21) PACKAGING: FUNCTIONS

Introduction

Packaging fresh fruits and vegetables is one of the more important steps in the long and complicated journey from grower to consumer. Bags, crates, hampers, baskets, cartons, bulk bins, and palletised containers are convenient containers for handling, transporting, and marketing fresh produce. More than 1,500 different types of packages are used for produce in the U.S. and the number continues to increase as the industry introduces new packaging materials and concepts. Although the industry generally agrees that container standardization is one way to reduce cost, the trend in recent years has moved toward a wider range of package sizes to accommodate the diverse needs of wholesalers, consumers, food service buyers, and processing operations.

The Function of Packaging

Most food is consumed far removed in time and space from the point of its production, hence the need for the preservation processes. A necessary aid for the storage and distribution is packaging. The functions of packaging are several.

Packaging serves as a material-handling tool containing the desired unit amount of food within a single container and may facilitate the assembly several such units into aggregates. For example, some fluids are packaged in bottles, which may be placed in boxes, and these boxes in turn can be assembled into easily handled pallets. The container must enclose the produce in convenient units for handling and distribution. The produce should fit well inside the container, with little wasted space. Small produce items that are spherical or oblong (such as potatoes, onions, and apples) may be packaged efficiently utilizing a variety of different package shapes and sizes. However, many produce items such as asparagus, berries, or soft fruit may require containers specially designed for that item.

The package may also serve as a processing aid. For instance, the metal can be used in heat sterilization of many food items serves not only a protective function but, by its dimensional stability, assures that when fully packed the food maintains a certain shape and location for which heat penetrations can be calculated.

The package is a convenience item for the consumer. The examples one could choose here are very numerous. A beer can, for instance, serves as the drinking utensil as well as a process, storage, and distribution container. A variety of packages aids in the handling, preparation, and consumption of foods by the consumer.

The package is a marketing tool. The sales appeal and product identification aspects of packaging are particularly important to sales and marketing branches of food companies, and since these branches often have a dominant role in business decisions it is these aspects that dominate package design. The package must identify and provide useful information about the produce. It is customary (and may be required in some cases) to provide information such as the produce name, brand, size, grade, variety, net weight, count, grower, shipper, and country of origin. It is also becoming more common to find included on the package, nutritional information, recipes, and other useful information directed specifically at the consumer. In consumer marketing, pack-age appearance has
also become an important part of point of sale displays. Universal Product Codes (UPC or bar codes) may be included as part of the labelling. The UPCs used in the food industry consist of a ten-digit machine-readable code. The first five digits are a number assigned to the specific producer (packer or shipper) and the second five digits represent specific product information such as type of produce and size of package. Although no price information is included, UPCs are used more and more by packers, shippers, buyers, and retailers as a fast and convenient method of inventory control and cost accounting. Efficient use of UPCs requires coordination with everyone who handles the package.

Packaging, when properly used, can be a cost saving device. Certain packages have obvious economic benefits, such as prevention of spills, ease of transporting, prevention of contamination, reduction of labour cost.

Protection of the product is the most important aspect of packaging. The package must protect the produce from mechanical damage and poor environmental conditions during handling and distribution. To produce buyers, torn, dented, or collapsed produce packages usually indicate lack of care in handling the contents. Produce containers must be sturdy enough to resist damage during packaging, storage, and transportation to market. Because almost all produce packages are palletised, produce containers should have sufficient stacking strength to resist crushing in a low temperature, high humidity environment. Although the cost of packaging materials has escalated sharply in recent years, packers or buyers no longer tolerate poor quality, lightweight containers that are easily damaged by handling or moisture.

Packaging can be categorized as follows:

1. Primary: The package in contact with food material (e.g. cereal mix inside plastic bag)
2. Secondary: The package that is sold as a unit (e.g. cereal mix box). Package provides consumers with legally required information about the food product
3. Tertiary: The carton of secondary packages (e.g. case of cereal mix boxes)

**PROTECTIVE PACKAGING**

The quality of products as they reach the consumer depends on the condition of the raw material, on method and severity of processing, and on conditions of storage. Quality decreases in storage by time. The rate and extent of this decrease depends on the conditions of the environment. The chemical, physical and biological mechanisms of food deterioration are sensitive to various environmental factors, and the most pertinent barrier property of the package varies with each product. Some of the environmental factors and the corresponding pertinent packaging properties are listed in Table 1.
Table 1. Package-Environment interactions (from Fennema, O., Karel, M., Lundy D., 1975)

<table>
<thead>
<tr>
<th>Environmental factors</th>
<th>Pertinent package properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical shocks</td>
<td>Strength</td>
</tr>
<tr>
<td>Pressure of oxygen, water vapour, etc.</td>
<td>Permeability</td>
</tr>
<tr>
<td>Light intensity</td>
<td>Light transmission</td>
</tr>
<tr>
<td>Temperature</td>
<td>Thermal conductivity</td>
</tr>
<tr>
<td></td>
<td>Porosity</td>
</tr>
<tr>
<td></td>
<td>Reflectivity</td>
</tr>
<tr>
<td>Biological agents</td>
<td>Penetrability</td>
</tr>
</tbody>
</table>

**EFFECT OF ENVIRONMENT ON FOOD STABILITY AND THE NEED FOR PROTECTIVE PACKAGING**

The package affects the quality of foods by controlling the degree to which factors connected with processing, storage, and handling can act on components of foods. The processing and storage factors amenable to control by packaging include light, oxygen concentration, moisture concentration, heat transfer, contamination, and attack by biological agents.

