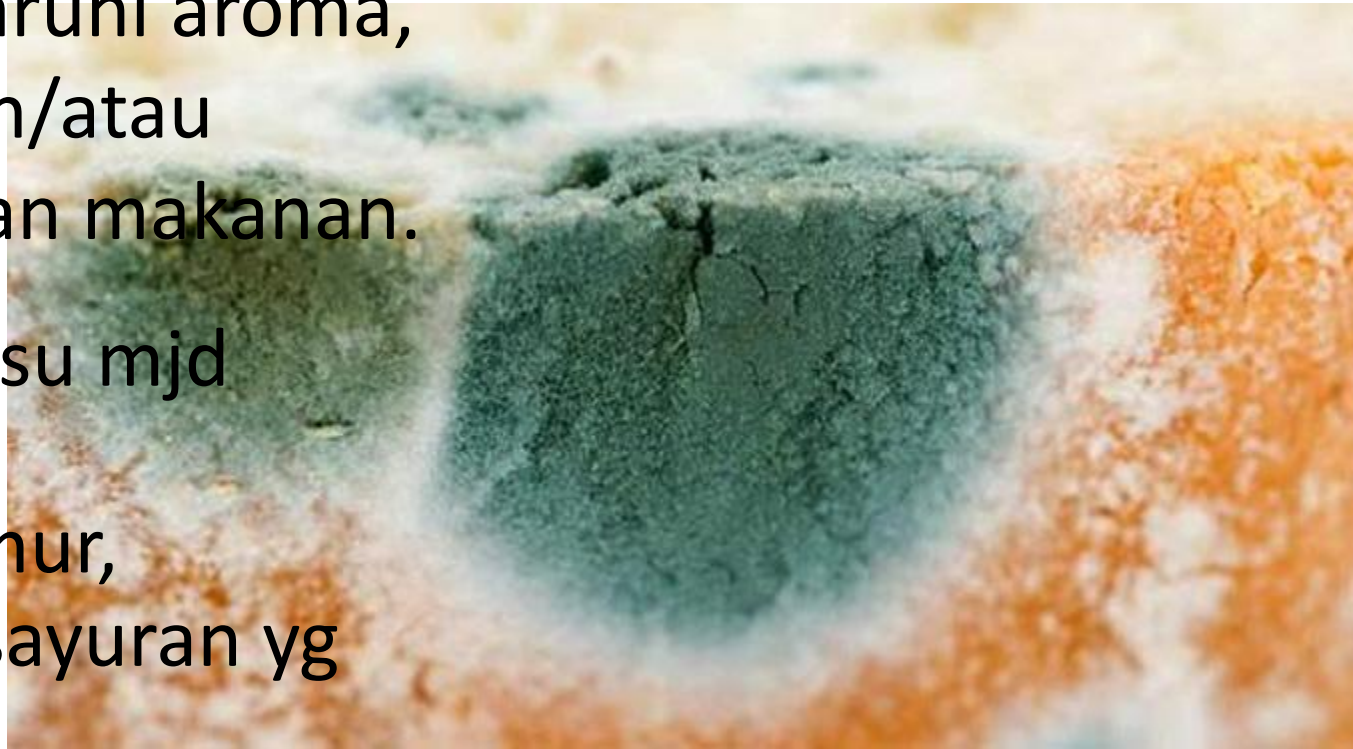


FOOD SPOILAGE

Food spoilage

Spoilage dapat mempengaruhi aroma, tekstur, dan/atau kenampakan makanan.

