SOME RECENT DEVELOPMENTS IN FOOD PACKAGING

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The paper deals with various types of recently developed food packaging materials specially suitable for dehydrated food-stuffs. Though mettalic cans continue to enjoy important place in packaging industry, laminated flexible pouches of desired machanical strength and durability have also been found to be equally suitable with less weight and cost.

Packaging of food is a means of protecting it from deterioration by providing an adequate covering to the product so that it reaches the ultimate consumer in proper condition. Every food product requires packaging [1,2] to protect it from physical damage, chemical change and microbial contamination. Though suitability of a packaging [3-5] material for a particular food-stuff is the first consideration in selecting a good packaging material, its size and shape is very often determined on the basis of economy, convenience and consumer's appeal. The physical nature of food *i.e.*, solid, liquid or paste is also of primary importance in selecting a packaging material.

Food products are mainly spoiled by two factors *viz.* changes in moisture content and oxidation. In order to arrive at a suitable packaging material [5,6,7], the most important factors that merit considerations are (*i*) Properties of food to be packed (*ii*) Anticipated shelf life (*iii*) Condition under which food will be transported (destination and mode of transport) (*iv*) Quantity of food to be packed in each unit and (*v*) Packaging material available. Besides these, other characteristics [8,9] such as mechanical properties (tensile strength, tearing strength and folding endurance), physico-chemical properties (water absorption, vapour permeability, resistance to greases and oils) and permanency properties (resistance to temperature variations, sunlight and storage) of a packaging material must be determined while selecting a good pack.

PACKAGING MATERIALS

Metal cans

Among a wide variety of available packaging materials, tin cans [10] have since long been used as standard containers for heat sterilised preserved food-stuffs. Two other metals used for food containers are aluminium and untinned steel sheet. Although aluminium is light and colourless, it has low rigidity and lacks resistance to corrosion [11]. Metal cans are moisture proof, resistant to physical damage, impermeable to gases and vapours but they are relatively heavy from the military point of view and corrosion as well as metallic contamination of their contents is also possible [6, 10, 12]. However, the addition of 400–600 ppm of sodium nitrite to process water was found to be advantageous and inexpensive in retarding the formation of rust [13].

Although packaging of foodstuff in paper containers is an old method, a mould proof paper containing solublished copper—8—quinolate is currently being marketed for many possible applications in food industry [14]. Some of the recently developed packaging materials particularly those which could be conveniently used for dehydrated foods are enumerated below:

Aluminium foil

Aluminium foil[6, 15, 16] is very much in common use due to its very low permeability to gases, moisture and odour etc. It is not toxic and can be used in direct contact with many types of food. It gets heated and cooled quickly and is unaffected by light. Foil alone, however, cannot be sealed efficiently but in combination with paper and/or plastics it satisfies nearly all the conditions of a good barrier. The more common laminating media are adhesive, waxes and resins. These laminates are light in weight and when double seamed can store freeze dried meat for seven months without any deterioration[12]. Having combined resistance to oxygen and moisture, foil is a very successful packaging material[17] for dehydrated foods and can also withstand rough handling during transportation. It does not shrink, swell or soften in contact with moist contents and is non-absorptive to all types of liquids. It is dimensionally stable and its flexibility is not altered on aging[8]. Colour sensitive foods packed in 4 mil. polythene, 6 mil. polypropylene and 2 mil. polyester phthalate showed objectionable discoloration when stored for three weeks at room temperature but when laminates including aluminium foil were used, there was no objectionable discoloration after six months[18, 19].

Flexible packs

Laminates are formed by combining two or more packaging materials into a single sheet. Aluminium foil may be laminated to any other film or transparent films be laminated to one another or other opaque materials. In recent years considerable progress in the development of flexible packs[5, 6] as barrier against water vapours, oxygen and greases has been made but, apart from a metal foil free from pin hole, not a single flexible material has been found completely vapour proof. However, papers coated with plastics of various kinds such as polythene, polyvinilidine chloride, polyvinyl derivatives, cellulose acetate and cellulose nitrate etc. are used as water vapour and gas barriers. The passage of oxygen and moisture into flexible packages are through the main body of the sheets, their folds and creases and through the closures. The efficiency of closing is a very important factor in controlling the ingress and egress of moisture. If the sealing is not done properly, the use of a good packaging material will not be of any benefit. The closing of creases in packages is also an important factor and recent studies have established that the uncreased flexible packages have lower water vapour permeabilities as compared to the creased ones. Laminates[20] such as cellophane/aluminium foil/polythene, polythene/saran/cellophane and mylar/saran/polythene are being extensively used for packing cooked meat. Various combinations of polyester films, cellulose film, nylon, p.v.c. and aluminium foil may be used for packing frozen foods. Confectionary can be packed in moisture proof cellulose film and Melinex, while for fruits and vegetables a nitro cellulose film can be successfully used.

