MOUNTAIN TOP UNIVERSITY

E-Courseware

COLLEGE OF BASIC AND APPLIED SCIENCES

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Published By:

Mountain Top University

COURSE GUIDE

COURSE TITLE: Food Microbiology

COURSE CODE: MCB 309

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COURSE OBJECTIVES

GENERAL INTORDUCTION AND COURSE OBJECTIVES

This course aimed at relating interaction of microorganisms and food in relation to food bioprocessing, food spoilage, and foodborne diseases. It also provides information on the interaction of food and microorganisms. In addition, it provides valuable knowledge and explain the distribution, role and significance of micro-organisms in food; intrinsic and extrinsic parameters of foods that affect microbial growth, food spoilage and food borne diseases. It also involves studying the indices of food sanitary growth and food microbiology standards and disease of animal transmittable to man via food products.

COURSE CONTENTS

LECTURE ONE

INTRODUCTION TO FOOD MICROBIOLOGY

1.0 Food production:

This lecture focuses on basic concepts that will be useful in the subsequent lectures. Food production occurs at specific areas and at certain periods of the year. Food therefore has to be collected and stored for use during periods of low or no food production. However, storage is complicated by the fact that food begin to deteriorate shortly after harvest, gather or slaughter.

Objectives

At the end of this lecture, students should be able to:

1. describe the contributions of some pioneer scientists to food microbiology
2. have a good understanding of the current developments in food microbiology
3. explain in details the significant of microorganisms in food
4. explain in details the characteristics of microorganisms important in food

Pre-Test

1. Enumerate the microorganisms of importance in food microbiology
2. What are the major roles of microorganisms in food?

CONTENT

1.1 Food Microbiology, Past and Present

Our early Homo ancestors, the hunters and gatherers, were aware of food spoilage and foodborne diseases. Food preservation through ice and fire foods and make them safe. Around 8000 B.C, adoption of agriculture and animal husbandry by the early civilizations, abundance food supply, especially agricultural produce emerged. In 1875, Louis Pasteur for instance, carried out wine fermentation from grapes and souring, established spoilage of meat and milk by microorganisms, several diseases in humans, cattle, and sheep. He also development of vaccines

1.2 Microorganisms and Food

Microorganisms are present everywhere on Earth, including humans, animals, plants and other living creatures, soil, water, and atmosphere, and they can multiply everywhere except in the atmosphere. Among the microorganisms, some moulds, yeasts, bacteria, and viruses have both desirable and undesirable roles in our food.

1.3 Organisms that are studied in food microbiology

The microorganisms of focus in Food Microbiology include:

- Bacteria
- Fungi which include moulds and yeasts
- Algae — dinoflagellates/shellfish
- Protozoa — amoeba, Giardia
- Viruses — Hepatitis/shellfish
- Prions
- Helminths — worms

However, these microorganisms are classified based on their significance in food into:

1. pathogenic organisms
2. spoilage organisms
3. useful organisms

1.4 Presence of microorganism in Foods

Microorganisms have two opposing roles in food production and preservation.

i. Microorganisms can be used to transform raw foods into various food products such as cheeses, pickles, sausages, wines, beers etc through microbial activity.

ii. Microorganisms can degrade food quality and lead to spoilage. Contaminated foods can serve as vehicles for disease transmission.

The presence of microorganisms in foods may results in:

- ✓ Food spoilage
- ✓ Transformation of food's properties in a beneficial way such as food fermentation
- ✓ Foodborne illness

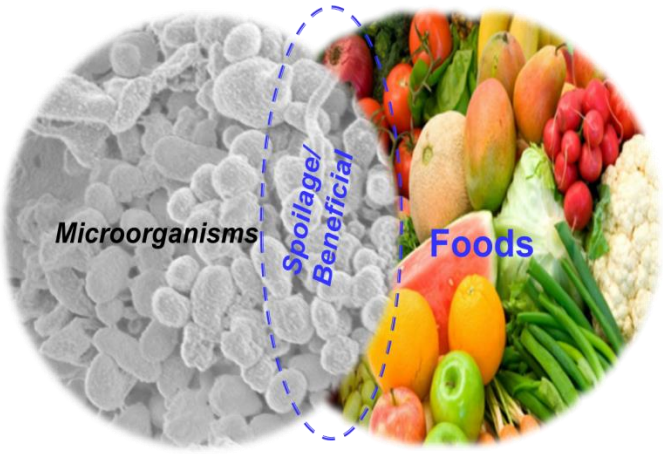

Figure 1: Pictorial representation of the interaction between microorganisms and foods.

