Novel Technologies for Food Processing and Shelf Life Extension

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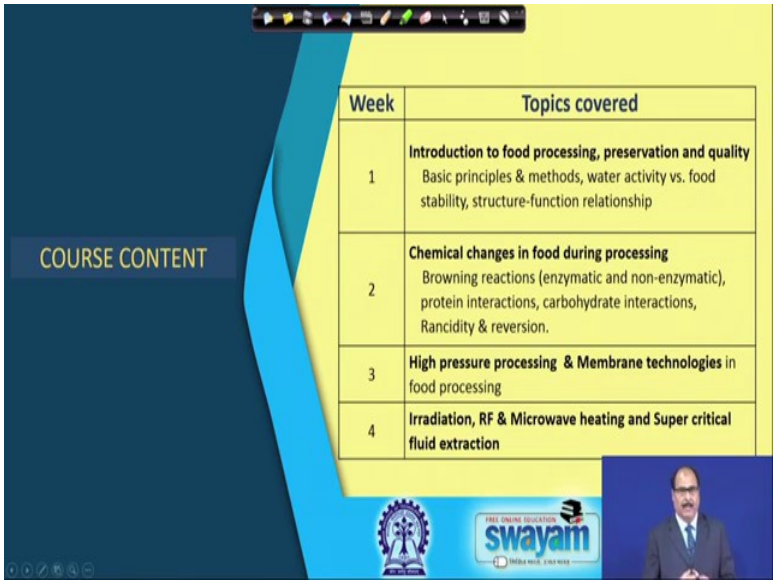
Lecture – 01
Course Introduction and Food Constituents & Functions

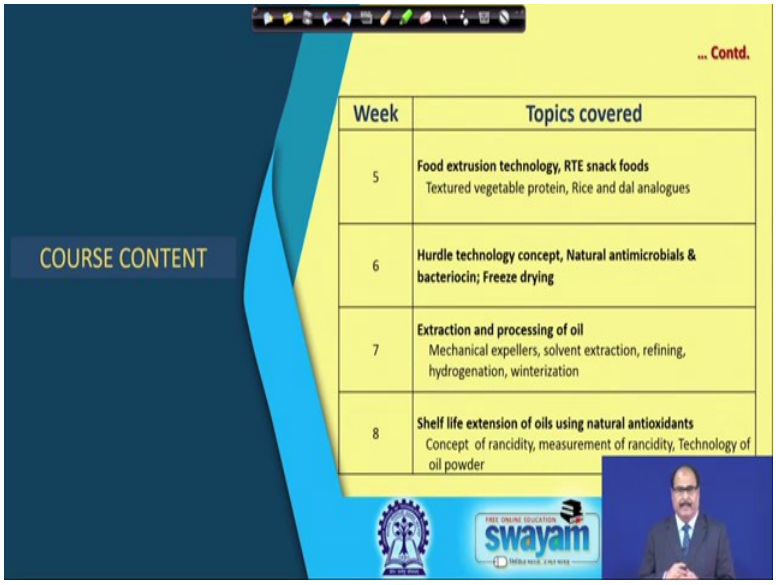
In this first lecture, a brief introduction of the course followed by a brief discussion on constituents of food and its function will be given.

This course is a 12 week course having 60 lectures of 30 min each. There will be 12 assignments, most probably one at the end of every week. There will be one online examination at the end of the course. The broad areas that will be covered in this course include food structure and changes occurring in food during processing, novel and emerging technologies for processing and value addition of food, food products manufacture, preservation and shelf life extension of perishable foods. Also towards the end of the course, some selected ready to eat, ready to cook, health foods and beverages manufacturing technologies will be discussed.

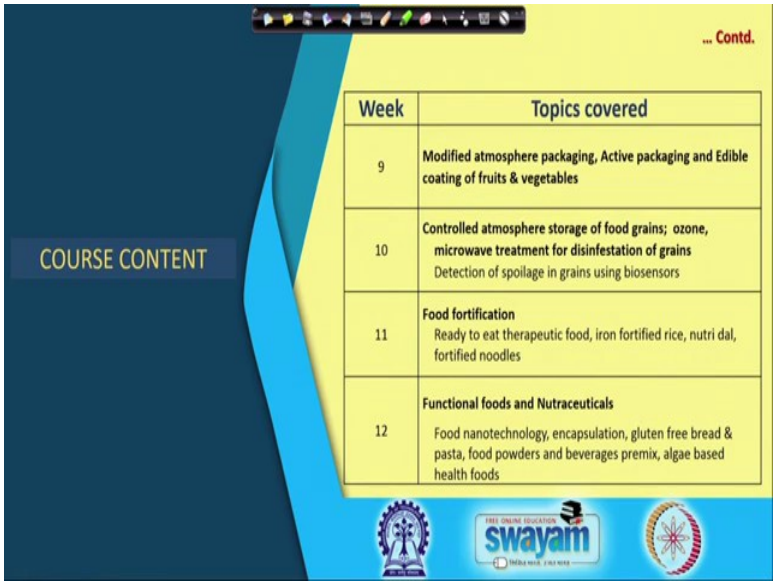


The topics that will be covered in this course include:

In the week 1, Introduction to Food processing, preservation and quality will be outlined where the basic principles and methods of food preservation and processing, water activity versus food stability, how changes in the water activity and other factors influence the stability and quality of food and also the relationship between structure and function of food will be discussed. In the 2nd week, changes that occur during processing of food will be introduced. It may involve browning reactions both enzymatic and non-enzymatic, protein interactions, carbohydrate interactions, rancidity and reversion. A brief overview of the science aspects of the food will be then switched on to the processing technologies wherein from 3rd week onwards, the processing technologies like high pressure processing, membrane technologies, irradiation, radio frequency and microwave heating, supercritical fluid extraction, extrusion technology for production of RTE snack foods, textured vegetable protein, rice and dal analogues, etc. will be taken up.



