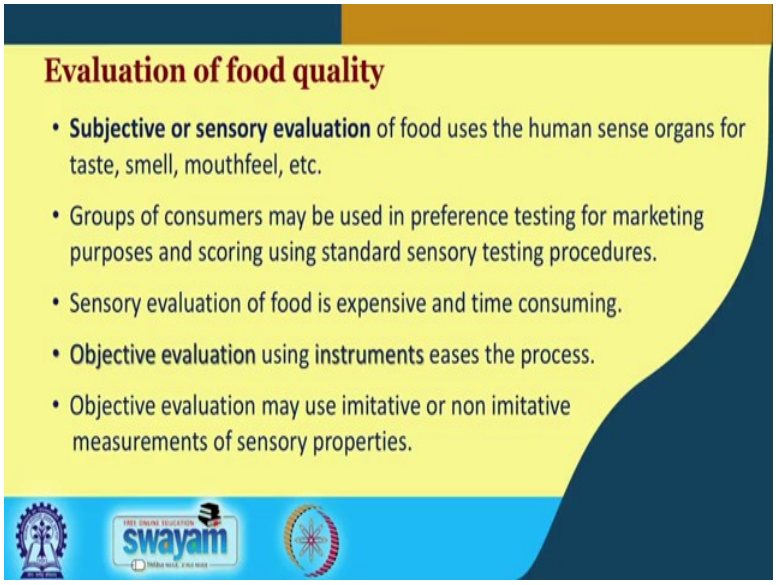
Prof. Hari Niwas Mishra
Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur

Lecture - 02
Quality and Safety Aspects of Food

In this section, a brief overview of the Quality and Safety Aspects of Food is highlighted.

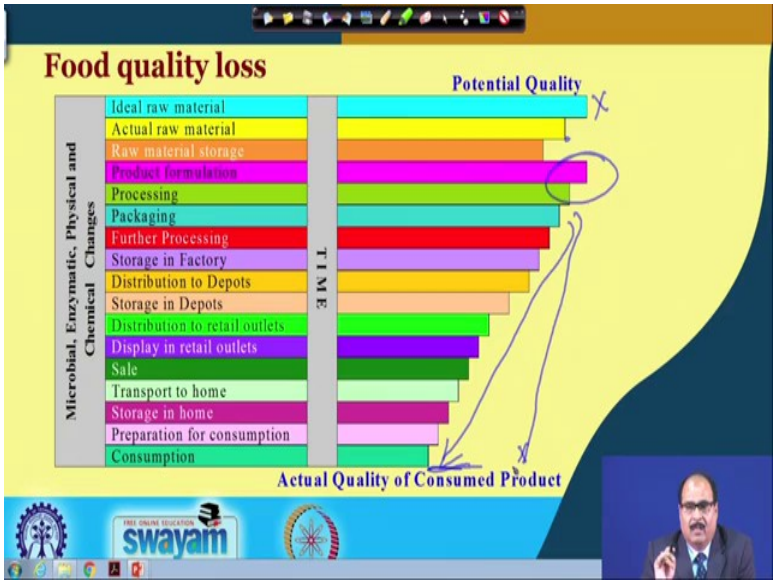


Food quality is a complex concept; it includes the properties like taste, texture, appearance, nutritional value and safety. These properties must be evaluated in order to assess or assure the quality of raw and processed foods. These quality attributes may be evaluated by subjective or sensory methods or objective like instrumental or chemical methods.



The sensory quality of food may be classified according to the major senses by which they are perceived. Subjective or sensory evaluation of food generally uses the human sense organs for taste, smell, mouthfeel etc.

