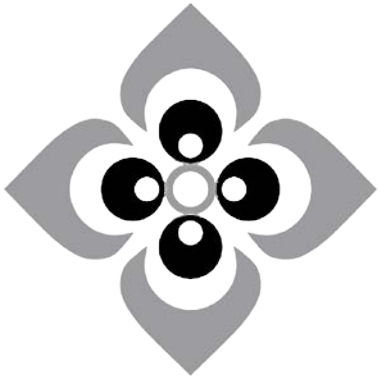

Consortium for Educational Communication

Module
on
Controlling Microbial Growth In Foods

By
RABIYA MAJEED
University of Kashmir

Introduction

Food is any substance consumed by an organism for the proper development and growth. It is usually of plant or animal origin, and contains essential elements, such as carbohydrates, fats, proteins, vitamins, or minerals. Foods from both plant and animal origin normally carry micro flora on the surface of their parts. Apart from this naturally occurring micro flora they may get contaminated from outside source usually in the field or during storage, transport and distribution processes. There are thousands of microorganisms found everywhere in the environment that have great potential and impact on our lives, but not always in a pleasant way. Though they are useful in the production of wine, beer, dairy products, they are also the main culprits of most cases of food and cultivar deterioration. Bacteria, molds and yeasts are the examples of the micro- organisms that plays major role in the food spoilage as well as food poisoning and hence proves fatal for the human consumption. There are many factors that influence the growth of microorganisms in foods like nutrient content, pH, oxygen, water content etc.

Consequence of micro organisms

Although every micro-organism is not dangerous, some of them known as microbes causes diseases and infections in humans and other living things. These disease-causing microbes can also be called as pathogens, germs or bugs and are also responsible for causing food borne illness as well as food spoilage.

Food spoilage: is a metabolic process that causes foods to be undesirable or unacceptable for human consumption due to changes in sensory characteristics. Spoiled foods may be safe to eat, i.e. they may not cause illness because there are no pathogens or a toxin present, but changes in texture, smell, taste, or appearance cause them to be unsuitable.

Microorganisms, specifically bacteria, mold, and yeasts, can cause food to spoil. For example, microorganisms that break down fats in unsalted butter can cause it to become rancid. Also, if milk is kept too long or at improper temperatures, it will sour.

The general sources of food spoilage microorganisms are the air, soil, sewage and animal wastes. Some microorganisms that are naturally present on the surface of foods grown in the ground can also cause food spoilage. Bacteria from the animal's internal organs, skin, and/or feet can contaminate meat and fish. Fish tissues are contaminated more readily than meat because they are more delicate and so more easily penetrated.

Canned foods undergo a sterilization process to make them shelf-stable. If canned foods are not properly processed, food spoilage (or food safety concerns) may occur. Swollen cans usually contain gas produced by the bacteria *Clostridium*. Sour spoilage without gas is commonly due to *Bacillus*. This type of spoilage is called flat-sour spoilage (FSP).

Food borne illness:

Foodborne illness or foodborne disease referred to as food poisoning is any illness resulting from the contaminated food and drink. There are more then ٢٥٠ known foodborne diseases. The majority is infectious and is caused by bacteria, viruses, and parasites. Other foodborne diseases are essentially poisonings caused by toxins, chemicals contaminating the food. All foodborne microbes and toxins enter the body through the gastrointestinal tract and often cause the symptoms like Nausea, vomiting, abdominal cramps and diarrhea

The most common foodborne infections are caused by three bacteria -- Campylobacter, Salmonella, and E. coli O157:H7 --

- **Campylobacter:** Campylobacter is the most common bacterial cause of diarrheal illness in the world. The bacteria live in the intestines of healthy birds, and most raw poultry meat has Campylobacter on it. Eating undercooked chicken or other food that has been contaminated with juices dripping from raw chicken is the most frequent source of this infection. Aside from diarrhea, common symptoms include fever, abdominal cramps. Long-term exposure to this infection leads to severe complications like Guilin- Barré Syndrome (GBS) most common cause of acute generalized paralysis in the western world.
- **Salmonella:** Salmonella is widespread in the intestines of birds, reptiles and mammals. The common symptoms of the disease salmonellosis include fever, diarrhea and abdominal cramps
- **E. coli O157:H7 --** E. coli O157:H7 has a reservoir in cattle and other similar animals. Illness typically follows consumption of food or water that has been contaminated with microscopic amounts of cow feces. The illness it causes is often a severe and bloody diarrhea and painful abdominal cramps, without much fever.

Foods Associated with Foodborne Illness

- Raw foods of animal origin, that is, raw meat and poultry, raw eggs, unpasteurized milk, and raw shellfish are the most likely to be contaminated.
- Fruits and vegetables can also be contaminated with animal waste when manure is used to fertilize produce in the field, or unclean water is used for washing the produce.
- Raw sprouts are particularly concerning because the conditions under which they are sprouted are ideal for growing microbes.

- Unpasteurized fruit juices or cider can also be contaminated if there are pathogens on the fruit that is used to make it.

- Any food item that is touched by a person who is ill with vomiting or diarrhea, or who has recently had such an illness, can become contaminated. When these food items are not subsequently cooked (e.g., salads, cut fruit) they can pass the illness to other people.