Then, 6th week onwards, hurdle technology concepts, natural antimicrobials, bacteriocins and freeze drying will be outlined. 7th week will include extraction and processing of oils including mechanical expression, solvent extraction, refining, hydrogenation and winterization. Also the shelf life extension of oils using natural antioxidants, concept of rancidity, measurement of rancidity and preparation of oil powder will be discussed.

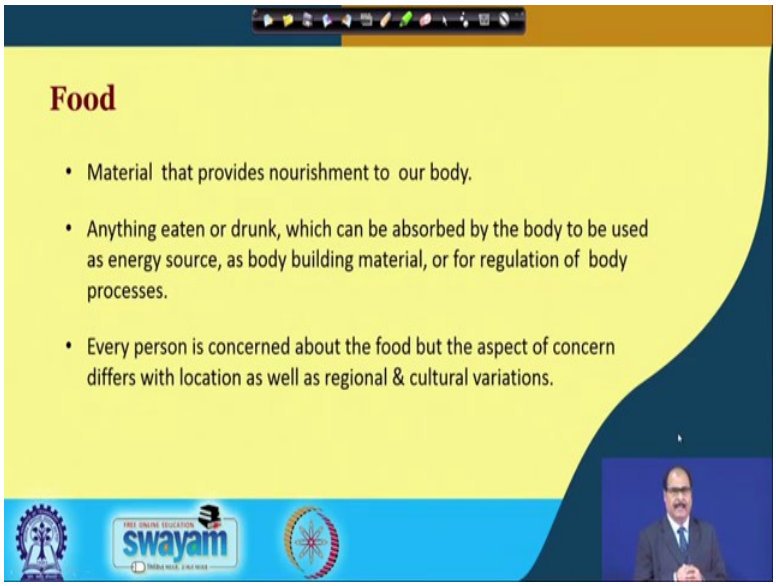


In the week 9, the issues related to the shelf life extension of fruits and vegetables will be taken up where the novel technologies like modified atmosphere packaging, active packaging, edible coating and related processes for the extension of shelf life of high value perishable foods will be discussed. This will be followed by the methods for control atmosphere storage of food grains, ozone treatment and microwave treatment for

disinfestation of food grains as well as the methods for detection of spoilage of grains. In the last two weeks of the course, i.e. weeks 11 and 12, food fortification technology will be highlighted where in pilot-scale manufacturing technologies for RTE high energy food pastes, iron fortified rice, nutri dal, fortified noodles and other products will be introduced. Manufacturing technologies of products like pasta, food powders, beverages, health foods and processes like microencapsulation, food nanotechnology, etc. shall be discussed.

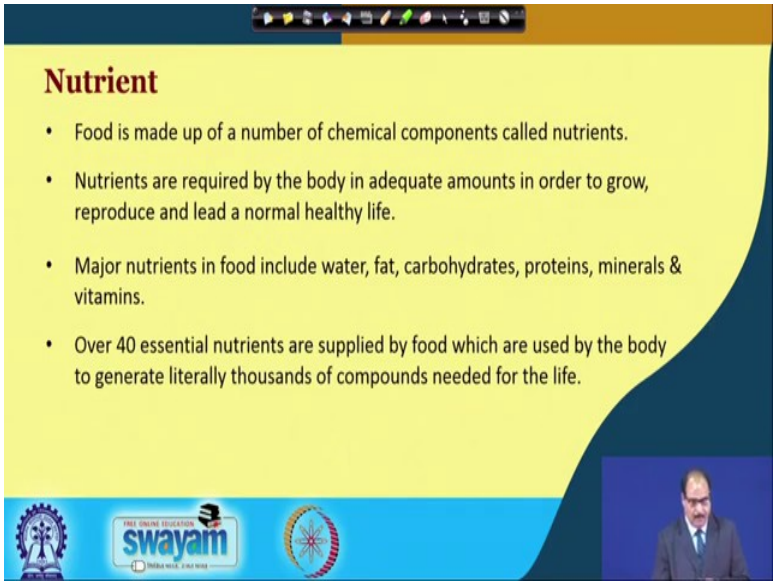
A list of the suggested readings -i.e the books which might be useful for this course is given as follow:

- Food Chemistry, Revised and Expanded Edition by Owen R Fennema.
- Modern Food Microbiology by James M Jay.
- Mechanism of Action of Food Preservation Procedures by G W Gould.
- Principles of Food Science (Part II): Physical Principles of Food Preservation by M Karel Owen R Fennema and D B Lund.
- Food Processing Technologies Principles and Practices by P J Fellows.
- Food Processing Principles and Application by Stephanie Clark and others.
- Food Processing and Preservation Techniques by Peter Zeuthen and Leif Bagh,
- Non Thermal Preservation of Foods by Gustavo V Barbosa and others.
- Food Product and Process Innovations (2 volumes) by Hari Niwas Mishra.

