PACKAGING OF SNACK FOOD

Snack food generally do not form a part of the main meal but are items eaten in between meals for pleasure and during relaxation. Snack food are highly subjected to impulse buying and have gained popularity, today, due to:

- growing urban population
- increase in number of nuclear families
- increase in the number of working women
- media penetration leading to attraction for novel food, and
- higher disposable incomes

Snack Food Packs on Sale

Though snack food are categorised and perceived differently from region to region, by manufacturers and consumers, conventionally, snack food embrace a group of savoury, crispy items, which are ready-to-eat and are shelf stable for 2 to 16 weeks at the normal room temperature.

In the last five years, revenue from the Indian savoury snacks market has increased significantly to reach Rs. 6 billion (US $ 123.5 million), more than twice its size previously. However, per capita consumption remains very small, as the un-packaged snacks sector is considerably cheaper. Future growth will depend upon the extent of change in the purchase pattern of consumers i.e. from buying unpacked products to the more Western snack food purchase pattern.

Product Range

Based on the processing method, snack food may be broadly classified as:

Chips, Wafers, Crisps

These include deep fried potato chips, strips, sticks, rings etc. and represent a substantial share of the snack food market. Banana wafers, jack fruit chips, tapioca wafers, which are popular in South India, also fall into this group.

Unbranded Traditional Food Snacks

Extruded Food

These are of two types:

- The traditional items made from flours and spices and extruded in the form of sticks, strips or spirals such as sev, boondi, papdi, gathia, chakli etc. These items traditionally prepared in households are now marketed in pre-packed forms with different flavours and seasonings.
- The non-traditional pre-formed partly cooked pellets derived from potato, starch from cereals and fried at high temperatures for a short time to give expanded light textured products.

This group also includes cereal / potato powder mixes, which are extrusion cooked and enrobed with oil and flavor.

Many of these products are highly flavoured with spices, herbs or cheese. Typical examples are cheese balls, "cheetos", "kurkure" etc. A large number of products are available in this category and display varying sizes, shapes and textures.

High Value Items

These are roasted / fried / salted / flavoured nuts, such as peanuts, cashewnuts, almonds etc.

Product Characteristics and Packaging Requirements

Irrespective of the group under which snack food fall, most of them have low moisture content and high fat content and, therefore, are highly affected by moisture, oxygen and changes in flavour.

In the category of fried snack food, the presence of oil becomes the key factor for spoilage. The oil is spread over large surface areas and exposed to the oxygen in the atmosphere, unsaturated fatty acids in the oil are prone to oxidative rancidity in the presence of air. These reactions are accelerated by heat, moisture and light, as well as the added salt in the product.

The packaging requirements of snack food are:

Branded Traditional Extruded Snack Food in Flexible Plastic

Greaseproofness

The presence of fat indicates that the main requirement of snack food packaging is that it should be greaseproof. This requirement is of significance not only in reducing the rancidity but also to prevent unsightly staining of the package, smudging of the printing and to avoid the actual seepage of the oil and the greasy package feel.

Rancidity

Another requirement due to the high fat content is the prevention of the product coming in contact with the oxygen in the air. A packaging material with low oxygen permeability is desirable to be used, to prevent oxidation and rancidity of fat.