Cellophane

The original cellophane[8] was a transparent regenerated film which lacked moisture proofness and heat sealability. Later on it was developed into a heat sealable, water proof and odourless film. It is available in four different forms viz. plain or non-moisture proof cellophane, intermediate moisture proof cellophane, moisture proof non-heat sealing films and moisture proof heat sealing films. The moisture proof heat sealing cellophane is mostly used[20] for fresh meat by coating one side with nitro-cellulose or its polymer. Cellophane coated on one side with polythene (·0005 inch thick) has the best colour characteristics. 'Crystophane' which has been chiefly used by the biscuit manufactures[21] is equally suitable for bakery products, meat or fish.

Plastics

Since World War II considerable development has been made in the synthesis of plastic films. All plastic films[8] are made from synthetic resins or synthetic or natural

polymers. These are all sealable by heat and pressure. Examples of such films[6] are melamines formaldehyde, phenol-formaldehyde, cellulose acetate, cellulose nitrate, ethylcellulose and rubber hydrochloride. Weak acids and weak alkalies have very little effect on these films but they are decomposed by strong acids and strong alkalies.

Cellulose acetate

It is obtained by reacting cellulose with acetic anhydride[6, 8]. These films are stable durable and are generally combined with papers or foils. They are highly permeable to moisture and are thus suitable only for products with high moisture content. A hot-melt transparent coating consisting of 60–70% acetylated monoglycerides and 30–40% cellulose acetate butyrates[22] has proved to be very effective in protecting food from dehydration, freeze burn, discolouration, rancidity, microbial contamination and ordinary handling.

Polythene

The use of polythene as a packaging material is very common now-a-days. It is moisture proof, tough, durable and has low water vapour transmission rate but high transmission rate to other gases. Polythene is most suitable for packaging frozen foods as it is flexible even at low temperature. It has been seen that among the film materials[23], coated polythene gave the best red colour preservation of the vacuum packaged beef samples although cans with small headspace had better red colour than those in any film type package.

Rubber hydrochloride (Plio-films)

It is made by treating crude rubber with hydrogen chloride gas. The material is tough and can be easily stretched if warmed. It is mostly used for wrapping purposes. It is also used as inner liner or laminate with paper or foil bags for moisture products[6]. Plio-film was tested along with cellophane, cellulose acetate, cryovac and polythene films to learn whether E. coli and Leuconostoc mesenteriods could pass through them. It was observed that cellulose acetate and polythene films were permeable to those micro-organisms[24].

Vinylidine chloride—Vinylchloride (Saran, Cryovac)

These are excellent films for vacuum and gas packaging as they have low water vapour and gas permeabilities. These films are very strong and flexible and can work up to the temperature of 150°C enabling certain meat products to be cooked in the package directly[8]. A co-polymer of the polyvinylidine chloride and p.v.c. has been used for some years in U.S.A. for food packaging. The mylar/saran/polythene laminates have been used in U.S.A. for packaging cooked meat and sausages and no growth of micro-organism was observed even after a period of 4 months[25].

Mylar

Plastic bags made of mylar polyster are excellent films for vacuum packaging and are extensively used for packing of pre-cooked food stuffs[16]. Mylar[26] is the condensation polymer of ethylene-glycol and terephthalic acid and is produced as an oriented film in sheets of 0·25 mm to 7·5 mm thickness. It has high tensile strength and its tear resistance is also satisfactory. This film performs well in the range of — 62°C to 150°C and does not melt below 250°C. It is non-toxic and odourless and as such it can be used in direct contact with food products. In combination with other materials such as foil, polythene, saran etc., it can be used where extreme gas proofness is required.

Polyester film[27] has low gas and odour permeability and attractive packs can be made with melinex polyster films. Recently a new packaging material called Telestrene has been developed which is an extended polyster foil for vacuum forming into trays and

carton liners. It is available in thickness ranging from 0·01 to 0·07 inch. A laminate[28] of polyster film and aluminium foil makes a bright, strong and opaque pack providing an excellent barrier against moisture. The combination of polyster/aluminium foil/polythene is believed to be practically impervious to all gases and vapours. The laminate polyster film/aluminium foil can be used for packing freeze-dried foods when other side of the aluminium foil is coated with rubber hydrochloride. A new product[29] in sheets known as "Sarolene" has been developed from polypropylene. These sheets are available in thickness ranging from 0·01 to 0·04 inches and are intended for the manufacture of thin wall packages where high softening point and resistance to chemical attack are an advantage.

High and low impact styrenes[30] polyvinylchloride, polypropylene and vinyls are finding promising use as packaging material in Europe. Polyamide 11 film [31] known as Rilsan has been manufactured from castor oil and is transparent, strong flexible and resistant to sunlight with a sparkling appearance. It allows the passage of ultra-violet rays and has proved impermeable to microorganism both before and after sterilisation. Very low gas permeabilities allows this film to be used for vacuum packaging or packaging under inert atmosphere. Minisota Mining and manufacturing Co. U.S.A. [32] has developed a polyster packaging film "Scotchpak" which can be both boiled and frozen. The film can be heat sealed on both sides. Dow Chemical's [33] new polystrene packaging film "Trycile" can be used for packaging many food products. It is known as breathing film and is very stable dimensionally. It has high tensile strength and does not absorb moisture, distort or become brittle. Tests were conducted on the permeability of seven different packaging materials[34] to ethylalcohol vapour at room temperature of 25°—28°C and R.H. 85%. It was found that aluminium foil, saran and saran coated cellophane had lowest permeability and cellophane the highest and mylar intermediate.

