VEGETABLES

Minerals, Vitamins, Main source of dietary fibers

Vegetable classification (*elaborate if need be*)

Postharvest: Maintaining quality from production to consumption

Great losses from produce (10-40% never makes it after harvest due to damage, rotting, or pests)

Poor quality crops cannot be improved by post-harvest treatment

Fresh Produce losses > processed product losses, affected by:

- Warm and humid climate for the crops (disease control becomes harder; temperature control becomes more difficult)
- Transportation of the harvest: maintenance of cool surrounding is harder for long distance transport.
- Production management: general conditions affecting growth and quality (irrigation, fertilization)
- Harvest after optimal maturity

1. Cooling
2. Curing
3. Handling
4. Storage
5. Processing
6. Packaging
7. Transport
8. Marketing

Different processing methods

Fresh/minimally processed

- Require immediate cooling after harvest (heat accumulated in vegetables must be lowered
- Morning is the optimal timing for harvest (temperature of crops is the lowest compared to the outside)
- field debris cleaned off
- cutting of ends (general cutting depending on retail goal)
- leafy vegetables are bundled (convenience food products)
- sorting and grading (of roots and legumes)
- Packaging (depending on the retail purpose)
- Refrigerated Transport and retail (required for all products)

Buying fresh-cut convenience foods minimizes the possibilities of cross-contamination (due to the different Processes applied that ensure a cleaner product than a freshly harvested one

Gas modification in packages allows for adequate amounts of Oxygen, sufficient only for the viability of the product. Oxygen is mostly replaced by CO_2 or N_2 gas (same applies for moisture content)

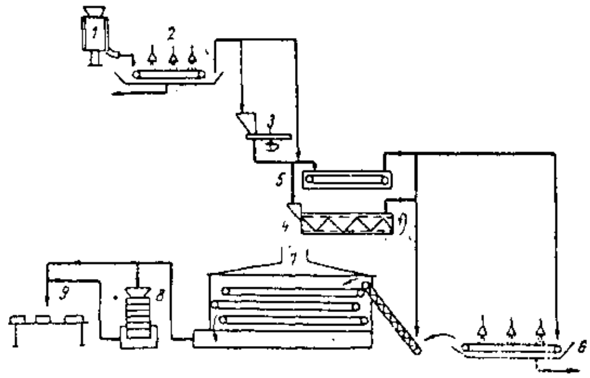
2. **Processed Fruits and Vegetables**

Processing means adding value to the crop and its modification (potentially to a different form)
Perishable products become more stable for an estimated amount of time
Sensory and nutritional attributes may be lost in process

- Blanching:
- creates a limp-structured vegetable (which is usually easier to package)
- Process may enhance certain off-flavors, may denature anti-nutritional or inedible factors, enzymes may be modified
- Steam (for less than a minute at 100°C) vs. Water (for 2-5 minutes at 88°C) blanching: time and temperature are the two variables.
- **Rapid cooling** is necessary (usually performed by dipping in cool water
- **Buffer zone** required after products reach the end of the heat-blanching tunnel, afterwards the products are transferred to a cooling tunnel
- Tests performed: **Peroxidase, catalase, lipoxygenase**
- Perceived physical changes: **withering-color** properties may arise

- Dehydration:
- **sun drying** vs. **electrical energy** driven dehydration
- Water reduction also benefits in weight and volume decrease, microorganism immobilization and destruction (inability to survive)
- **Salts and sugars** may be added for their antimicrobial, heat conducting, and blanching-contribution effects
- **Vitamin loss** (mostly under sun-drying)
- **Oxidation/rancidity**
- **Browning potential and Caramelization:** enzymatic and non-enzymatic
- **Changes in sensory properties**: shape and texture
  - **Sun drying** slowest, most uncontrolled method, generally exposing the product to pests and microorganisms. (for grapes, figs, apricots, tomatoes…)
  - **Hot air drying** can be via batch (Air Drying Cabinet) or continuous. Lower loss of nutrients.
  - **Drum Drying** mostly for flaky product drying. Oppositely rotating steam rollers dry the pasty-product
  - **Freeze Drying** sublimation for a frozen food under vacuum contributes to the retention of the fruit's original shape (therefore applied to delicate fruits such as strawberries. Best nutrient quality and process control. Most
    Reduce light exposure and use of air-tight packaging prevents the oxidation of dehydrated products

Dehydration process:



1. Trimming
2. Washing
3. Cutting
4. Blanching
5. Steaming
6. Cooling
7. Belt dryer
8. Press (for compressed vegetables)
9. Packing

- Canning:

