Chapter 3: Food Packaging

Expected outcome:

a) Able to discuss the roles of food packaging
b) Able to characterize of various materials of food packaging
Content

• Introduction
• Functions of food packaging
• Issues in food packaging
• Packaging materials
• MAP
• The enclosing of food requires protection from tempering whether by physical, chemical or biological means

• Communicate nutritional information

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Function of food packaging

• Efficient delivery to the customer
• protecting the food → physical, chemical and biological damages

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Function of food packaging

• Physical barrier to oxygen, moisture, volatile chemical compounds, and microorganisms
• providing convenience to the customer → Microwavability, resealability, ease of use
• conveying product information → product contents, nutritional values, preparation instruction

Photo credit: Sarah Lee; Dailymail; PD
Issues in food packaging

• Physical damage
  • Distribution environment handling, storage, transportation
  • Shock, vibration and compression
  • Shock – during handling drop height based on size, weight
  • Vibration – during transportation
  • Compression – warehousing and shipping
  • Product fragility

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Issues in food packaging

• Food-package interaction
  • Chemical and physical interaction
  • Chemical – corrosion of the material
  • Physical – mass transport ➔ food and package

• Migration – volatile compounds ➔ package to food

• Scalping – volatile compounds ➔ food to package

• Packaging and waste disposal

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Issues in food packaging

• Regulation ➔ packing, shipping, selling, advertising, grading, standardizing, marking
  • Weight – consumer is not misled/deceived by the printing or appearance of the package
  • Adulteration – prevent direct or indirect addition of foreign components
  • Public safety – temper-resistance package

Photo credit: StickerYou; Stickeryou; PD
Issues in food packaging

Other considerations

- Suitable packaging machinery
- Economic consideration
- Good packaging graphics

Photo credit: Selo; Selo; PD

farhanmsaid@ocw,
farhan_msaid@yahoo.co.uk
Packaging materials

• Basic material ➔ glass, metal, paper and plastic
• Each has both advantages and disadvantages
• Selection ➔ functional requirements, economics of specific applications
• To optimize performance and cost ➔ food packages use > 1 type of package material
Packaging materials

Glass

- Excellent barrier → protecting from oxygen and moisture
- Excellent visibility and an image of cleanliness
- Major constituents → SiO$_2$, Na$_2$O and CaO
- Properties of glass (e.g., strength, transparency, moldability) can be modified → composition of these constituents
Packaging materials

Glass

• Considerations in designing glass containers
  • Mechanical strength
  • Thermal strength
  • Optical properties

Photo credit: Isaac Fletcher; vertassets; PD
Packaging materials

- Excellent protection of oxygen, moisture and light
- Most common - Steel and aluminum
- Aluminum foil and metalized films
  - Aluminum foil food-packaging application, such as pouches
  - Metalized films – very thin layer of aluminum (vapor deposited) on a plastic film
Packaging materials

Metal - aluminum

• Odorless, tasteless, non-toxic
• Provides a very good barrier to moisture, gases and light
• Retains the volatile flavors.
• Foil is fragile → protection from torn or punctured.

Photo credit Toronto; Toronto; PD
Packaging materials

- Made of wood fibers ➔ cellulose, hemicellulose, and polymeric residues
- Good mechanical strength ➔ protect physical damage
- Poor gas-barrier properties and mechanical strength
- Often coated with aluminum or plastic for better performance
Packaging materials

Plastic

- Polymers/long chain macromolecules → molded, extruded and cast → films, sheet and containers
- Broad range of gas-barrier properties → permeability
- Permeability → plastic material, permeate gas, temperature, and RH
- Versatility of packaging many different foods