- Microbial growth in foods will:

i. Either result in deterioration of food – ***Spoilage***

OR

ii Beneficial to humans

- googleimage.com

1.5 Recent changes in Food Microbiology

In some ways, food microbiology has changed radically in the last 20 years. The number of recognized foodborne pathogens has doubled and identification of emerging foodborne pathogens such as non-O157 Shiga toxing-producing *E. coli* (non-O157 STEC) serogroups have increased. Safety through end product testing has given way to the safety by design provided by Hazard Analysis and Critical.

1.6 Food Microbiology: Current Status

This entails understanding the association and importance of microorganisms, especially pathogenic bacteria in food, development of specific method for microbial isolation and identification. More emphasis will be on sanitation in the handling of food to reduce contamination by microorganisms. It also entails specific methods to prevent growth as well as to destroy the spoilage and pathogenic bacteria, isolation of beneficial bacteria associated with food fermentation, especially dairy fermentation.

Post-test

1. What are the beneficial roles of microorganisms in food
2. Enumerate the important areas of current studies in food microbiology

LECTURE TWO

THE SOURCES AND DISTRIBUTION OF MICROORGANISMS IN FOOD

1.0 INTRODUCTION

Microorganisms get into foods from both natural (including internal) sources and from external Sources to which a food comes into contact from the time of production until the time of consumption. An understanding of the sources of microorganisms in food is important to develop methods to control access of some microorganisms in the food, develop processing methods to kill them in food, and determine the microbiological quality of food, as well as set up microbiological standards and specifications of foods and food ingredients

Objectives

At the end of this lecture, students should be able to:

1. have a good understanding of various sources of microbial contamination in food
2. develop methods to control access of some microorganisms in the food
3. explain in details the characteristics of microorganisms important in food

Pre-test

1. What are the major sources of microbial contamination in foods?
2. How can an understanding of the microbial sources in food be useful in food preservation?

1.1 Sources of microorganisms which may contaminate food

The major sources of microorganisms include:

i. Atmosphere – This include Airborne Bacteria and Airborne Fungi
ii. Soil
iii. Water
iv. Plants
v. Human and Animal Origin
vi. Sewage
vii. Equipment

(i). **Airborne Microorganisms**

The predominant bacterial flora in the air is Gram-positive rods and cocci. Bacteria have no active mechanisms for becoming airborne, they are dispersed on dust particles and water droplets (formation of an aerosol). They become airborne in the same way as fine dry dust

particles by physical disturbance and wind. Examples to considered are spores of *Penicillium* and *Aspergillus*, *Fusarium*, they produce spores that are responsible for food spoilage.

(ii).**Microorganisms in Soil**

Soil is a rich reservoir of microorganisms that are of industrial importance such as bacterial strains used for the industrial production of antibiotics, enzymes, amino acids, vitamins and other products. Protecting food from 'dirt' is a potential means of reducing the likelihood of inoculating food with potential spoilage organisms. Many soil bacteria and fungi produce resistant structures such as endospores of *Bacillus* and *Clostridium*, and chlamydospores and sclerotia of many fungi which can withstand desiccation and a wide range of temperature fluctuations.

(iii). **Microorganisms in water**

The surface of fish from cold water contains bacterial flora which are predominantly psychrophilic and psychrotrophic species. This entails considering i**ndicator microorganisms" which are** pathogens in human faeces which are unlikely to grow in fresh water, but will survive at least as long as any pathogen. Species usually chosen in temperate climates is *Escherichia coli*.

(iv). **Microorganisms of Plants**

Moulds, yeasts, lactic acid bacteria, and bacteria from genera *Pseudomonas, Alcaligenes, Micrococcus, Erwinia, Bacillus, Clostridium*, and *Enterobacter* can be expected from this source. Yeast flora is also found in association with the nectaries of flowers and the surfaces of fruits. Presence of some of these is important in the spontaneous fermentation of fruit juices. Some genera of fungi, such as *Fusarium*, contain a spectrum of species, some of which are specialized plant pathogens

Spoilage of fruits by *Botrytis cinerea*

Source: www.googleimage.com

(v). **Microorganisms of Human and Animal origin**

All healthy humans and animals carry a complex microbial flora, part of which may be very specialized and adapted to growth and survival on its host. Between production and consumption, foods come in contact with different people handling the foods.