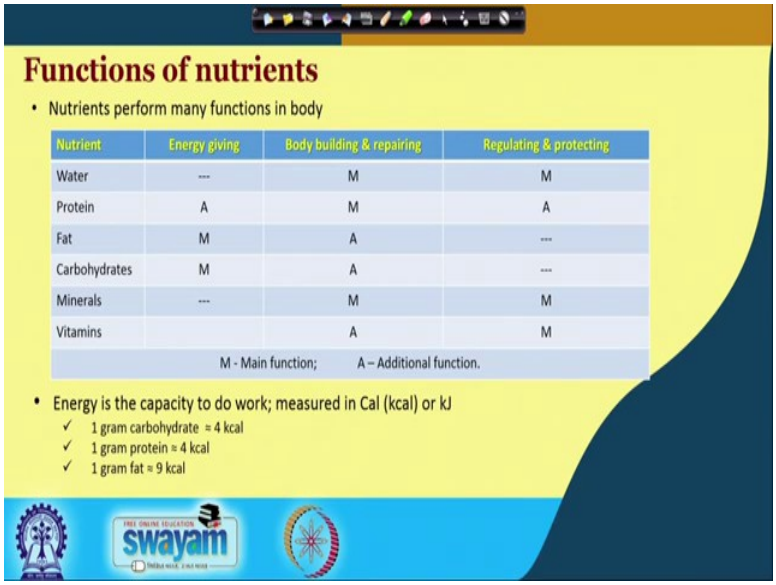


Food can be defined as anything eaten or drunk which can be absorbed by the body to be used as an energy source, as a body building material or for the regulation of body processes; food is the raw material from which our body is made of. Every person is concerned about the food, but the aspect of concern differs with location as well as with regional and cultural variations. A person from south would have different interest as far as his food is concerned whereas the persons from north, east, west like to have their special consideration. Taking the example of developed nations and developing nations; in developing countries, where majority of the population is involved in production of food but, still the main issue there is how to feed the people, how to provide adequate quantity of food to the masses? On the other hand, in developed countries, the scenario is just different. Although less proportion of the population is involved in agriculture and

food production in these countries, yet they have plenty of food. In these countries, most of the produced food is processed or value added. So, the main aspect of concern about the food in those countries or those regions of the world include how to give good quality food, how to give health foods or the food which provide nutrition and health benefits.

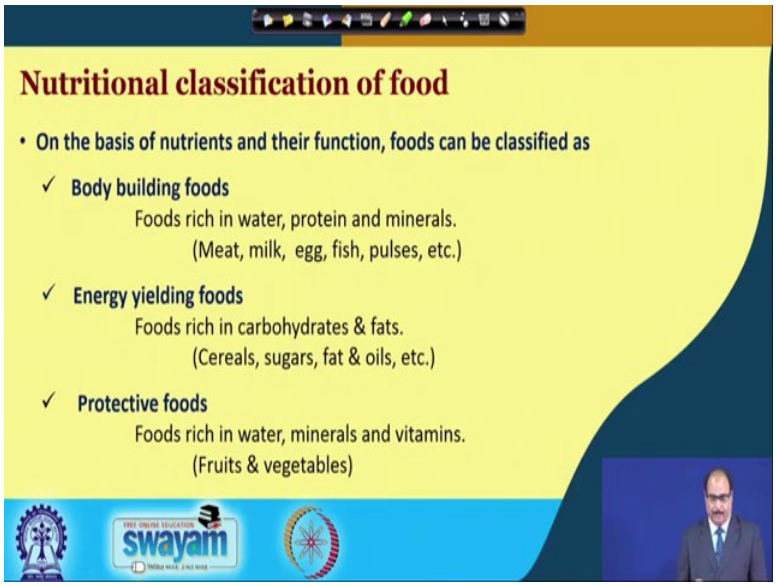


The food is made up of a number of chemical components which are called nutrients. These nutrients are required by the body in adequate amounts in order to grow, reproduce and lead a normal healthy life. Major nutrients in food include water, fat, carbohydrates, proteins, minerals and vitamins. Over 40 essential nutrients are supplied by food which are used by the body to generate literally thousands of compounds needed for the life.