Controlling Microbial Growth

Control of microbial growth", means to inhibit or prevent growth of microorganisms. This control is affected in two basic ways: (1) by killing microorganisms or (2) by inhibiting the growth of microorganisms. Control of growth usually involves the use of physical or chemical agents, which either kill or prevent the growth of microorganisms. Agents which kill cells are called cidal agents; agents which inhibit the growth of cells (without killing them) are referred to as static agents. Thus, the term bactericidal refers to killing bacteria, and bacteriostatic refers to inhibiting the growth of bacterial cells A bactericide kills bacteria; a fungicide kills fungi, and so on. There are number of ways to control the growth of the micro organisms and to prevent the food from being spoiled as well as the humans from the several food borne diseases caused by these micro organisms.

- **Heat**: most important and widely used for controlling the growth of micro organisms For example by cooking the food relatively at a high temperature leads to the killing of the microbes present in the food as well as boiling the food at a temperature of 100° for ٣٠ minutes kills almost everything except some endospores. To kill the endospores very long (>٦ hours) boiling, or **intermittent boiling** is required.

- **Blanching:** exposure of a food to extremely hot water for a few seconds inactivates enzymes that will deteriorate the food and allow microbes to enter. Blanching is a common process for fruits or vegetables that will be frozen for later use.

- **Pasteurization**: is a process used in the milk industry to kill microbes by heating milk to a temperature of 145°F (63°C) for 30 minutes and then allow it to cool by means of refrigeration. Although the process does not kill all the microorganisms present in milk but slows down the growth of the surviving microbes. Eventually, even with refrigeration, the microbes will grow and spoil the milk, giving it the sour smell and flavor. Pasteurization is also used with certain juice and egg products.

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- **Autoclaving:** Autoclaving is the most effective and most efficient means of sterilization. All autoclaves operate on a time/temperature relationship. These two variables are extremely important. Higher temperatures ensure more rapid killing. The usual standard temperature/pressure employed is 121ºC/15 psi for 15 minutes. Longer times are needed for larger loads, large volumes of liquid, and more dense materials. Autoclaving is ideal for sterilizing biohazardous waste, surgical dressings, glassware, and many types of microbiologic media, liquids, and many other things. However, certain items, such as plastics and certain medical instruments (e.g. fiber-optic endoscopes), cannot withstand autoclaving and should be sterilized with chemical or gas sterilants. When proper conditions and time are employed, no living organisms will survive through the autoclave process.

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Moist heat: is a technique that utilize hot air that is heavily laden with water vapor and where this moisture plays the most important role in the sterilization and is thought to kill microorganisms by causing denaturation of essential proteins. Death rate is directly proportional to the concentration of microorganisms at any given time. The time required to kill a known population of microorganisms in a specific suspension at a particular temperature is referred to as **thermal death time (TDT)**. Increasing the temperature decreases TDT, and lowering the temperature increases TDT.

- **Ultraviolet** lamps are used to sterilize workspaces and tools used in microbiology laboratories and health care facilities. UV light at germicidal wavelengths (two peaks, 185 nm and 265 nm) causes adjacent thymine molecules on DNA to dimerize, thereby inhibiting DNA replication (even though the organism may not be killed outright, it will not be able to reproduce).

Gamma radiation: and electron beam radiations are forms of ionizing radiation used primarily in the health care industry. Gamma rays, emitted from cobalt-60, are similar in many ways to microwaves and x-rays. Gamma rays delivered during sterilization break chemical bonds by interacting with the electrons of atomic constituents. Gamma rays are highly effective in killing microorganisms and do not leave residues or have sufficient energy to impart radioactivity.

Filtration: involves the physical removal (exclusion) of all cells in a liquid or gas. It is especially important for sterilization of solutions, which would be denatured by heat (e.g. antibiotics, injectable drugs, amino acids, vitamins, etc.). Essentially, solutions or gases are passed through a filter of sufficient pore diameter (generally 0.22 micron) to remove the smallest known bacterial cells.

Chemicals

Chemicals used for sterilization include the gases ethylene oxide and formaldehyde, and liquids such

as glutaraldehyde. Ozone, hydrogen peroxide and peracetic acid are also examples of chemical sterilization techniques are based on oxidative capabilities of the chemical.

Ethylene oxide (ETO) is the most commonly used form of chemical sterilization Due to its low boiling point of ١٠,٤ºC at atmospheric pressure, EtO) behaves as a gas at room temperature. EtO chemically reacts with amino acids, proteins, and DNA to prevent microbial reproduction. The sterilization process is carried out in a specialized gas chamber .After sterilization, products are transferred to an aeration cell, where they remain until the gas disperses and the product is safe to handle. Ethylene oxide can be used with a wide range of plastics (e.g. petri dishes, pipettes, syringes, medical devices, etc.) and other materials without affecting their integrity.

Ozone: Ozone gas for sterilization process has been recently approved in the U.S. Ozone is used as a disinfectant for water and food and is used in both gas and liquid forms as an antimicrobial agent in the treatment, storage and processing of foods, including meat, poultry and eggs. Ozone sterilizers are used in many hospitals and in other medical centers for sterilization processes.

Low Temperature Gas Plasma (LTGP): This LTGP chamber is also used for controlling the microbial growth. LTGP is used as an alternative to ethylene oxide which uses a small amount of liquid hydrogen peroxide (H_2O_2), which is energized with radio frequency waves into gas plasma. This leads to the generation of free radicals and other chemical species, which destroy micro organisms.