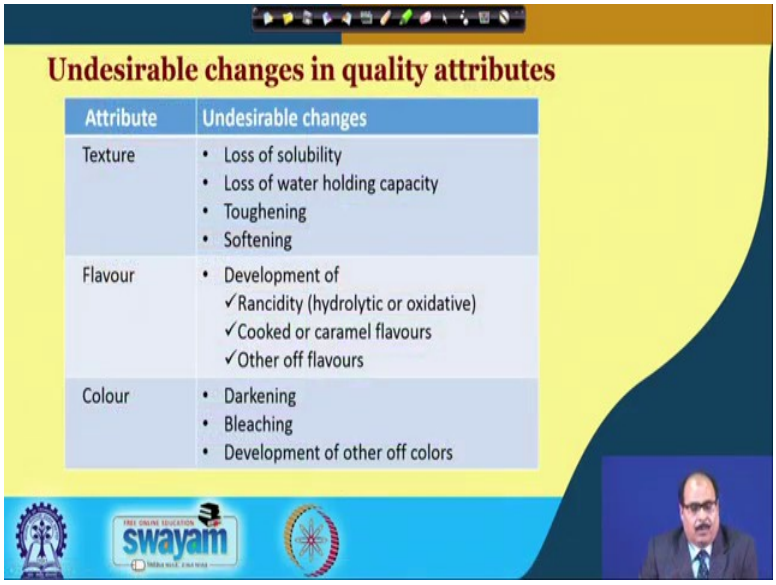
For this, a group of consumers or even trained panelists may be used in preference testing for marketing purposes and scoring using standard sensory test procedures or protocols. Sensory evaluation; however, is an expensive and time consuming process; although it is highly desirable particularly when a new food is to be introduced in the market. So, before that it is always desirable to be tested by human individuals or by consumers for its attributes. Objective evaluation of food normally involves instruments and this instrumental analysis or chemical analysis may generally ease the processes. Objective evaluation may use imitative or non imitative measurements of sensory properties.



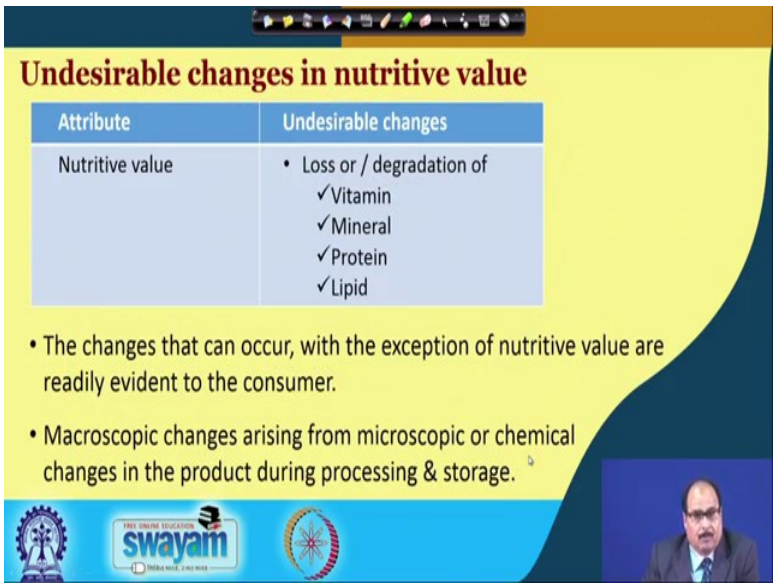
Before the food material goes to the table for consumption, it has to pass through different stages. In this slide, the stages in the food value chain i.e. starting from the raw material to the consumption are given. Sometimes, the actual raw material that is taken may be little inferior than that required in the ideal raw material and this may be because of different agronomical, environmental, horticultural or other factors.

Except for the case where by appropriate selection of the proper material, its blending and formulation in proper proportion, in each and every stage there is reduction in the quality. Whether in processing, packaging further processing, storage in factory, distribution to depots etc., in each and every stage there is a great potential for the loss in quality of the food. Food has different chemicals, biochemical, bioactive, enzymes, microorganisms etc. These have constant and continuous interactions during all these stages and therefore, they bring about changes in different constituents of the food.

So, in the actual quality of the product is less than what was to be perceived in the potential quality of the ideal raw material. All these changes in the quality i.e. whether it is a microbiological, enzymatic, physical, or chemical; can be minimized or accelerated. This is done in processing by appropriate selection of process or other parameters during storage and handling. Aim is to keep the undesirable changes to as minimum as possible; so that the food quality is retained to the maximum extent.