These include people:

- *working in farms and food processing plants*
- *those handling foods at restaurants,*
- *catering services,*
- *retail stores, and at home*

Human carriers are one of the major sources of foodborne pathogenic microorganisms in foods that later caused foodborne diseases, especially with ready to-eat foods.

(vi). **Microorganism from sewage**

Sewage, especially when used as fertilizer in crops, can contaminate food with pathogenic microorganisms. Major concern with organically grown food and many imported fruits and vegetables is the application of untreated sewage and manure as fertilizer. Pathogenic parasites can also get into food from sewage.

(vii). **Microorganisms from Equipment**

A wide variety of equipment is used in harvesting, slaughtering, transporting, processing, and storing foods. Many types of microorganisms from air, raw foods, water, and personnel can get into the equipment and contaminate foods. *Example*: Biofilms formation in milk processing

Post-test

1. List five major sources of foodborne pathogens in food and indicate the measures that should be implemented to reduce their incidence in food.

LECTURE THREE

MICROBIAL SPOILAGE OF FOODS

1.0 INTRODUCTION

Food spoilage is defined as damage or injury to food that renders it unsuitable for human consumption. Food can also be considered spoiled if it is contaminated with pathogenic microorganisms or various poisonous agents, such as pesticides, heavy metals etc. In most occasions there may be no physical sign of spoilage on the food and only after microbiological examination that spoilage level can be established.

Objectives

At the end of this lecture, students should be able to:

1. enumerate the major causes of spoilage

Pre-test

Describe when a food is considered spoiled by microorganisms

CONTENTS

1.1 Causes of food spoilage

Spoilage may also be due to one or more of the following:

1. Growth and activity of microorganisms: Bacteria, yeasts and moulds are microorganisms that cause food spoilage. They produce various enzymes that decompose the various constituents of food.

2. Action of the enzymes of the plant or animal food: Action of enzymes found inherently in plant or animal tissues start the decomposition of various food components after death of plant or animal.

3. Purely chemical reactions: These are reactions that are not catalysed by enzymes.,e.g. oxidation of fat.

4. Physical changes such as those caused by freezing, burning, drying, pressure etc.

5. Activities of Vermin and insects: Vermin includes weevils, ants, rats, cocroaches, mice, birds, larval stages of some insects. Vermin are important because they are capable of transmitting pathogenic agents.

Post-test

Discuss the major causes of food spoilage

LECTURE FOUR & FIVE

FACTORS AFFECTING MICROBIAL GROWTH IN FOOD

INTRODUCTION

The ability of microorganisms to grow or multiply in a food is determined by the food environment and the environment in which the food is stored. These environments are designated as the intrinsic and extrinsic environment of food. The factors that affect microbial growth in foods, and the associations that develop from such factors determine the nature of spoilage and any health risks posed to the consumers.

Objectives

At the end of this lecture, students should be able to:

1. enumerate various factors that affect microbial growth in food.
2. explain in details the impact of those factors on microbial and subsequently on food spoilage

Pre-test

1. What are the factors that influence microbial growth in food
2. Briefly describe the influence of water activity on microbial and on food spoilage

CONTENT

1.0 The factors that affect microbial growth are grouped into two main categories:

(i). Intrinsic factors or Food environment

(ii). Extrinsic factors or Environmental factors

Other factors include:

(iii). Implicit factors e.g processing factors, mutualism, antagonism and commensalism

(iv). Processing factors e.g slicing, packaging, pasteurization, washing and irradiation

1.1 Intrinsic factors or Food environment

In a food system the factors are present together and exert effects on microbial growth in combination, either favourably or adversely. These are inherent in the food. They Include:

1.1.1 Nutrient content

1.1.2 Growth Factors and Inhibitors (Antimicrobials)

1.1.3 Water Activity and Growth

1.1.4 Hydrogen ion concentration (pH)

1.1.5 Oxidation–reduction (O–R) potential

1.1.6 Biological Barriers

1.1.1 Nutrient content and microbial growth

Microorganisms can use foods as a source of nutrients and energy. Inability of a microorganism to utilize a major component of a food material will limit its growth and put it at a competitive disadvantage compared with those that can. Microorganisms require proteins, carbohydrates, lipids, water, energy, nitrogen, sulphur, phosphorus, vitamins, and minerals for growth. Microorganisms capable of using these molecules do so by producing specific extracellular enzymes (or exo-enzymes).