Contoh: susu mjd asam,
keju berjamur,
berlendir, sayuran yg berjamur

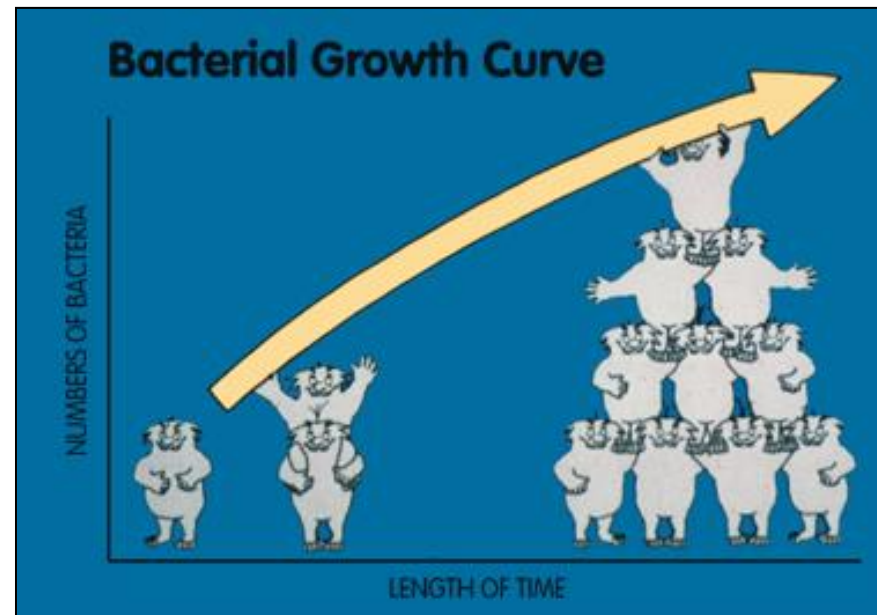
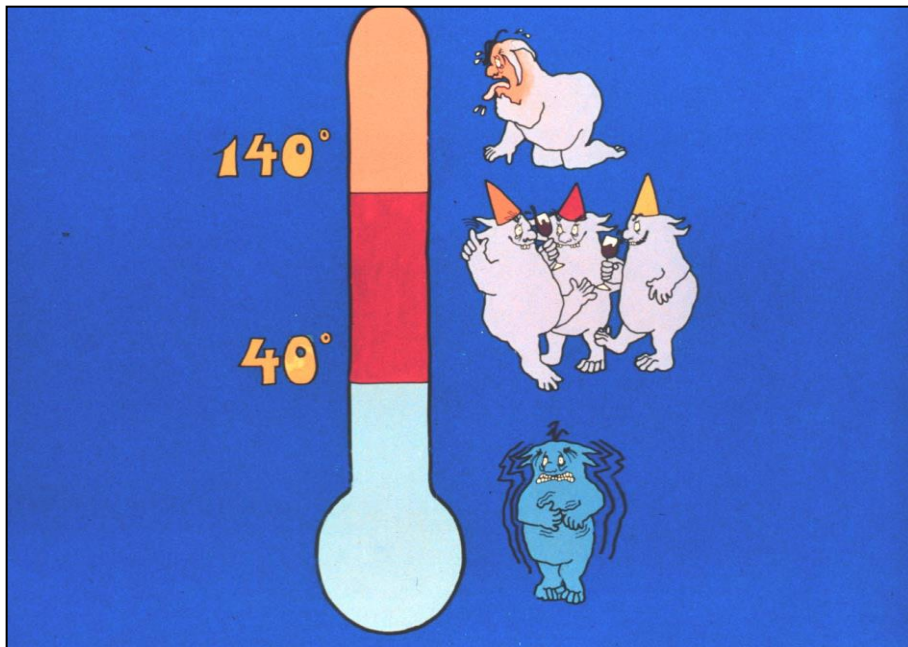


Ada 3 faktor yg menyebabkan makanan mjd rusak/tercemar

- 1. Faktor Mikrobia**
- 2. Enzim yg secara alami ada pada makanan**
- 3. Faktor-faktor lain**

Faktor Mikrobia

MO yg tumbuh dan menghsikan metabolit & menyebabkan perubahan terhadap odor/flavor, rasa, dan tekstur yg tdk diinginkan



Enzim yg scr alami ada di bahan makanan

Perubahan warna pd buah & sayuran yg disebabkan oleh enzim.



Enzim

Suatu molekul protein yg kompleks yg dapat menstimulasi suatu reaksi kimia tertentu.

