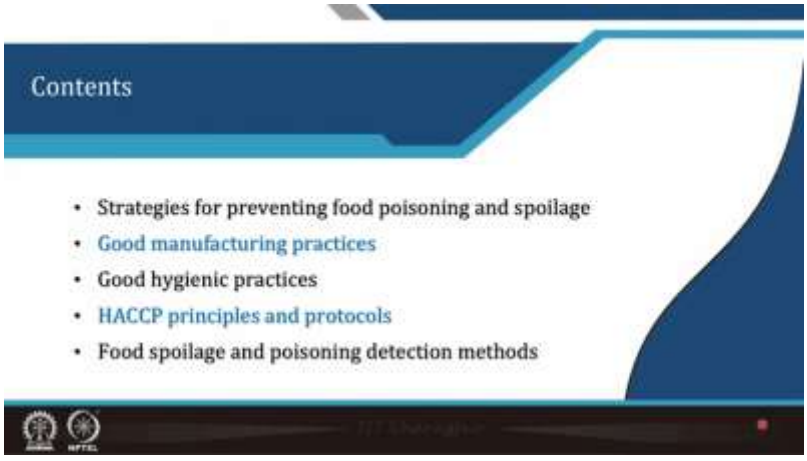
FOOD SCIENCE AND TECHNOLOGY

Lecture34

Lecture 34: Prevention of Food Poisoning and Spoilage

Hello everyone. Namaste.

Now, in today's lecture, we will talk about the prevention of food poisoning and spoilage.

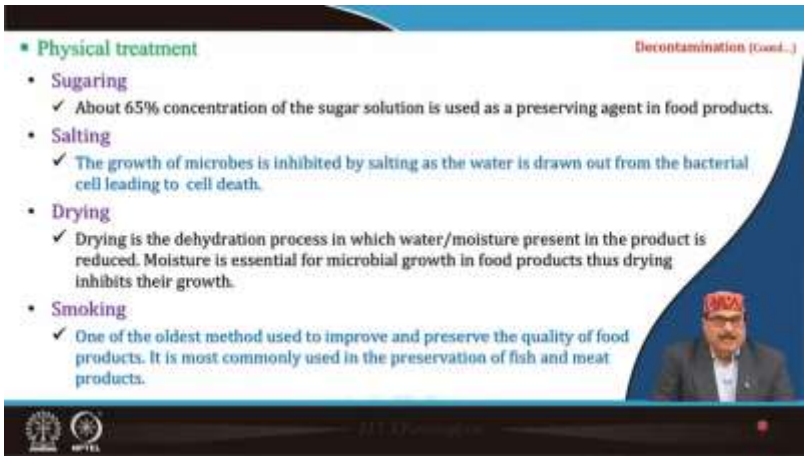


Here, we will discuss the various strategies for preventing food poisoning and spoilage, good manufacturing practices and good hygienic practices, HACCP principles and protocols, and finally, we will also talk about food spoilage and poisoning detection methods.

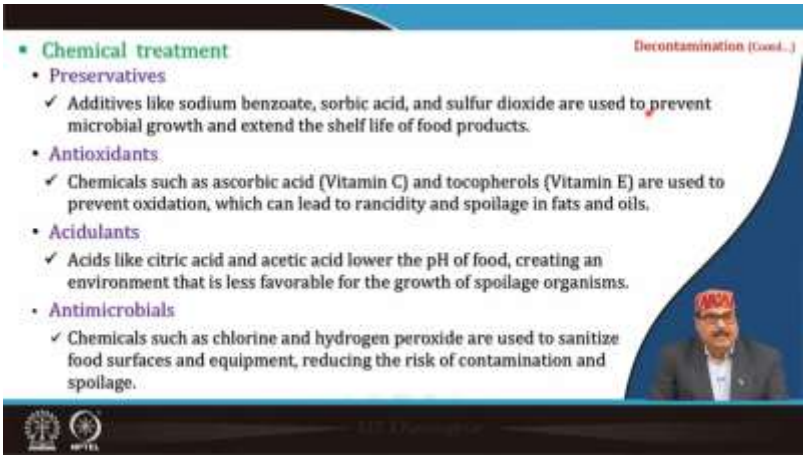
So, let us discuss the various strategies for the prevention of food spoilage and poisoning. You know, preventing food poisoning and spoilage involves rigorous hygienic practices, proper food storage and careful handling throughout the food supply chain. Key measures include maintaining cleanliness, controlling temperature to inhibit bacterial growth, using preservatives or safe packaging methods, and ensuring thorough cooking of the food materials. Regular monitoring and adherence to food safety protocols like hazard analysis and critical control points, commonly known as HACCP, are essential to prevent contamination in food materials. HACCP can protect consumers from food burn illness and ensure the quality and safety of products.

So, decontamination means decontaminating food or keeping it or removing or inhibiting or restricting the access of microorganisms to food to prevent the food from contamination. If that is already contaminated, how can it be removed? So, food decontamination involves using various techniques to eliminate or reduce contaminants in food while preserving its

nutritional quality, flavour and appearance. So, some of the contamination prevention methods. include physical treatment, chemical treatment, heat treatment, cold treatment, packaging and equipment sanitation.