1.1.2 Growth Factors and Inhibitors (Antimicrobials)

Food inhibitors, depending on their mode of action, can prevent, reduce growth or kill microorganisms. Some of the natural inhibitors are lysozyme in egg, agglutinin in milk, and eugenol in cloves. Lysozyme enzyme catalyses the hydrolysis of glycosidic linkages in peptidoglycan which is the structural polymer that is responsible for the strength and rigidity of the bacterial cell wall). Destruction or weakening of this layer causes the cell to rupture (lyse) under osmotic pressure.

1.1.3 Water Activity (a_w) and Growth

Life is totally dependent on the presence of water in its liquid state. The cytoplasm is surrounded by a membrane which is permeable to water molecules Water molecules pass freely from the cytoplasm to the environment and from the environment to the cytoplasm. The a_w of a food can be expressed by the ratio of water vapour pressure of the food (P, which is <1) to that of pure water (Po, which is 1).

This is numerically equal to the equilibrium relative humidity (ERH) expressed as a fraction rather than as a percentage.

$$a_w = \frac{P}{P_O} = \frac{1}{100} ERH$$

Table 1: Minimum water activity that supports growth of some microorganisms

Microorganism	Water activity
Clostridium botulinum,	0.95
Bacillus cereus,	0.95
Pseudmonas aeroginosa,	0.95
Salmonella spp.	0.95
Staphylococcus aureus (anaerobic), *Candida spp., Saccharomyces*	0.90
Penicillium spp.	0.82
Most spoilage yeast	0.88
Most spoilage moulds	0.80

1.1.4 Hydrogen ion concentration (pH)

The pH of a food has a profound effect on the growth and viability of microbial cells. Each species has an optimum and a range of pH for growth. In general, moulds and yeasts are able to grow at lower pH than do bacteria, and Gram-negative bacteria are more sensitive to low pH than are Gram-positive bacteria. When the pH in a food is reduced below the lower limit for growth of a microbial species, the cells not only stop growing but also lose viability, the rate of which depends on the extent of pH reduction

Table 2: pH values of some food products

Food type	Range of pH values
Beef	5.1 – 6.2
Chicken	6.2 – 6.4
Milk	6.3 – 6.8
Cheese	4.9 – 5.9
Fish	6.6 – 6.8
Oyester	4.8 – 6.3
Fruits	< 4.5 (most < 3.5)
Vegetables	3.0 – 6.1

1.1.5 Oxidation–reduction (O–R) potential

The redox or oxidation–reduction (O–R) potential measures the potential difference in a system generated by a coupled reaction in which one substance is oxidized and a second

substance is reduced simultaneously. The tendency of a medium to accept or donate electrons, to oxidize or reduce, is termed its redox potential (Eh). Microbial growth in a food reduces its Eh. This is usually ascribed to a combination of oxygen depletion and the production of reducing compounds such as hydrogen the microorganisms.

Redox potential (Eh) is important in microbial spoilage of a food (such as putrification of meat by *Clostridium* spp. under anaerobic conditions) and to produce desirable characteristics of fermented foods (such as growth of *Penicillium* species in blue cheese under aerobic conditions)

1.1.6 Biological Barriers

Some foods have biological structures that prevent microbial entry. For example, meat has fascia, skin and other membranes that prevent microbial entry. Eggs have shell and inner membranes that prevent yolk and egg white from infection.