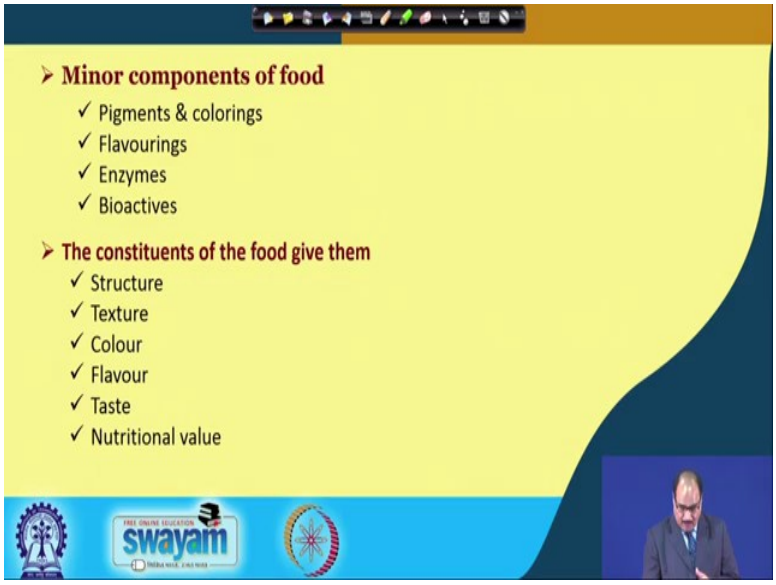


These nutrients have specific roles or specific functions to perform in the body. For example, the main function of water is body building and repairing as well as regulating or protecting the body processes. Main function of protein is body building and repairing whereas its additional functions include energy giving, regulating and protecting body processes. Fats and carbohydrates are mainly consumed for energy purposes. Their main function is energy giving whereas body building and repairing become the additional function. Main function of minerals is body building or repairing as well as regulating and protecting body processes. Main function of vitamins is regulating and protecting body processes and additional function is body building and repairing.

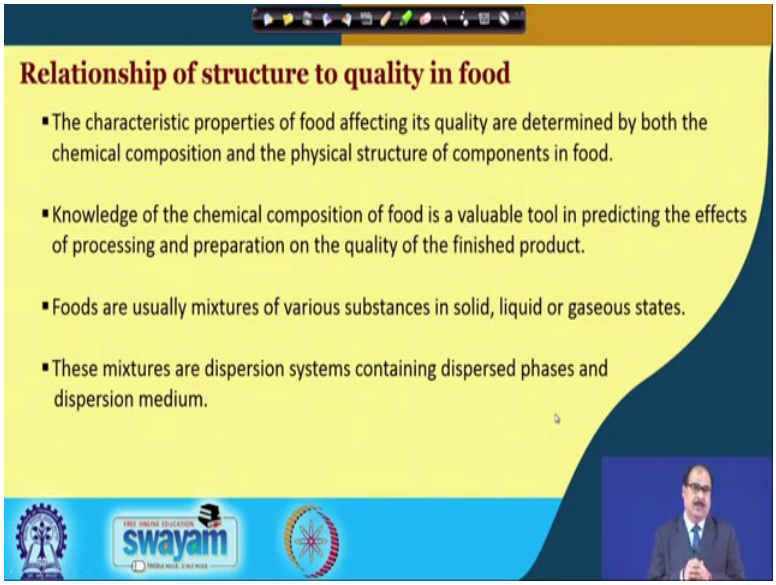
The energy is the capacity to do work. In case of food materials, it is generally measured in Cal or kcal or sometime it is also expressed in kJ. One gram carbohydrate upon complete oxidation gives 4 Cal; equal amount of energy is given by protein as well. One g fat gives 9 Cal.



The foods are classified on the basis of the nutrients they include as well as the functions which the nutrients perform in the body. For example, the foods which are rich in water, protein and minerals are generally termed as body building foods whereas the foods rich in carbohydrates and fats are called energy yielding foods. The foods rich in water, mineral and vitamins such as fruits and vegetables are termed as protective foods.

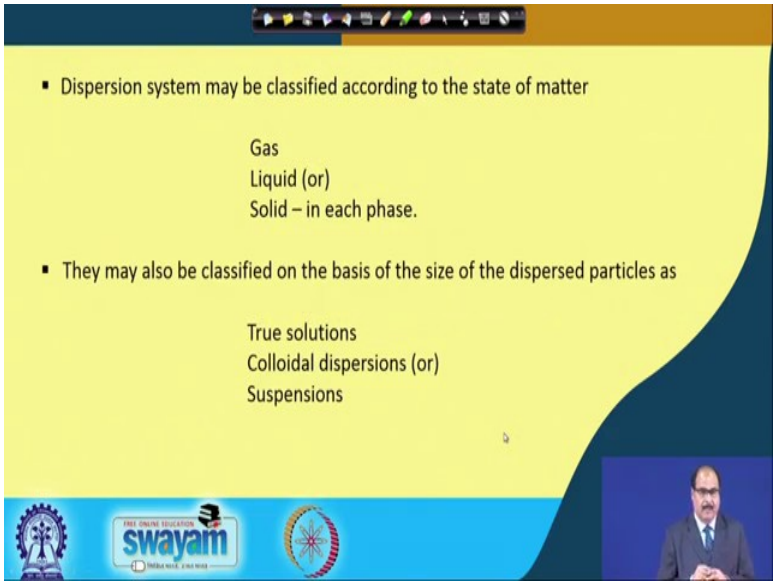


Apart from this six major group of nutrients that food contain, there are also certain minor components present in food and these minor components include pigments and colorings, flavorings, enzymes and bioactives. All these constituents, i.e. the nutrients as well as the minor components give the food its structure, texture, colour, flavor, taste and nutritional value. So, it is not only the content of these constituents but also the manner in which these constituents interact in the food contributes to the characteristics of food. For example, milk which on an average has around 14 to 16 % total solids including fat and 84 to 86 % of water but it is a liquid food. On the other hand, tomato and cucumber which have around 95 to 98 % water are solid foods.

