SPOILAGE OF FRUITS AND VEGETABLES

- Fruits and vegetables are constantly subjected to microbial attack
- Agric. Envt. is exceedingly rich in MOs
- E.g. 1g of soil contains 50 million of MOs
- Therefore, the external surface of F&V become easily contaminated

- Underground parts become directly contaminated
- Aerial parts are mostly contaminated with spores
- MOs may or may not gain entry to fruit or vegetable
- Mechanical damages greatly enhances the chance of their invasion

- 30% of fruits and vegetables, on average, become unsuitable for human consumption due to postharvest diseases
- Bacteria yeasts and molds are mainly responsible
- Fruits contain more CHO, acids and less water than vegetables, in general.
- Their protein and fat contents are low but contain vitamins and minerals

- pH of fruits is comparatively low
- Thus, fruits in general do not favor bacterial growth
- Molds and yeasts which can bear a wider range of pH initiate spoilage of fruits and then bacteria follow
- MOs that secrete pectolytic enzymes take the lead

- They first utilize simple compounds such as sugars, AA, organic acids etc.
- When the simple compounds are exhausted, they start utilizing high molecular weight complex compounds such as starch cellulose, polypeptides etc. to simple compounds
- Yeasts utilize simple sugars and bring about fermentation
- Yeasts grow faster than molds and generate CO_2 and alcohol

Contamination

- F & V are contaminated by
  - Contaminated containers (boxes, baskets, bags)
  - Wash water – during agitation – use of wash water more than one time
  - During washing F&V become moistened thus during holding Mos can grow
  - Mechanical damages during handling, transportation greatly increases chance of contamination

- From contaminated equipment, vessels during processing

- Spoilt, damaged, decayed F & V should be discarded, trimmed off at the beginning
- Addition of decayed fruits/portions into fruit juice mixtures greatly increase the MO no. e.g. E coli count may significantly increase

Product	MO	Quantity (per gram)
Vegetables	Bacteria	
	Psuedomonas, Alcaligenes, Erwinia, Xanthomonas, LAB	10^3 - 10^7
	Molds Fusarium , Alternaria, Penicillium, Botrytis, Rhizopus	10^3 - 10^4
Fruits	Bacteria Gram negatives (if present)	Less
	Molds Fusarium , Alternaria, Penicillium, Botrytis, Rhizopus Cladosporium, Trichoderma	10^3 - 10^4

- Hydrocooling followed by chilling can prolong the shelf life of F & V
- Preservatives should not be used
- Sometimes sulfites are used which may increase asthma conditions
- Irradiation is often used for salads etc.
- Dilute salt solution may be used with some Vegetables

- Freezing is another popular method used
- Dehydration too can be done
- Blanching is commonly done prior to freezing/dehydration for vegetables
- Fruits are not commonly blanched
- MAS/CAS can prolong the storage life

- Shelf life of fruits can be extended by
  - Use of wax, paraffin, mineral oils
  - Use of sulfite, iodine or borax treated wrappers
  - Hypochlorites
- Use of CAS gives promising resluts

- Examples

	CO2%	O2%
Apples	1.5-10	2.5
Lettuce	2.5	2.5
Cabbage	2.5	5.0
Onions	5-10	3.0

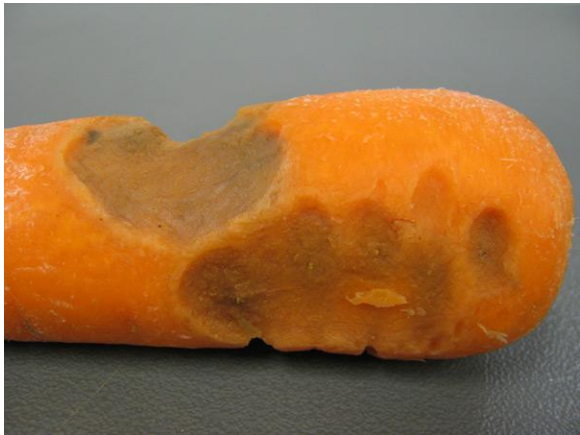
Spoilage

- Spoilage may be due to
  - Plant pathogens acting on stems, leaves, flowers, fruits, roots etc.
  - Saprophytes - usually they are secondary invaders. E.g. in rots
  - At times a succession of saprophytes may occur or they may succeed pathogens

- Each fruit or vegetable has its own type of decomposition and predominant Mos
- However, some generalization can be done
- Vegetables contain more water (90%) less CHO, protein and fat. Contain vitamins and minerals
- pH is generally high
- Thus, vegetables harbor all three types of MOs

Bacterial Spoilage

- 1. Bacterial Soft Rot:
- *Erwinia* caratovora and *Pseudomonas marginalis* are very common bacterial genera that spoil many vegetables leading to **bacterial soft rot**
- Bacillus and Clostridium can also implicated
- Causative organisms break down the tissues giving rise to a soft, mushy spots appearing water-soaked nature. E.g. carrot, onion, lettuce, rhubarb, potato, cabbage



- Due to the rapid growth of bacteria, the involvement of fungi is limited
- Bacteria with pectolytic activities enter first and digest pectic substances
- Break down of pectin leads to soft mushy patches
- **Common in onion, beans, carrots, beet, cabbage, lettuce, spinach, tomato, cucumber**