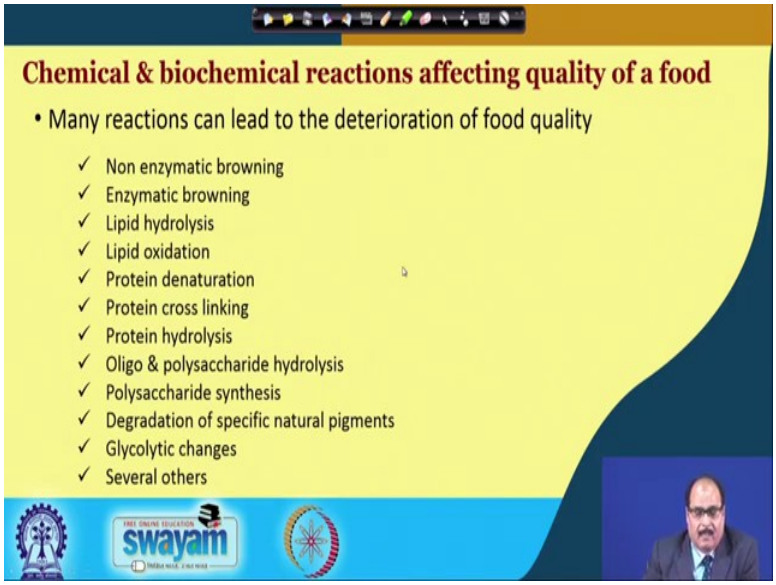


Undesirable changes in food quality attributes may be numerous. In texture, there may be loss of solubility, water holding capacity; the food may become tough it may become soft. Depending upon the components present in the food, the factors which are there during processing and handling; there may be development of rancidity, both either hydrolytic or oxidative. There may be development of cooked or caramel flavour or other off flavours. Regarding undesirable changes in the colour of the food during processing, handling and storage etc., there may be darkening, bleaching or development of a new colour.

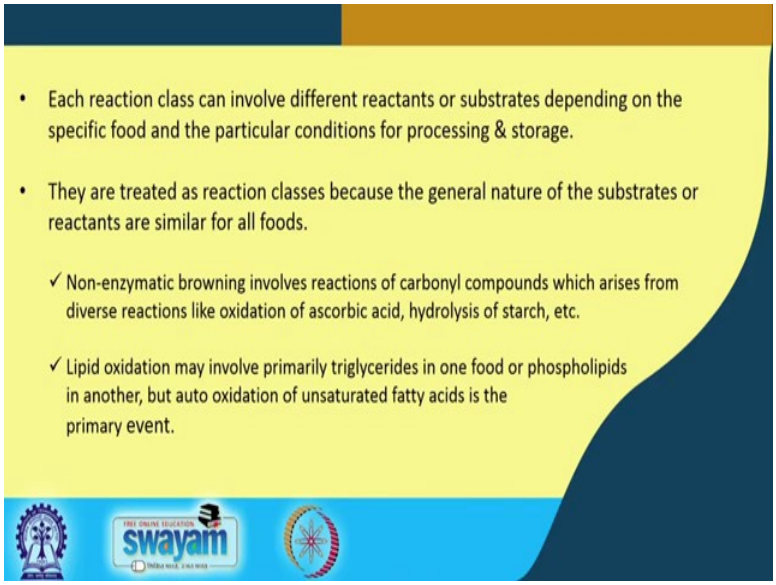


All these changes are macroscopic changes arising from the microscopic or chemical changes in the product during processing and storage. There might be certain undesirable

microscopic changes in the nutritional value of the food because of the loss or degradation of vitamins, minerals, proteins, lipid, etc.

