Chapter 6

PACKAGING ASPECTS OF FRUITS AND VEGETABLES

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PRODUCT CHARACTERISTICS

Fruits and vegetables are living organisms even after harvesting; they can remain fresh only as long as normal metabolism continues. Metabolism involves absorption of oxygen which breaks down the carbohydrates in the product to water and carbon dioxide. If the availability of oxygen is restricted, the chemical reaction changes and small quantities of alcohol are produced. This results in off-odours and flavours and breakdown of plant cells. This series of events is called anaerobic decay and can spoil fruits or vegetables within a few hours. Fruits and vegetables have very high moisture content, ranging from 75-95%. Their equilibrium relative humidites are as high as 98%. Under any normal atmospheric condition, they will dry rapidly. This causes wilting and shriveling due to loss of rigidity and shrinkage of the cells. Proper packaging can prolong the storage life of fresh fruits and vegetables by preventing moisture loss and thereby wilting. The rate of moisture loss varies with the product and water vapour permeability of the packaging film. The use of small perforations for oxygen permeation has an insignificant effect upon moisture loss. A type of spoilage much prevalent in fruits and vegetables is that caused by microorganisms such as yeasts, molds, and bacteria. These organisms can cause destruction by growing on the exterior of the product or they may invade the interior through a surface bruise or cut and cause internal decay. Therefore careful handling and packaging are very important in preservation of freshness and quality.

Normal ripening of fruits and vegetables causes alterations in colour, texture, odour and flavour. At some point, for each type, ideal ripeness is achieved. Beyond that point, the product becomes overripe and quality deteriorates. The primary goal of fresh produce merchandising is to deliver the product to the consumer at such a point in the ripening scale, that it will achieve perfect ripeness at time of eating. This of course is extremely difficult to do. In practice, the produce is delivered somewhat underripe at the time of purchase and the consumer delays consumption until ripening is completed. Since all these processes are highly sensitive to temperature, they can be slowed down by storing the produce under refrigeration. Each fruit or vegetable has an ideal temperature for storage. If this temperature is not used, deleterious result occurs—for example, tomatoes will not ripen if chilled below 4°C, bananas will turn black below 11°C and potatoes develop a sweet flavour below 4°C. An additional reason for the necessity of refrigeration for fresh produce is the heat generated due to metabolism or respiration. For example, green beans, sweet corn, broccoli, green peas, spinach, and strawberries generate from 15,000 to 50,000 Btu of energy per ton per 24 hours of storage at 15°C. Even when chilled to 0^0 - 4^0C, they still evolve 2,500-17,000 Btu per ton per 24 hours. This heat must be taken into consideration in the design of refrigeration equipment. Some types of fresh produce give off volatile compounds during ripening which will impart unacceptable odour and flavour if not allowed to escape, or they may prematurely ripen the fruit.

PACKAGING REQUIREMENTS

For the most part, packaging cannot delay or prevent fresh fruits and vegetables from spoilage. Incorrect packaging can accelerate spoilage. However, packaging can serve to protect against contamination, damage and, most importantly, against excess moisture loss. Too much of a moisture barrier will cause an excessively high relative humidity in the package and result in accelerated spoilage due to micro-organisms or in skin splitting on some fruits.

PACKING HOUSE OPERATIONS

The packaging line begins with unloading of harvested produce. Bulk bins of 200-500 kg capacity are used for big packaging houses but in India, reusable plastic crates are used. Freshly harvested produce is stacked up for interim storage. Interim storage may serve several purposes, depending on the type of produce. Latest damage, sustained during harvesting, will appear as visual defects several hours later and can be detected. Storing field-warm produce for few hours in a cool place, such as cold storage corridors, whereby produce temperature is reduced by several degrees before processing will help reducing subsequent spoilage and damage in the packaging line.

The most important process in fresh produce is respiration, a biochemical oxidation of all living cells. Respiration rate is proportional to temperature, approximately doubling every 10°C. Due to high respiration, heat build up will be more, which in turn increases the temperature and respiration of produce. This reduces shelf-life of the produce. The heat produced may be calculated by

1 mg CO_2 / kg hr. = 61.2 k.cal / ton. day = 220 BTU / ton.day.