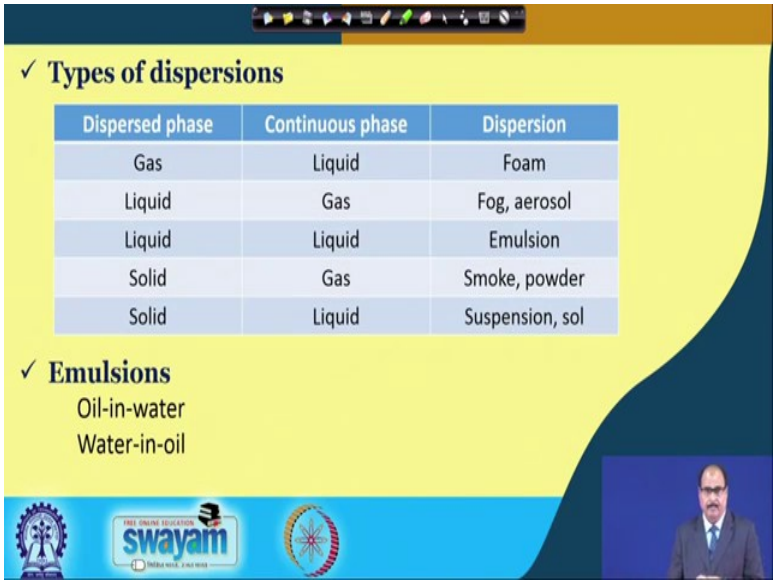


How they are present inside the food that decides actually the structure, function and other attributes of the food. The characteristic properties of food affecting its quality are determined by both the chemical composition and the physical structure of food components. The knowledge of chemical composition of a food is therefore a valuable tool in predicting the effects of processing and preservation on quality of the finished product.

Foods are usually mixture of various substances in solid, liquid or gaseous state. These mixtures are dispersion systems containing dispersed phases and dispersion medium.

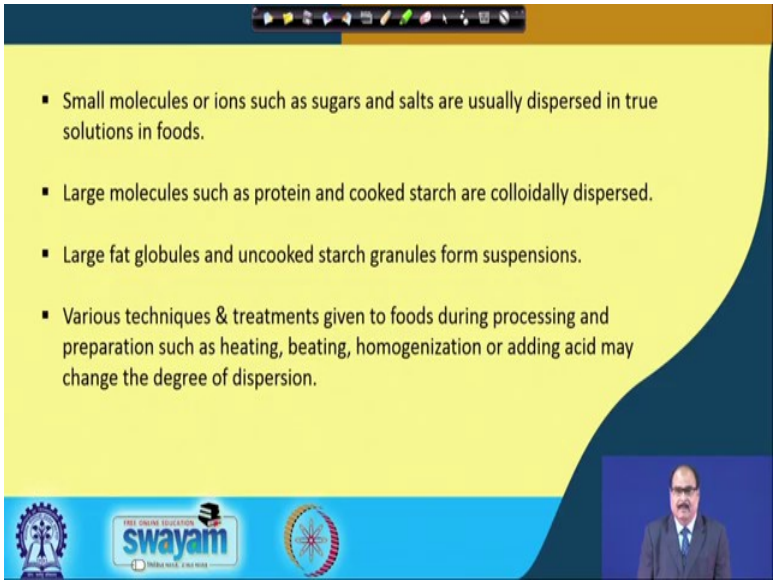


Dispersion system may be classified according to the state of the matter like gas, liquid or solid in each phase. They may also be classified on the basis of the size of the dispersed particle as true solutions, colloidal dispersions or suspensions.

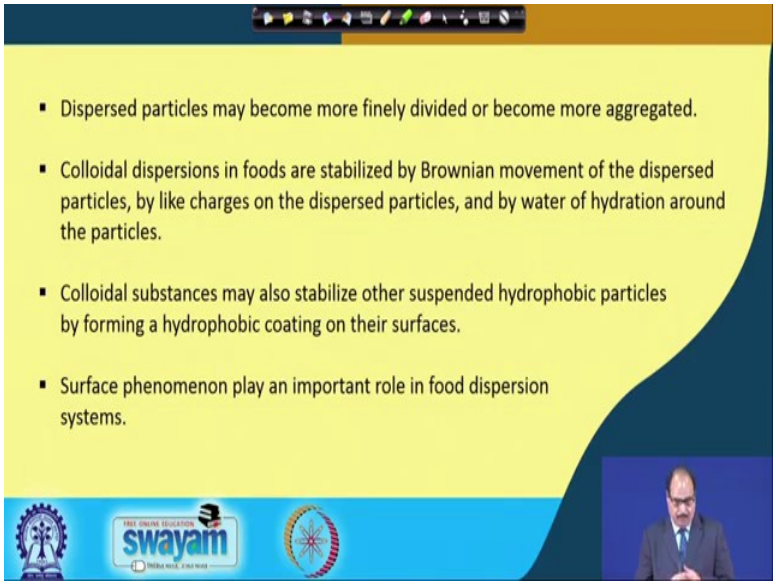


There might be different types of dispersions depending upon the dispersed phase as well as continuous phase. For example, if the dispersed phase is gas and continuous phase is liquid, the dispersion may be a foam. Similarly, when the dispersed phase is liquid, continuous phase is gas, dispersion may be fog or aerosol. When both dispersed phase and continuous phase are liquid, dispersion may be an emulsion. When the dispersed phase is solid, continuous phase is gas, dispersion may be a smoke, or a powder. Finally, if the dispersed phase is solid and continuous phase is liquid, the dispersion may be a suspension or a sol.