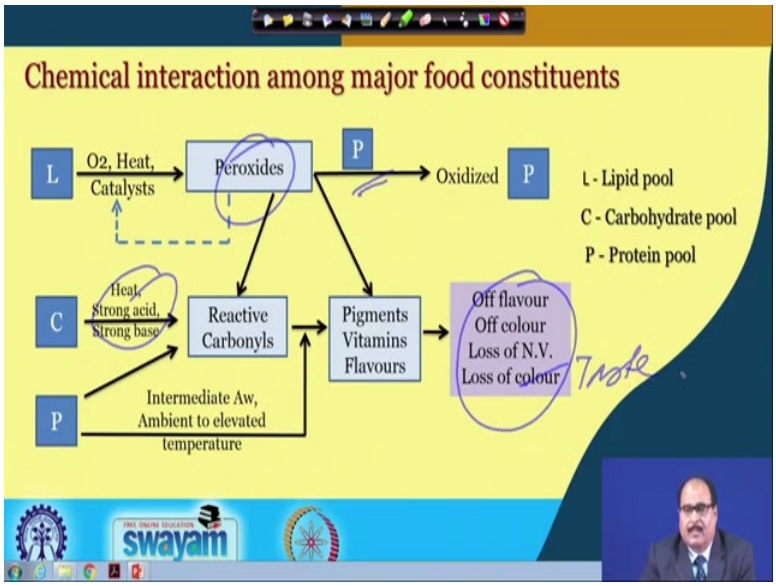


When the food is transported, handled, or exposed to various conditions during processing, it comes across various reactions which influence its quality. Major reactions may be non-enzymatic browning, enzymatic browning, lipid hydrolysis, oxidation, protein denaturation, crosslinking, protein hydrolysis, oligo and polysaccharide hydrolysis, polysaccharide synthesis, degradation of certain natural pigments, glycolytic changes, etc.

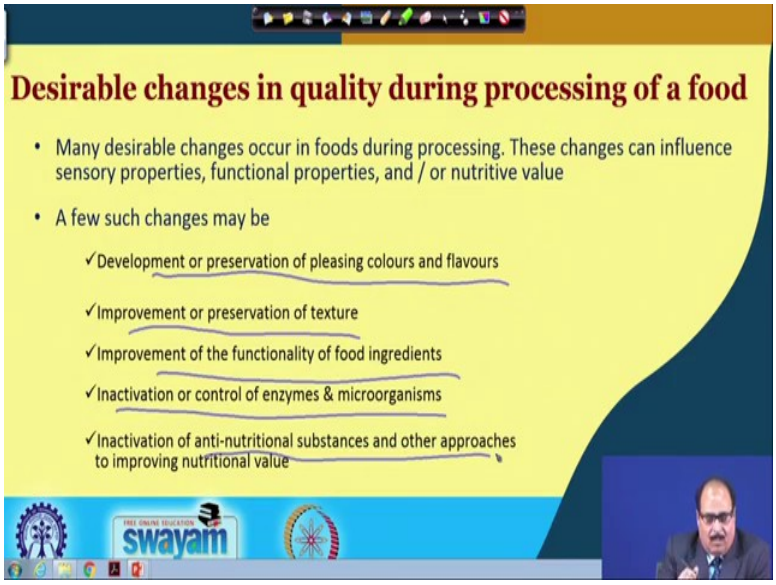


Each reaction can involve different reactants or substrates depending upon specific food and the particular conditions for processing and storage. They are treated as reaction

classes because the general nature of the substrates or reactants is similar for all foods. For example, non enzymatic browning involves a reaction of carbonyl compounds which arise from different diverse reactions like oxidation of ascorbic acid, hydrolysis of starch, etc. Similarly, lipid oxidation may involve primary triglycerides in one food or phospholipids in other food, but the oxidation of unsaturated fatty acid is the primary event.