The term, precooling, refers to several practices whereby the temperature of the freshly harvested produce is quickly lowered to shorten the period of initial high respiration rate as well as to reduce the loads on the long-term cold storage facilities. Success of efficient precooling depends upon fast removal of field heat from all fruits, preferably within 2 to 3 hours. Regular cold storage room with about 150 air changes per hour gives best result, but with danger of excess moisture loss. Hydrocooling consist of drenching field-warm produce with a stream of cold water taking care of chilling injury caused especially to leafy vegetables. There are three types of hydrocoolers: immersion, flooding and spraying. Another precooling method is vacuum cooling. This system uses hermetically sealed vacuum chambers whereby the pressure is reduced until the vaporising temperature of water is achieved, which removes moisture uniformly from all tissues, not just from the surfaces.

The produce is subjected to a cleaning process, which begins with soaking tank, where dirt clods and pesticide residues are softened and diluted by warm or cold solution of water detergents and disinfectants. The fruit is thoroughly washed by piece of cloth or soft brushes with water spray. The produce is then treated with fungicide treatment, if any. Before processing further, produce is dried by air streams from overhead fans.

In the next stage, the undersized produce called as culls is eliminated, which can be sent for converting, called as presizer stage. The grading process follows next to segregate the produce into quality groups, such as ripe fruits which must be marketed immediately, grade A,B,C, export grade or culls. Before or after grading, high quality fresh produce processing may include waxing operation, especially when long shelf-life is desired. Most produce has a natural wax layer on its rind or skin which protects it from excessive moisture loss while allowing free metabolic gas exchange. This wax is largely removed by the cleaning operation. By applying an artificial wax, the keeping quality of produce is restored or even improved, by including chemical additives to inhibit spoilage or to add gloss to colour for sales appeal.

Sizing is an additional sorting operation whereby sorting is done according to size. Now uniformly sized and graded produce is ready to be packaged. Depending upon produce type and grade, distance to markets, cost and availability of packaging materials, the produce may be packed in a large variety of shipping containers.

The packaging operation usually includes setting up of container, before quantitizing of produce, filling and container closure. Quantitizing may be by count or by weight or a combination of the two. Accurate sizing provides proportional link between count and weight whereby only ‘check-weighing’ is required after filling by count. Container fill may be random or pattern packed. Pattern packing increases protection to produce by minimising contact pressure by increasing number of contact points to a maximum of 12 and maximises volume utilisation. Sometimes, the produce is pre-packed in packaging house in consumer packs, mostly different types of plastic bags or overwrapped trays. The final packaging operation is container closing which may be performed by gluing, stapling and strapping. Unitization and palletization may be done according to the container requirement and market need.

SPECIFIC APPLICATIONS

The particular type of package used depends upon the shape and perishability of the product. There are five main classifications—soft fruit, hard fruit; stem products; root vegetables; and green vegetables.

Soft fruits are highly perishable and easily subject to anaerobic spoilage. They bruise and crush easily which leads to rotting. They are packaged in semi-rigid containers with a cover of cellophane, cellulose acetate, polystyrene or other suitable film cover. Sometimes, polyethylene bags with ventilation holes are used. Adequate ventilation is a must to avoid fogging. Handling must be gentle and avoided as much as possible. Shelf-life is limited due to individual damage and decay. Some berries under ideal conditions only retain top quality for 2 or 3 days. Typical soft fruits are cherries, grapes, blueberries, strawberries, raspberries and plums.

Fig. 6.1. Transparent trays

Hard fruits are better able to resist damage from handling. They are also less perishable and have lower respiratory rates. Shelf-life is weeks rather than days. The most common package is an open tray, a plastic film overwrap or sleeve. Hard fruits may also be bagged in perforated polyethylene film or in nets. Examples of hard fruits are apples, bananas, citrus fruits, peaches, pears and tomatoes.

Stem products are highly perishable as they rapidly lose moisture. They should be bagged or wrapped in moisture proof cellophane or polyethylene with ventilation, or they should be banded or sleeved with shrink film. Typical stem products are celery, rhubarb, and asparagus.