Another important thing in the food is emulsions i.e. emulsions may be present in two forms; either oil in water or water in oil. Here again, milk is a good example. The fat which is present in the natural milk is an emulsion of oil in water, but when this fat is separated from the milk in the cream or then cream is further converted into butter, the phase changes. There it becomes an emulsion of water in oil.

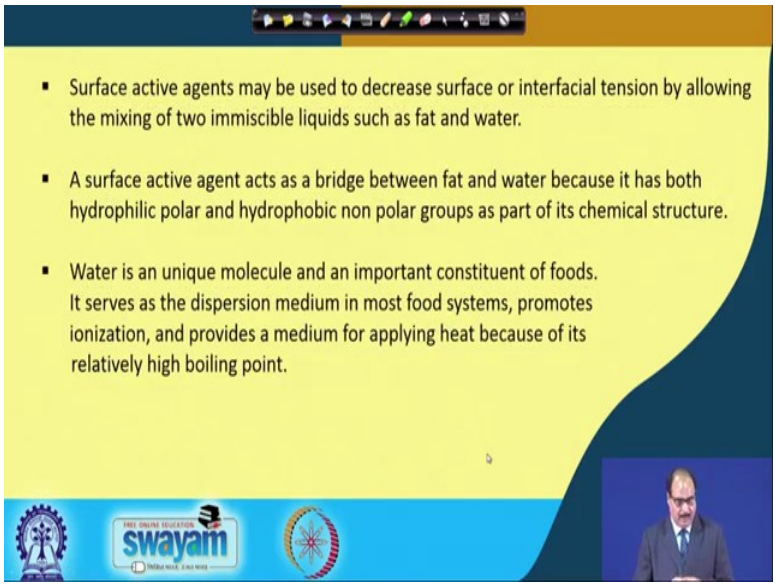


Small molecules or ions such as sugars and salts are usually dispersed in true solutions in food. Large molecules such as protein and cooked starch are colloidally dispersed. Large fat globules and uncooked starch granules form suspension. Various techniques and treatments which are given to food during processing and preparation such as heating, beating, homogenization or adding acid or any other treatment to which food come across during handling, processing, distribution, etc. may change the degree of dispersion.

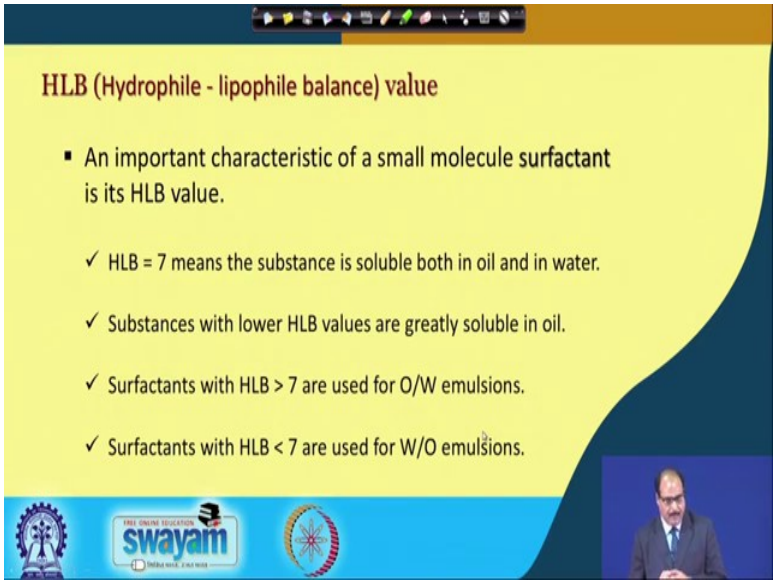


This change in the degree of dispersion may bring about different changes in the characteristics and properties of the final food and that what actually happens i.e. how the changes take place in the food properties during processing and handling. Dispersed

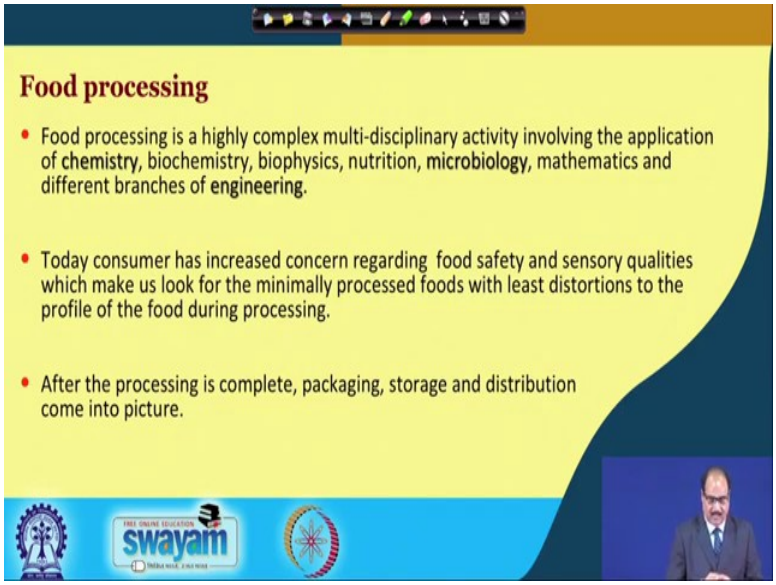
particle may become more finely divided or may become more aggregated. Colloidal dispersions in food are generally stabilized by Brownian movement of the dispersed particle by like charges on the dispersed particles as well as by water of hydration around the particles. Colloidal substances may also stabilize other suspended hydrophobic particles by forming a hydrophobic coating on their surfaces. So, the surface phenomenon plays a very important role in the food dispersion systems.