1.2 Extrinsic factors or Environmental factors

Extrinsic factors that are important for microbial growth in foods include: The relative humidity and gaseous condition of storage, respectively, influence the *Aw* and Eh of the food.

i. Temperature of storage,
ii. Presence and concentration of gases in the environment (Gaseous Atmosphere)
iii. Relative humidity of food storage environment

1.2.1 Temperature of storage,

Principle: Microbial growth is accomplished through enzymatic reactions. Within a certain range, with every $10^{o}C$ rise in temperature, the catalytic rate of an enzyme doubles. Similarly, the enzymatic reaction rate is reduced to half by decreasing the temperature by $10^{o}C$.Because temperature influences enzyme reactions; it has an important role in microbial growth in food. The growth of microorganisms is affected by the environmental temperatures.

Microorganisms can be divided into three groups depending upon their optimum temperature of growth.

1. **Thermophilic bacteria.**
   They grow at relatively high temperature
   optimum $55^{o}C$
   range 45 to $70^{o}C$;

These grow at temperatures above 45^{o}C. Often their optimum growth temperatures are between 55^{o}C and 70^{o}C.

2. **Mesophilic bacteria**

They grow at ambient temperature

optimum at 35^{o}C

range 10 to 45^{o}C

These organisms grow between 25^{o}C and 40^{o}C, with an optimum growth temperature of around 35^{o}C

3. **Psychrophilic microorganisms**

They grow at cold temperature.

optimum at 15^{o}C and

range –5 to 20^{o}C.

Psychrotrophs microorganisms grow at refrigerated temperature (0 to 5^{o}C), They can cause food spoilage at low temperatures. They usually grow rapidly between 10 and 30^{o}C.

1.2.2 Presence and concentration of gases in the environment (Gaseous Atmosphere)

This relates to the presence and concentration of gases in the food environment. Various microorganisms require for growth, either high oxygen tension (aerobic), low oxygen tension (micro-aerobic) or absence of oxygen (anaerobic). Some microorganisms may grow either in high oxygen tension, or in the absence of oxygen (facultative anaerobes).

1.2.3 Relative humidity of food storage environment

Relative humidity is the amount of moisture in the atmosphere or food environment. Foods with low water activity placed at high humidity environment take up water, increase their water activity and get spoiled easily. For example, dry grains stored in a environment with high humidity will take up water and undergo mould spoilage.

Post-test

1. Enumerate the intrinsic and extrinsic factors necessary for microbial growth in a food.
2. Discuss the importance of Hydrogen ion concentration (pH) in foods that can adversely affect microbial growth.

LECTURE SIX & SEVEN:

FOOD SPOILAGE MICROORGANISMS

1.0 INTRODUCTION

When a food is spoiled its characteristics are changed so that it is no longer acceptable. Microbiological food spoilage can manifest itself in several different ways, some of which often occur in combination. Visible microbial growth may be apparent in the form of surface slime or colonies, degradation of structural components of the food. Food spoilage by microorganisms depends on the bacterial characteristics, food characteristics, and the storage conditions.

Objectives

At the end of this lecture, students should be able to:

1. explain in details the microbial spoilage of foods
2. understand in full the bacterial and food characteristics that influence food spoilage

Pre-test

1. what are psychrotrophic bacteria
2. list two (2) examples of Thermoduric Psychrotrophs

CONTENTS

Bacterial species from various genera that have been implicated with spoilage of most foods include:

1.1 Psychrotrophic Bacteria

Some of the foods stored on ice (chilling) and in refrigerators are expected to have a long shelf life of about 50 days or more. Between processing and consumption, there can be temperature abuse up to 10^{o}C and higher which will encourage the growth of psychrophilic bacteria.

1.1.1 Psychrotrophic aerobic spoilage bacteria

Psychrotrophic aerobes are the predominant spoilage bacteria in the food stored under aerobic conditions. If the food is given low-heat treatment and not exposed to post-heat contamination during storage at low temperature, psychrotrophic thermoduric bacteria can cause it to spoil.

Psychrotrophic aerobic spoilage bacteria include *Pseudomonas fluorescens, Pse. fragi*, other *Pseudomonas* species, *Acinetobacter*, *Moraxella*, and *Flavobacterium*.

1.1.2 Psychrotrophic Facultative Anaerobic Spoilage Bacteria

They include *Lactobacillus viridescens, Lab. sake, Lab. curvatus, Leuconostoc carnosum, Leu. gelidum, Leu.mesenteroides,* Some *Enterococcus spp., Alcaligenes spp., Enterobacter spp., Serratia liquifaciens,* some *Hafnia* and *Proteus spp*., and *Shewanella* (previously *Alteromonas*) *putrefaciens* (and some microaerophilic yeasts).