Faktor-faktor lain

Kelembaban → RH, air

Oksigen

pH

Struktur fisik

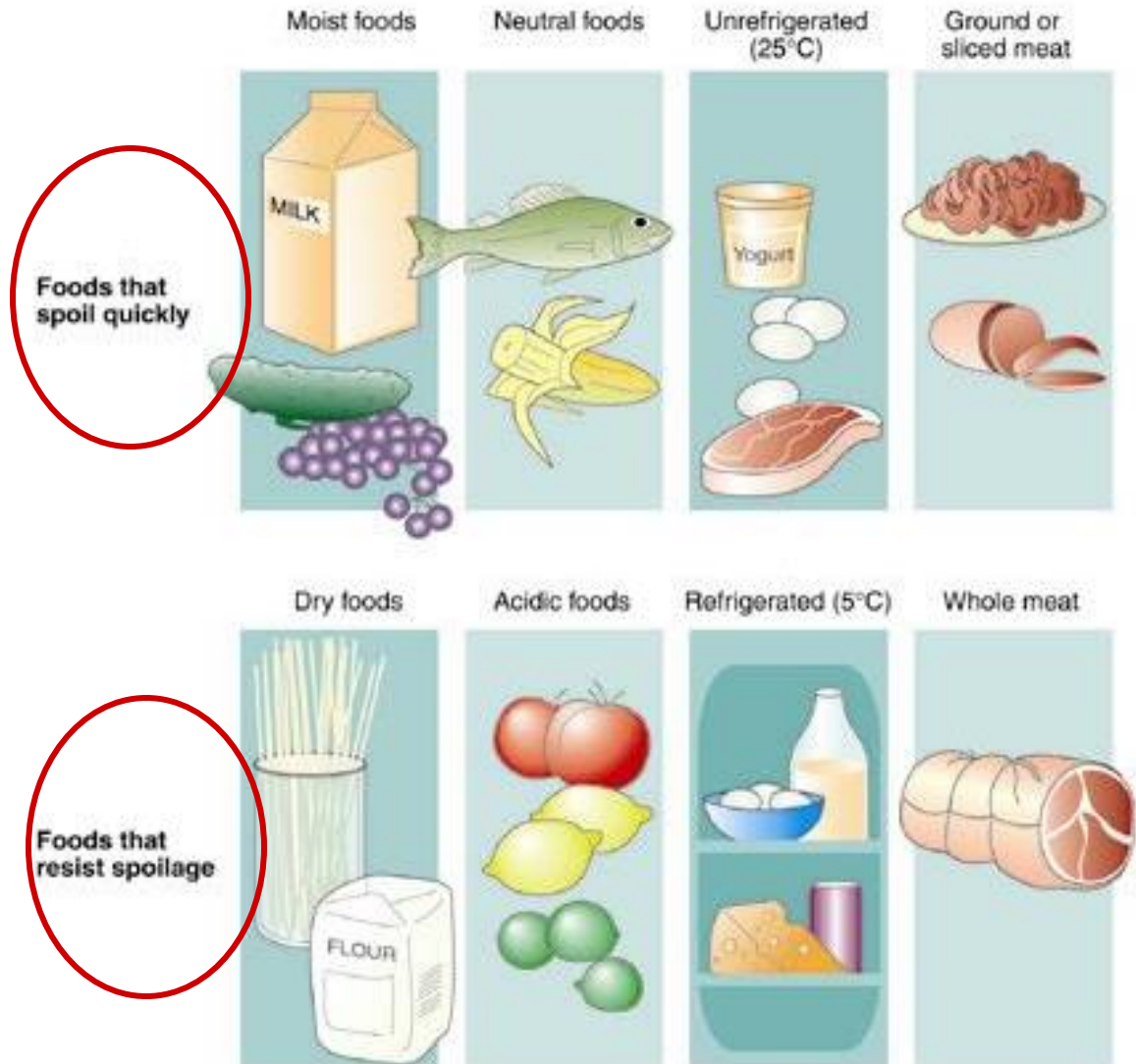
Suhu

Waktu

- Jika makanan salah dlm penanganan atau terekspose pd kondisi yg tdk sesuai maka makanan tsb dpt tercemar dan mengalami kerusakan.