Surface active agents may be used to decrease surface or interfacial tensions by allowing the mixing of two immiscible liquids such as fat in water. A surface active agent acts as a bridge between fat and water because it has both hydrophilic polar and hydrophobic non polar groups as part of its chemical structure. Water is a unique molecule and an important constituent of the food. It serves as dispersion medium in most food systems. It promotes ionization and provides a medium for applying heat because of its relatively high boiling point.



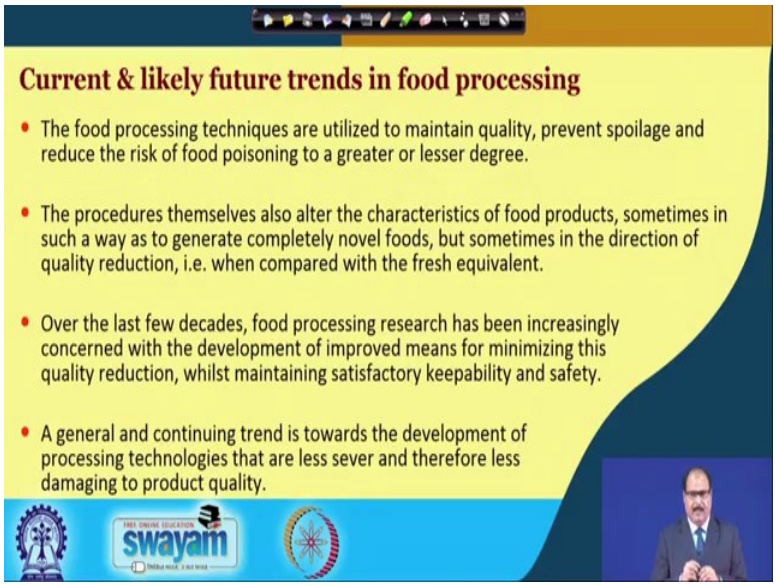
HLB that is Hydrophile Lipophile Balance value, it is an important characteristic of a small molecules surfactant. HLB value of 7 means the substance is soluble both in oil and in water. Substances which have lower HLB values are generally soluble in oil. Surfactants with HLB value more than 7 are used for oil-in-water emulsions whereas surfactants with HLB less than 7 are used for water-in-oil emulsions.



Food processing is a highly complex multidisciplinary activity involving the application of chemistry, biochemistry, biophysics, microbiology, mathematics and different branches of engineering. Today, consumer has increased concern regarding food safety and sensory qualities which need to find techniques for development of the minimally

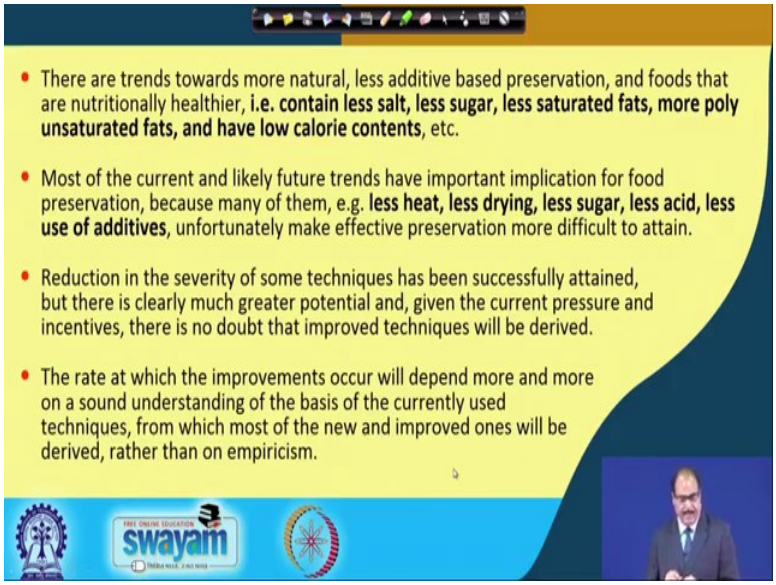
processed foods with least distortions to the profile of the food during processing. After the processing is complete, packaging, storage and distribution come into picture.

Food processing ensures generation of traditional employment through forward and backward linkages, employment mostly done in rural areas. Food processing also helps in reduction of wastages, it helps in increasing the farmer's income by getting better prices. It ensures consumers' welfare by increasing availability of food.