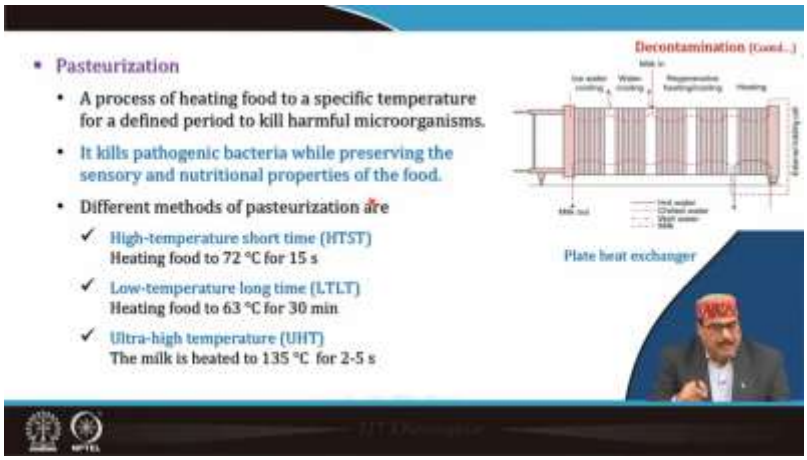


Then, in the physical treatment, sugaring, salting, drying, and smoking are the major processes. About 65% concentration of the sugar solution is used in preserving use as a preserving agent in food products. The growth of microorganisms is inhibited by salting as the water is drawn out from the bacterial cell, which leads to cell death. Drying is the dehydration process in which water or moisture present in the food product is reduced, and moisture is essential for microbial growth in food products. Therefore, drying inhibits their growth, and accordingly, drying is an excellent and effective method of decontaminating foods. Smoking is one of the oldest methods used to improve and preserve the quality of food products. It is most commonly used in the preservation of fish and meat products.

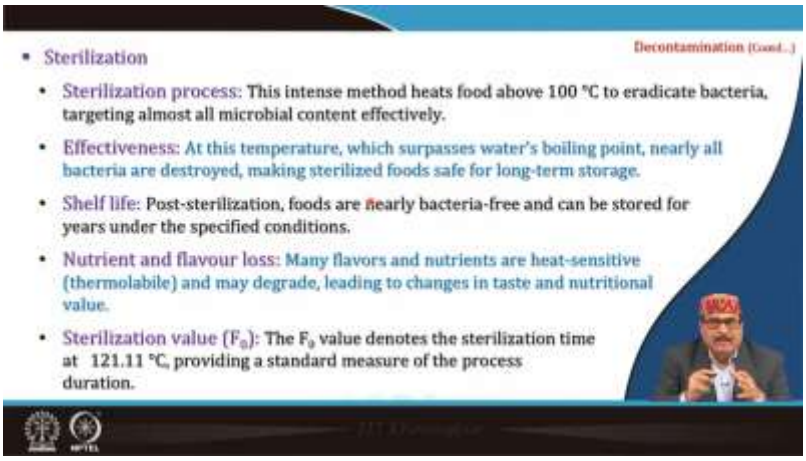


Then, among the chemical treatments, different preservatives, antioxidants, acidulants, or even various antimicrobial substances are added to the food or used with the food materials to prevent contamination or microbial growth. Additives like sodium benzoate, sorbic acid, and sulphur dioxide prevent microbial growth and extend the shelf life of food products. Chemicals such as ascorbic acid, popularly known as vitamin C, and tocopherols, which are known as vitamin E, are used to prevent oxidation, and you know oxidation is the major process that leads to the rancidity and spoilage in fats and oils. Therefore, these antioxidants can prevent the spoilage of fat products, fats and oils. Acids like citric acid and acetic acid lower the pH of the food, creating an environment that is less favourable for the growth and spoilage of microorganisms. Antimicrobial chemicals such as chlorine and hydrogen peroxide sanitize food surfaces and equipment, reducing the risk of contamination and spoilage. Several bacteriocins, etcetera, niacin, and other chemicals are used to decontaminate or manage the undesirable microorganisms present in the food to stop their growth.

Heat treatment is again a very popular method for decontaminating food. Canning is a food preservation method that involves sealing the food in airtight containers like jars or cans, heating the can, and applying heat to destroy harmful microorganisms that cause spoilage and foodborne illness.

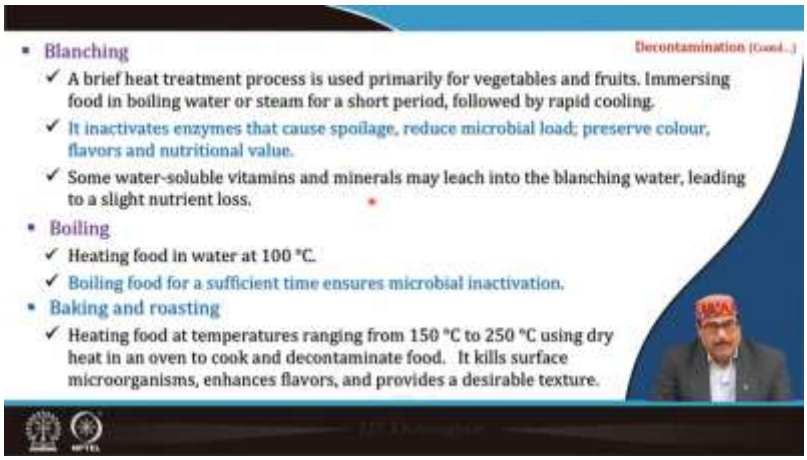


Pasteurization is another method of heat treatment. It is a process of heating food to a specific temperature for a defined period. The purpose is to kill harmful microorganisms, particularly the disease-causing or pathogenic microorganisms. So, pasteurization kills the microorganisms. Pathogenic bacteria while preserving the food's sensory and nutritional properties. The pasteurization method is a high temperature in a short time, like HTST, where the food is heated to 72 °C for 15 seconds. In the LTLT process, food is heated to 63 °C for 30 minutes. In the ultra-high temperature UHT process, the milk is heated to around 130 to 145 °C or even higher temperatures for a few seconds, for 2 to 5 Seconds or 1 to 2 seconds, depending upon. So, I have discussed the details of all these heat processes, like pasteurization, sterilization, canning, cooking, etc., in my other course, which is novel food processing technologies and shelf life. So, here I am giving you a very brief overview.

