Introduction to Food technology

Spoilage of food

Spoilage of Food

- **Chemical spoilage**
  - **Chem. rxn in food not due to enzyme**
    - **Predominant in Oil Rancidity**
- **Biochemical spoilage**
  - **Enzymatic activity is involved**
    - **Predominant in Butter rancidity**
- **Microbiological Spoilage**
  - **Mold, yeast, Bacteria ..**
- **Insects and Rodents**
- **Physical Factors**
  - **Variation in Temperature, storage**
  - **Presence of foreign material (Glass, metal..etc.)**

Spoilage of Food

- **Classification according to ease of spoilage:**
  - **Non-perishable:**
    - **No need of processing (rice, sugar, wheat..)**
  - **Semi-perishable:**
    - **Need some processing**
      - **Apple → keep in fridges**
  - **Perishable:**
    - **Need processing**
      - **Vegetable, meat, fish, milk … etc.**

Spoilage of Food

- **Indicators of spoilage:**
  - **Change in appearance (color)**
  - **Change in Flavor:**
    - **Smell**
    - **Taste**
  - **Change in texture**
    - **Consistency (Spoiled milk will coagulate when boiled)**
  - **Illness**
    - **Ex. Diarrhea after eating spoiled food**

Chemical and Biochemical (Flavor)

Chemical & Biochemical Spoilage

1. Rancidity: (1/8)

- decomposition of fats, oils and other lipids by
  - hydrolysis *Enzymatic* or
  - Oxidation *Non- Enzymatic*,
  - or both
    - generate highly reactive molecules responsible for producing unpleasant and noxious odors and flavors
    - may also destroy nutrients in food.

Chemical & Biochemical Spoilage

1. Rancidity: (2/8)

a) Hydrolysis:

- **Ester linkage (fatty acid – glycerol) breakage (lipase)**
- **These free fatty acids undergo further auto-oxidation. (The fatty acid breaks down into hydrocarbons, ketones, aldehydes, and smaller amounts of epoxides and alcohols.)**
- **Source of enzyme:**
  - **Microorganism**
  - **Food itself**

Chemical & Biochemical Spoilage

1. Rancidity: (3/8)

a) Hydrolysis:

- **Control:**
  - Hygiene
  - Refrigeration (< 5ºC or freezing at -10º or -20ºC)
  - Addition of salt (1→ 3% in butter)
  - H2O reduction (less water → less Microorganism activity → less likely enz. Rancidity in oil))
    - » Ghee (Samneh: 1% moisture) production from Butter
- **Butter (~80-85% fat and 15% water)**
  - Rancidity; Butteric Acid (3 -4% of butter) is liberated

Chemical & Biochemical Spoilage

1. Rancidity: (4/8)

b) Oxidation:

- Primarily occurs with unsaturated fats by a free radical-mediated process.
- O_2 in atmosphere
  - Attacks double bound in Unsaturated Fatty Acids
    - » Breakage and resulting in free Fatty acid (May be treated by Caustic soda (fish preserved in olive oil))
    - » Thus Acidity increases → Flavor affected

Chemical & Biochemical Spoilage

1. Rancidity: (6/8)

b) Oxidation:

- **Control:**
  - In Darkness (avoid UV light)
  - Cool storage
  - Moisture free environment
  - Pro-oxidant free environment (metals)
  - Anti- oxidants (free radical Scavengers→ easily oxidized→ stop its rxns and)
    - Vitamin E
    - butylated hydroxyanisole (BHA)
    - butylated hydroxytoluene (BHT),

Chemical & Biochemical Spoilage

1. Rancidity: (7/8)

c) Enzymatic oxidative rancidity: *(Both)*

- **Importance in Vegetable processing**
  - **Especially by freezing procedure**
- **Cause:**
  - **Lipoxygenases enzyme:**
    - » **iron-containing enzymes that catalyse the dioxygenation of polyunsaturated fatty acids in reaction:**
    - » **fatty acid + O2 = fatty acid hydro peroxide**

