QUALITY AND SHELF LIFE OF PACKAGED FOODS

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SUPPORTING

- https://www.slideshare.net/JaideepBanerjee/calculating-shelf-life- of-foods

SHELF LIFE?

Introduction

- The intention of this topics is to illustrate how the product quality and shelf life of packaged foods can be affected by the appropriate selection of packaging materials.
- Factors that affect product quality and shelf life are considered with examples of how packaging has been used to influence them to extend shelf life.
- Packaging can become a shelf life limiting factor in its own right. For example, this may be as a result of migration of tainting compounds from the packaging into the food or the migration of food components into the packaging.

WHAT IS SHELF LIFE?

- The Institute of Food Science and Technology (IFST) Guidelines (1993) provides a definition of shelf life:
  - ‘shelf life is the period of time during which the food product will remain safe; be certain to retain desired sensory, chemical, physical and microbiological characteristics; and comply with any label declaration of nutritional data.’

- The shelf life of a product begins from the time the food is prepared or manufactured.
- Its length is dependent on many factors including the types of ingredients, manufacturing process, type of packaging and how the food is stored.
- It is indicated by labelling the product with a date mark.

FACTORS AFFECTING PRODUCT QUALITY AND SHELF LIFE

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- For many foods, the product shelf life is limited by specific or key attributes that can be predicted at the time of product development. This is either on the basis of experience with similar products or observations of them, or from a consideration of
  - the make-up of the product (intrinsic factors)
  - the environment that it will encounter during its life (extrinsic factors)
  - and the shelf life limiting processes that this combination of intrinsic and extrinsic factors is likely to result in.

INTRINSIC FACTORS

Intrinsic factors are the properties resulting from the make-up of the final product and include the following:

- water activity (available water)
- pH/total acidity; type of acid
- natural microflora and surviving microbiological counts in final product
- availability of oxygen
- Redox potential (*Eh*)
- natural biochemistry/chemistry of the product
- added preservatives (e.g. salt, spices, antioxidants)
- product formulation
- packaging interactions (e.g. tin pickup, migration).

Selection of raw materials is important for controlling intrinsic factors, since subsequent processing can rarely compensate for poor-quality raw materials.

Product packaging can have significant effects on many of these extrinsic factors and many developments in packaging materials have been driven by the need to reduce the impact of these environmental factors and extend shelf life. In some instances, the packaging alone may be effective in extending shelf life, e.g. by providing a complete light and oxygen barrier. In most instances, however, it acts as one of a number of *hurdles* that, acting together, influence the shelf life.

EXTRINSIC FACTORS

Extrinsic factors are a result of the environment that the product encounters during life and include the following:

- ✓ time–temperature profile during processing
- ✓ temperature control during storage and distribution
- ✓ relative humidity (RH) during storage and distribution
- ✓ exposure to light (UV and IR) during storage and distribution
- ✓ composition of gas atmosphere within packaging
- ✓ consumer handling

Shelf life limiting processes

- The interactions of intrinsic and extrinsic factors affect the likelihood of the occurrence of reactions or processes that affect shelf life.
- For ease of discussion these shelf life limiting reactions or processes can be classified as:
- chemical/biochemical (Oxidation, Enzymatic activity)
- microbiological
- physical

1. CHEMICAL/BIOCHEMICAL PROCESSES

Many important deteriorative changes can occur as a result of reactions between components within the food, or between components of the food and the environment.

a. Oxidation

- A number of chemical components of food react with oxygen affecting the color, flavor, nutritional status and occasionally the physical characteristics of foods.
- Packaging is used to both exclude, control or contain oxygen at the level most suited for a particular product. Foods differ in their avidity for oxygen, i.e. the amount that they take up, and their sensitivity to oxygen, i.e. the amount that results in quality changes.
- Estimates of the maximum oxygen tolerance of foods are useful to determine the oxygen permeability of packaging materials required to meet a desired shelf life.
- Foods containing a high percentage of fats, particularly unsaturated fats, are susceptible to oxidative rancidity and changes in flavor. Saturated fatty acids oxidize slowly compared with unsaturated fatty acids.
- Antioxidants that occur naturally or are added, either slow the rate of, or increase the lag time to, the onset of rancidity.