Photo credit print-packaging; PD

farhanmsaid@ocw, farhan_msaid@yahoo.co.uk
Packaging materials

• Polyethylene (PE)
  • Most frequently used in food packaging – low cost, easy process and good mechanical properties
  • HDPE, LDPE and LLDPE
  • HDPE (0.94 – 0.97 g/cm³, 135°C)
    • greater tensile strength, hardness and better chemical resistance
    • blow-molded bottles, food containers, bags
  • LDPE (0.91 - 0.93 g/cm³, 110°C)
    • Soft, flexible and stretchable
    • Films for fresh produce and baked goods
    • Good clarity and sealability
  • LLDPE, density same as LDPE
    • Has clarity and heat sealability of LDPE and strength and toughness of HDPE
Packaging materials

- **Polypropylene (PP)**
  - ↑ melting point (165°C)
  - ↓ density (0.9 kg/m³) but higher tensile strength, stiffness and hardness than PE
  - ➔ hot filling, retorting, good heat seal strength, excellent clarity

- **Polystyrene (PS)**
  - Excellent clarity, hard, low impact strength
  - ↓ gas barrier, ↓ melting point (88°C)
  - Cups, dishware, closures, windows in paperboard boxes ➔ display products
Packaging materials

- Polyethylene terephthalate (PET)
  - Mostly in injection blow-molded bottles for carbonated soft drinks, water, edible oil, juices
  - Stronger, clearer and better gas barrier than HDPE, more expensive
  - Films that have high strength, high melting point (267°C), high scuff resistance, good clarity, good printing characteristic, excellent dimensional stability
  - Food trays used in microwave/oven

farhanmsaid@ocw,
farhan_msaid@yahoo.co.uk
# Advantages and Disadvantages of Food Packaging Materials

<table>
<thead>
<tr>
<th>Materials</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>Excellent barrier → oxygen &amp; moisture &lt;br&gt;Chemically inert &lt;br&gt;Transparent</td>
<td>Easily breakable &lt;br&gt;Relatively heavier</td>
</tr>
<tr>
<td>Metal</td>
<td>Excellent barrier → oxygen, moisture, light &lt;br&gt;Good mechanical strength &amp; durability &lt;br&gt;Good thermal stability</td>
<td>Susceptible to corrosion &lt;br&gt;Metal cans generally more difficult to open and reseal</td>
</tr>
<tr>
<td>Paper</td>
<td>Relatively inexpensive &lt;br&gt;Excellent printability &lt;br&gt;Lightweight</td>
<td>Poor gas and moisture barrier &lt;br&gt;Greatly reduced mechanical strength when wet</td>
</tr>
<tr>
<td>Plastic</td>
<td>More versatile &lt;br&gt;Can be formed easily into many shapes &lt;br&gt;Lightweight</td>
<td>More susceptible to migration and flavor-scalping problems</td>
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</tbody>
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MAP

• Relatively new preservation technology
• Normal composition of air; 20.9% O$_2$, 78% N$_2$, 0.9% Ar, 0.03% CO$_2$
• MAP – normal composition of air is changed within a package, but the change is not constant due to product respiration and permeation of gas
• Normally involve the reduction of oxygen content and increase in level of carbon dioxide in the package headspace
• Always enhancement of refrigeration as preservation technology
MAP

• Methods of atmosphere modification
  • Passive modification
    • Used in fresh respiring fruits and vegetables
    • Film with a correct gas permeability
    • Atmosphere within the packaged product is modified; consumption of oxygen and generation of carbon dioxide through respiration of product and the permeation of gases
    • Depletion of oxygen to near ‘0’ leads to anaerobic respiration or fermentation → results in spoilage
MAP

• Active modification
  • Used in meat industry to extend shelf life, keeping quality
  • Film of low $O_2$ permeability, air is removed under vacuum, package is heat sealed
  • Headspace $O_2$ is reduced < 1%, $CO_2$ produced from tissue and microbiological respiration, may increase to 10 to 20%
  • $\rightarrow$ Extend the shelf life of meat by inhibiting the growth of meat-spoilage microbes, particularly *Pseudomonas* and *Alternaria* species
  • Other method $\rightarrow$ oxygen absorbent

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