Loss of Crispness

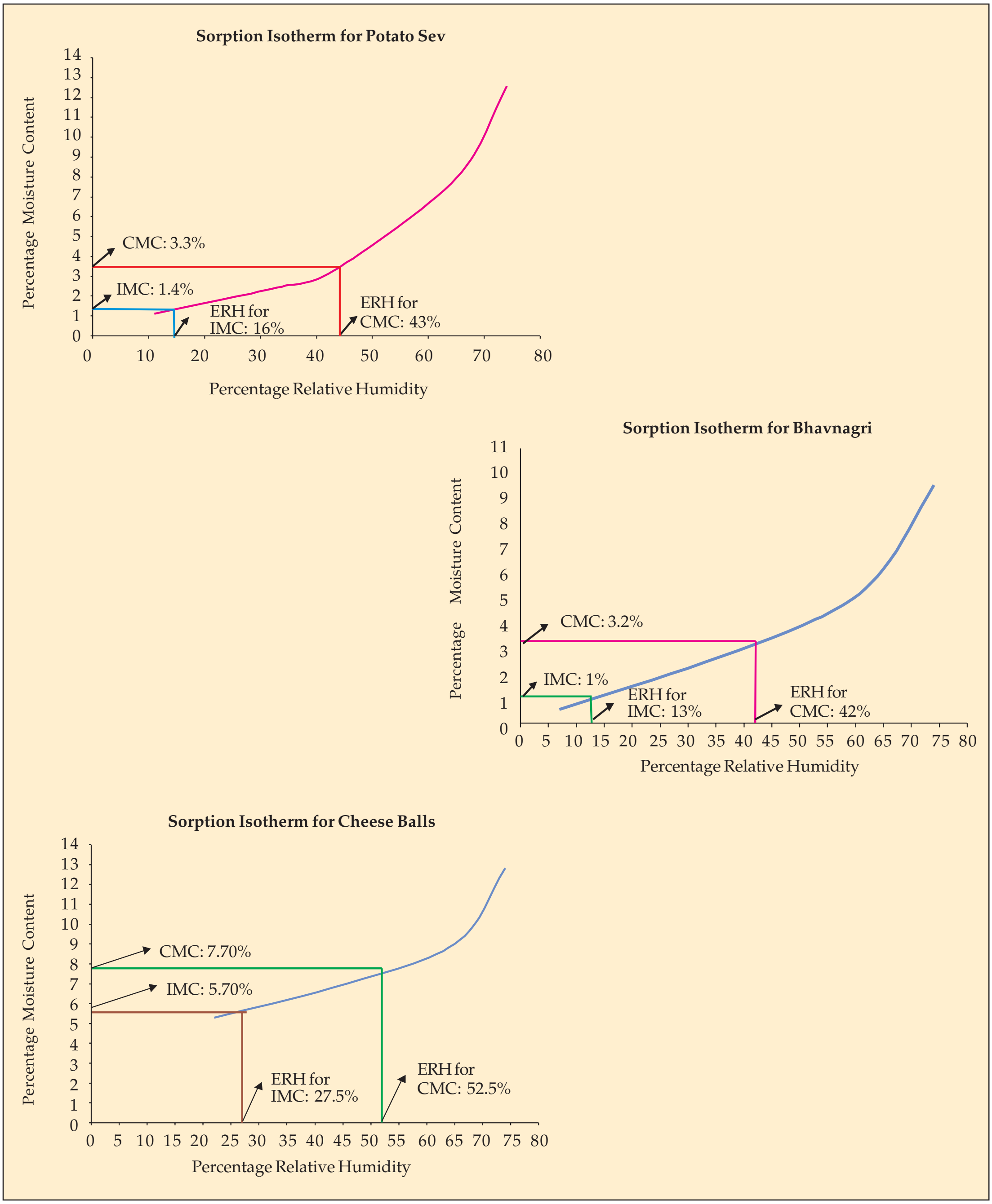
One of the major properties of snacks is the crispness, which is achieved during the manufacture of the product by one of the drying methods such as roasting, baking or frying to reduce the level of moisture content. Retention of desirable texture (crispness) is directly related to the moisture level in the product. The moisture content of snack is very low, and any increase due to the hygroscopic nature of the product may lead to loss of crispness of the product. Moreover, added moisture also accelerates other biochemical changes such as oxidative rancidity. Low water vapour permeability of the package is, therefore, another very critical requirement.

For predicting product shelf-life and package performance in respect of water vapour transfer, the data required are:

- The moisture isotherm data
- The WVTR of the film/laminate
- The storage conditions

The sensitivity of some of the snack food is illustrated graphically (Fig. 1) by the sorption isotherm studies carried out at the Institute. The Equilibrium Relative Humidity (ERH) for these products was determined.

Figure 1: Moisture Sorption Isotherms of Snack Foods



Product	IMC (%)	CMC (%)	ERH (%) at IMC	ERH(%) at CMC
Potato Sev	1.40	3.30	16.00	43.00
Bhavnagri	1.00	3.20	13.00	42.00
Cheese balls	5.70	7.70	27.50	52.50

From the above results it is evident that these snack food are extremely moisture sensitive, and can easily absorb moisture even at low Relative Humidity conditions, and at CMC levels, loss of crispness occurs, rendering the product unacceptable to the consumers.

The Water Vapour Transmission Rates (WVTR) and Oxygen Transmission Rate (OTR) of some of the flexible packaging materials, which were assessed for snack food packaging were determined in the laboratory at the Institute. The values obtained are given Table 1.