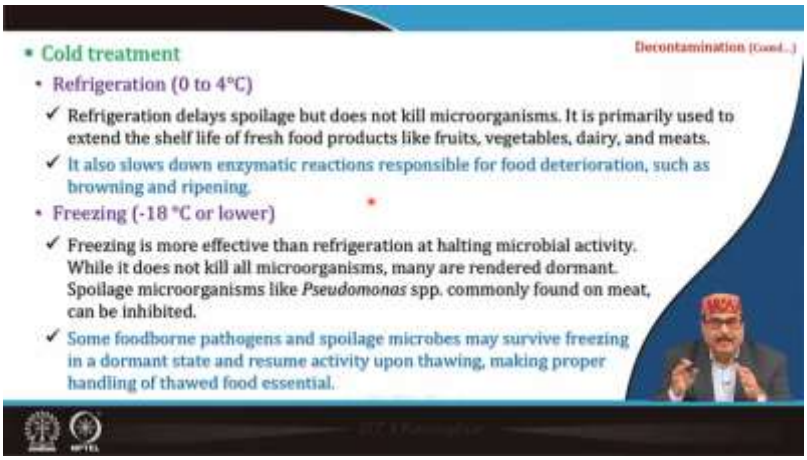


Sterilization is an intense method. In this process, the food is heated above 100 °C, and the purpose is to reduce or eradicate bacteria, targeting almost all microbial content effectively. In pasteurization, we target only pathogenic microorganisms; in sterilization, all microorganisms are targeted or killed. And, at this temperature, which surpasses water's

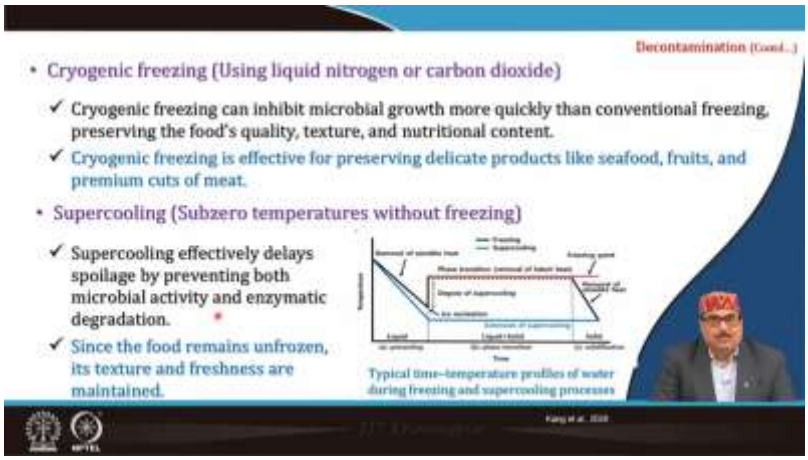
boiling point, nearly all bacteria are destroyed, making the sterile food safe for long-term storage. Post-sterilization, however, foods are nearly bacteria-free, but they need to be appropriately packaged and stored. So, if post-sterilization decontamination is avoided, then these sterilized foods can be kept together for even years, sometimes depending upon the food being in proper condition and proper storage conditions. So, many flavours and nutrients are heat-sensitive; they are thermolabile, and therefore, that is the one that, during the sterilization process, because the heat process is given severe, comparatively severe heat process, then it may result in degradation or changes in the taste and nutritional value, etcetera. The sterilization value F_0 denotes the sterilization time at around 121.1 °C, providing a standard measure of the process duration.



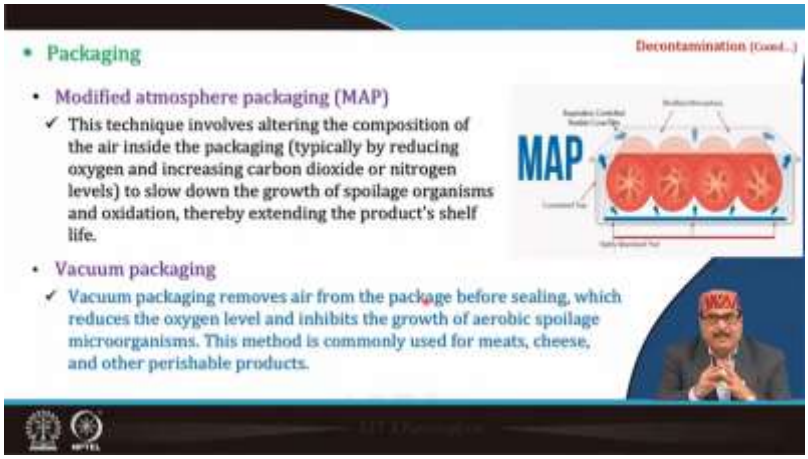
Blanching is a brief heat treatment used primarily for vegetables and fruits, immersing food in boiling water or steam for a short period, followed by rapid cooling. So, the major purpose is the inactivation of the enzymes; it inactivates enzymes that cause spoilage, reduce microbial load, and preserve colour, flavour, and nutritional value. Some water-soluble vitamins and minerals may leach into the blanching water, particularly if the water-dipping method is used, and this may result in causing a slight nutrient loss. Boiling again here, the food is heated in water at around 100 °C. Boiling for a sufficient time ensures microbial inactivation. Other heat treatments are baking and roasting, where food is heated at a temperature ranging from 150 to 250 °C using dry heat in an oven to cook and decontaminate food. It kills surface microorganisms, enhances flavours, and provides a desirable texture.