Chemical & Biochemical Spoilage

1. Rancidity: (8/8)

c) Enzymatic oxidative rancidity: *(Both)*

- **Control:**
  - **Blanching → inactivate enzyme**
    - **Vegetables plunged in boiling water for short time then cooled down quickly**
  - **Use of strong oxidizing agents (that can be flushed easily from food)**
    - **Permanganate**
    - **sodium hypochlorite (clorox)**

Chemical and Biochemical (Appearance)

Chemical & Biochemical Spoilage

2. Browning: (1/3)

- **Sometimes desirable (Bread, coffee..)**

a) Enzymatic:

- **Polyphenol oxidase (POx) create melanins→ brown**
  - **catechol** (plus O2 with POx)→ Quinone (dark in color)
- **Bananas, apple when cut (Cells are broken)**

- **create melanins, resulting in a brown color**

Chemical & Biochemical Spoilage

2. Browning: (2/3)

a) Enzymatic:

- **Control:**
  - Heating
    - » Cut apples heat till 60^{o}C and dry no change in color (After that non- enzymatic browning)
  - Lower PH
    - » Citric acid (lemon juice on banana cuts)
  - Dip in Sulfur Solution
    - » Either Sulfur reacts with O_2 →SO2 gas → released
    - » Or reacts with sodium and O2→ Na2S2O5 (Sodium meta bisulfite)→ dissolved

Chemical & Biochemical Spoilage

2. Browning: (3/3)

b) Non- Enzymatic:

- Milliard reaction (Amadori):
  - chemical reaction between an amino acid -amino group- and a reducing sugar -aldehyde group- , usually requiring heat.→ Melanins
- Undesirable in:
  - Drying apples and onions with heat
- Control:
  - Lowering Temperature
  - Lowering pH
  - Sulfering

Chemical and Biochemical (Texture)

Chemical & Biochemical Spoilage

3. Texture: (1/3)

a) Enzymatic:

- **Cellulase:**
  - Break Cellulose → Softening of tissues
    - » Result in softening of pickles
  - Source: Mold, bacteria and plant itself
    - » Top of cucumber (the flower side)
    - » Grape leaves inhibit it
- **Control:**
  - Hygiene
  - Mold inhibitor like Na Sorbate

Chemical & Biochemical Spoilage

3. Texture: (1/3)

b) Non- Enzymatic:

- **Hard water:**
  - **High in Calcium ions**
    - » **Ca^{2+} replace the Na^{+} ions → lentils, peas too hard**
- **Control:**
  - **Add mono-valent ions → Softer**
    - » **$NaHCO_3$ (use it at home)**