EXAMPLE FOR FIGHTING AGAINST OXIDATION

1. In milk chocolate, the presence of tocopherol (vitamin E), a natural antioxidant in cocoa liquor provides a high degree of protection against rancidity. Light barrier packaging is done.
2. Such sensitive products (snack products and particularly nuts) are often packed gas flushed to remove oxygen and packed with 100% nitrogen to protect against oxidation and provide a cushion to protect against physical damage.
3. Investigations of rancidity in potato chips in relation to the light barrier properties of various films showed that improved light barrier properties of packaging films gave extended shelf life with respect to rancidity.
4. Vacuum packaging extends the shelf life of chilled fatty fish.
    1. Trout stored on ice packaged in polyethylene (high oxygen permeability) can develop a markedly rancid taste after 8 days.
    2. For trout vacuum packed in a plastic material with low oxygen permeability the shelf life at 0°C is increased to 20 days.

EXAMPLE FOR FIGHTING AGAINST OXIDATION

5.Oxidation of lycopene, a red/orange carotenoid pigment in tomatoes, causes an adverse color change from red to brown and affects flavor. In canned tomato products this can be minimized by using plain unlacquered cans.

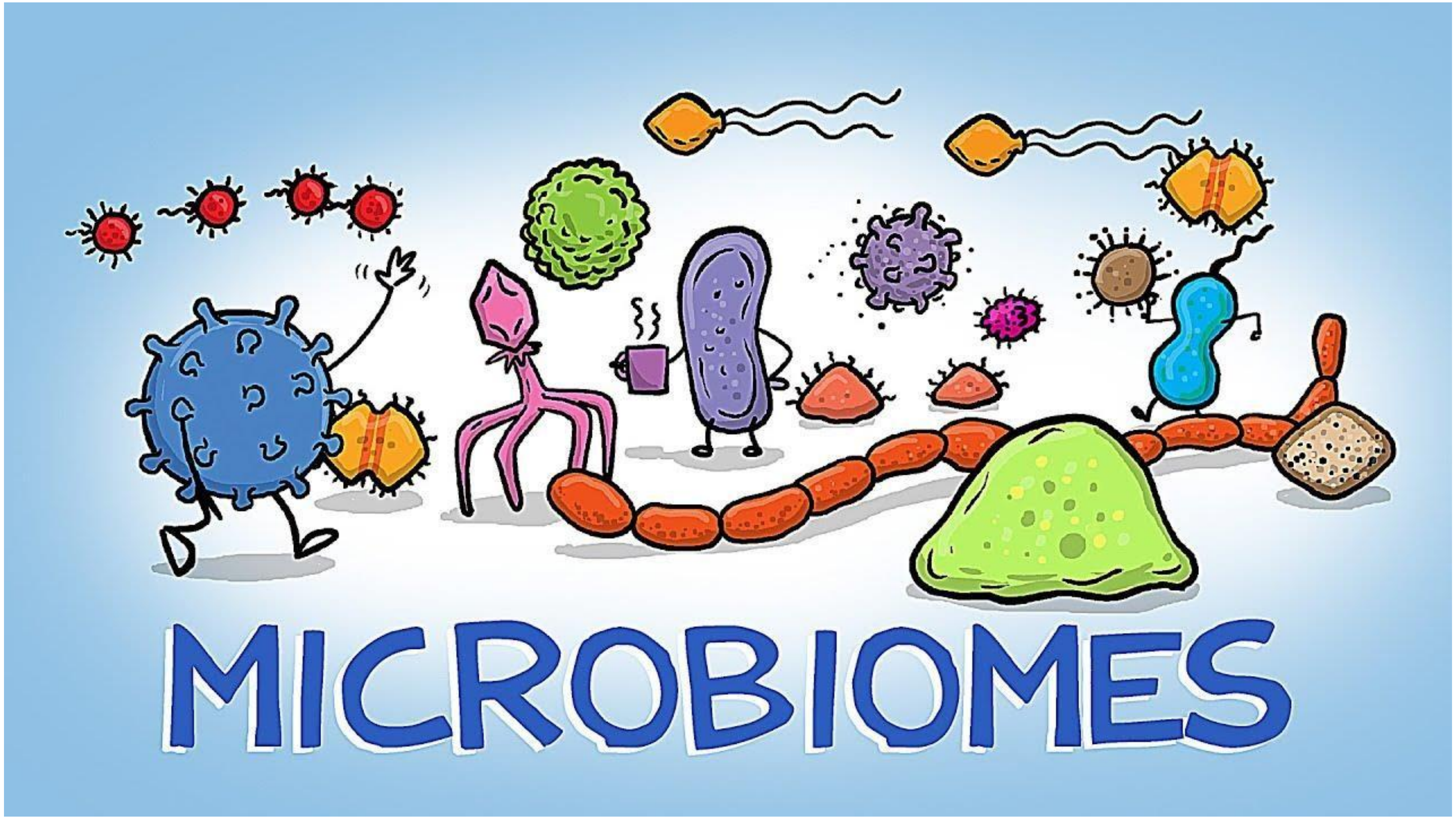
6.Oxygenated myoglobin, oxymyoglobin, is the pigment in raw meat that is responsible for the bright attractive red color, which consumers associate with freshness and good eating quality.