Root vegetables are not highly peri-shable. They can be stored for long periods; however,

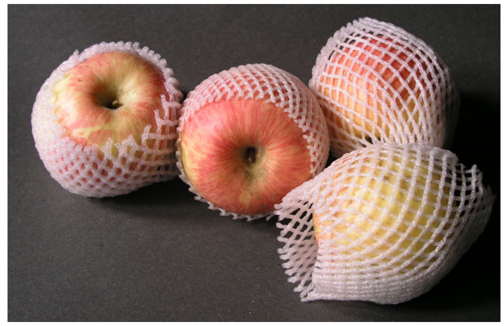

Fig. 6.2. Apple with individual cushioning of expanded PS net

it is desirable to protect them against moisture losses. They are washed, graded and sized prior to packaging, which is usually in durable polyethylene bags with perforations. Typical root vegetables include carrots, turnips, radishes, onions, beets, yams and potatoes.

Types of packaging: Packaging can be classified in a number of ways; the most important one is by stages of distribution system for which it is primarily intended.

- Consumer or unit packaging,
- Transport packaging;
- Unit load packaging.

Fig. 6.3. Root vegetables in pouch

CONSUMER PACKAGING

The package in which consumer receives the produce is called consumer packaging. The term prepackaging of produce refers to consumer units prior to its presentation to the final consumer. Prepackaging may be undertaken at any stage throughout the distribution chain from the field to the retailer's premises, depending upon the need of produce for protection, expected transport and storage time, required shelf-life, packaging material costs and costs of packaging and sorting at different points, transport and storage cost and latest knowledge of the market requirements.

Types of Consumer Package

Bags

Fig. 6.4. Frozen fresh peas in bags

Fig. 6.5. Grapes in ventilated pouch

Fig. 6.6. Net bags; perforated bags

Bags are the most common and favoured retail packs because of their low material and packaging cost. In terms of cost to strength ratio, 25-40 mm low density polyethylene or 12.5 mm high density polyethylene bags are most suited. Net bags are used to provide desired ventilation and allow free air movement for the produce such as citrus fruits, onions, potatoes, etc. The bags can be made of paper, perforated polyethylene or polypropylene film, plastic or cotton nets.

Tray

Tray packs made of foamed polystyrene or PVC or PP are overwapped with heat shrinkable or stretch films. A tight wrap immobilizes the fruits and keeps them apart. Trays of moulded pulp, card board, thermoformed plastic or expanded polystyrene are also used.

Carton with transparent window

Tray with stretch wrap

Tray with shrink wrap

Fig. 6.7. Trays and cartons

Sleeve Packs

These combine the low cost of bags and protective qualities and sales appeal of tray packs. Wraps of plastic film such as polyethylene or PVC, in the form of shrink-wrap, stretch film or cling film and regular net stocking or expanded plastic netting can also be used. The traditional fruits and vegetable retail trader packs the produce in the presence of consumers in the qualities and quantities required by them. The package normally used is a simple wrap of paper or a paper or polyethylene bag. Sleeve packs can be fabricated to contain from one to as many as ten fruits. The main advantage in sleeve packs is that they immobilize the produce at a fraction of cost of tray packs and the produce can be seen from all sides without damage to the fruit.

TRANSPORT PACKAGING

Transport packaging for fresh produce may be divided into two size groups:

i) The predominant size group, suitable for carrying by man, is in the range of 15 to 25 kg.

ii) The other group, recently becoming increasingly popular in 200-500 kg range suitable for fork lift handling is referred as pallet container.

Wooden Boxes

Includes natural wood and industrially manufactured wood-based sheet materials. Timber used must be inexpensive and easily worked. All wood that is used for the production of the packaging should be well dried in order to prevent cracks and mould growth later. Manufactured wood based sheet materials include ply wood, hard board and particle board. Plywood is usually made from birch. It is rigid and strong, though perhaps somewhat less resistant to splintering than poplar, but is smoother and flatter to be suitable for direct printing. Hard board is dark in colour but its appearance can be improved with decorative printing, but deforms after long storage in high relative humidity. Particle board is thicker and rigid but relatively brittle.

Corrugated Fibreboard Boxes

Corrugated fibreboard (CFB) boxes are the most commonly used shipping containers where cartons, glass, cans and pouches are the unit containers. The popularity of CFB box as a container in food industry as well as in other industrial packaging is for the following reasons:

1. Low cost to strength and weight ratio.
2. Smooth and non-abrasive surface.
3. Good cushioning characteristics.
4. Excellent printability.
5. Easy to set up and collapsible for storage,
6. Reusable and recyclable market.