Then cold treatment is another method of decontamination. Here, refrigeration and freezing are the popular methods used to control microorganisms in food. So, refrigeration, where food is generally stored at 0 to 4 °C, delays spoilage, but this cold treatment does not kill the microorganisms. It primarily extends the shelf life of fresh products like fruits, vegetables, dairy, meat, etc. So, it slows down the enzymatic reactions responsible for deterioration, such as browning, ripening, etcetera. Then, freezing is another cold treatment where the food is frozen and stored at minus 18 °C or even lower. So, it is more effective than refrigeration at halting microbial activity, while this also does not kill microorganisms. The microorganisms during freezing and frozen storage are rendered dormant. Spoilage microorganisms like Pseudomonas species, commonly found on meat, can be effectively inhibited by this freezing method. Foodborne pathogens and spoilage microorganisms may survive freezing in a dormant state and resume activity upon thawing, making proper handling of thawed food essential. That is, once you remove the food from the frozen environment, bring it back to normal and during these processes, the microorganisms are not killed; instead, they go stationary. So, when they again get a suitable environment, the food comes under the typical environment after thawing; these microorganisms can grow again rather can develop more vigorously. So, this has to be taken care of with frozen foods after taking them out of the environment. They should be consumed as quickly as possible.

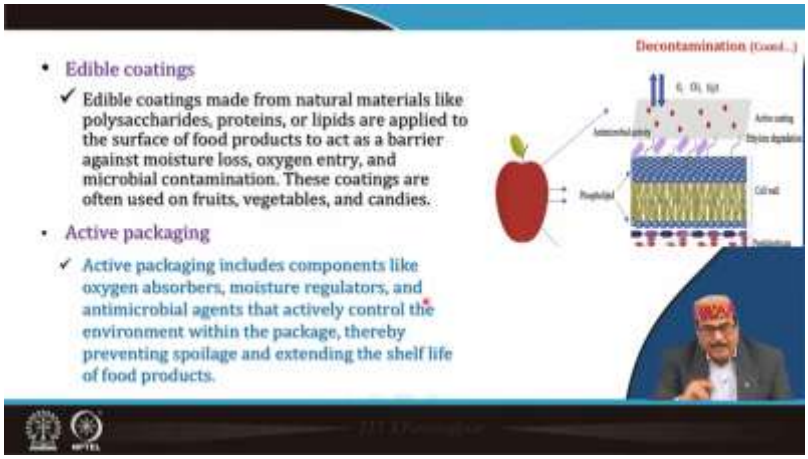


So, cryogenic freezing is another liquid nitrogen or carbon dioxide method. It can inhibit microbial growth more quickly than conventional freezing or slightly better preserve the food's quality, texture, and nutritional value than traditional cooling processes. Cryogenic freezing is effective for preserving delicate products like seafood, fruits, and premium cuts of meat, etcetera. Then, supercooling is sub-zero temperature without freezing. So, if you look at the freezing curve, you can see that the material goes to the It is supercooled and then comes slightly above where nucleation takes place and freezing starts. So, it involves the removal of sensible heat during freezing. So, supercooling effectively delays spoilage by preventing microbial activity and enzymatic degradation. Since the food remains unfrozen, its texture and freshness are maintained.



Then, let us briefly talk about the packaging, that is, the modified atmosphere packaging or vacuum packaging, which are essential methods commonly used to decontaminate or control microbial contamination of food. Modified atmosphere packaging involves altering

the composition of the air inside the package. Typically, by reducing the oxygen and increasing the carbon dioxide or nitrogen levels, this lowering of oxygen and increasing CO_2 value reduces or slows down the growth of spoilage microorganisms and oxidation, thereby extending the product's shelf life. All air is removed from the package before sealing, which reduces the oxygen levels and, therefore, inhibits the growth of aerobic spoilage microorganisms. This method is commonly used for meat, cheese and other perishable products.

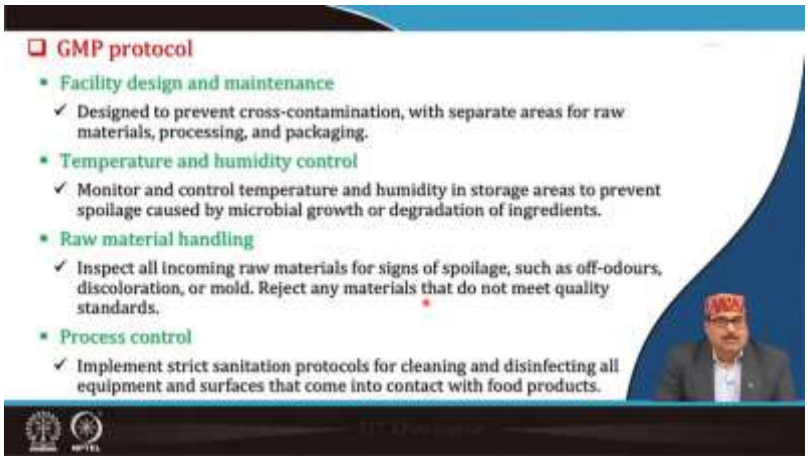


Edible coating is another method that provides a coating made from natural materials like polysaccharides, proteins, or lipids. These coatings are applied to the surface of the food products to act as a barrier against moisture loss, oxygen entry and microbial contaminations. These coatings are often used on fruits, vegetables and candies. Active packaging is another important method. It includes components like oxygen absorbers, moisture regulators, and antimicrobial agents that actively control the environment within the package. Thereby preventing spoilage and extending the shelf life of food products. So, again, the details of all this engineering detail, process details, etc., of all these vacuum packaging, edible coating, active packaging, and modified atmosphere packaging have been discussed in length in great detail in my other course, the post-harvest operations and processing of fruits, vegetable and other products.

Sanitation is a critical method to decontaminate food or control the contamination of food products, such as cleaning and sanitation. Regular cleaning with detergent and disinfectants helps remove food residues, dirt, and microbial contamination from the food contact surfaces and equipment. Sanitizing agents like chlorine, quaternary ammonium compounds, iodine peracetic acid, etcetera are commonly used to sanitize food contact surfaces, equipment, etc., where the food is. So, if the surfaces are adequately sanitized, good hygienic practices, like implementing protocols, ensure that food handlers maintain high personal and environmental hygiene standards. Thus, it includes proper hand washing or cleaning, protective clothes, and sanitized tools and equipment. This becomes a critical protocol and tool for maintaining hygienic conditions and, therefore, avoiding contamination of food materials.