In conventionally packed fresh beef, meat on a plastic tray is overwrapped with a highly gas permeable plastic material which allows an almost unrestricted supply of oxygen to the myoglobin, favoring the red color.

B.ENZYME ACTIVITY

- Fruits and vegetables are living commodities and their rate of respiration affects shelf life – generally the greater the rate of respiration, the shorter the shelf life.
- Respiration is the metabolic process whereby sugars and oxygen are converted to more usable sources of energy for living cells.
- Use of temperature control reduces the respiration rate ,extending the life of the product. Temperature control combined with MAP further suppresses the growth of yeasts, molds and bacteria, extending shelf life further.
- Physical (cutting) or chill injury induces the production of ethylene particularly in fruiting tissue due to its effect on the rate limiting enzyme (1-aminocyclopropane-1-carboxylic acid synthase) in the biochemical pathway leading to ethylene formation and increases tissue sensitivity to ethylene

What are these?



2. Microbiological Processes

- During growth in foods, microorganisms will consume nutrients from the food and produce metabolic by-products such as gases or acids. They may release extra-cellular enzymes (e.g. amylases, lipases, proteases) that affect the texture, flavor, odor and appearance of the product.
- **Examples where packaging is key to maintaining microbiological shelf life:**

1. In canning, low acid foods are filled into containers that are hermetically sealed and sterilized, typically at 115.5–121°C or above, to ensure all pathogens, especially Clostridium botulinum, are destroyed.
2. Pseudomonas species, the major spoilage group in chilled proteinaceous foods, require the presence of oxygen to grow. The use of vacuum packaging or modified atmospheres excluding oxygen will prevent the growth of this type of bacteria.
3. In MAP, the gas mixture must be chosen to meet the needs of the specific product; this is usually some combination of oxygen, nitrogen and carbon dioxide. Carbon dioxide at 20–60% has bacteriostatic and fungistatic properties and will retard the growth of mold and aerobic bacteria by increasing the lag phase and generation time of susceptible microorganisms.