Fig. 6.8. Corrugated fibreboard boxes

Plastic Corrugated Boxes

The most commonly used material for plastic corrugated box is polypropylene and HDPE. Its advantage over CFB is low weight to strength ratio and its reusability. The printability is also excellent when compared to CFB boxes. But CFB box has an edge over plastic fibreboard boxes when cushioning properties are taken into consideration. The disadvantages are ultraviolet degradation and temperature resistant, which can be taken care by use of additives.

Plastic Crates

Plastic crates, usually made up of HDPE or polypropylene by injection moulding have been replacing wooden and wire crates. These crates must have good resistant properties to ultraviolet degradation and shock damages.

Fig. 6.9. Plastic crates

Sacks

These are flexible shipping containers which are generally used in food industries to transport raw materials viz. fruits and vegetables from the field. If the weight of content is more than 10 kg then it is called sack otherwise bag. The commonly used materials for sacks are cotton, jute, flan, woven plastics (HDPE, Polypropylene). These sacks are advantageous to use as they cost less, have high strength, reusable and require little space for the empties. Disadvantage of plastic woven sack is poor stackability due to low coefficient of friction, whcih can be overcome by making anti-slip bags.

Palletization

Pallets have been standardised keeping in view of the standard package sizes and sea containers. The sizes of the pallets are of strategic importance since they correspond directly to the sizes of various types of containers, ship cargo compartments, trucks, fork trucks, etc. Most commonly used pallet sizes are 120x80 cm (Euro pallet) and 120x100 cm (Sea pallet). Sea pallets are most commonly used outside Europe. Reusable plastic pallets are in use. They are made up of HDPE or polypropylene. They are easy to clean and light in weight as compared to wooden pallets.

Palletized loads are used in order to reduce handling costs by allowing substitution of mechanical handling for manual methods with the following advantages:

- A decrease in sorting operations.
- Reduced labelling requirement.
- Better utilization of storage space.

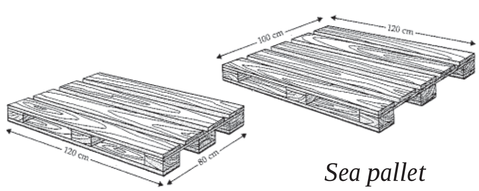

Fig. 6.10. Pallet types

- A reduction in mechanical strains and damages.
- A reduction in total distribution time.
- Better maintenance of product quality.

Two principles are used in the assembly of pallet loads.

1. The modular principle, in which all packages are oriented in the same direction.
2. The two-way principle, in which the packages in each tier form a pattern such that some packages are oriented lengthwise and others cross-wise on the pallet.

Unitization

Corner posts made of plastic or wood or moulded paper boards are generally used as columns for unitization. The boxes are held together by means of strapping or stretch wrapping around the boxes as shown in Fig. 10. The strapping is of polypropylene.

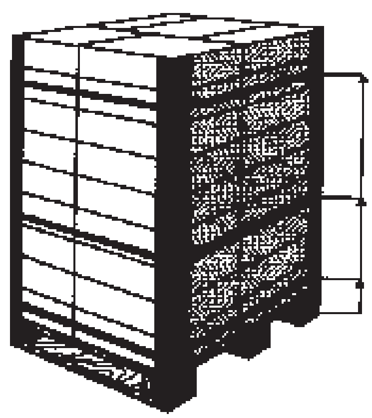

Fig.6.11. Unitization of pallets using corner posts and straps

NEW TRENDS

Several new technologies offer the packer opportunities to modify the atmosphere inside the shipping package during distribution even though such control traditionally finishes with the sealing of the package.

Packaging is termed as “active” when it performs some desired role other than to provide an inert barrier to the external environment. The goal of developing such packaging is the achievement of a more ideal match of the properties of the package to the requirements of the food. Hence, it addresses one or more specific needs of the food without necessarily having any impact on other food properties.

