# Microbial Food Spoilage

Microbial food spoilage occurs as a consequence of either microbial growth in a food or release of extracellular and intracellular(following cell lysis)

.enzymes in the food environment

**:Signs of spoilage of different types of food**

Changes in color

Changes in odor

Changes in texture e.g slime formation

Accumulation of gas or foam

Accumulation of liquid

Spoilage by microbial growth occurs much faster than spoilage by microbial extracellular or intracellular

.enzymes in the absence of viable microbial cells

For microbial food spoilage to occur, microorganisms have to get into the food from one or more sources e.g environment, food handling, food ingredients, humans …etc

Food environment should favor the growth of one or .more types of these contaminating microorganisms

Food environment includes pH, Aw, oxidation-reduction .potential, nutrients and inhibitory agents

The food must be stored at a temperature which favors .the growth of microorganisms

The food must be stored for sufficient period of time , so microorganisms multiply in high numbers necessary .to cause detectable changes in food

# Changes In Food

In a heat-treated food, microorganisms associated with spoilage either survive the specific heat treatment or get into the food .following heating

Spoilage of a heated food by microbial products in the absence of viable microbial cells, can result from some heat stable enzymes produced by microorganisms in the .foods before heat treatment

# Significance of Microorganisms

## A- Microbial Types

Raw and most processed foods normally contain many types of molds, yeasts and bacteria capable of .multiplying and causing spoilage

.Bacteria and yeasts cause rapid spoilage of foods

In foods where bacteria or yeasts do not grow favorably and foods are stored for longer period of time such as breads, hard cheeses, fermented dry sausages and acidic fruits and vegetables, spoilage .due to mold growth is more prevalent

Anaerobic packaging of foods have greatly reduced the spoilage of food by molds, but not by anaerobic and facultative anaerobic bacteria.

## B- Microbial numbers

Microorganisms must multiply to certain levels in order to be able to cause food spoilage. This is referred to as spoilage detection level

Bacteria and yeasts need to grow and reach 10(7) cells/g,ml or cm(2).

The spoilage detection level can range from 10(6)-10(8) cells/g, ml, or cm(2).

Spoilage associated with H2S, some amines, and H2O2 formation can be detected at a lower microbial load, where as formation of lactic acid .may be detected at higher microbial load

Higher initial loads of spoilage bacteria or yeasts and a storage conditions that favors rapid growth .will cause the food to spoil more rapidly

Food with low initial microorganisms load and stored at 4c, the generation time will be longer, spoilage will take more time to occur and food could .be stored for long time

In fermented foods, some undesirable .microorganisms may cause food spoilage

# C- Predominant Microorganisms

Unspoiled, nonsterile food generally contains many types of microorganisms from .different genera

When the same food is spoiled, it is found to contain predominantly one or two types and they may not even be present initially in the highest numbers in the unspoiled fresh .product

# *Results of a Study*

A beef sample(pH 6.0) initially contained 10(3) bacteria/g;  Pseudomonas 1%, Acinetobacter 11%, Staphylococcus, Enteric bacteria and lactic acid .bacteria 75%

Aerobic storage at 2C for 12 days, the population reached 6(by)10(7) cells/g with the relative levels .of Pseudomonas spp. 99% and all others 1%

.Pseudomonas Spp. Have short generation time

If the same meat samples were stored at 2C anaerobically, the predominant bacteria would be facultative anaerobic  lactobacillus or leuconostoc .Spp

# Important Food Spoilage Bacteria

Any microorganism including those used in food fermentation and pathogens that can multiply in a food to reach a high level(spoilage detection level) is capable of causing it to spoil.

Bacterial characteristics, food characteristics and the storage conditions are among the factors that lead to food spoilage.

# *A- Psychrotrophic Bacteria*

These bacteria are capable of growing at 5C .and below, but multiply rapidly at 10-25C

Many foods are stored on ice and in refrigerator and some are expected to have a long shelf life; 50 .days or more

Between processing and consumption, they can be temperature abused to 10C and higher. So psychrotrophic bacteria, yeasts, and molds can .cause spoilage in these foods

If the food is stored under aerobic conditions, psychrotrophic aerobes are the predominant spoilage bacteria.

In foods stored anaerobically, also in the interior of prepared food, anaerobic and facultative anaerobic bacteria predominate.

*Some important psychrotrophic aerobic spoilage bacteria*

*Pseudomonas fluorescens, Pseudomonas fragi, Acinetobacter, Moraxella, Flavobacterium, Some molds and yeasts*

# *Psychrotrophic Facultative Anaerobic Spoilage Bacteria*

*Lactobacillus viridescens, Lactobacillus sake, Lactobacillus curvatus, Leuconostoc carnosum, Leuconostoc gelidum, some Enterococcus Spp., Alcaligenes Spp., Enterobacter Spp., Some Microaerophilic yeasts.*

# *Thermoduric Psychrotrophs*

They include facultative anaerobes such as spores of *bacillus coagulans, Bacillus megaterium, Lactobacillus viridescens*.

