FOOD PROCESSING

Food preservation 3-7 weeks

WHY PROCESS FOODS?

1. EXTEND SHELF LIFE
2. MAINTAIN SENSORY PROPERTIES
3. MAINTAIN OR IMPROVE NUTRITIVE PROPERTIES
4. **ENSURE SAFETY**
5. MAKE MORE CONVENIENT
6. BOTTOM LINE: $$ (ECONOMIC VALUE)

HEAT PROCESSING:

Use of high temperatures to destroy enzymes and microorganisms that could reduce quality and/or safety of food

1. BLANCHING –

A mild heat treatment that primarily destroys enzymes and,

reduces microbial load (does not necessarily kill pathogens), further preservation methods needed to extend shelf life.

Example: Vegetables, frozen, canned

2. PASTEURIZATION –

A mild heat treatment used primarily to destroy pathogenic organisms but it also destroys enzymes and reduces microbial load.

Requires an addition preservation method to extend shelf life (example: refrigeration, drying).

3. **COMMERCIAL STERILIZATION** –
   A severe heat treatment that destroys pathogenic and many microorganisms that could spoil food. Extends shelf life, room temperature stable. (canned foods)

4. **STERILIZATION** - A very severe heat treatment that destroys all microorganisms.

METHODS OF HEAT TRANSFER

1. CONDUCTION: Heating of solids; Slow heating; Heating of fixed molecules in a row.

- Examples: spoon in sauce pan; Solid pack pumpkin in a can.

METHODS OF HEAT TRANSFER

2. CONVECTION: Faster heating of liquids and gas; Hot liquids and gasses raise, cooler portions sink, creating a flow or current.

- Examples: forced air heating in houses; Canned juices. Air vs. liquid heating - liquid faster.

METHODS OF HEAT TRANSFER

3. RADIATION: Electromagnetic waves. Two general types:

   a. Heat radiation from a heat source.

   - Flames: campfire and marshmallows, hot dogs, hamburgers, BBQ. Infrared.

   b. No heat radiation that causes the food to heat up

   - Microwaves
   - Irradiation that does not transfer heat: Gamma rays, x-rays, electrons (E-beam), Ultraviolet).

FACTORS INFLUENCING CHOICE OF HEAT TREATMENTS

1. Type of food
   - a. pH
     - Low acid: 5.0 - 6.8. Meat, dairy, vegetables
     - Medium acid: 4.6 - 5.0. Soups, vegetables
     - Acid: 3.7 - 4.5. Fruits
     - High acid: 2.3 - 3.6.Citrus fruits, berries
   - In medium & low acid (>4.5 pH) Foods, the canning process is designed to kill C. Botulinum.

TYPE OF FOOD (cont.)

- This is insured by:
  - i. Margin of safety process
    - microbial population reduced significantly
  - ii. Use of more heat resistant organism to base study
  - iii. Process is regulated by government.
    - Aw (more information in dried food section)
    - Composition

FACTORS INFLUENCING CHOICE OF HEAT TREATMENTS (cont.)

2. Level of contamination
3. Presence of oxygen
4. Heat resistance of organisms or enzymes
5. Heat penetration
    - characteristics of the food
6. Packaging material
7. Size of container
8. Sensory qualities desired

BLANCHING OF FRUITS AND VEGETABLES

OBJECTIVES:

1. Inactivate enzymes**
    A. Metabolic
    B. Maintain color
    C. Texture
    D. Flavor
    E. Nutritive value

BLANCHING OF FRUITS AND VEGETABLES

OBJECTIVES (cont.):

2. Lower microbial load (combination of rinsing action and heat)
3. Aids in packaging – wilts vegetables and removes respiratory gases
4. Removes dirt, leaves, etc.
5. Aids in peeling

WATER: Typically 190-210° F

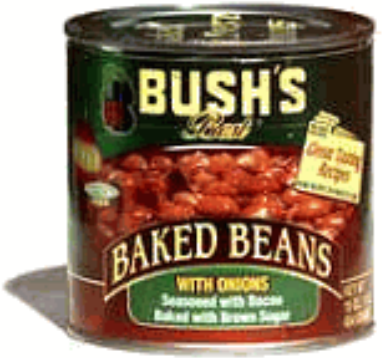
- 1.5 (peas) to 12 minutes (corn on the cob); Some exceptions: green beans.

