UMP OPEN COURSEWARE

Universiti Malaysia PAHANG
Engineering • Technology • Creativity

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

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Content

- Introduction
- Functions of food packaging
- Issues in food packaging
- Packaging materials
- MAP

Introduction

Photo credit: R L Sheehan; Wikipedia; PD

- The enclosing of food→ requires protection from tempering whether by physical, chemical or biological means
- Communicate nutritional information

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

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

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Packaging materials

Glass

- Excellent barrier → protecting from oxygen and moisture
- Excellent visibility and an image of cleanliness
- Major constituents → SiO_2, Na_2O and CaO
- Properties of glass (eg strength, transparency, moldability) can be modified → composition of these constituents

Packaging materials

Glass

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

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Packaging materials

Metal

- 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 → moisture, gases and light
- Retains the volatile flavors.
- Foil is fragile → protection from torn or punctured.

Photo credit Toronto; Toronto; PD

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Packaging materials

Paper and paperboard

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

Photo credit Toronto; Toronto; PD

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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

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Packaging materials

Plastic	Types

- 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/cm^3 , 135^{o}C)
    - greater tensile strength, hardness and better chemical resistance
    - blow-molded bottles, food containers, bags
  - LDPE (0.91 - 0.93 g/cm^3 , 110^{o}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

Plastic	Types

- Polypropylene (PP)
  - ↑ melting point (165°C)
  - ↓ density (0.9 kg/m^3) 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

Plastic	Types

- Polyethylene terephthalate (PET)
  - Mostly in injection blow-molded bottles → 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^{o}C), high scuff resistance, good clarity, good printing characteristic, excellent dimensional stability
  - → food trays used in microwave/oven

Advantages and disadvantages of food packaging materials

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

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

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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%
  - → Extend the shelf life of meat by inhibiting the growth of meat-spoilage microbes, particularly *Pseudomonas* and *Alternaria* species
  - Other method → oxygen absorbent

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