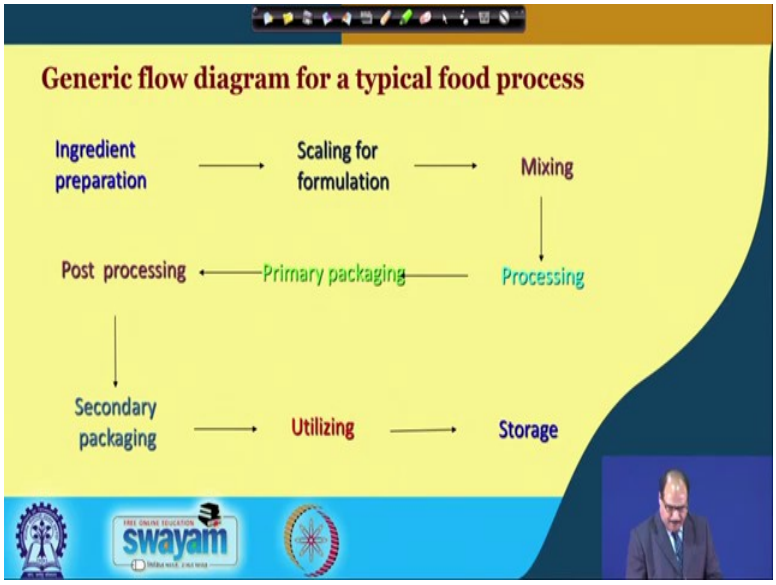
An overview of the current and likely future trends in food processing: The food processing techniques are utilized to maintain quality, prevent spoilage and reduce the risk of food poisoning to a greater or lesser degree. The procedures themselves alter the characteristics of food products; sometimes, in such a way as to generate completely

novel food but sometimes, in the direction of quality reduction particularly when compared with the fresh counterpart. Over the last few decades, therefore, the food processing research has been increasingly concerned with the development of improved means of technologies for minimizing this quality reduction while maintaining satisfactory keepability and safety. A general and continuing trend is towards the development of processing technologies that are less severe and therefore, less damaging to the product quality.

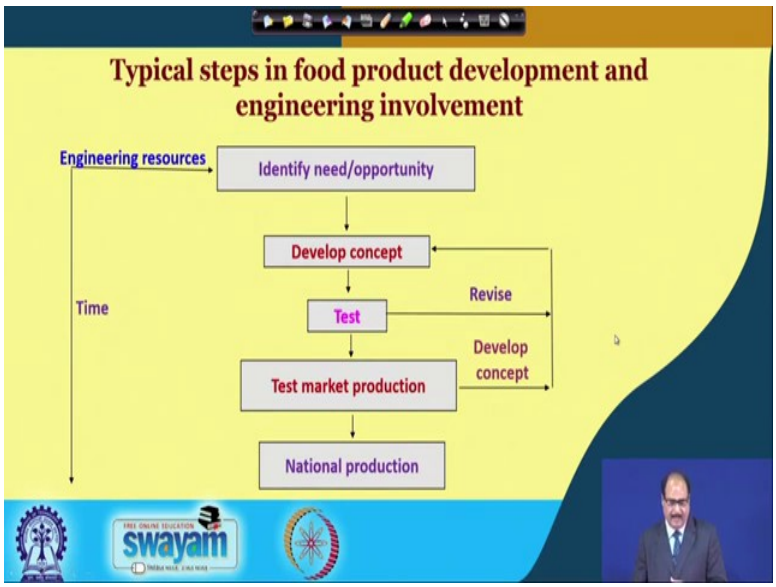


There are trends towards more natural, less additive based preservation and foods that are nutritionally healthier i.e., they contain less salt, less sugar, less saturated fats, more polyunsaturated fats and have low calorie contents, etc.. Most of these current and likely future trends have important implications for food preservations because many of them; for example, less heat, less drying, less sugar, less acid, less use of additives, unfortunately make effective preservation more difficult to attain.

Reduction in the severity of some techniques has been successfully attained but there is clearly much greater potential and given the current pressure and incentives, there is no doubt that improved techniques will be derived. But, the rate at which the improvement occur will depend more and more on a sound understanding of the basis of the currently used techniques from which most of the new and improved means will be derived rather than on empiricism.



In any food product manufacturing and preparation, certain ingredients are needed. The raw material might not be available in the form in which they are to be processed. So, it might require certain preparation or primary processing like cleaning, sorting, grading, peeling, slicing, etc. After the ingredients are prepared, they are scaled as per the formulation. Most of the food processes require mixing of one or the other kind. It may be mixing of solid to solid, solid into liquid, liquid into gas and so on. After mixing, they are processed and packaged. In some cases, the foods might be subjected to secondary processing as well as secondary packaging and finally warehousing and storage.



For the development of a food product; first the need or opportunity is to be identified, some surveys might be conducted. Depending upon engineering as well as financial

resources, how the demand can actually be met is to be conceptualized. This concept is then tested in laboratory. If it passes the laboratory test, it can be further proceeded to market production. Sometimes, it so happens that the concept passes in the laboratory, but when taken for the pilot or large scale production, it fails. This is mainly because, in the laboratory study, the parameters are optimized on the smaller sample size. In such cases, the concept should be revised or altogether a new concept should be developed and tested using the similar procedure. It is to be made sure that while making a product, one should not spend too much time in all these process. Otherwise in today's highly competitive world, one keeps on testing and doing these and some of the competitor may bring a similar product in the market.