1.1.3 Thermoduric Psychrotrophs

They produce spores which survive low-heat treatment. Following germination and outgrowth, the cells grow at low temperature. When a food is temperature abused above 5^{o}C (such as during transport or display in stores), some true mesophiles can also grow. At 10 to 15^{o}C, psychrotrophs will generally grow much faster than the mesophiles.

Examples thermoduric psychrotrophs include: facultative anaerobes, such as spores of *Bacillus coagulans* and *Bac.megaterium.*

Post-test

1. Describe under what conditions can low-pH food product cause foodborne disease
2. Discuss the significance of psychrotrophic and thermoduric microorganisms in the processing and refrigerated storage of food.

LECTURE EIGHT

Lecture Eight: Mid semester assessment

Mid semester Assessment questions

Question 1: List the different ways microorganisms are used beneficially in foods

Question 2: List five major sources of foodborne pathogens in foods and indicate the measures that should be implemented to reduce their incidence.

Question 3: How are moulds used in different ways in food? Name two species and list their uses.

LECTURE NINE & TEN

THE MICROBIOLOGY OF FOOD PRESERVATION

1.0 INTRODUCTION

Food preservation is a process through which physical and /or chemical agents are used to prevent microbial spoilage of food. Food preservation aims at treating food in a manner to prolong its storage life. In food preservation, efforts are made to destroy organisms in the food, or increase the period taken by microorganism to adapt to the food environment before they start to spoil the food.

Objectives

At the end of this lecture, students should be able to:

1. Explain in details the principles of food preservation

Pre-test

1. enumerate the principles used in food preservation
2. Define Decimal Reduction Time (D-Value)

CONTENTS

Two general principles are employed in food preservation.

(1). Inhibition principle

(2). Killing principle

1.1 Inhibition principle

Food preservation is achieved by inhibiting the growth and multiplication of microorganisms. Preservation of food by inhibition methods does not necessarily imply the destruction of organisms. On removal of the inhibiting influence, the food will undergo spoilage as the microorganism present will grow and multiply to cause spoilage.

The inhibition principle can be achieved by any of the following methods:

i. Reduction of water activity e.g. By drying and salting
ii. Reduction in pH e.g. by fermentation and addition of acids.
iii. Use of preservatives, e.g. sodium benzoate
iv. Use of low temperatures (chilling or freezing)
v. Smoking – which has a drying and preservative effect

1.1.1 Food preservation by lowering water activity

Lowering of water activity can be achieved by:

***Addition of high content of salt*:** Sodium chloride and sometimes nitrates and nitrites

Addition of high content of sugar

Drying: Sun/air drying; electrical drying or freeze drying.

1.1.2 Reduction in pH

Many food products can be preserved by lowering pH so that the growth of spoilage and pathogenic bacteria is prevented. The lowering of pH can be achieved by addition of acids and fermentation. Fermentation is the breakdown of carbohydrates under anaerobic conditions into alcohol or lactic acid and carbon dioxide.

1.1.3 Use of preservatives

Antimicrobial chemicals are used in food in relatively small doses either to kill undesirable microorganisms or to prevent or retard their growth. They differ greatly in the abilities to act against different microorganisms (broad spectrum). Some are effective against many microorganisms, whereas others are effective against either moulds and yeasts or only bacteria (narrow spectrum). Foods can have antimicrobial compounds in three ways: present naturally, formed during processing, or added as ingredients. Those added have to be GRAS-listed and approved by regulatory agencies. Some of these are added specifically as antimicrobial preservatives, whereas others, although having antimicrobial properties, are added for different reasons.

1.1.4 Use of low temperatures (chilling or freezing)

Two methods are employed to arrest microbial growth and multiplication. These are chilling (cold storage) and freezing. Chilling is keeping food at temperatures between 0-15^{o}C. The common chilling temperatures ranges between 4-5^{o}C. Freezing is keeping food at temperatures between 0oC and -35^{o}C. Low temperatures are used to retard chemical reactions and actions of food enzymes and to slow down or stop the growth and activity of microorganisms in the food.