STEAM: 212 ° F ATM Pressure

CHEMICAL: Ascorbic acid (color only), Bisulfite salts (color, preservative

GREEN BEANS: Become mushy upon high heat treatment. Therefore, one way to keep them firmer is to activate Pectin Methyl Esterase (PME). The resulting negative charge on the pectin attracts divalent cations (calcium) allowing cross-linking of the pectin molecules, which makes them more resistant to heat induced softening. Can you have too much of a good thing?? Turn to your neighbor and discuss.

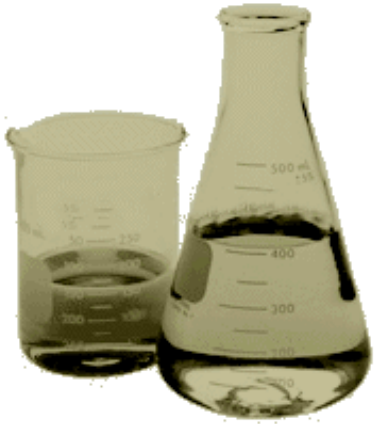
DRY BEANS: Must be partly rehydrated before blanching can take place. Multiple blanchers or long water blanchers are used. Where does the rest of the water come from to finish the thermal process (example: canned chili). How long do you cook the canned dried beans?



ADEQUACY OF BLANCHING:

Enzyme tests:

- Peroxidase
- Catalase
- Lipoxygenase



Physical:

- Wilting
- Color

PASTEURIZATION

- Used for milk, liquid eggs, fruit juices and beer.
- Destroy pathogens
- Reduce microbial load (numbers)
- Inactivate enzymes
- Extend shelf life

MILK PASTEURIZATION: Based upon T.B. Microorganism; Test for adequacy using phosphatase (blue color test).

- Vat: 145° F (62.8° C) for 30 minutes
- HTSH:161° F (71.7° C) for 15 seconds
- 191° F (88.3° C) for 1 second
- 194° F (90° C) for 0.5 second
- UHT: 275-284° F (135 to 140° C) for a few seconds

CREAM: 150-155° F (65.6-68.3° C) For 30 minutes

- 166-175° F(74.4-79.4° C) For 15 seconds

EGG PASTEURIZATION: Based upon killing and preventing growth of salmonella (food-borne illness microorganism).

- Liquid eggs heated to 140-144° F (60-62° C) and held for 3.5-4.0 minutes. Often sugar or salts are added. Why?

FRUIT JUICE PASTEURIZATION: New to kill E. Coli 0157:H7 And/or other food-borne illness microorganisms. It also reduces microbial load, inactivates enzymes, and extends shelf life.

BEER PASTEURIZATION:

1. Use of heat before or after bottling
2. Cold pasteurization - sterile filtering: better flavor than heat pasteurization not to be confused with irradiation.

CANNING - COMMERCIALLY STERILE PRODUCT

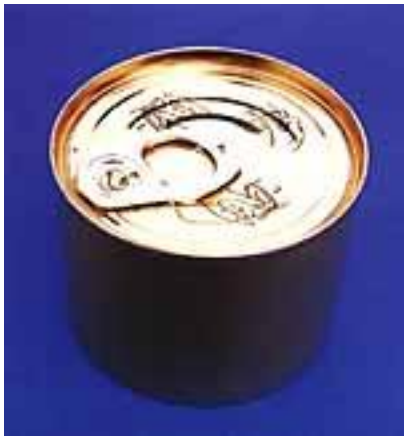
THEORY - USE OF HEAT AND ABSENCE OF OXYGEN TO PREVENT THE SPOILAGE FOODS.