**A. Light**

Food can be adversely affected by prolonged exposure to light. Light promotes the following chemical reactions in food: oxidation of fats and oils to produce the complex of changes known as oxidative rancidity, and changes in various pigments. Riboflavin is especially photosensitive and when exposed to sunlight it losses its vitamin value and also activates or sensitises other components to photo degradation. Ascorbic acid, or Vitamin c, is also quite sensitive to light and it interacts with other components during light exposure. To prevent such changes a packaging material, which is opaque to light may be used or, where sight of the product is desirable, the packaging material may be coloured to exclude short length light waves. Amber glass, commonly used for beer bottles, is an example of latter.

**B. Oxygen**

Oxidation reactions are often the cause of undesirable changes in foods. One such reaction is oxidative rancidity due to peroxidation of fats and oils in various foods. In addition many vitamins, pigments and some amino acids and proteins are oxygen sensitive. Packaging can control two variables with respect to oxygen, and these have different effects on rate of oxidation reactions in foods. The first variable is the total amount of oxygen available. Another important variable is the concentration of oxygen in food, and in turns depends on oxygen pressure. Oxygen response of foods is varied and must be known before package selection is undertaken.

Creating an atmosphere inside the package, which has a low oxygen content, may extend the shelf life of many foods. This is achieved by maintaining a partial vacuum in the container or by displacing air with nitrogen or carbon dioxide (gas packaging). Cheese, cooked and cured meat products, dried meats, eggs, and coffee are examples of such foods. In these and other similar cases it is necessary that packaging material used should be a good barrier to gases and the package effectively sealed so that the composition of the in-pack atmosphere does not change significantly during the storage and distribution of the product.
However, if the fresh produce is sealed in a gas tight container, the oxygen within the pack will be used up and replaced with carbon dioxide as a result of respiration. Thus over a period of time an aerobic atmosphere will develop inside the package. If the oxygen level falls below 2% off-flavours may develop and discolouration occur in certain fruit and vegetables. To prevent such changes it is necessary to use a packaging material that permits movement of oxygen into and carbon dioxide out of the package.

C. Water
The water content of foods is dependent on the relative humidity of the immediate environment. Water relations of foods strongly affect packaging requirements. Foods with high equilibrium relative humidity will tend to lose moisture to the atmosphere and this can result in a loss in weight and deterioration in appearance and texture. Meat and cheese are typical examples of such foods. Products with low equilibrium relative humidity tend to absorb moisture, particularly in high humidity atmospheres, and this can also cause a loss in quality. Dry powders, such as cake mixes and custard powder, may cake, biscuits and snack foods may lose their crispness and dehydrated products may spoil if their water activity rises above the level, which permits microbiological and/or chemical activity. On the other hand, in the case of fresh products with high respiration rates, i.e. some fruits and vegetables, it may be necessary to allow for the passage of water vapour out of the package, otherwise a high humidity will develop in the package and fogging may occur when the temperature fluctuates.

D. Temperature
Packaging affects the rate of heat transfer to and from the food products. The temperature rise in refrigerated food products can be retarded by the use of insulating containers. Insulating properties of packages are greater importance in handling and distribution of frozen foods. The package must be able to withstand the changes in temperature, which it is likely encounter without any loss of performance or appearance. This is of particular importance when foods are to be heated or cooled in their packages. The rate of change of temperature and the type of heat may influence the choice of packaging material. For example glass containers must be heated and cooled slowly to avoid breakage and specially formulated paperboards are required for microwave heating to avoid off-flavours developing.

E. Mechanical Damage
Both fresh and processed foods are susceptible to mechanical damage. The cracking of egg shells, the bruising of fruit and the breaking of biscuits are examples. Such damage may result from: sudden impacts or shocks during handling and transport, vibration during transport by road, rail or air, and compression loads imposed while packages are stacked in warehouses or ships holds. Appropriate packaging can reduce the incidence and extent of mechanical injury. The selection of strong, rigid packaging material, e.g. metal, glass, wood and fibreboard can reduce damage due to compression loads. The inclusion of a cushioning material as a component in the package can protect against shocks and vibration. Examples of such cushioning materials are tissue paper, corrugated papers and boards, pulpboard and and foamed plastics.
F. Attack by Biological Agents

1. Microorganisms
One function of package is to prevent microbiological contamination of the contents. In the case of pasteurised products, or foods preserved by drying, freezing, curing this role is vital. The protection of package content from attack by micro organisms depends on mechanical integrity of the package (absence of breaks and seal imperfections) and on the resistance of the package to penetration by micro organisms. Micro organisms, including moulds, yeast and bacteria cannot penetrate the plastic films or metal sheets in the absence of pinholes. The potential for growth of micro organisms, in particular moulds, on package surfaces is greatest when the surfaces are subjected to very high humidity. Under tropical conditions this danger becomes very significant and may require the treatment of package surfaces with anti-microbial agents.

2. Insect Infestation
In order to avoid insect infestation one must assure that the package contents are free of viable insect eggs or larvae, and that that the package cannot be penetrated from the outside by adults or larvae. In storage and distribution, external package environment (truck interiors, warehouses, railroad cars) should be insect free. Package is expected to provide a defence against insect penetration: Highly polished and slippery surfaces, free of debris and dust are desirable. Odour barrier combined with cleanliness of surface helps avoid insect attack. Well-formed seals and closures assure protection.

REFERENCES


Packaging Requirements for Fruit and Vegetables, North Carolina State University web page: www2.ncsu.edu/eos/service