The use of acetoglycerides as protective coating[35] has been suggested for processed meat and other foods. Brokaw[36] recommended FDA-cleared acetylated monoglycerides for edible protective coating for fish, poultry, meat, dried fruit, candy cheese and other foods. It was reported by Ayeres [37] that microbial flora was lower on frozen pork chops dipped in "Lepak" food coating than on foil wrapped counterparts. The acceptability of cooked poultry products[38] has also been reported when protected by acetylated monoglycerides coating during storage.

PACKAGING MATERIAL FOR FREEZE DRIED PRODUCTS

Dehydrated products specially freeze-dried are very hygroscopic and must be packed in an oxygen free atmosphere. The container should be air tight and moisture proof. The packaging of dehydrated foods should be carried out in a cool[39], clean, dry, well-ventilated room separate from other parts and every effort should be made to exclude dust and insects. If packing is done in a flexible bag[40, 41] then 80 per cent of the bag's opening should be heat sealed immediately. The bag should then be evacuated and flushed with nitrogen twice. Afterwards it may be sealed finally.

In case of can [1] a hole is pierced in a filled can which then is evacuated in cabinet. When a sufficiently low pressure is reached, inert gas is flushed in until atmospheric pressure is attained. The can is then removed and the hole is sealed by soldering. Although the storage life of dehydrated meat[42] is increased in air tight container in the atmosphere of an inert gas, it has been reported that granular dehydrated meat having 40 per cent fat and 0·5 gm per ml. density remains in good condition for six months in non-air tight container provided the moisture content is not allowed to rise to the point where moulds can grow. Metal cans provide excellent protection from oxygen penetration and from mechanical

damage but they are not readily adopted to automatic packaging of products such as fish or meat steaks[43].

A series of experiments were performed by Anderton[44] on the storage of freeze-dried meat in flexible packs made of kraft/aluminium foil/rubber hydrochloride and mylar/aluminium foil/rubber hydrochloride. It was reported that vacuum retention by mylar laminate was better than the kraft pouches and weight increase per day (as the percentage of original weight of meat) was much lower in case of mylar bags than kraft pouches. The transmission rates were also much lower for mylar bags. Freeze-dried green asparagus[45] were packed under atmosphere of nitrogen in Mylar Saran polythene laminate and aluminium film combination (AFC) pouches and tested for storage stability at 32°, 68° and 98°F. It was observed that samples packed in AFC pouches at 32° and 68°F showed better rehydration properties than those packed in laminate pouches at 68° and 98°F after 11 months of storage. The plastic laminate packs proved inferior because of permeability to moisture and oxygen.

The latest developments in the cekatainer system[43, 46] make provisions for packing accelerated freeze dried (AFD) food stuffs successfully under high vacuum or in the presence of an inert gas. The cekatainer consists of normal glue end carton with a flexible film liner secured by adhesive to the inside walls of the pack. The ends of the liner protrude beyond the ends of the carton so that they can be heat sealed. It is claimed that AFD food can be kept for two years in an inert atmosphere in a cekavac container.

It was reported[47] that freeze dried meat could be stored for six months at 73°F and 100°F in packs of cellucine/aluminium foil/polythene and kraft/aluminium foil/rubber hydrochloride. During the period of storage, acceptability of the meat did not decrease significantly—its moisture remained unchanged and vacuum packs maintained their vacuum. Promising results were obtained when foil/acetate/rubber hydrochloride was used for packing freeze dried cooked beef. In U.S.A. mylar (Melinex)/foil/PVC laminate is used for packaging freeze dried foods[17] for military. Other pouches consisting of aluminium foil such as (*i*) mylar/aluminium foil/rubber hydrochloride (*ii*) mylar/aluminium foil/polythene laminate (*iii*) aluminium foil laminated with polythene and (*iv*) paper/polythene/foil/polythene laminate have also been successfully used for packaging freeze dried foods [44,28].

Packaging of sapce foods

Beatric and John[48] have suggested the pre-dominant use of pre-cooked dehydrated foods as space foods which may be freeze-dried, spray-dried or drum-dried. The combination of polythene, Aclar and Nylon produced a package with strong heat seal capacity which can be successfully used for packing space foods. Taylor *at el*[49], demonstrated the use of collapsible aluminium tooth paste type tubes for packing space foods.

The tubes had a non-toxic food grade organic coating. They were of the opinion that to enable the astronaut to identify the foods readily and see the amount of water added to the foods requiring reconstitution, a transparent packaging was required and after much testing they developed a transparent film laminate that could protect extremely hygroscopic foods against moisture pick up and oxidation.

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