3. PHYSICAL AND PHYSICO-CHEMICAL PROCESSES

Physical changes affecting shelf life can be brought about directly by physical damage or by physico- chemical processes resulting from the underlying food chemistry.

a. Physical damage

- During product life, particularly in storage, distribution and consumer handling, products are subjected to vibration on vehicles, compressive loads during stacking in warehouses and sudden jolts and knocks.
- Vulnerable areas on packs are heat seals and screw caps, where damage resulting in leakage may result in loss of the preservation effect provided by the packaging.
- For fragile products, that are susceptible to crushing, such as soft cheeses, breakfast cereals and biscuits, the outer carton provides protection from physical damage and from potential tampering.

b. Insect damage

- Package pests are classified in two groups – penetrators and invaders.
- Penetrators are capable of boring through one or more layers of flexible packaging materials. It is possible to reduce infestation with penetrators by preventing the escape of odours from the package through the use of barrier materials. Arapid method to evaluate the usefulness of odours barriers has been developed.
- Invaders are more common and enter packages through existing openings, usually created from poor seals, openings made by other insects or mechanical damage. It is therefore important that seals are not vulnerable to attack from insects.

3. Physical and Physico-Chemical Processes

c. Moisture changes

- Moisture changes leading to loss or gain of moisture is a significant physical cause of the loss of shelf life of foods.
- Hygroscopic foods require protection from moisture take up which in dry products such as breakfast cereals and biscuits causes loss of texture, particularly crispness.
- Films used in MAP packaging should have low water vapor transmission rates (WVTR) to minimize changes in moisture content inside the pack.

d. Barrier to odor pick-up

- ✓ Dairy products, eggs and fresh meat are highly susceptible to picking up strong odours.
- ✓ Chocolate products have a high fat content and sometimes bland flavor.
- ✓ Unacceptable flavor pick-up can result if they are inadequately wrapped and stored next to strong smelling chemicals, such as cleaning fluids, or in shops close to strongly flavored sweets, such as poorly wrapped mints.
- ✓ Packaging reduces the problem but most plastic materials allow quite a significant volatile penetration – the plastic materials used for vacuum packs and MAP have low permeability,

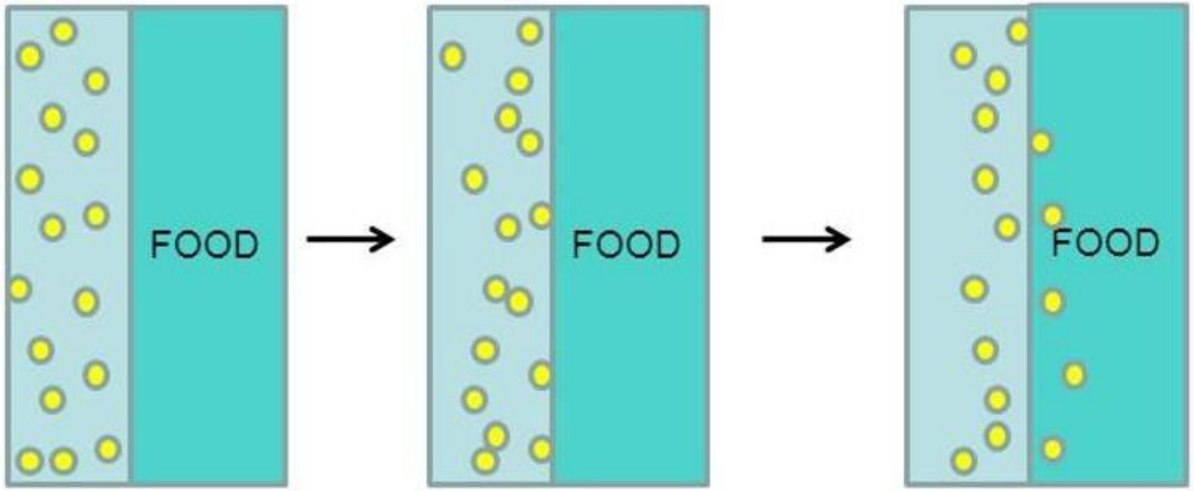
  and this reduces, but does not prevent, the uptake of foreign odours i.e. taints.