A brief overview of the chemical interactions among the major food constituents and which ultimately bring about certain changes in the quality is given in this slide. These changes may be desirable or even may be undesirable. In any food material, the three major pools are lipid, carbohydrate and protein. When lipids come across oxygen, heat or other catalysts, it may be converted into peroxide. These peroxides may interact with proteins which may be oxidized. Similarly, carbohydrate pool of the food if come across various factors like heat, strong acid, strong base, it may be converted into different reactive carbonyls. These reactive carbonyls further may interact with pigments, vitamins, flavours and finally, result to off flavor, off colour, loss of nutritive value, loss of colour etc. Even the peroxides may also react or interact with reactive carbonyls; protein pool may directly interact with the reactive carbonyls and the chain may follow. Depending upon the water activity, temperature etc., they may get degraded or may interact with pigments, vitamins, flavours, etc. which may result in change in flavour, colour, nutritive value, taste etc.



When the food is exposed to certain factors during processing, many desirable changes can also occur. These changes can influence the sensory properties, functional properties or nutritional value of the food. Few such changes include development or preservation of pleasing colours and flavours, improvement or preservation of texture, improvement of the functionality of food ingredients, inactivation or control of enzymes, and microorganisms or inactivation of anti-nutritional substances or other approaches for improving the nutritional value.

Regarding development or preservation of pleasing colour and flavour during processing, there are different examples in the food to this effect. The desirable colour and flavour develop in food during processing of foods like meat, coffee beans, nuts, olives etc. The

freshly harvested coffee beans do not have characteristic flavour or colour, but it develops during the roasting process. Similarly in processing of fabricated foods like bakery products, confectionery products, snack foods, breakfast cereals etc., they might differ in taste and flavour depending upon the raw material and other ingredients as well as process used. In fermentation processes like cheese, alcoholic beverages etc., the desirable change in flavour can be easily noticed. The desirable changes in colour, flavor, taste etc. can be seen even when the fruits ripen.

The preservation of colour and flavour is also often achieved by addition of certain chemicals like antioxidant etc. or by removal of undesirable components from the food. Like for example, glucose is removed from egg white to retard the browning of the dried product. Before it is put to the thermal processing or heating or drying, the egg white is given certain treatment or even sometime it is allowed to be acted upon by certain microorganisms which eat away the glucose pyramid; so it retards the browning reaction.

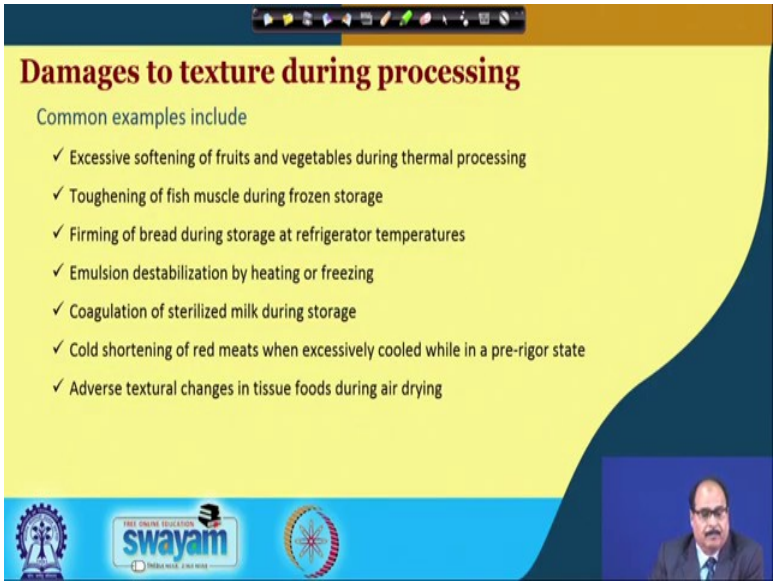
Examples of desirable modification of the texture in food during processing include softening of the plant tissues by heat, firming of plant tissues through the action of calcium and endogenous pectin methyl esterase, tenderization of meat by addition of proteases, development of desirable texture in meat analogs, gelling coagulation or firming of egg products, puddings and bakery products by heat.

Formation of cheese by the development or addition of acid to milk; even certain hydrolytic reactions many of which are enzyme catalyzed appear predominantly among the processes that cause softening of texture of the food.