Kondisi yg mempengaruhi kerusakan pd makanan

- Air
- pH
- Struktur fisik
- Oksigen
- suhu



Pertumbuhan MO dlm Makanan

Controlling factors:

Changes over time

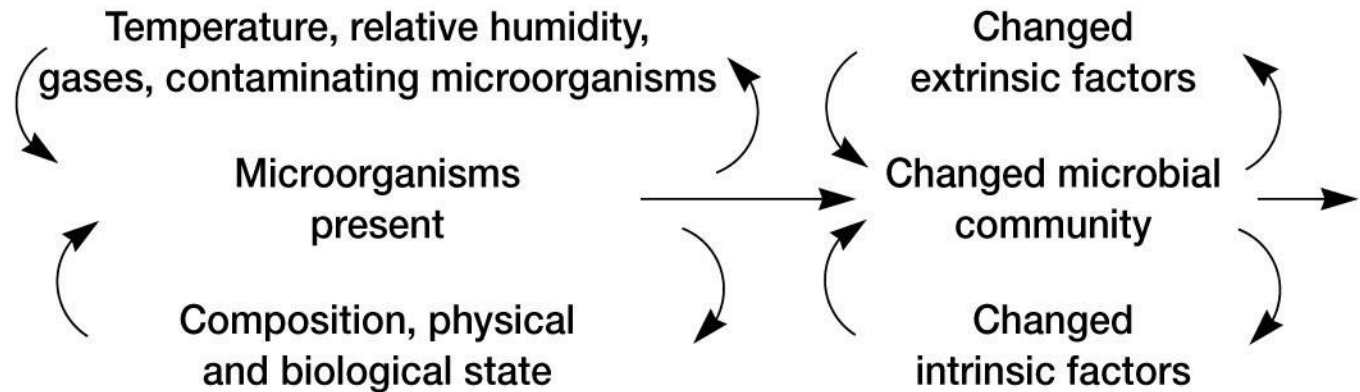
Extrinsic

Microorganisms

Intrinsic

State 1

State 2



Faktor-faktor intrinsik

- Komposisi bahan makanan
- pH
- Kadar air
- Potensial oksidasi-reduksi
- Struktur fisik
- Adanya senyawa antimikrobia

Komposisi dan pH

Perbedaan Proses Kerusakan Makanan dihubungkan dg Karakteristik BM

Substrate	Food Example	Chemical Reactions or Processes ^a	Typical Products and Effects
Pectin	Fruits	Pectinolysis	Methanol, uronic acids (loss of fruit structure, soft rots)
Proteins	Meat	Proteolysis, deamination	Amino acids, peptides, amines, H ₂ S, ammonia, indole (bitterness, souring, bad odor, sliminess)
Carbohydrates	Starchy foods	Hydrolysis, fermentations	Organic acids, CO ₂ , mixed alcohols (souring, acidification)
Lipids	Butter	Hydrolysis, fatty acid degradation	Glycerol and mixed fatty acids (rancidity, bitterness)

^aOther reactions also occur during the spoilage of these substrates.

- proteolisis dan pemecahan protein secara anaerobik menghasilkan senyawa berbau amoniak.
- pH mempengaruhi spesies mikrobial yg dpt tumbuh dan hal ini akan mempengaruhi tipe reaksi kimia yg dpt terjadi

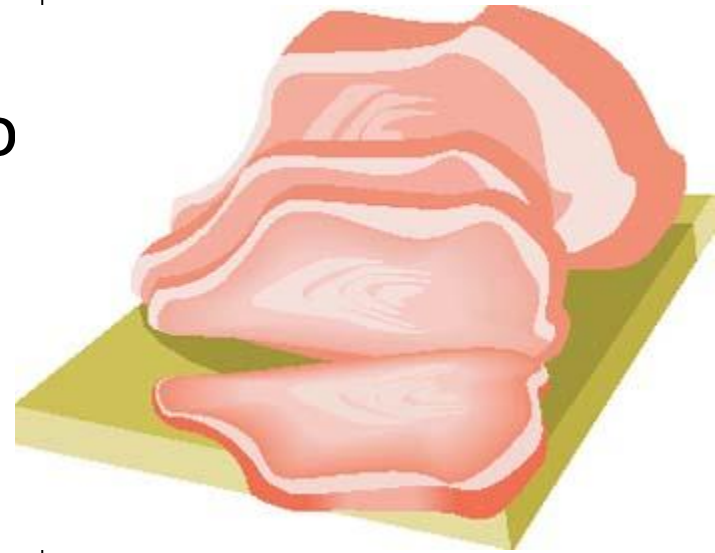
Ketersediaan air

- Scr umum, Aw rendah akan menghambat pertumbuhan mikrobia
- Aw dpt diturunkan dg :
 - pengeringan
 - Penambahan garam atau gula
- MO osmofilik
 - Tumbuh pd tek osmotik yg tinggi
- MO xerofilik
 - Tumbuh pada Aw rendah