SOME TECHNOLOGICAL INNOVATIONS

Most applications of active packaging involve the use of polymers. The role played by the polymer may be that of a conventional packaging material as in the fabrication of sachets that are used commercially to scavenge oxygen or carbon dioxide, or to release ethanol or carbon dioxide. When the active agent is dispersed in a packaging film or sheet, as in OXYGUARD™ thermoformed trays (Toyo Seikan Kaisha, Japan), the polymer acts as a somewhat permeable carrier. The polymer can play an even more active role when it interacts physically or chemically with the components of the headspace of the package. Such interactions include absorption as in the case of humidity buffering linings for produce cartons, or reactions as in the case of oxygen scavenging plastics.

Permeability Regulation via Thermally Sensitive Packaging Materials

A significant development is that of side-chain-crystallizable (SCC) polymers with the ability to effectively and reversibly melt as the temperature increases and thus foster increased gas transmission through them. SCC polymers are acrylics with side-chains independent of the main chain. By varying the side-chain length, the melting point can be altered. By making the appropriate copolymers, it is possible to produce any melting point from 0 to 68°C., well within the extreme distribution temperature range of minimally processed foods. When elevated to the switch temperature, SCC polymers become molten fluids which are inherently high in gas permeability. The permeation properties may be modified by inclusion of other polymers to change the carbon dioxide to oxygen permeability ratios. The resulting materials can permit the packaging technologist to achieve the lowest oxygen concentration without going anaerobic within the package. Thus, optimum gas concentration may be employed with minimum concern for elevated distribution temperatures. In addition to the reversible temperature sensitivities, the materials are generally capable of 100 times greater oxygen permeability than mainstream polyethylene films without compromising the carbon dioxide to oxygen permeability ratio. This is accomplished by coating a porous substrate with a proprietary SCC polymer and applying the membrane as a package label over an aperture on an otherwise reasonably well sealed package. These SCC materials are manufactured by Landec Corp., Menlo Park, California.

Ethylene Scavengers

Ethylene (C_2H_4) acts as a plant hormone that has different physiological effects on fresh fruit and vegetables. It accelerates respiration, leading to maturity and senescence, and also softening and ripening of many kinds of fruits. Furthermore, ethylene accumulation can cause yellowing of green vegetables and may be responsible for a number of specific postharvest disorders in fresh fruits and vegetables. Although some effects of ethylene are positive such as degreening of citrus fruit, ethylene is often detrimental to the quality and shelf life of fruits and vegetables. To prolong shelf life and maintain an acceptable visual and organoleptic quality, accumulation of ethylene in the packaging should be avoided. Most of these ethylene absorbers are supplied as sachets or integrated into films. Potassium permanganate ($KMnO_4$), which oxidizes ethylene to acetate and ethanol and in this process, colour changes from purple to brown indicating the remaining C_2H_4 scavenging capacity. Products based on $KMnO_4$ cannot be integrated into food-contact materials, but are only supplied in the form of sachets because $KMnO_4$ is toxic and has a purple colour. Rengo Co. (Japan) developed 'Green Pack', a sachet of $KMnO_4$ embedded in silica. The silica adsorbs the ethylene and the permanganate oxidizes it to acetate and ethanol.

Another type of C_2H_4 scavenging concept is based on the adsorption and subsequent breakdown of ethylene on activated carbon. Charcoal containing PdCl as a metal catalyst was effective at 20^0C in preventing the accumulation of ethylene, in reducing the rate of softening in mini-mally processed kiwifruits and bananas and in reducing chlorophyll loss in spinach leaves but not in broccoli. Other C_2H_4 adsorbing technologies are based on inclusion of finely dispersed minerals such as zeolites, clays and Japanese oya into packaging films. Most of these packaging films, however, are opaque and not capable of adsorbing C_2H_4 sufficiently. Although the incorporated minerals may adsorb ethylene, they also alter the permeability of the films: C_2H_4 and CO_2 will diffuse much more rapidly and O_2 will enter more readily than through pure PE. These effects can improve shelf life and reduce headspace C_2H_4 concentrations independently of any C_2H_4 adsorption. In fact, any powdered material can be used to reach such effects.