Examples of improved functionality of processed food include heat denaturation of whey protein in dried milk intended for bread making, pre rigor freezing of meat intended for sausage making, alteration in the functionality of starch by gelatinization or chemical modification, alkali processing of soy proteins to impart new textural properties, control of thiol-disulfide interchange reactions in gluten to develop proper rheological properties in bread dough or increasing the sweetness of corn syrup by isomerizing glucose to fructose. In all these processes, the functionality of the food is improved by processing.

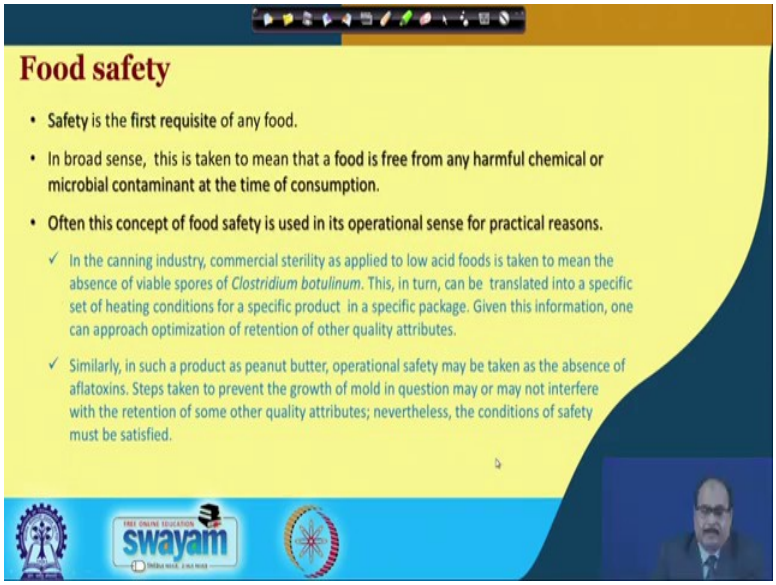
During processing there may be inactivation of anti-nutritional substances. The foods contain various natural anti-nutritional substances like trypsin inhibitors, hemagglutinins in legumes, thiaminase in fish, avidin in egg, phytate in cereal grains and many of these are protein in nature, and therefore, are subject to inactivation during moderate heating of moist food.

In other instances, removal or chemical modification is a feasible approach for inactivating anti-nutrients factors. For example, enzymatic hydrolysis or removal of lactose from milk that is intended for lactose intolerance individuals. Reduction of stachyose and raffinose; this stachyose and raffinose are the flatulence producing chemicals present in pulses etc. So, their concentration if it is reduced in leguminous seeds by the processes like germination etc. then it may provide beneficial effects or results in the inactivation of anti-nutritionals. Similarly, removal of phytates from grain by milling is an example of this. Bran and hulls of cereal grains contain some undesirable substances called phytates etc.; when the grains are dehulled or polished, these phytates are removed.



There might be certain damages to the food texture during processing. The common examples include excessive softening of fruits and vegetables during thermal processing, toughening of fish muscle during frozen storage, firming or staling of bread during refrigerated storage, emulsion destabilization by heating or freezing, coagulation of sterilized milk during storage, cold shortening of red meats when it is excessively cooled

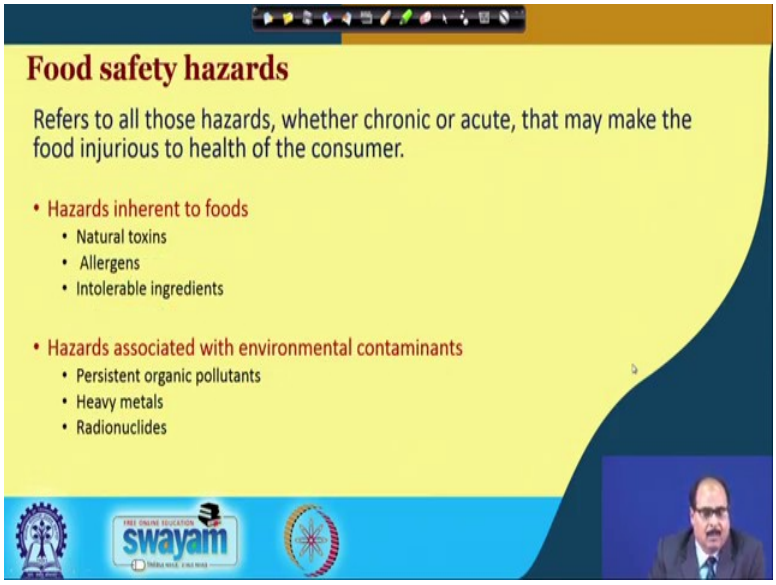
while it is in a pre rigor state, or adverse textural changes in tissue foods during air drying.