TABLE 1

WVTR and OTR for Flexible Packaging Materials for Snack Food

Packaging material	WVTR g / m^2 / 24hrs at 38°C, 90% RH	OTR cc / m^2 / 24 hrs at 24°C, 1 ATM.
LLDPE – Tie – Nylon – Tie – LLDPE (130μ)	0.24	0.55
12μ PET/12μ Al foil/ 80μ LD – HD	0.60	1.65
10μ PET/9μ Al foil/ 80μ LD – HD	0.74	1.90
12μ PET/12μ met. PET/ 80μ LLDPE	5.14	–
12μ PET/155μ LD – HD	2.20	105
12μ met. PET/135μ LD – HD	5.76	116
12μ met. PET/155μ LD – HD	3.60	110
12μ PET/135μ LD – LLD – HD	6.50	>999

Machinability

Some of the snacks have recently moved away from manual filling into preformed bags and are packed on automatic form-fill-seal machines which may run on fairly high speeds. Packaging materials must, therefore, be capable of running continuously and efficiently on these machines.

Physical Strength

Due to the high fat content of the snack food products and the associated problem of rancidity, in some of the packages, where longer shelf-life is the requirement, oxygen inside the package may be replaced by an inert gas like nitrogen. The packaging material must be physically strong to withstand the processes of vacuumising/gas flushing. The question of stiffness of the material is also debatable. It is desirable that the package should be able to stand up on the shelf, however, high stiffness leads to problems of machinability.

Printability

The packaging material should provide a good printing surface. Attractive printing is the order of the day as a number of brands of similar snack food have to compete in the market.

Seal Integrity

To ensure protection against environmental conditions and to provide a long shelf-life, the seal integrity of the pack must be good enough to prevent leakage and/or prevent entry of the air or moisture through the seal areas.

The above requirements for snack food packaging are met by plastics to a large extent in various forms such as flexible pouches of films and laminates, plastic containers and trays and as a component in the composite packs.

Packaging Materials for Snack Food

Flexible Plastics

The overwhelming majority of snacks today are in flexible bags. For snack food in the Indian market, a range of flexible materials are used depending on the product and the market segment.

Low value, typically traditional snack food and wafers may be branded or non-branded. Non – branded snacks are packed for shorter shelf-life in unprinted low density polyethylene (LDPE) and polypropylene (PP) pouches. For branded snacks and nuts laminated structures are used.

Some of the typical structures are:

- BOPP / LDPE
- BOPP / Polyester / LDPE
- Metallised Polyester / LDPE
- BOPP / Metallised Polyester / LDPE
- Polyester / LDPE
- Polyester / Al foil / LDPE

(The sealant layer could also be LLDPE or cast PP)

In the European and American markets, the typical structures used for packaging of crisps and similar snack food are:

- PVDC coated glassine
- PVDC coated glassine / OPP
- Sulfite paper / OPP

Branded Snack Food in Flexible Plastic Pouches

- Co – extruded HDPE
- Oriented Polypropylene Films (uncoated, coated, co – extruded)
- LDPE / EVA films
- HDPE / EVA ionomer seal layer
- OPP / PE / PVDC coated OPP
- OPP / PE / metallised heat sealable OPP
- PVDC coated PET
- OPP / PVDC / OPP lamination

Biaxially oriented films are most widely used for snack food in Europe. OPP has qualities of toughness (against puncture and abrasion) and clarity and is rendered heat sealable by co-extrusion with polyolefin copolymers or by coatings like PVDC.

Composite Containers

Composite containers are used for packaging of moulded chips and nuts. The containers are round and the body (side walls) is made of PE coated foil laminated spirally wound paper. The top and bottom ends of the containers may be made from metal or plastic. The bottom may also be made from PE coated foil laminated paper. An aluminium pull-tab top and re-closable plastic lid on the container form a complete pack.

Potato Chips in Composite Containers

A new process has recently been developed for composite packs, wherein the main body comprises of a composite material consisting of a light-weight high impact core of expanded polystyrene in the thickness range of 0.6 to 1.2mm. Externally the core is coated with a plastic film. The inner face is coated with a plastic film or a combination of film and aluminium foil, the function of these materials is to ensure optimum barrier properties against moisture, oxygen etc. A wide choice of films such as Polyester, PVDC or EVOH is available. The base, the lid and the snap-on re-closable caps are generally moulded from High Impact Polystyrene (HIPS) coated with polyester or other films to enhance the barrier properties. The base is solid moulding, whereas the lid incorporates a membrane which when pierced gives access to the product.