Introduction to Food technology

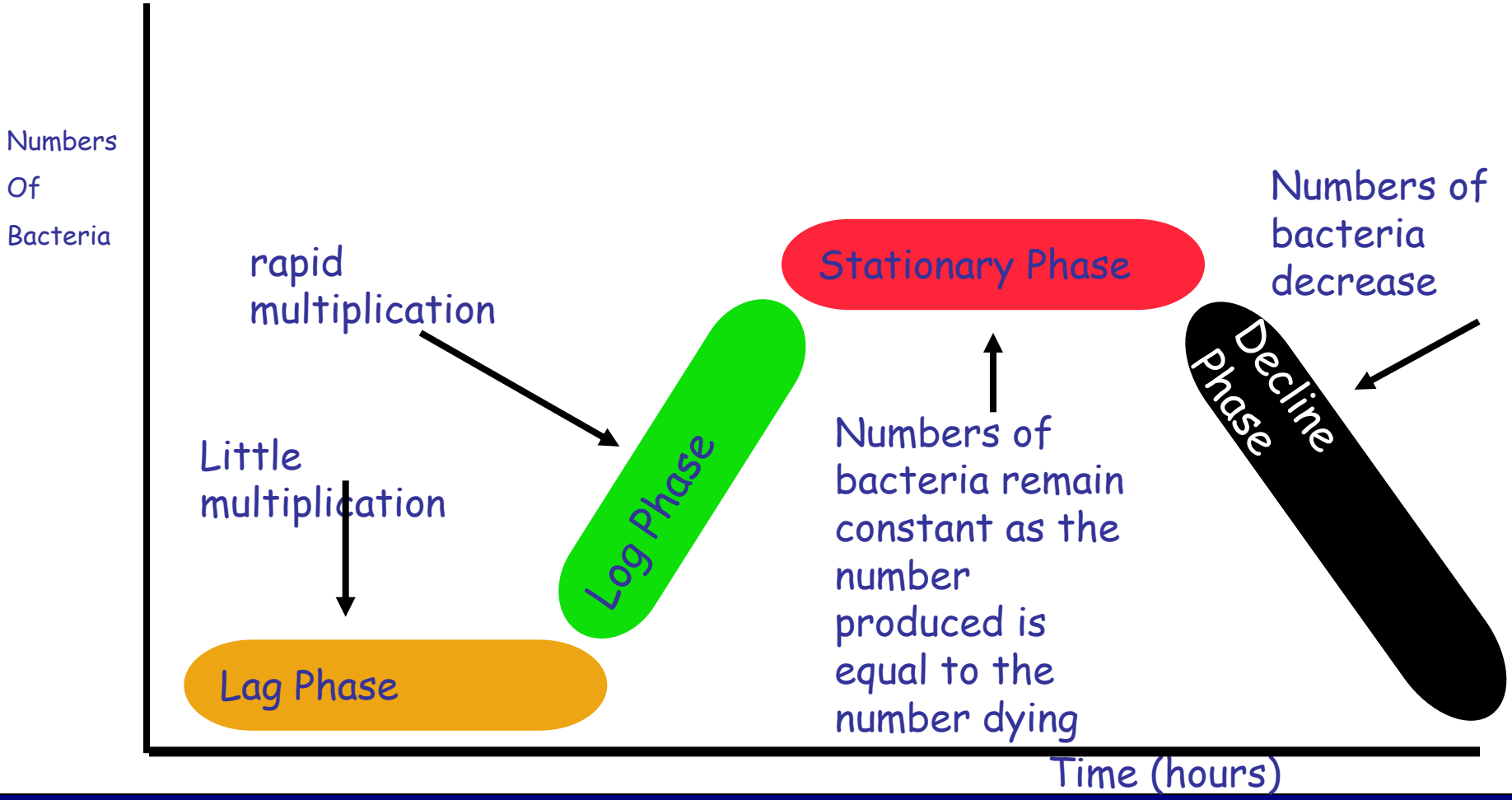
Spoilage of food2

-Microbiological

Microbiological Spoilage of Food

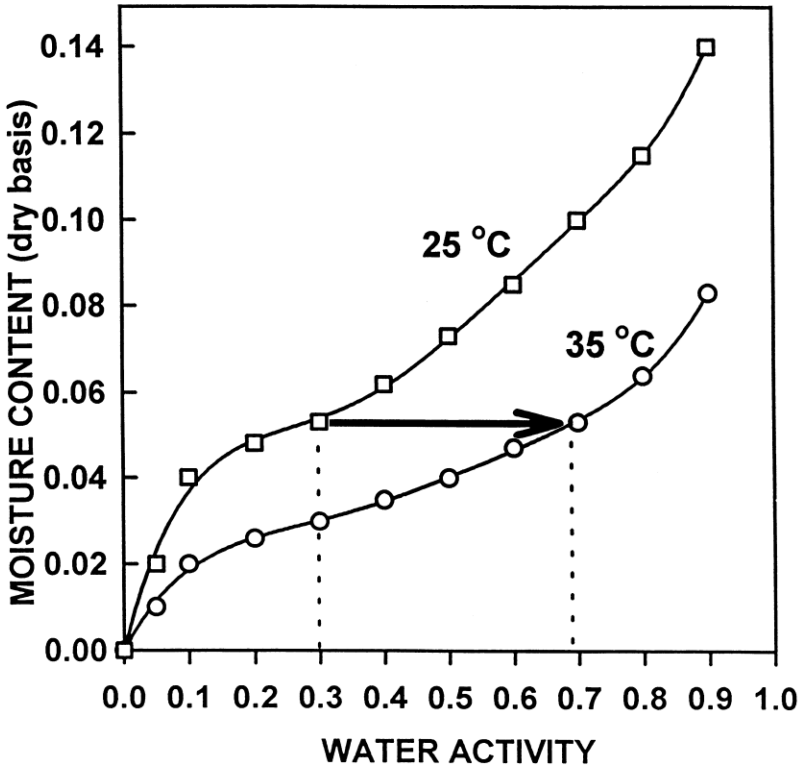
- **Microorganisms are also benificial:**
  - **Molds in Blue Cheese**
  - **Yeast in bread**
  - **Bacteria in pickles**
- **Microorganisms may produce vitamins, commercial chemicals..etc.**