Properly processed canned vegetables can be stored at room temperature for years

- Unfortunately, because of the severe heat treatment, some canned vegetables can have inferior quality and less nutritive value than fresh and frozen products
- The nutrient most susceptible to destruction in canning is vitamin C
- For high-quality products, aseptic canning is practiced (also known as high-temperature–short-time (HTST) processing): Process whereby pre-sterilized containers are filled with a sterilized and cooled product and sealed in a sterile atmosphere with a sterile cover
- Avoids slow heat penetration inherent in the traditional in-container heating process, creating products of superior quality
- Process:
  - Vegetables are often cut into pieces
  - Packed in cans or jars
  - Containers sealed hot, creating a vacuum inside at room temp.
  - Sterilized in retorts to ensure the destruction of bacteria spores

Even though most heat-resistant spores are nonpathogenic, spores of Clostridium botulinum can survive under-processing and produce deadly toxins that cause botulism.

corn canning:

canned tomatoes

- **Freezing**

- Outstanding quality and nutritive value, may have superior flavor over fresh produce
- Refrigeration [-2 & 8°C]
- Freezing < -20°C
- Methods:
  - IQF (Individually, quick frozen method): minimizes ice crystal size, particles don't adhere
  - Blast Freezing
  - Belt-tunnel freezing
  - Cryogenic freezing injection of CO_2
  - De-hydrofreezing

Frozen French fries

- **Fermentation and Pickling**
  - Controlled growth of microorganisms, preserves food by production of alcohol or acids by converting carbohydrates into acid or alcohol
  - Alters texture of foods, Produces subtle flavors and aromas
  - Reduce the pH of the food or produce substances which make the environment uninhabitable by other organisms by anaerobic fermentation in brine to produce lactic acid
  - Process:
    - Harvest: before maturity
    - Washing
    - Brining: Salt, water, vinegar, calcium chloride
      They are soaked in brine, Acetic acid from vinegar is added for pH reduction.
    - Inoculation by Lactic Acid Bacteria: Fermentation of sugars into Lactic acid and CO_2. Ethanol, acetaldehyde… may be produced (contribute to flavor)
    - Addition of Nitrogen: prevents bloating
    - Packaging

Fermentation and Pickling

- **Irradiation**:

Very expensive, denatures DNA of insects, extends shelf life, prevents sprouting during long-term storage.
PACKAGING: package specific irradiation (PVC, PET, cardboard, plastics… are useless)
Proper packaging allows proper irradiation without changes in structure, color, and strength

FRUITS

Growth: increase in fruit size
Maturation: Flavor development, increase in sugar content
Ripening and Senescence: chemical synthesizing pathways giving way to degradation.
Respiration and Transpiration occur and continue following harvest, afterwards the fruit becomes perishable
Storage: every 10°C increase in storage temperature doubles the rate of chemical change

- results in extreme color formation

- Development of strong off-flavors with intense aromas
- Flesh softening
- Physiological disorders and manifestation of diseases
- Chilling injury: due to overcooling: pitting and browning of the surface, darkening of the flesh

Classification

- **Fresh and Minimally Processed:** washed, cut… Simple breathable package. Modified Atmosphere Packaging is particularly useful here

Fruit Juice

- **Cloudy product**: natural form
- **Nectar type:** containing suspended solids (pulp in orange juice)
- **Clarified juices:** such as clarified apple juice
- **Juice concentrates**
- **Fruit drinks**

- **Juice Processing** from pulping fleshy fruits and pressing for extraction
  - Preparation
    Pitting of stone fruit; Pealing of fruit such as pineapple
    Some fruits may require heat treatment prior to pulping (such as tomatoes)
  - Extraction
    For citrus fruit: reaming technique (cut in half and reamed) vs extraction
    Entire fruit usage: drum grater or hammer mill used to break down the fruit
    Pressing: rack and frame press is the most traditional
    Other methods may involve the continuous belt press, the bladder press, and the basket press
    Liquefaction is an alternative to press systems: includes the use of pectinase and amylase
  - Clarification different filtration systems with the traditional being a diatomaceous earth filtration (DE) used to aggregate and collect suspended solids
    DE is collected on filter paper to produce a clear
    Membrane filtration include open tubular ceramic membranes
  - Preservation
    Single strength juice: 88°C heating followed by bottling
    Concentrates are filled at 45% dissolved solids and require a 3:1 dilution for a product with 12% soluble solids.