CANNING METHODS

A. STILL RETORTS
B. AGITATION
C. ASEPTIC
D. OHMIC
E. PRESSURE
F. SOUS-VIDE (UNDER VACUUM)
G. MICROWAVE

PACKAGING

A. Metal
   - Tin/iron/tin cans
   - Aluminum



B. Glass

C. Plastic/metal/fiber flexible pouches

USE OF RETORT (PRESSURE COOKER)

- Allowed processing at higher temperature. So process time can be reduced.

NEW METHODS:

- OHMIC Heating (heat generated)
- Pulsed Electrical Fields (PEF) And Oscillating Magnetic Fields (OMF)
  Minimize heating.

NUTRITIVE AND OVERALL QUALITY OF CANNED FOOD

1. PROTEIN - Quality of the protein can be improved or impaired.
2. FATS - Oxidative rancidity can be increased if oxygen not properly removed from cans.

NUTRITIVE AND OVERALL QUALITY OF CANNED FOOD

3. CARBOHYDRATES - Nonenzymatic browning increases.
4. VITAMINS - Some water soluble vitamins lost: Thiamin, vitamin C. High temperature short time best.
   - Fat soluble vitamin A and D lost at high temperatures in presence of oxygen.

PRESERVATION OF FOODS BY LOWERING THE TEMPERATURE

THEORY - LOWERING THE STORAGE TEMPERATURE OF THE FOOD WILL REDUCE OR PREVENT SPOILAGE BY MICROORGANISMS AND/OR CHEMICAL REACTIONS.

NOTE:
TECHNOLOGY IS RELATIVELY NEW
ENERGY INTENSIVE

I. **REFRIGERATION** - Temperatures typically between 45 - 32° F (7.2 - 0° C). Prefer below 38° F.

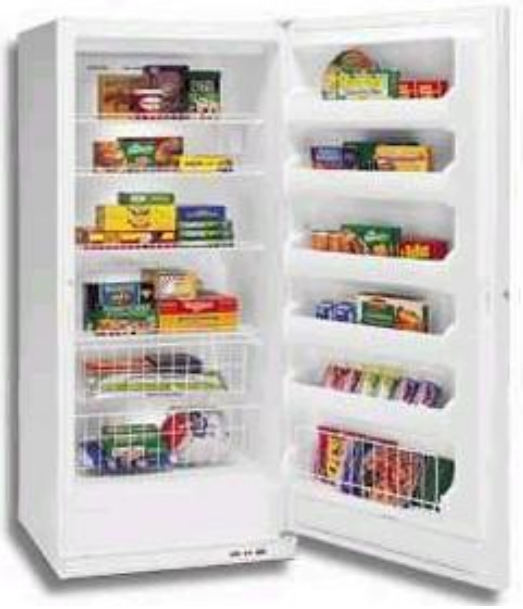
THEORY - LOWER TEMPERATURE WILL REDUCE SPOILAGE.

ALTER GASES: Controlled atmosphere storage: increase carbon dioxide and lower oxygen to slow respiration of tissues or microorganisms in fruits, vegetables, nuts, meats and eggs.

ISSUE - Spoilage organisms and chemical reactions can occur at refrigerator temperatures. But at a slower rate
e.g. lower shelf life.

CONCERNS:

1. Some pathogenic microorganisms can grow at these temperatures.
2. Cross-contamination in refrigerator.
3. Odor transfer
4. Spoilage



TRADITIONAL REFRIGERATED FOODS

1. Fresh foods (unprocessed), fruits and vegetables, (fresh meats, poultry, fish)
2. Processed foods: doughs, minimally processed vegetables
3. Refrigerated foods containing fruits and vegetables: entrees, dinners, salads. (Pasteurized dairy products cured meats)

WHY DO WE SEE MORE NEW REFRIGERATED FOODS ENTERING THE MARKETPLACE THAN OTHER FOODS?