Anaerobes:

*Clostridium* laramie, *Clostridium putrefaciens*

*The spores survive low-heat treatment, following germination and outgrowth, the cells grow at low temperature.*

*When food is temperature abused above 5C, some true mesophiles can also grow, however at 10-15C psychrotrophs will grow much faster than these mesophiles.*

# *Thermophilic Bacteria*

This group of bacteria grow between 40-90C .with optimum temperature at 55-65C

Some high heat processed foods are kept warm between 50-60C for a long period of time .e.g at restaurants

Spores of some thermophilic bacillus and Clostridium Spp. Can be present in these heat-treated foods, which at warm temperature .germinate and multiply to cause spoilage

Some thermoduric vegetative bacteria surviving low heat processing(such as pasteurization), or thermophiles can also multiply in these warm foods especially if the .temperature is close to 50C

These include some lactic acid bacteria such as Pediococcus Spp. And Streptococcus Spp., .Bacillus and Clostridium Spp

They can also survive and cause spoilage of foods as that are cooked at low heat(60-65C)as for some processed meat or kept warm for .long time

# *Aciduric Bacteria*

These are the bacteria that can grow in food at pH .4.6 or below

They are associated with spoilage of acidic food products such as fruit juices, pickles, salsa, salad .dressing and fermented sausages

Heterofermentative and homofermentative lactic .acid bacteria have been associated with such spoilage

Yeasts and molds are aciduric and are also .associated with spoilage of such foods

# Food Types

On the basis of susceptibility of spoilage, foods can be grouped as:

.Perishable which spoil quickly within few days

They must be kept refrigerated or frozen, perishable foods include dairy products, meat, poultry, fish.

Semiperishable have relatively long shelf life; few weeks or months. e.g bread, butter, cake , many canned fruits

Nonperishable having very long shelf life for months or years e.g canned fruits and vegetables, dried fruits and vegetables, pea nut butter

# End Products From Microbial Metabolism Of Food Nutrients

*Carbohydrates*

*CO2, H2, H2O2, Lactate, Acetate . Formate, Succinate, Butyrate, Ethanol, Propanol,butanol, .Diacetyl, Dextran*

*Proteins and Non Protein Nitrogen compounds*

*CO2, H2, NH3, H2S, Amines, Ketoacids. Putrescines*

*Lipids*

*Fatty acids, Glycerol, Hydroperoxides, Aldehydes, Ketones*

# Indicators Of Microbial Food Spoilage

**:Microorganisms cause food spoilage by**

Growth and active metabolism of food components by .the live cells

enzymes Through their extracellular and intracellular

Indicators which can predict expected shelf life and estimate :stages of microbial food spoilage include

Sensory indicators…….change in color, odor, flavor, texture and general appearance

Microbiological Indicators…..types of microorganisms causing spoilage

Chemical indicators……..specific microbial metabolites

## The contributing factors in microbial spoilage :of a food include

The type of a product

Its composition

Methods used during processing

Contamination during processing

Nature of packaging

Temperature and time of storage

Possible temperature abuse

These factors differ with products, so it is necessary to select indicators on the basis of a product or a .group of similar products

# Microbiological Indicators

Enumeration of colony-forming units(CFUs)

Select the microorganisms predominantly involved in spoilage of a food(or food group) as indicators of .spoilage for that food

Example: Refrigerated ground meat during aerobic storage is normally spoiled by Gram-negative psychrotrophic aerobic rods, most importantly by .*Pseudomonas* Spp

Aerobic plate count(APC), or standard plate count(SPC) indicate the effectiveness of sanitary procedures used during processing and handling and before storage of a .product

A high APC in a food product such as pasteurized milk is viewed with suspecion both for stability and safety.

It is good to include APC along with the method suitable to detect the load of an appropriate spoilage indicator group for a food based on its specific type and storage conditions.

# *Specific Microbial Spoilage Indicators*

:Refrigerated raw (fresh) meats stored aerobically

Enumeration of CFUs of psychrotrophic aerobes especially Gram-negative aerobes. Incubation .temperature 10-25C

Refrigerated raw(fresh) meats stored anaerobically (vacuum packaged)

Enumeration of CFUs of psychrotrophic lactic acid bacteria and Enterobacteriaceae under anaerobic conditions

## Raw Milk

SPC, psychrotrophic Gram-negative bacteria and thermoduric bacteria

## Pasteurized Milk

SPC, psychrotrophic bacteria both Gram-negative and Gram-positive

## Butter

Lipolytic microorganisms

## Salad Dressing

.Lactobacillus Spp

The major disadvantage of microbiological enumeration methods is that it takes several days. To overcome this problem, ;other indirect methods have been used

Determination of lipopolysaccharides(LPS) in a food(for Gram-negative bacteria)

Measurement of ATP as its concentration is increased with high numbers of viable .cells

# *Chemical Indicators*

As microorganisms grow in foods, they produce many types of metabolic by-products associated :with the spoilage characteristics

$H_2S$, $NH_3$, $CO_2$, Diacetyl, Acetoin, Indole, changes in pH especially in meat and meat products due to microbial growth

Biosensors may be developed that could be effective for indicating changes in specific metabolites by a group of bacteria with similar characteristics that are considered important .spoilage bacteria in a food group

# *Heat-Stable Proteinases In Milk*

Proteinases of some psychrotrophic bacteria such as Pseudomonas fluorescens

Even when present as low as 1ng/ml in raw milk can reduce the acceptance quality of milk during normal storage. So it is very important to use a sensitive assay .to predict the shelf life of dairy products

:Laboratory tests for these proteinases include

ELISA, Flurescamine assay, it reacts with amino acids to form a fluorescent compound at pH 9.0 and measured .fluorimetrically to determine protein hydrolysis

# Trinitrobenzene sulfonic acid(TNBS)

It reacts with free amino groups and develops color that can be colorimetrically measured to determine the amount of free amino acids present because of .proteolysis

## *Heat-Stable Lipases In Milk*

Milk is heated to destroy milk lipases but not the .bacterial heat-stable lipases

Assay methods depend on the release of free fatty acids due to hydrolysis of milk fat

ELISA is also used to measure lipases of .Pseudomonas *Spp*