Furthermore, the adsorbing capacity is often lost when incorporating these minerals into a polymer matrix. Commer-cially available examples of these mineral containing materials are the Orega plastic film (Cho Yang Heung San Co., Korea), Evert-Fresh (Evert-Fresh Co., USA), Peak-fresh TM (Peakfresh Products, Australia), BO film (Odja Shoji Co., Japan) and Profresh™ (Europe). C_2H_4 scavengers are not yet very successful, probably because of insufficient adsorbing capacity. A large proportion of the fresh fruits and vegetables harvested each year are lost due to fungal contamination and physiological damage. The C_2H_4 adsorbing packaging concepts could possibly contribute to an increase in the internal trade as well as export of fresh produce.

CO_2 Scavengers

CO_2 is formed in some foods due to deterioration and respiration reactions. The CO_2 produced has to be removed from the package to avoid food deterioration and / or package destruction. CO_2 absorbers might therefore be useful. The active compound $Ca(OH)_2$ of FreshLock® reacts at sufficiently high humidity with the CO_2 to produce $CaCO_3$. Multiform Desiccants have patented (US 5322701) a CO_2 absorbent sachet including a porous envelope containing CaO and a hydrating agent such as silica gel on which water is adsorbed.

Humidity Regulators

This approach allows the food packer to reduce the surface concentration of water in a food by reducing the in-pack relative humidity. This can be done by placing one or more humectants between two layers of a plastic film which is highly permeable to water vapour. An example of this type of product is "Pitchit" manufactured by Showa Denko in Japan. The film duplex is described as containing an alcohol, as propylene glycol and a carbohydrate, both of which are humectants.

A different approach to humidity buffering is being developed for use in the distribution of horticultural produce which is normally distributed in fibreboard cartons, usually with a polyethylene liner or made from very expensive waxed fibreboard without a liner. A recent development has been the water-barrier coating of the inside of fibreboard cartons to allow moist produce to be placed directly into the carton. Besides the introduction of liquid water with the produce, packing into closed spaces allows the build-up of water vapour. Since temperature cycling is very difficult to avoid during handling there is every likelihood of condensation and with this the growth of microorganisms on fruits and vegetables.

Two widely different approaches have been used to buffer the humidity in the cartons in order to prevent condensation while not concurrently causing desiccation of the produce. One is to include micro-porous bags or pads of inorganic salts and the other is to line the carton with a protected layer of a solid polymeric humectant.

The main purpose of moisture control is to lower water activity (a_w), thereby reducing the growth of moulds, yeast and spoilage bacteria on foods with high a_w. The shelf life of packaged tomatoes at 20^0C was extended from 5 to 15-17 days with a pouch containing NaCl, mainly by retardation of surface mould growth. Another application is in the removal of melting water from frozen foods. A third reason for moisture control is to prevent condensation when fresh horticultural produce respires. Drip-absorbent sheets such as Thermarite® (Australia), Toppan™ (Japan) or Peaksorb® (Peakfresh Products, Australia) for liquid water control in high a_w foods such as meat, fish, poultry, fruits and vegetables, basically consist of a super absorbent polymer in between two layers. The preferred polymers for absorbing water are polyacrylate salts and graft copolymers of starch.

Oxygen Scavenging

Oxygen is such a broadly effective agent of deterioration in foods that a substantial industry has been established to provide a wide range of alternative means of oxygen removal from package headspace to reduce chemical deterioration.

Technologies for thin films typically used in MAP systems need an additional feature to prevent premature reaction, if they are to provide maximum scavenging capacity. The transition-metal-catalyzed (optionally light-activated) process patented by W.R. Grace, Inc. approaches this by pre-planned activation involving generation of full capacity by consumption of antioxidants. This type of film, involving side-chain oxidation of a polydiene, appears to be designed as a permeation barrier for chilled, short shelf life processed meats. Amoco Chemicals have reported some performance data for their Amosorb®, water-activated masterbatch for blending into a variety of plastics.

Examples of light-activated scavengers, incorporated in the packaging film, are $Zero_2$™ developed by CSIRO and marketed by Southcorp Packaging (Australia) and OS1000 developed by Cryovac Sealed Air.

Oxygen scavengers can be used alone or in combination with MAP. Their use alone eliminates the need for MAP machinery and can increase packaging speeds. However, it is usually more common in commercial applications to remove most of the atmospheric O_2 by MAP and then use a relatively small and inexpensive scavenger to remove the residual O_2 within the food package. For an O_2 absorber to be effective, the packaging material needs to have an O_2 barrier of intermediate performance (20 ml / m^2.d.atm), otherwise the scavenger will rapidly become saturated and lose its ability to trap O_2.