Struktur Fisik

- Penggilingan & pencampuran dpt meningkatkan luas area permukaan dan penyebaran mikroba
 - Dpt meningkatkan pertumbuhan mikroba
- Kulit luar yg teksturnya sdkt keras spt pd apel, pepaya dpt menghambat pertumbuhan mikroba



Senyawa Antimikrobia

- coumarin – buah dan sayuran
- lysozyme – susu sapi dan telur
- aldehydic and phenolic compounds – herbal dan rempah2
- allicin – bawang putih
- polyphenols – teh hijau dan hitam



Faktor-faktor Ekstrinsik

- Suhu
 - Suhu rendah menghambat pertumbuhan mikrobia
- RH/kelembaban relatif
 - RH tinggi mendorong pertumbuhan mikrobia
- atmosfer
 - oksigen dpt mendorong pertumbuhan
 - **modified atmosphere packaging (MAP)**
 - Menggunakan kemasan kedap udara utk mengemas makanan dlm atmosfer terkendali



Pertumbuhan Mikrobia dan Kerusakan Makanan

- Kerusakan makanan
 - Merupakan hasil dari pertumbuhan mikrobia dlm makanan
 - Melibatkan suksesi mikrobia
 - Bahan makanan yg berbeda mengalami proses kerusakan yg berbeda
 - Racun2 kadang2 dpt diproduksi slm proses kerusakan berlangsung
 - Contoh : aflatoxin pada kacang-kacangan yang terkontaminasi *A. flavus*; algal toxin pd seafood



Kerusakan Makanan

- Hampir 1/3 dari makanan yg diproduksi di seluruh dunia rusak krn mikrobia
- Kandungan mikrobia awal pd makanan (microbial load) berpengaruh : kualitatif (mo yg mana) dan kuantitatif (brp jmlnya)
- Umur simpan
 - Non-perishable foods (pasta)
 - Semiperishable foods (bread)
 - Perishable foods (fresh milk)



Prinsip Utama

Kontaminasi mikrobial dpt diminimalkan dengan:

- Pengelolaan proses yg baik
- Kondisi sanitasi yg dpt diterima
- Prosedur pengawetan Bahan Makanan yg sudah teruji



Sumber kontaminasi mikrobial penyebab kerusakan

- Daging

- Kontaminasi pd papan utk pemotongan (“talenan”)
- Conveyor belts
- Suhu
- Tidak dpt didistribusikan scr cepat
- Kontaminasi bakteri dari kotoran/feses



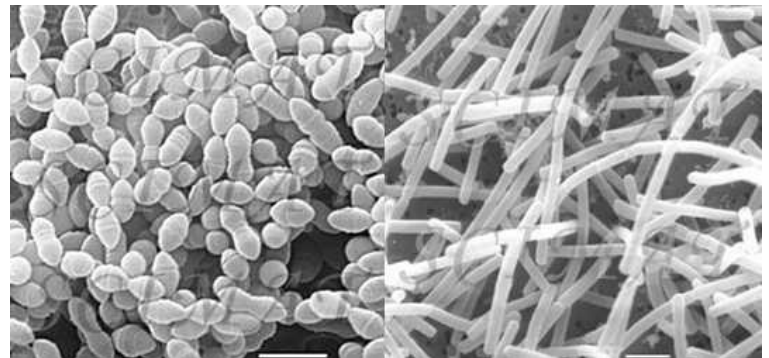
- Ikan

- Air yg mengalami polusi
- Wadah/sarana pengangkutan



Sumber kontaminasi mikrobial penyebab kerusakan

- Unggas dan telur
 - Kontak dengan manusia
- Susu & produk olahannya
 - Spesies *Lactobacillus* dan *Streptococcus* dapat tahan pada proses pasteurisasi (sour milk)
- Roti
 - Spora dan jamur yg tahan terhadap pemanngangan
- Bijian
 - Jamur penghasil toksin