So, we will discuss a minor detail. Let us talk about good manufacturing practices or GMP. It is a system of guidelines that ensures products are consistently produced and controlled

according to quality standards, as specified in the SOPs. It covers all aspects of production, from raw material sourcing to manufacturing, packaging, and distribution. GMP focuses on hygiene, process control, and equipment maintenance to prevent contamination, ensure product safety, and maintain quality. So, the critical steps in GMP include personal hygiene and employee facilities, sanitation and waste protocols, and pest control protocols. Water treatment: The water quality used in food should be processed. It should be good, then preventive maintenance, traceability, and storage should be done. So, these are the major, you can say, the pillars of good manufacturing storage compliance.

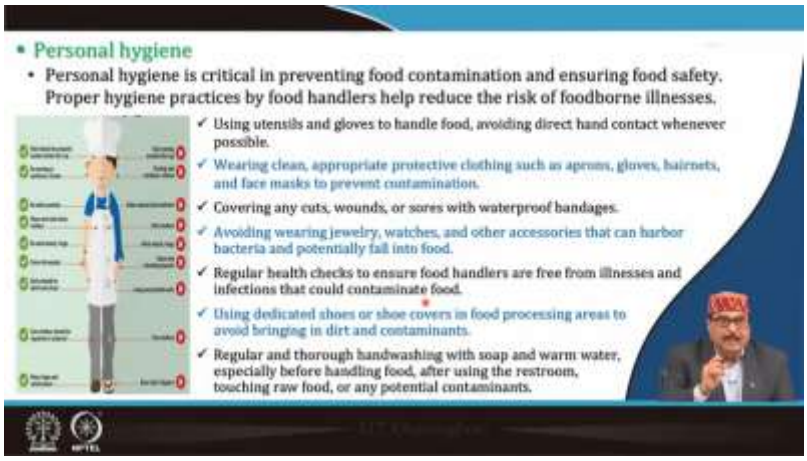


So, let us briefly talk about GMP protocols. When we speak about GMP protocols, it may even include facility design and maintenance. For example, the area where the food is processed, handled, and stored should be designed appropriately. To prevent cross-contamination, there should be separate areas for raw materials, processed products, packaged products, processing, and other conditions and details. It should be there properly; the facility should be appropriately designed and have all the features necessary for maintaining hygienic and good conditions. Then, temperature and humidity control become very important. Monitor and control temperature and humidity in the storage, processing, and food-handling areas. This can effectively prevent spoilage caused by microbial growth or degradation of ingredients. So, proper monitoring and control of temperature and humidity are essential. Then, raw material handling is properly inspecting all incoming raw materials for signs of spoilage, such as off-odours, discolouration, mould, etc., and rejecting any materials that do not meet the quality standards. Then, one should implement strict sanitation protocols for cleaning and disinfecting all equipment and surfaces that come into contact with the food products. So, this means everything possible

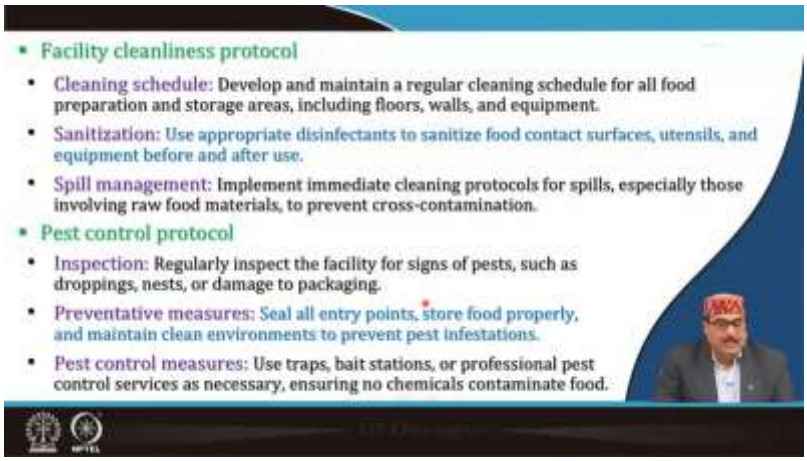
should be undertaken to ensure there is no chance of contamination by microorganisms in the food during handling, etc.

Then, packaging and sealing: Use packaging material that provides practical barriers against moisture, oxygen, and light and which can, of course, contribute to spoilage. And then, finally, waste management. Implement procedures for prompt disposal of waste and spoiled materials to prevent cross-contamination. So, the 5P's of good manufacturing practices include people comprehending roles and responsibilities. They should know their roles and responsibilities. Even products should have precise specifications for every phase of the production process. There should be proper SOPs defined. Then, the process should also be adequately documented, simple, and consistent. Procedures should have clear-cut guidelines for undertaking critical processes, etc. And finally, the premises: cleanliness and equipment calibration, etc., at all times. So, these are the five P's of good manufacturing processes.

Good hygienic practices are essential guidelines that ensure cleanliness and safety in food handling, processing, and preparation environments. GHP involves personal hygiene, facility cleanliness, pest control, proper waste management, and safe food handling practices. These practices prevent contamination, maintain food quality, and extend shelf life. GHP can improve food businesses, reduce the risk of foodborne illnesses, comply with regulatory standards, and protect consumer health, ensuring safe and high-quality food products are produced.