1. Consumer demand for high quality foods:
   A. Typically less change in the quality of food product.
   B. Convenient - shorter cook times

2. Changes in food distribution
    A. Buying habits
    B. Improved food distribution

3. Improved processing techniques
    A. Aseptic processes
    B. Gas storage (CA and map)

II. FREEZING – TEMPERATURES

- < 32 F (0° C)
- Change in water from liquid to solid.

THEORY:

1. Lower temperature. Will reduce spoilage.
2. Water is unavailable for microorganisms and chemical reactions.

WHY FREEZE?

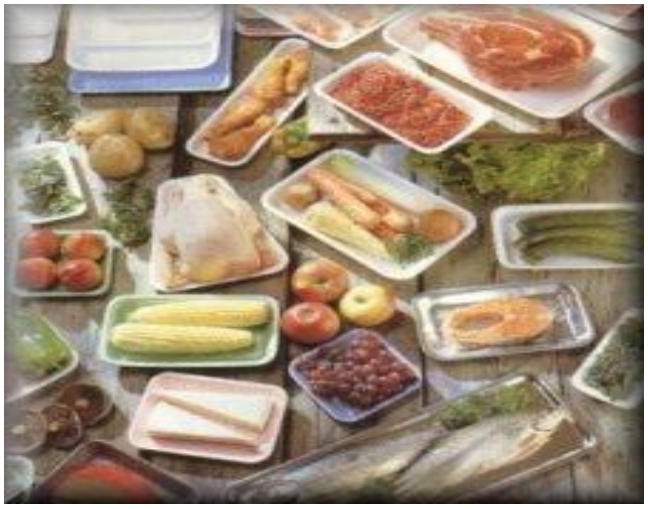
1. In general frozen foods are better nutritionally and organoleptically than other processed foods.
2. Long shelf life
3. Convenient - shorter cook times

DISADVANTAGE:

- Energy intensive

ISSUES W/ FROZEN FOODS

1. Chemical reactions can occur in unfrozen water.
   A. Some foods blanched or sulfited before freezing.
   B. Vacuum packaging to keep out oxygen.



ISSUES W/ FROZEN FOODS (cont.)

2. Undesirable physical changes
   A. Fruits and vegetables lose crispness
   B. Drip loss in meats and colloidal type foods (starch, emulsions)
      - Freeze product faster
      - Control temperature fluctuations in storage.
      - Modify starch, egg systems, etc.

UNDESIRABLE PHYSICAL CHANGES (cont.)

C. Freezer burn
   - Package properly
   - Control temperature fluctuations in storage.

D. Oxidation
   - Off-flavors
   - Vitamin loss
   - Browning

E. Recrystallization

TYPES OF FREEZING:

1. AIR FREEZING - Products frozen by either "still" or "blast" forced air.
   - cheapest (investment)
   - "still" slowest more product changes
   - "blast" faster, more commonly used
2. INDIRECT CONTACT - Food placed in direct contact with cooled metal surface.
   - relatively faster
   - more expensive

TYPES OF FREEZING (cont.):

3. DIRECT CONTACT - Food placed in direct contact w/refrigerant (liquid nitrogen, "green" freon, carbon dioxide snow)
   - faster
   - expensive
   - freeze individual food particles

DRYING

- Probably oldest form of food preservation
- Most widely used preservative method

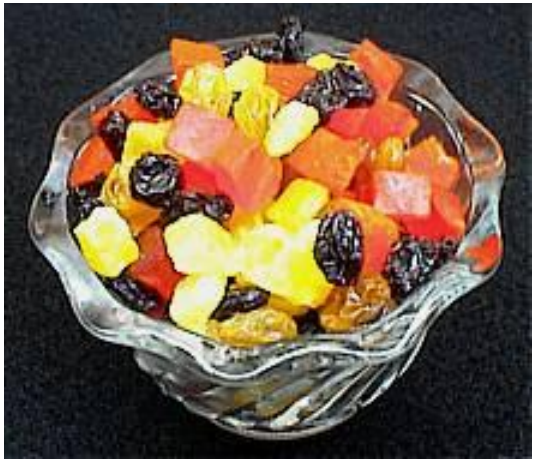
THEORY: REDUCING THE AMOUNT OF FREE WATER WILL PREVENT MICROBIAL AND CHEMICAL SPOILAGE

DRY FOODS - Aw OF 0.2 TO 0.6

- < 0.6 prevents microbial growth
- 0.2 - 0.3 prevents many chemical reactions.