Antimicrobial Packaging

Substantial recent research has been directed at determining how the surfaces of plastics can be made not only sterile but also capable of having an antimicrobial effect on the packaged food or beverage. This type of effect has already been achieved in outer layers of laminates by use of modified printing presses.

Release of antimicrobial agents will be restricted by regulatory approval as intended food additives. The concept has been advanced in the case of an edible coating. An alternative approach which has been developed in Japan by Mitsubishi is based on the inclusion of zeolite particles on the surface of the food-contact layer in laminates. The zeolite has some of its surface atoms replaced by silver which appears to release silver ions as aqueous solution from the food enters the exposed cavities of the porous zeolite structure. The water then appears to leach traces of silver from the particles giving the highly efficient antimicrobial activity of this ion. The use of edible coatings to apply relatively constant concentrations of permitted antimicrobial agents at the food surface has been developed. The relative rates of diffusion within the coating and within the food itself are very important. Such a process could be important where antimicrobials, such as sorbate, are lost by degradation. Application of antimicrobial via edible coatings is likely to gain importance with minimally processed foods distributed under MAP conditions.

To control undesirable microorganisms on foods, antimicrobial substances can be incorporated in or coated onto food packaging materials. The principle action of antimicrobial films is based on the release of antimicrobial entities, some of which could pose a safety risk to consumers if the release is not tightly controlled by some mechanisms within the packaging material. The major potential food applications for antimicrobial films include meat, fish, poultry, bread, cheese, fruits and vegetables.

Several other compounds have been proposed and / or tested for antimicrobial activity in food packaging including organic acids such as sorbate, propionate and benzoate or their respective acid anhydrides, bacteriocins e.g. nisin and pediocin, enzymes such as lysozyme, metals and fungicides such as benomyl and imazalil. A film contains a natural antimicrobial compound derived from grape-fruit seed. Many of the incorporated antimicrobials are not yet permitted for food use. The choice of the antimicrobial is often limited by the incompatibility of the component with the packaging material or by the heat unstability of the component during extrusion. Two commercial biocidal films are currently marketed. One is composed of a chlorinated phenoxy compound and the other consists of chlorine dioxide. A commercial antifungal coating containing chitosan is also sold as a shelf-life extender for fresh fruit.

CSIRO (Australia) is developing systems which gradually release SO_2 to control mould growth in some fruits. However, excessive release of SO_2 from pads of sodium metabisulphite incorporated microporous material has been shown to cause partial bleaching problems in grapes. The accumulation or absorption of the excess SO_2 by foods could cause toxicological problems. Knowledge about the diffusion rate of SO_2 into the food is essential to address toxicological issues and ensure safety in SO_2 releasing active packaging systems. In contrast to conventional antimicrobial films, some functional groups that have anti-microbial activity have been immobilized on the surface of polymer films.

CONCLUSION

In recent days, entrepreneurs in India are showing greater interest in internal marketing as well as export of fresh produce. The trade is attractive but is not an easy enterprise; a high degree of organisation and professionalism is necessary to export fresh produce successfully, especially to the sophisticated markets of Europe. It can make good use of indigenous horticultural skills. The combined requirements of fresh produce and of its transport environment often impose unusually severe conditions on the packaging employed. As a result, higher package quantity is usually needed for fresh fruits and vegetables when compared to manufactured goods of the same weight. For designing of a package for a specific product and particular target market, a clear picture of distribution system should be drawn up, as hazards involved in transportation are different for different modes (i.e., packaging requirements for ship transportation are totally different than that by air transportation). Models may be used depending upon the characteristics of the produce and the market.

Active packaging is an emerging and exciting area of food preservation technique, which can confer many preservation benefits on a wide range of foods. The aim of active packaging is to match the properties of the package to the more critical requirements of the food. Adoption of some of these methods will require changes in attitude to packaging and a willingness to address regulatory issues where chemical effects are used. Application of these and other emerging technologies offers the prospect of greater satisfaction in India as these are relatively new concepts that maximise the benefits from some of our traditional agricultural industries.

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