- This paves the way for non-pectolytic organisms
- these MOs grow rapidly and start fermenting sugars
- The mal odors are due to the volatile compounds such as ammonia, volatile acids produced by MOs

Some common bacterial spoilage conditions (field and storage)

Organism	Condition
Corynebacterium	Vascular wilt and fruit spots of tomatoes
	Leaf blight, leaf spot and wilt of corn
	Tuber rot of potatoes
Pseudomonas agarici	Drippy gills of mushroom
P. corrupata	Tomato pith necrosis
P. marginalis	Soft rot of many vegetables
P. syringae	Angular leaf spot of cucumber
	Blight of pears
	Bacterial speck of tomatoes

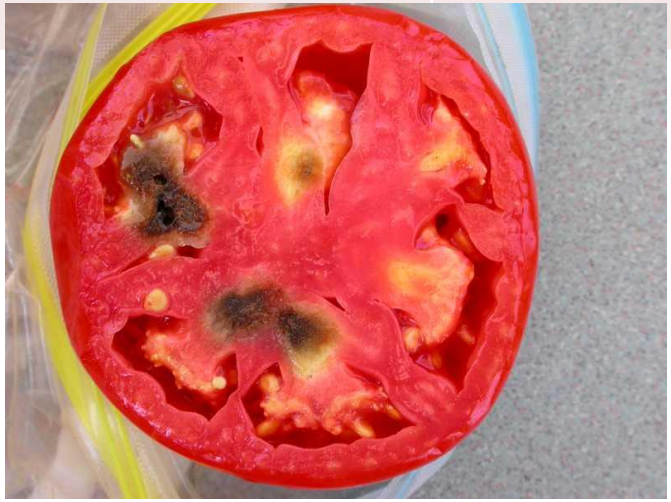
Organism	Condition
Xanthomonas campestris	Black rot of cabbage and cauliflower
X. phaseoli	Blight of beans
	Bacterial spot of tomato and peppers

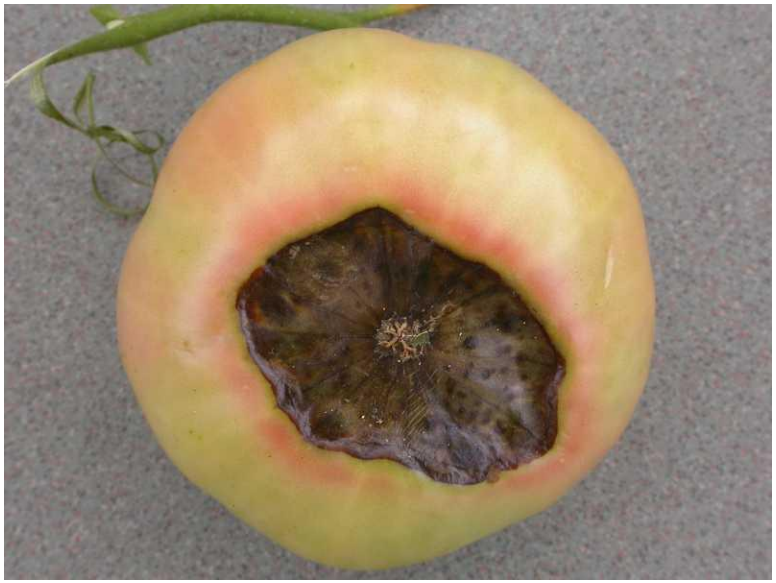
FUNGAL SPOILAGE

Condition	Agent	Product
Alternaria rot	*A.tenuis* *Greenish brown spots later become brown or black*	Citrus fruits
Black mold rot	*Aspergillus niger* *Black masses are spores*	Onion
Brown rot	*Phytopthera spp.*	Citrus
Dry rot	*Fusarium spp.*	potato
Gray mold rot	*Botrytis cinerea* *Favored by warm temp and high humidity*	Grapes & others
Pink mold rot	*Trichothecium roseum*	vegetables
Sour rot	*Geotrichum candidum*	Tomato, citrus

Rhizopus soft rot	Rhizopus stolonifer a soft and mushy spots will be developed	
Anthracnose	Coletotrichum lindemuthianum , coccodes. Spotting happens	Banana
Blue mold rot	Penicillum digitatum Bluish green color spots appear due to mycelial growth	
Downy mildew	Phytophthora White wooly masses can be seen	
Stem end rot	Diplodia, Alternaria, Fusarium	

Green mold rot	Cladosporium or Trichoderma Green colored spots	
Black rot	Alternaria Physalospora	
Fusarium rot	Fusarium causes various types of rots	





- Fungal spoilage often results in water soaked, mushy areas
- Rots of juicy fruits leads to leakage
- Dry rots are not water soaked

- Fruit juices are often subjected to yeast attack thus are fermented
- Lactic acid fermentation is possible
- *L. pastorianus, L. brveis, Leuconostoc mesenteroides [Homofermenters]*

Control of microbial spoilage in fresh fruits and vegetables

- Infection may occur before or after harvest
- In the filed contamination from soil-borne MOs is unavoidable
- However, sources of infections can be kept to a minimum

- Maintenance of a healthy crop.
  - Proper agronomic practices
  - Timely fertilizer application, soil management etc.
  - pest and disease management
  - Application of fungicides/pesticides etc if necessary
- Cold storage after harvest reduces chances of infections
- Rotten F/V should be removed from harvest