Extras


Numbers
Of
Bacteria
rapid
multiplication
Little
multiplication
Lag Phase
Log Phase
Stationary Phase
Numbers of
bacteria remain
constant as the
number
produced is
equal to the
number dying
Numbers of
bacteria
decrease
Decline
Phase
Time (hours)

WATER ACTIVITY

- Temperature dependency of the sorption isotherm can be a major problem and often overlooked



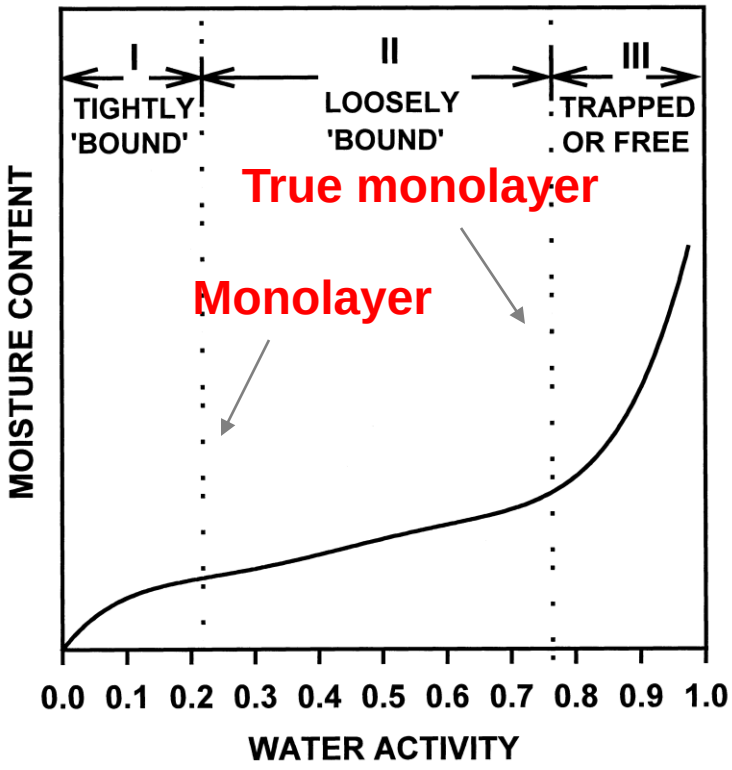
Example:

Crackers that experience a temperature rise during transportation

At the same moisture content which would spoil faster? (with higher Temp.

WATER ACTIVITY

- Sorption isotherms also explain the level of water binding in a food (i.e. types of water)
  - Type I: Tightly “bound” water (monolayer)
    - Unavailable/Unfreezable (at -40C)
    - Water - ion; water - dipole interactions
  - Type II: additional water layer (Vicinal water)
    - Slightly more mobility
    - Some solvent capacity
  - Type III: Water condensating in capillaries and pores (multilayer → bulk-phase water)
    - More available (like dilute salt solution)
    - Can be entrapped in gels
    - Supports biological and chemical reactions
    - Freezable



WATER ACTIVITY

- Importance of a_w in foods
  - Food stability directly related to a_w
  - Influences storage, microbial growth, chemical & enzymatic deteriorations, etc.