Lec (4): # Microbial Spoilage of Food

Microbial spoilage is any organoleptic change in food makes it unacceptable by consumer. The change usually occurred in the flavor, color, odor, taste and texture.

In spite, the differences between the signs of spoilage according to the type of food, there are three main signs of microbial spoilage are common in most foods:

I) **Color change**: Many colors may be appeared on the surface of the spoiled food as a diffusible exopigments or colored colonies with endopigments. This food discoloration caused by bacteria, yeasts and molds.

1) Bacterial Discoloration

Appeared Color	Causative agents
Fluorescent yellow-green	Pseudomonas fluorescence (pyoverdin production)
Blue	P. aeruginosa (pyocyanin production)
Black	Bacillus sp. (Melanin production)
Yellow	Micrococcus luteus , Flavobacterium
Rose	Micrococcus roseus
Red	Serratia marcescence

2) Yeast Discoloration

A) White-Pale colonies of non-pigmented yeasts ex. Saccharomyces cerevisiae.

B) Red-Pink colonies of pigmented yeasts ex. Rhodotorula.

3) Mold Discoloration

Wide range of water-soluble and insoluble pigments and color mold colonies on food surfaces.

II) **Sliminess**: Activity of m-ms in the food may be lead to form a slime on the food surface by one of the following mechanisms:

1) Production of light slime; by pectolytic bacteria such as Erwinia carotovora which lyses the pectin in plant tissues (Pectin is adhesive material between plant cells).

2) Production of heavy viscous slime; through production of viscous polysaccharides such as levan and dextran from food mono and disaccharides by Pseudomonas viscosa or Leuconostoc mesenteriodes.

III) Changes in flavours and odors:

The normal acceptable flavor of food may be changed to non- acceptable flavor in spoiled food; the change is occurred by two mechanisms:

1- Microbial destruction of natural flavor compounds of food; as in the destruction of natural flavor of butter di-acetyl to off-flavor acetyl-methyl carbinol by Pseudomonas fragi, or destruction of natural fruit organic acid to unacceptable alcohol, ethers, ketones, aldehydes.

2- Microbial production of unacceptable off-flavors and off-odor in the food as in the following examples:

Bacterial production of off-flavor or off-odor in food

Off-flavor	Causing m-ms	Mechanisms of production
Souring flavor	Lactobacillus Acetobacter, Probionibacterium, Clostridium butyricum	Foods sugar → Lactic acid Acetic acid Probionic acid Butyric acid
Bitterness flavor	Pseudomonas Bacillus	Protein hydrolysis, Fatty acid degradation, sugar → Bitter Aldonic acid
Sulfide odor	Clostridium Proteus	Protein → Sulfur A.A. → H_2S
Rancidity	Lipolytic m-ms	Lipid → Fatty acids → Ketones
Unclean flavor	Escherichia coli (heavy growth)	Tryptophane → Skatol+Indol
Earthiness (soil flavor)	Streptomyces	Production of "Geosmin" adsorbed by food contaminated with soil
Cabbage & potato flavor	Pseudomonas	Production of vegetable, fruit flavour in refrigerated milk & meat
Soapiness of meat and cheese	Pseudomonas	Reaction between free A.A. and free F.A. leads to production of soapiness compounds

- F. A. Fatty acid
- A. A. Amino acid
- m-ms microorganisms

Indicator Bacteria of Food Contamination & Microbiological Standards of Food

We should examine the food and food plants for contamination indicators for the following purposes:

1) To detect the food is healthy or not healthy for human consumption.
2) For assessment the sanitary practices of food plant.
3) The official standards are meeting the produced food. (For compatibility with official standards and sanitary constructions).

Routine tests for selected food pathogens or toxins such as salmonella or staphylococcal enterotoxins are necessary whenever epidemiological outbreaks are occurred.

1) In most cases such as infectious hepatitis, detecting methods for causative agent are not available to food microbiologists.
2) For other food-borne infections such as shigellosis, the methods may be unreliable, especially when the pathogens are distributed in food heavily contaminated with other m-ms.
3) In addition tests for pathogens directly are very dangerous for laboratory workers.

For all these reasons and difficulties all microbiological labs firstly test species which are more readily cultivated, enumerated, not dangerous to the workers and environment, normal inhabitants of human and animal intestine which indicate the exposure of food to wastes and conditions containing pathogenic m-ms and their toxic products. These species so used are called (Indicator Bacteria).

Such indicators also help in assessing the quality of food and the presence of dirty particles such as insects parts, hairs, rodents excretion.. etc.

Microbiological Standards of Food

The main purposes of microbiological standards of food are to give assurance that:

1) The food will be acceptable from the public health standpoint.
2) The food will be acceptable from the nutritive value and normal characteristics.
3) The food will be acceptable from an esthetic viewpoint. (Not filthy with fecal materials, parts of vermin, pus cells, mycelia…)
4) The food will have keeping quality that should be expected.

In order to issue food microbiological standards it is important to take into consideration the following principles. (1,2,3,4 example1) (5example2).

1- Determination the higher limit of m-ms permissed in each food.
2- Determination the types and higher limit for each type of m-ms in each food.
3- All types of food must be free of any pathogenic and toxigenic m- ms (in some cases except staphylococci).
4- For the same food may be more than one standard according to the state of food (Fresh, canned, minced, dried, frozen..etc.).
5- In some cases as in the milk, the food divided into many grades: A, B, C) according to the microbial content, and a standard for each grade.
6- The standards may be not identical for all countries, all town; because different conditions between these countries as follow:
   A- Level of food productivity and available foods.
   B- Economical situation
   C- Sanitary situation D-
   Nutrition habits
   E- Emergencies outbreaks such as war and catastrophes.

There are many organizations responsible for microbiological standards of foods such as:

1) WHO: World Health Organization- U. N.
2) FAO : Food Agriculture Organization - U. N.
3) CAC : Codex Alimentaricus commission
4) FDA : Food & Drug Administration
5) APHA: American Public Health Association
6) EPA : Environmental Protection Agency
7) EOF : European Organization of Food
8) COSQC: Central Organization for Standardization and Quality Control. (Local organization).

Examples of Microbiological Standards of Food

1) **Bacteriological Standards of meat, chicken, fish**(principal 1,2,3,4)

Type and state of meat	m-ms	Maximum count/gram
Fresh red meat	T.B.C.	$1\text{-}5x10^6$
	E. coli	10-50
	Salmonella	———
Minced red meat	T.B.C.	$1\text{-}5x10^7$
	E. coli	50-100
	Salmonella	———
Frozen red meat	T.B.C.	$1\text{-}5x10^6$
	E. coli	10-50
	Salmonella	———
Fresh frozen chicken	T.B.C.	$1x10^5$
	E. coli	10-50
	Salmonella	———

2) Milk and milk products

m-ms (m-count)	Milk Grades					Milk powder	
	Grade A		Grade B		Grade C		
	Raw	Pasteurized	Raw	Pasteurized	Raw& Pasteurized	Standard	Extra quality
T.B.C	$2x10^5$	$3x10^4$	$1x10^6$	$5x10^4$	More than count of B. grade	$1x10^5$	$5x10^4$
Coliform	10	10	10	10		90	90

3) Butter

Tests	Microbial count
T.B.C	$1x10^4$
Mold & Yeast	20
Psychrophilic Bacteria	10^3
Lipolytic Bacteria	10^3
Proteolytic Bacteria	50
Coliforms	10
Fecal sterptococci	10

4) Ice cream

Tests	Microbial count
T.B.C	$1x10^4$
Coliforms	10
S. aureus	10
Salmonella	ــــ