INTERMEDIATE MOISTURE FOODS

- 0.8 to 0.9
- Use mold inhibitors



ADVANTAGES OF DRIED FOODS

1. Less costly to produce
2. Less costly to store and transport

NUTRIENT CHANGES AND OVERALL QUALITY

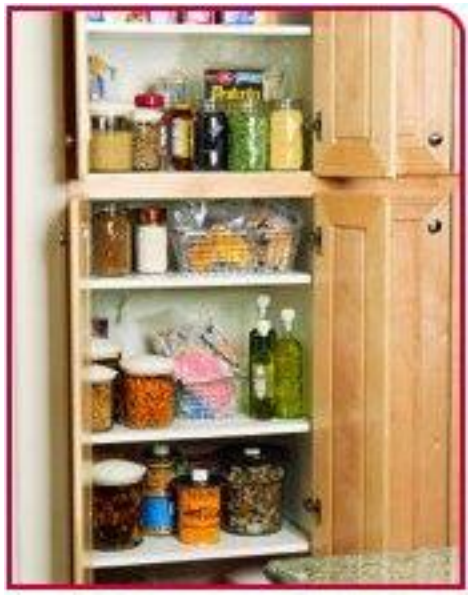
1. PROTEINS:
    - Digestibility can be reduced (high temperatures)
2. LOSS IN VITAMINS
    - Water soluble
    - Fat soluble
3. FATS:
    - Potential for oxidative rancidity increases (high temperatures)

NUTRIENT CHANGES AND OVERALL QUALITY (cont.)

4. CARBOHYDRATES:
   - Enzymatic and nonenzymatic browning.
   - Carmelization increases
   - Prevent or reduce color changes:
     - sulfites
     - blanching
5. SHAPE CHANGES

STORAGE (KEEP OUT O_2 AND LIGHT)

1. Air space (vacuum)
2. Reduce exposure to light
3. Good moisture barrier



TYPES OF DRYING

A. SUN DRYING

- Slow process
- Problems: no control
- Microorganisms and pests can attack
- Rain
- High nutrient loss
- Inexpensive products: grains, acid fruits, spices

TYPES OF DRYING (cont.)

B. HOT AIR DRYING
   - More efficient/control
   - Lower nutrient loss
   - More expensive
   - Products: dried vegetables, pasta, some fruits

C. DRUM DRYING
   - More efficient than hot air
   - Lower nutrient loss
   - Cost about equal with air
   - Products: potato pastes & slurries

TYPES OF DRYING (cont.)

D. SPRAY DRYING

- Low nutrient loss
- More expensive than drum or air drying
- Good control/efficiency
- Use only for liquids
- Products: milk, instant tea and coffee

E. PUFF DRYING: PRESSURE DROP

- Using heating systems; Air poppers; Extruders.

TYPES OF DRYING (cont.)

F. FREEZE DRYING

- Best nutrient quality
- Best product quality (shape; rehydration)
- Most expensive
- Good control
- Products: coffee, camping foods, military, NASA

TYPES OF DRYING (cont.)

G. HOT OIL

- Good heat transfer
- Good control
- Distinctive flavor/aroma
- Oil uptake, mouth feel/hand/calories
- Oxidation, free fatty acid, and flavor concern
- Products: potato chips, french fries, onion rings, some popcorn, doughnuts, some specialty meats (different countries)

TYPES OF DRYING (cont.)