Orange Juice

Apple Juice

Preserves, Jams, Jellies, Marmalades

Preserves, jams, jellies, marmalades:

Provides means for fruit preserving beyond shelf life while making use of imperfect harvest

Essential ingredients include: **Sugar, acid, and pectin**

Essential process:

- *Initial mix (must not contain less than 45 parts-by-weight fruit for every 55 parts-by-weight sugar solids)*
- *Acid and pectin added during the cooking process. Approx. pH, 3.1.*

- *Exact sugar used depends on the acidity level. Increased acidity reduces amount of sugar needed.*

- *Too low sugar toughens the jelly*
- *Excessive acidity results in syneresis*
- *Inadequate amounts of pectin prevent gel formation*

Jam fruit boiling (Pectin + acid) with sugar: shape not retained
Fruit preserve retains the fruit shape
Jelly is prepared by concentrating fruit juices with sugar until reaching a desirable consistency
Marmalade is jelly with orange peal
Produces a shelf-stable product
Need for: acids (to allow pectin to set), sugars(preservation), pectin
45:55 parts by weight for fruit weight: sugar solids.
Process aims to increase total dissolved solid content 65-69(anything above induces crystallization); measured by brix via refractometer.
Temperature: 7 to 12^{o}C above the boiling point to compensate for the differences in boiling points due to the differences in altitudes (and therefore pressure)

- Weights taken for fruit and ingredients
- Fruits boiled with sugar (added in its first batch)
  too low sugar produces a tough jelly, excess sugar gives a soft, breakable texture
- Pectin (early, quick, low temperature set pectin) is added
- Acid induces unbound/weakly-bound water oozing from the fruit (syneresis due to week gel structure) occurs due to high amounts of acid. Inadequate amounts do not set pectin enough to hold its matrix together

Cherry Jam

- **Dehydration for Fruit Preservation**

Hot-Air drying

- Enzyme activity is accelerated under heat:
- blanching inactivates enzymes prior to heat exposure
- sugars or salts are used for more uniform heat distribution and the acceleration of the process. Sugar coating allows for further moisture absorption prevention

Raisins

- **Canning**:

Similar process to vegetable canning
85-90°C since fruits are more delicate (prevents browning)
Tomatoes and pineapples are filled in non-coated tin cans (this tin helps exert an extra flavor)

Pectin addition:
Pectin grade: identifies the ratio of sugar to pectin ratio (1:120) for a 120-grade pectin

- **Freezing**:

One difference exists between fruits and vegetables (veggies always require blanching prior to their freezing) where veggies always require cooking after freezing
Blanching changes texture and sensory effects (so does freezing)
Fruits are harvested at maturity, while veggies are harvested prior to maturity
General steps:

-harvesting
-washing
-Sorting
-Pitting (machine driven pitting always requires sorting prior to the process)
-Slicing (optional, depends on the retail goals)
-Tunnel freezing: IQF at [-23 to -35°C] (individual quick freezing prevents lumping in fruits, useless in some vegetable freezing processes depends on the type of vegetable being processed)

Frozen fruits

- Fruit Irradiation

HOMEWORK:

NEGATIVE EFFECTS OF GREEN SPROUTED POTATOES IN CHIPS PROCESSING (FRYING): ARSENIC

- The green color in potatoes is a due to the pigment of chlorophyll which does not pose any health threats. However, the excessive spread of chlorophyll is associated with the development of high levels of Glucoalkaloids. These compounds are alkaloid derivatives attached to sugars originating from the sprouting tuber, they are poorly absorbed by the intestine, typically causing irritation and in enough doses, poisoning symptoms such as nausea, vomiting, cardiac dysrhythmias and potential nervous system disturbances.
- Evolutionarily, these compounds play an important role in protecting these plants from external organisms as they are poisonous to most herbivores.
- These compounds include Solanidine and Chaconine and are abundant in plants such as potatoes, tomatoes, and eggplants whereby they may be concentrated in any part of the plant including the developing fruit.
- Glucoalkaloid development is speeded-up by factors such as heat and light and occur along other signs of spoilage such as the vegetable becoming limp, losing its firmness, texture, and quality. These compounds are produced during cultivation due to improper farming (soil, irrigation, cultivation temperatures, improper use of pesticides/fertilizers

Sorting potatoes based on their safety and quality depending on green-color-indications:

-Highly sprouted and limp potatoes are unsafe for consumption
-Green potatoes are salvageable if firm unless chlorophyll has spread below the skin (which must be peeled along with the first layer of discolored flesh)
-Minor-sprouting potatoes are salvageable if in good shape whereby Sprouts must be cut out

The maximum acceptable content has been set at **20 to 25 mg/100 g** of fresh potato weight. An oral dose of **225 to 1,000 mg/kg** is necessary to produce pathological effects in animals.

Processing Effects on glycoalkaloids (in potatoes)

-**Deep Frying (150°C)**: little to no effect
-**Freeze-drying/dehydration:** little to no effect
-**Boiling Potatoes**: may reduce levels of glycoalkaloids by 1.2-3.5%
-**Irradiation** (Microwave) reduces levels by 15%
-**Deep Frying at high temperature**s (> 170°C) significant degradation of glycoalkaloids
-**Deep Frying at very high temperatures** (> 210°C for 10 minutes) reduces levels by almost 40% (potential safety measure)

Potatoes also contain oxalic acid, arsenic, tannins, and nitrate