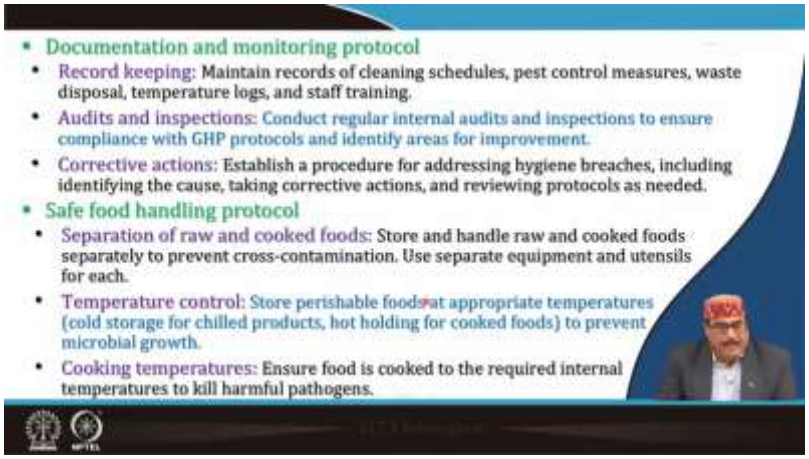
Then, in good hygienic practices, personal hygiene is essential. Personal hygiene is critical in preventing food contamination and ensuring food safety. Proper sanitary practices by food handlers help reduce the risk of foodborne illnesses. They use utensils and gloves to handle food, avoiding direct hand contact whenever possible—wearing clean, appropriate protective clothing such as aprons, gloves, hair nets, face masks, etc, to prevent contamination and covering any cut—wounds or sores with waterproof bandages. Avoid wearing jewellery, watches and other accessories that can harbour bacteria and potentially fall into food. Regular health checks are needed to ensure that food handlers are free from any illnesses and infections that could contaminate food. Use dedicated shoes or shoe covers in the food processing areas to avoid bringing in dirt and other contaminants. Regular and thorough hand washing with soaps, warm water, detergent, etcetera, especially before handling food, after using the restroom, touching raw food or any potential contaminants. So, these are some of the essential steps by which personal hygiene can be maintained.



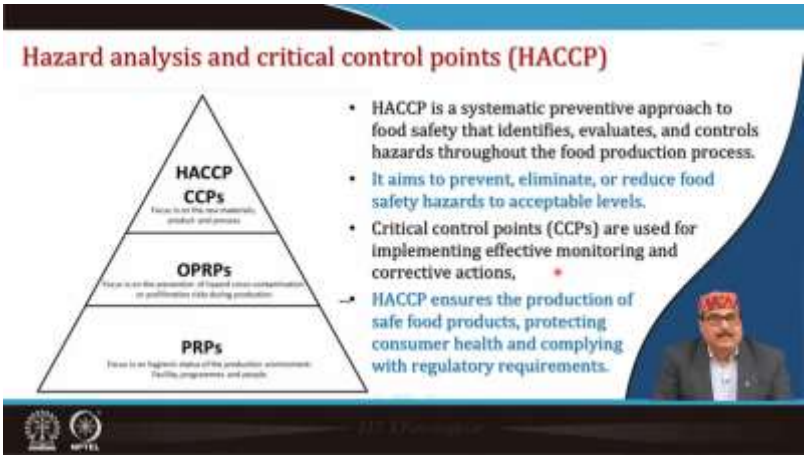
Then, facility cleanliness at disposal is the cleaning schedule. To prevent cross-contamination, the sanitation process involves appropriate disinfectants to sanitise the food contact surfaces, utensils, etc., or implementing immediate cleaning protocols for spills, especially those involving raw food materials. Then, prevention of pest control, pest control process, or the pest control protocol means that there should be a proper inspection of the facilities for any sign of pests such as droppings, nets, or damage to the packaging. Seal all entry points, store food properly and maintain clean environments to prevent pest infections. Use traps, bait stations or professional pest control services as necessary to ensure that there are no chemicals or any other contamination that the pest pesticides, etcetera used; they should not contaminate the food.

Then, a proper waste management protocol should be in place. There should be segregation of the waste and waste types like organic, recyclable, and general waste materials, and they should be stored in appropriate, clearly level bins. Then, empty waste bins regularly, which

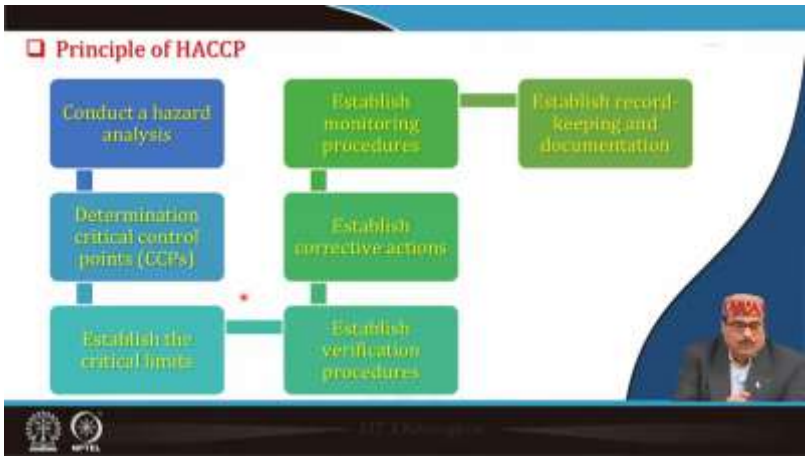
is very important to avoid overflow and potential contamination of food products. Clean and disinfect the waste bins regularly to prevent the buildup of bacteria and other problems. Then, the water quality protocol is water used in food processing for cleaning for indecision and as an ingredient in the food. This should also be properly tested. Regular tests of the water used for processing and preparation for contamination, such as bacteria, chemicals, heavy metals, etcetera, should be adequately performed. This water should be treated appropriately before use to ensure that it meets safety standards.