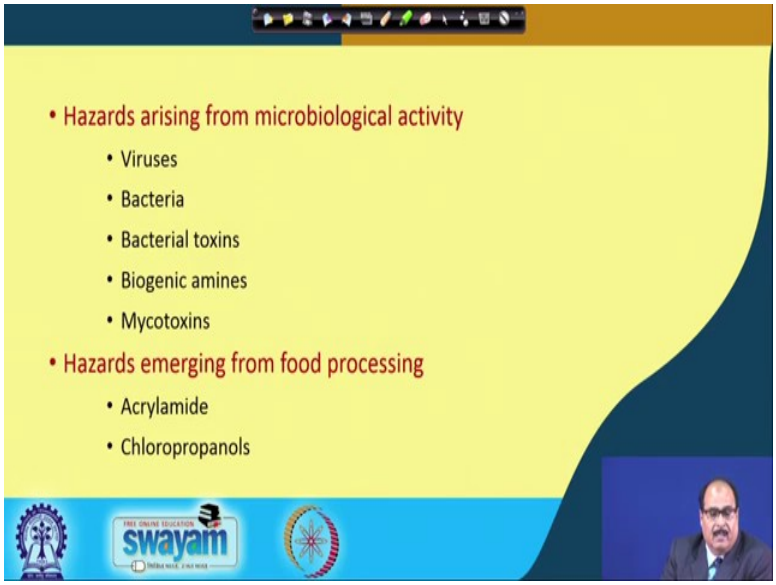
Safety is the first requisite of any food. In broad sense, the food safety is taken to mean that a food is free from any harmful chemical or microbiological contaminant at the time of its consumption.

Often this concept of food safety is used in its operational sense for practical reasons. Few examples include; in the canning industry, the commercial sterility as applied to low acid foods is taken to mean the absence of viable spores of clostridium botulinum. This in turn can be translated into a specific set of heating conditions; for a specific product in a specific package and given this information, one can approach optimization or retention of other quality attributes.

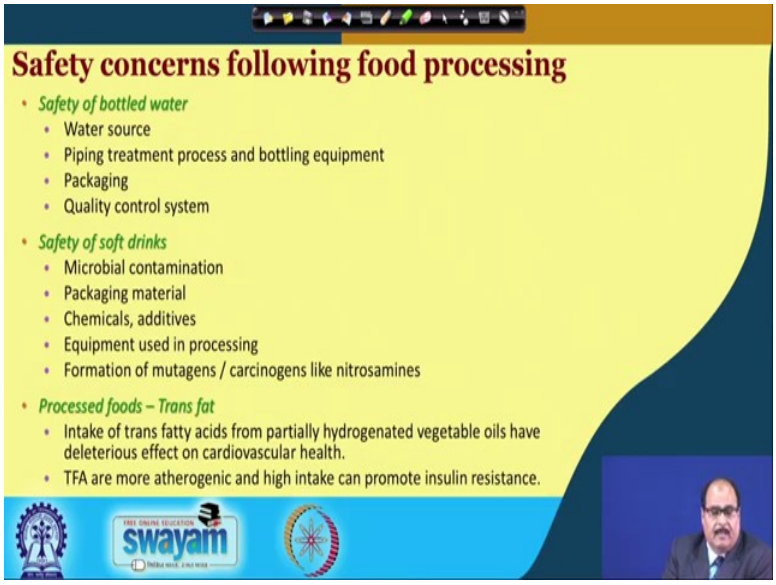
Similarly, in a product such as peanut butter; operational safety may be taken as the absence of aflatoxins. Steps taken to prevent the growth of the mold which is responsible for the production of aflatoxin, may or may not interfere with the retention of some quality attributes; nevertheless the conditions of the safety must be satisfied.