1.1.5 Smoking:

Smoking has a drying and preservative effect. Many meat and fish products are exposed to low heat and smoke for cooking and depositing smoke on the surface at the same time. The heating process removes water from the products, thereby lowering their Aw. Many low-heat-processed meat products (dry and semidry sausages) and smoked fishes are produced this way. Heat kills many microorganisms.

1.2 Killing principle

In this principle, spoilage microorganisms are destroyed (Killed) in the food, and the food protected against subsequent contamination by being enclosed in an air tight container.

1.2.1 Methods employed to achieve the killing principle

(i). ***Heat treatment***: through pasteurization or sterilization.

(ii). ***Irradiation:*** This is the use of ionizing or electromagnetic radiation e.g gamma rays, cobalt 60 radioactive particles. Radiations kill microorganisms by destruction of DNA and by creating toxic reactive compounds in a medium and in microbial cells.

(iii). ***Use of gases***: by use of ethylene oxide or ozone. The gases destroy both vegetative cells and spores.

1.3 Applications

In practice, combination of inhibition and killing principles and the various methods are often used depending on the food type.

Examples: use of pasteurization and chilling of milk, lowering of water activity and low temperature storage, use of preservatives and low temperature etc.

1.3.1 Decimal reduction Time (D-Value): D-Value is the time required at any temperature to destroy 90% of the spores or vegetative cells of a given organism.

1.3.2 The Z value: Is the number of degrees the temperature has to be increased in order to reduce the thermal death time tenfold.

1.3.3 F-value: The F-value expresses the time taken to expose food to the same amount of heat required to destroy spores and vegetative cells of a particular organism using different temperatures.

Post-test

1. Define the following terminologies used in food preservation
   (i). D - value
   (ii). Z - value
   (iii). F – value
2 Discuss in detail the general principles of food preservation

LECTURE ELEVEN

DETECTION OF MICROORGANISMS IN FOOD AND FOOD ENVIRONMENT

INTRODUCTION

Microbiological examination of foods and food ingredients helps assess their safety to consumers, their stability or shelf life under normal storage conditions, and the level of sanitation used during handling. In addition, the microbiological load and type can be important in determining whether a food and food ingredient meet acceptable standards, specifications, and guidelines.

Objectives

At the end of this lecture, students should be able to:

1. explain the significance of microbiological examination of food
2. Describe various methods used for microbiological evaluation or detection of foods.

Pre-test

1. As a food microbiologist, how can you determine the microbiological quality of food?
2. Enumerate the major methods used for microbiological examination of food

CONTENTS

1.0 The total microbial population in a food varies greatly, depending on:

i. the level of sanitation used at all phases,
ii. the degree of abuse that leads to microbial growth, and
iii. processing and preservation methods used to kill and prevent growth of microorganisms

1.1 Significance of microbiological examination of food

Microbiological examination of foods is important for the following reasons:

(i). It helps assess their safety to consumers,

(ii). To ascertain food stability or shelf life under normal storage conditions,

(iii). To determine the level of sanitation used during handling

The microbiological load and type can be important in determining whether a food and food ingredient meet acceptable standards, specifications, and guidelines. Microbiological evaluation of raw materials also provides important information about the heat-processing parameters to meet the microbiological standard, guideline, or specification of a product. Microbiological evaluation of a food helps determine possible sources of a specific microbial type in a food and, in the case of a heated food, the source and nature of post-heat treatment contamination.

1.2 Methods used for Microbiological evaluation or detection of foods.

1.2.1 Quantitative: Quantitative methods are designed to enumerate or estimate directly or indirectly the microbial load in a test material. Examples of the quantitative methods used are: aerobic plate counts (APCs, or standard plate counts, SPCs, for dairy products), anaerobic counts, psychrotrophic counts, thermoduric counts, coliform counts.

1.2.2 Qualitative: Qualitative methods are designed to determine whether a representative amount (a sample) of a food or a certain number of samples in a batch of a food contain a specific microbial species among the total microbial population. Detecting the possible presence of certain foodborne pathogens that are capable of inflicting high fatality rates among consumers

Examples: *Salmonella, Clostridium botulinum, Escherichia coli* O157:H7, and *Listeria monocytogenes* in ready-to-eat food.

Post-test

1. Discuss the significance of microbiological examination of food.
2. Write short note Quantitative and Qualitative methods for microbiological examination of food.

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