Pengendalian Food Spoilage

Pendekatan dasar pengawetan makanan

Approach	Examples of Process
Removal of microorganisms	Avoidance of microbial contamination; physical filtration, centrifugation
Low temperature	Refrigeration, freezing
High temperature	Partial or complete heat inactivation of microorganisms (pasteurization and canning)
Reduced water availability	Water removal, as with lyophilization or freeze drying; use of spray dryers or heating drums; decreasing water availability by addition of solutes such as salt or sugar
Chemical-based preservation	Addition of specific inhibitory compounds (e.g., organic acids, nitrates, sulfur dioxide)
Radiation	Use of ionizing (gamma rays) and nonionizing (UV) radiation
Microbial product–based inhibition	The addition of substances such as bacteriocins to foods to control food-borne pathogens

Penghilangan Mikroorganisme

- Biasanya menggunakan filtrasi
- Biasa dilakukan pd air, bir, wine, jus, soft drink, dan cairan lain



Suhu rendah

- Refrigerasi pd 5°C menghambat ttp tdk dpt menghentikan pertumbuhan mikrobial
 - psikrofil dan psikrotrop msh dpt menyebabkan spoilage



Suhu tinggi

- Canning/pengalengan
- Pasteurisasi



Canning

- Makanan dipanaskan dlm kontainer khusus (retort) pd 115°C slm 25-100 mnt
- Dpt membunuh mikrobia pembusuk, tp tdk semua mikrobia mati



Spoilage makanan kaleng

- Sudah tercemar sbllm dikalengkan
- underprocessing
- Kebocoran kaleng shg air yg terkontaminasi masuk selama proses pendinginan



Pasteurisasi

- Dpt membunuh patogen dan menurunkan jml mo pembusuk
- Prosedur pasteurisasi yg berbeda → wkt pemanasan berbeda
 - Pemanasan dlm wkt singkat dpt memperbaiki flavor

Ketersediaan Air

Pendekatan dasar pengawetan makanan

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Pengawetan dgn Bhn Kimia

- GRAS
 - Bhn kimia hrs “generally recognized as safe”
- pH bahan makanan sangat berpengaruh pd efektivitas bhn kimia yg digunakan

Table 41.5 Major Groups of Chemicals Used in Food Preservation

Preservatives	Approximate Maximum Use Range	Organisms Affected	Foods
Propionic acid/propionates	0.32%	Molds	Bread, cakes, some cheeses, inhibitor of ropy bread dough
Sorbic acid/sorbates	0.2%	Molds	Hard cheeses, figs, syrups, salad dressings, jellies, cakes
Benzoic acid/benzoates	0.1%	Yeasts and molds	Margarine, pickle relishes, apple cider, soft drinks, tomato ketchup, salad dressings
Parabens ^a	0.1%	Yeasts and molds	Bakery products, soft drinks, pickles, salad dressings
SO ₂ /sulfites	200–300 ppm	Insects and microorganisms	Molasses, dried fruits, wine, lemon juice (not to be used in meats or other foods recognized as sources of thiamine)
Ethylene/propylene oxides	700 ppm	Yeasts, molds, vermin	Fumigant for spices, nuts
Sodium diacetate	0.32%	Molds	Bread
Dehydroacetic acid	65 ppm	Insects	Pesticide on strawberries, squash
Sodium nitrite	120 ppm	Clostridia	Meat-curing preparations
Caprylic acid	—	Molds	Cheese wraps
Ethyl formate	15–200 ppm	Yeasts and molds	Dried fruits, nuts

From James M. Jay. 2000. *Modern Food Microbiology*, 6th edition. Reprinted by permission of Aspen Publishing, Frederick, Md.

^aMethyl-, propyl-, and heptyl-esters of *p*-hydroxybenzoic acid.

Radiasi

- ultraviolet (UV) radiation
 - Digunakan utk permukaan alat
- Gamma radiation
 - Penggunaan ionizing radiation (gamma radiation) utk memperpanjang umur simpan / sterilisasi daging, seafood, buah dan sayuran