Food safety hazards refer to all those hazards whether, chronic or acute that may make the food injurious to health of the consumers. These hazards may be inherent to food like natural toxins, allergens, intolerable ingredients, there may be hazards associated with the environmental contaminants like persistent organic pollutants, heavy metals, radionuclides, etc.

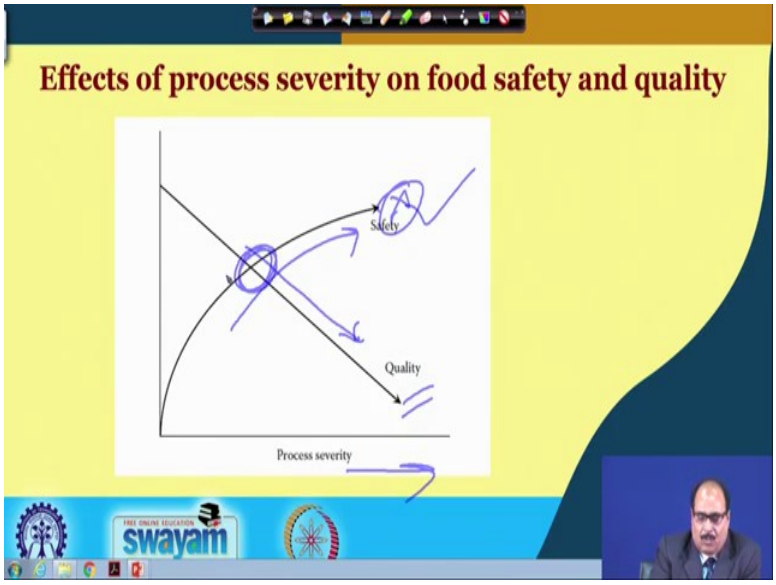


Hazards arising from microbiological activity in the food such as viruses, bacteria, bacterial toxins, biogenic amines, mycotoxins etc. or even hazards emerging from food processing like acrylamides, chloropropanols etc.



There are safety concerns following the food processing; i.e. whatever the ingredient that is being taken should should meet the quality requirements; GMP, GHP procedure should be followed. Like for example, if taken the safety of the bottled water, it is to be monitored that, what is the source of the water that has been used, piping treatment processes and bottling equipment even packaging material or what are the different quality control systems.

Sometimes gases are found in the packaged bottle when opened. So, that clearly indicates that the bottle while its packaging, the good conditions were not maintained. Similarly, in the case of soft drinks, safety aspects include microbiological contamination, packaging material, chemicals, additives, even equipment used in processing, formation of mutagens or carcinogens or even nitrosamines etc. during processing. In the process foods, even the processing conditions itself sometime create some problems; for example, the trans fats. Normally, in the virgin vegetable oils, the unsaturated groups have the cis fatty acids, but when these oils are heated, cis are converted into trans fat. Intake of trans fatty acids from the partially hydrogenated vegetable oils have deleterious effects on cardiovascular health. Even trans fatty acids are more atherogenic and high intake can promote insulin resistance.



Summary about how the quality and safety are interrelated, particularly the processing condition is given in the above slide. If a more severe process is used, it may be safe or its quality may get deteriorated. So, more severe process will ensure the safety i.e. microbial inactivation, toxin decontamination etc. but can compromise the quality.

In food processing, depending upon the requirements, the food, and its consumption pattern etc., a balance has to be made i.e. up to what extent it should be processed, so that it has a good quality as well as at the same time, it is safe for the consumption.