3. PHYSICAL AND PHYSICO-CHEMICALPROCESSES

e. Flavorscalping

- If a chemical compound present in the food has a high affinity for the packaging material, it will tend to be absorbed into or adsorbed onto the packaging until equilibrium concentrations have been established in food and packaging. This loss of food constituents to packaging is known as scalping.
    - A classic example is the absorption of various plastic flavors when soft drinks are stored in plastic bottles for an extended period
- Where particular food-packaging combinations are susceptible to scalping, introducing an effective barrier layer may reduce the problem.

4. MIGRATION FROM PACKAGING TO FOODS



4. MIGRATION FROM PACKAGING TO FOODS

The direct contact between food and packaging materials provides the potential for migration. Additive migration describes the physico-chemical migration of molecular species and ions from the packaging into food. Such interactions can be used to the advantage of the manufacturer and consumer in active and intelligent packaging, but they also have the potential to reduce the safety and quality of the product, thereby limiting product shelf life.

a. Migration from plastic packaging

- The popularization of polymeric packaging materials has resulted in increased concerns over the migration of undesirable components into foods. This has the potential to affect product quality as well as safety.
- The material itself is a polymer or copolymer manufactured from one or more types of monomers such as styrene, vinyl acetate, ethylene, propylene or acrylonitrile.
- All polymers contain small quantities of residual monomers left unreacted from the polymerization reaction. These constituents are potentially available to migrate into foods.

4. MIGRATION FROM PACKAGING TO FOODS

b. Migration from other packaging materials

- Although the majority of research into interactions between food and packaging is concentrated on plastics, more traditional materials such as paper, board and cans also present problems.
- A number of taint problems in foods have been attributed to paper and board packaging.
- Chlorophenols can be responsible for antiseptic taints.
- Health concerns have been raised over the use of recycled paper and board for food contact because of the possible migration of di-isopropyl-naphthalenes (DIPNs).
- Research has shown that DIPNs are not eliminated during the recycling of paper and have the potential to migrate into dry foods, such as husked rice, wheat semolina pasta, egg pasta and corn flour.
- Migration from can lacquers into canned foods has been another area of concern over recent years.

Factors affecting migration from food contact materials

- The extent of migration from food contact materials into food is dependent on a number of factors.
- Most obviously, the quantity of available potential migrants in the packaging material can be minimized by careful design and production of the packaging.
- The degree of contact between food and packaging also has a direct influence on migration, and in cases where particular problems have been encountered, it may be necessary to protect a food from direct contact with, for example, a printed surface.
- As migration is a process that usually occurs gradually, the period of time for which the food and packaging are in contact should also be considered when trying to anticipate potential migration issues.
- The intrinsic factors of a food are of great significance to the degree of migration likely to occur. A potential migrating constituent of the packaging is gradually transferred to the food causing the concentration of that constituent to gradually decrease in the packaging and increase in the food. Eventually, a point of equilibrium is reached when the concentration of the constituent stays constant in food and packaging.

Packaging selection to avoid migration and packaging taints

- For general selection of packaging, it is importance to ensure that the material complies with relevant legislation.
- When selecting a packaging material for a defined purpose, it is important to consider all components of the end product, how they are likely to interact, and the effect that the interaction will have on the food.
- The potential for taints can be evaluated by considering three questions:
- firstly, the composition of the packaging material – is it optimized to minimise the quantity of potential migrating components that are available to migrate into food?
- Secondly, what is the probability that any available migrating components might migrate into the food?
- Thirdly, what impact is the migrating compound likely to have on the product?
- This is influenced by how strongly flavoured the product is. For example, similar levels of migration into a white chocolate product and a meat pie may make the chocolate unpalatable, but may not be detectable in the pie. Thus, the levels of migration that can be tolerated (within legislative limits) are dependent on the flavour characteristics of the food.

Question:

- Thank You ………..