Then, documentation and monitoring protocol that all the records are should be adequately maintained, regular audit internal audits and inspections should be conducted to ensure with GHP protocols, etcetera. Then, there should be a proper protocol for corrective action that establishes a procedure for addressing Hygienic breaches if there are any at any step where hygienic conditions are not properly maintained, including identifying the cause, taking corrective actions, and reviewing the protocol as needed. Then, the safe food handling protocol is essential. Here, the separation of raw and cooked food is necessary. Store and handle raw and cooked food separately to prevent cross-contamination. Use separate equipment and utensils for each—store perishable foods at appropriate temperatures to prevent microbial growth. Ensure food is cooked to the required internal temperature to kill harmful pathogens. So, good hygienic practices are fundamental in the prevention of contamination. It helps extend shelf life, maintain food quality, reduce food waste, ensure compliance with regulations, and protect public health. Improvement of operational efficiency, etcetera. So, in brief, you can say that good hygienic practices help promote public health, promote brand reputation, and help maintain food safety by following regulations, lowering turnover, and increasing the morale of the company staff.

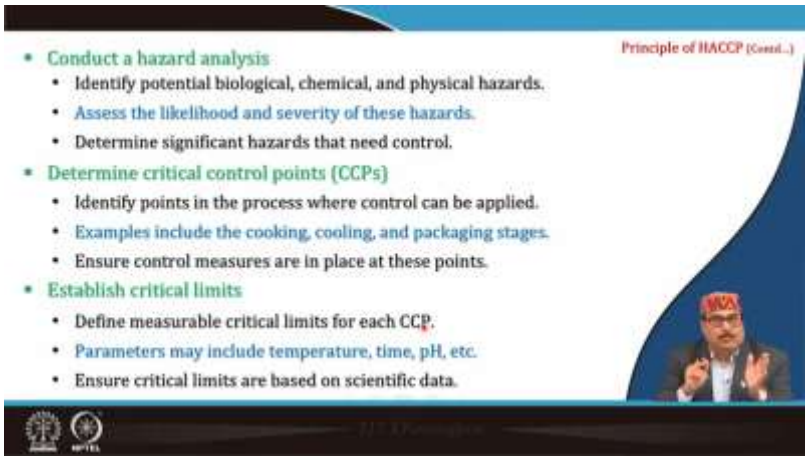


Then comes the Hazard Analysis and Critical Control Point (HACCP). This HACCP is a systematic preventive approach to food safety that identifies, evaluates, and controls hazards throughout food production. It aims to prevent, eliminate, or reduce food safety hazards to acceptable levels. Critical control points are used to implement effective monitoring and corrective actions. HACCP ensures the production of safe food products, protects consumer health, and ensures compliance with regulatory requirements. So, you can see that PRP, where the focus is on the hygienic status of the production environment; OPRP, where the focus is on the prevention of hazard cross-contamination; and HACCP CCPs, where the focus is on the raw materials and the process in the value chain. In the process chain, where there is a critical chance of contamination, that point should be identified and adequately controlled.

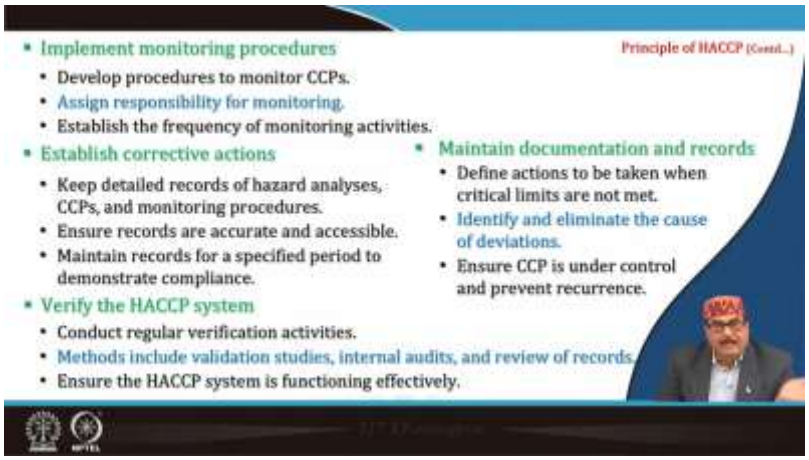


So, what do the seven principles of HACCP mean? First, conduct a hazard analysis, determine the critical control points, establish the critical limit, establish a verification

procedure, and establish the corrective actions. Establish monitoring protocols and, finally, establish record-keeping and documentation practices.

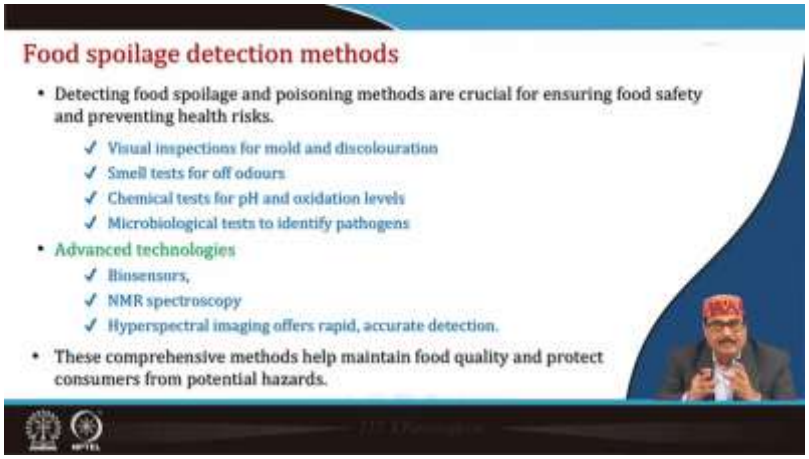


So, conducting hazard analysis means identifying potential biological, chemical and physical, assessing the likelihood and severity of these hazards, determining significant dangers that need to be controlled, and then determining the second step, critical control point like identifying the point in the process or step in the process where control needs to be applied. Examples include the cooking, cooling, and packaging stages to ensure the control measures are in place at all the critical points. Then, the essential limits that define measurable critical limits for each CCP are established. Parameters may include temperature, time, pH, etc., favour microbial growth. Our primary purpose is to reduce the microbial. So, what are the various factors at each point, either in the cooling or heating process? Suppose you have to control the temperature of pasteurisation, sterilisation, or other thermal treatments. Defined measurable critical limits for each CCP parameter and ensured that these vital limits were based on scientific data. The completed process chain value chain must be adequately studied, and based on scientific data, these limits should be identified.