H. CHEMICAL DRYING
   - Salt
   - Sugars

I. SMOKING: Heat and wood smoke

FOOD ADDITIVES - PRESERVATIVES THAT INHIBIT MICROORGANISMS

A. ACID
B. SUGAR AND SALTS
C. ANTIMICROBIAL AGENTS

MICROWAVE HEATING

CONVERSION OF ELECTRICAL ENERGY TO MICROWAVE ENERGY TO HEAT FOODS (MAGNETRON)

Interacts with charged molecules and heats by friction

- water
- salt
- sugars

Remaining heating takes place by conduction.

KEY DIFFERENCE BETWEEN MICROWAVE AND CONVENTIONAL HEATING. NO BROWNING OR CRISPING. WAYS TO SOLVE PROBLEM:

1. Color food
2. Combine with conventional heating
3. Use Suceptor (material that converts microwave energy to heat energy)

- Note - issue with Suceptor material and toxins in microwave oven.

FACTORS CAUSING UNEVEN HEATING IN THE MICROWAVE.

1. Nonuniform absorption of microwave energy
   - Frozen foods
   - Ice vs. Water vs. brine solution
   - Compound food products
2. Irregularly shaped products

KEY TO GOOD MICROWAVE PERFORMANCE

- Follow manufacturers directions

NUMBER OF MICROWAVE OVENS HAVE INCREASED DRAMATICALLY IN THE PAST TEN YEARS

- 75% Population own microwaves.

WHY THE INCREASE

1. Increased knowledge and acceptance
2. Decrease in microwave cost and size
3. Consumer lifestyle

WHAT IS IRRADIATION PROCESSING?

- Exposing food to gamma rays, x-rays or electrons to improve shelf life and safety.
- Irradiation breaks chemical bonds killing microorganisms, insects and inhibits ripening in fruits.
- Key advantage: no heat generated

SOURCES

A. GAMMA RADIATION - Cobalt 60 or cesium 137 (radioactive isotopes).

B. X-RAYS AND ELECTRONS - Generators (ex. ISU Linear Accelerator Facility - LAF)

   º Advantage: can be turned on or off.

- ABSORBED ENERGY MEASURED IN RADS AND GRAYS

WHY IS RADIATION CONSIDERED AN ADDITIVE ?

- Thought that it would change the nature of the food. In many other countries it is a process.
- By law any food irradiated requires the Radura symbol.
- Approved in 52 countries. Netherlands major user.

PROCESSING AFFECTS ON FOODS

- Food does not become radioactive
- “Unique Radiolytic Products are developed "(URPs)
  - are they unique?
    - pears get mushy
    - milk becomes rancid

NOT ONLY FOOD ARE IRRADIATED

A. PHARMACEUTICALS AND SUPPLIES

- plastic disposable items
- note: things typically destroyed by heat. stopped using gas (ethylene oxide) due to safety reasons

B. PACKAGING MATERIALS

- food cartons
- note: materials that come into contact with food.

C. WASTES

- hospitals
- research labs
- note: prevent contamination of sewers.

D. MISCELLANEOUS

- mascara
- sanitary napkins
- baby bottle nipples
- note: things in contact with body.

FOODS IRRADIATED TODAY

- Grains - kill insects (no fumigation gases)
- Tubers - inhibits sprouting
- Spices – kills bacteria and insects
- Vegetables and fruits - kill pests
- Pork - control Trichinae
- Poultry - kill salmonella
- Beef - kill E. Coli 0157:H7
- Hospital meals - persons with low immunological resistance
- NASA meals

CONCERNS

A. NUTRITIONAL EFFECTS

- º Vitamins, proteins, enzymes.
- º Example: thiamin in pork. Lose more cooking than by irradiation.

B. CARCINOGENS

- º Example: benzene in eggs. More produced by more boiling than with irradiation.

C. MUTAGENICITY

- º Example: may produce disease resistant microorganisms.

TYPES OF RADIATION PROCESSES

- RADURIZATION - Reduce number of common spoilage organisms - extends shelf life.
- RADICIDATION - Elimination of non-spore forming pathogenic bacteria.
- RADAPPERTIZATION - Commercial sterilization of foods.