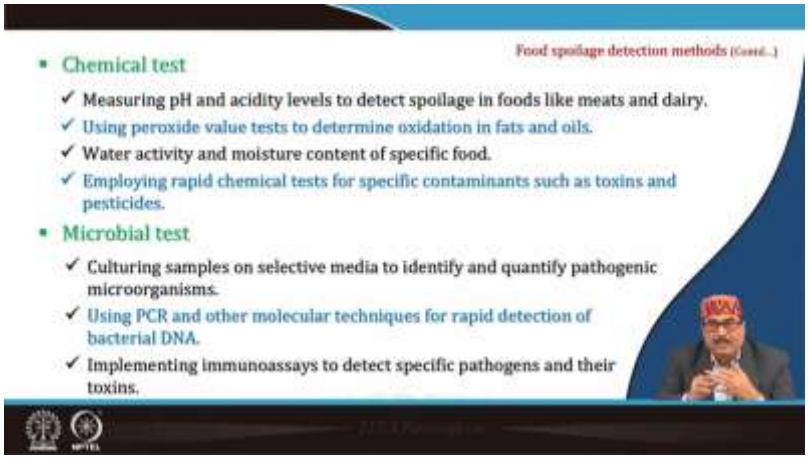


Then, these limits should be appropriately implemented and monitored by assigning responsibility for monitoring, establishing the frequency of monitoring activities and then establishing corrective actions, like keeping detailed records of hazard analysis. CCPs and monitoring procedures ensure records are accurate and accessible and maintain the records for a specified period to demonstrate compliance. Then, in the next step, the HACCP system will be verified by conducting regular verification activities. Methods include validation studies, internal audits, review of records, and ensuring that the HACCP system is functioning effectively. It is critical to maintain proper record documentation. If you have not done documentation, it means you have not done it. So, define actions to be taken when critical limits are unmet, identify and eliminate the cause of deviations, ensure that the CCP is under control, and prevent reoccurrence. So, all this should be adequately documented and recorded.

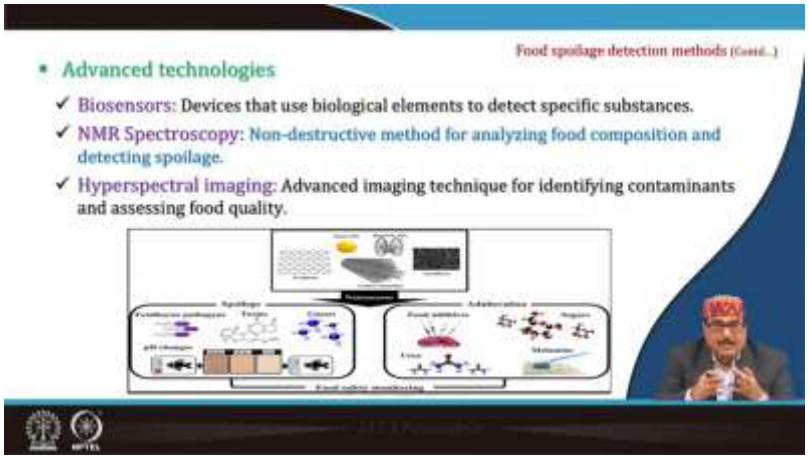
Now, let us briefly talk about food spoilage detection methods, like detecting food spoilage and poisoning. Methods are crucial for ensuring food safety and preventing health risks. We often need to analyse various methods and understand that detecting spoilage and poisoning is very important, and it may be a visual inspection for mould and discolouration. We can often just smell the taste or odour, etcetera, smell taste, for odours. Chemical tests may be performed to measure pH and oxidation levels or microbiological tests to identify pathogens.



So, there may be various methods. Advanced technologies like biosensors, NMR spectroscopy, hyperspectral imaging, etc., are also used. They are rapid methods, and they offer accurate detection. So, these comprehensive methods help maintain food quality and protect consumers from potential hazards.



So, chemical tests like measuring pH and acidity levels detect spoilage in foods like meat and dairy. Peroxide value tests and determines the oxidation in fats and oils, water activity, and moisture content. In the food powders, etcetera, where there are other food materials, dehydrated. Food materials, other grains, etcetera. Rapid chemical tests for specific contamination, such as toxins, pesticides, etcetera, should then be employed. Microbial tests, like culturing samples on selective media, identify and quantify pathogenic microorganisms. PCR and other molecular detection techniques should be used to detect bacterial DNA rapidly, and immunoassays should be implemented to detect specific pathogens and their toxins, etcetera.



Then, there are several advanced technologies, like biosensors. These devices use biological elements to detect specific substances, such as the presence of particular substances in food, particularly toxins, etcetera. NMR spectroscopy is a non-destructive method used to analyse food composition, detect spoilage, etc. Levels of toxins present even at minute levels are detectable. These can be detected using advanced technology. Hyperspectral imaging is an advanced imaging technique that identifies contaminants and assesses food quality. So, this can be used to identify various components present and indicate spoilage or even toxins, except microbial numbers. All these things can be detected.

So, finally, I would like to summarise this lecture by saying that practising strict hygiene and cleanliness across the food supply chain is essential. Storing food at safe temperatures inhibits bacterial growth and reduces spoilage. Preservatives and secure packaging methods help extend shelf life and prevent contamination. Physical and heat treatments

ensure harmful bacteria are destroyed, protecting consumer health. Following HACCP protocols, good hygienic practices, good manufacturing practices, etc., safeguard food safety and reduce the risk of foodborne illness.

So, these are the references used in this lecture.

With this, I thank you all for your patience hearing. Thank you.