Roasted Nuts in Tinplate Container

Tinplate Containers

Rigid, round tinplate containers, which are internally lacquered are used for roasted salted nuts that are packed with an inert gas like nitrogen for extended shelf-life. The containers are provided with ring pull type, easy open tops, fitted with re-closable plastic caps.

Other Plastics Packages

Other types of plastic packages less commonly used for roasted salts nuts are PET containers and injection moulded PET or PP trays with peelable lids.

Packaging Methods for Shelf – life Extension

The extension of shelf – life that can be achieved through inert gas flushing depends upon the product nature and the storage conditions. However, a reduced level of oxygen inside a package generally gives higher stability to rancidification. As stated earlier, three critical requirements for snack food packaging are moisture, oxygen and light barrier properties.

Snack food such as crisps have an initial moisture content (IMC) of 1 to 1.5% when packed. If this level reaches the critical moisture level (CMC) of 4-5%, the product becomes unacceptable. Crisps sold without nitrogen flushing in clear plastic pouches are said to have a short shelf-life owing to the high volume of air present in the pouches. To improve the shelf – life of these products, anti-oxidants are sometimes added in the oil used for frying. Flushing with an inert gas like nitrogen definitely increases the shelf-life, but until recently, was not used for low value products as it was claimed to be uneconomical.

Oxidative rancidity is accelerated by light, and therefore, light barrier properties are required in increasing the shelf-life. It has been reported that a potato snack product packaged in clear OPP film has a shelf – life (assessed by flavour and moisture changes) of only 8 to 10 weeks compared to over 26 weeks when packaged in metallised OPP film.

Flushing of potato crisps with nitrogen is said to have increased the shelf-life from about 60 days (without N_2) to about 120 days (Anon., 1988). Another advantage of nitrogen flushing is that uniform pillow packs are produced, which prevent damage of the fragile snack products during handling and distribution.

Flushing with nitrogen is today commonly used to reduce residual oxygen in packs containing raw, fried and roasted cashew-nuts, pistachios, almonds, mixed nuts etc. The use of this technique has doubled or tripled the shelf - life of these products which ranges from 10-12 months. An alternative to gas flushing is the use of oxygen scavenger, which is said to be more effective than gas flushing for reducing the residual oxygen level within the packages, thereby further increasing the shelf-life of packaged nuts. Sachets containing the scavenger are placed inside the packs and have been found to reduce the oxygen level in air-tight containers to 0.01% or less (Anon., 1995).

The other product, which has benefited when nitrogen flushed is popcorn. This product is packaged in a laminate of metallised PET / peelable PE.

The use of gas flushing has brought in improvements in barrier properties of packaging materials and in seal performance. Pouches made of metallised plastic films are increasingly used and are expected to grow for the packaging of snack food.

Studies Conducted at IIP

Shelf-life Studies of Snack Food

Shelf-life studies of snack food such as cheese balls, potato sev, bhavnagri were carried out at the Institute in nitrogen flushed flexible pouches of different compositions at accelerated storage conditions and standard storage conditions of 38°C±1°C, 90%±2% RH and 27°C±2°C, 65%± 2% RH respectively.

The keeping quality assessment of the products was based on the following parameters:

- Moisture content
- Texture – crispness
- Organoleptic/sensoric (smell, taste, flavour etc.)

The results of the studies conducted are given in the following table 2.

TABLE 2
Shelf-life of Snack Food in Nitrogen Flushed Flexible Pouches

Packaging Material	Shelf-life In Days					
	Cheese Balls		Potato Sev		Bhavnagri	
	ACC [1]	STD [2]	ACC [1]	STD [2]	ACC [1]	STD [2]
12µ PET / 9µ Al foil/ 37.5µ LDPE	>80	>180	–	–	>60	>210
12µ PET / 12µ met. PET / 37.5µ LDPE	14	33	37	206	–	–
12µ met. PET / 37.5µ LDPE	13	29	35	165	29	206
15µ BOPP/37.5µ LDPE	5	19	14	106	–	–
20µ BOPP / 12µ PET / 37.5µ LDPE	–	–	–	–	11	78
12µ PET / 40µ CPP	–	–	–	–	8	52
LDPE –TIE – Nylon – TIE – LDPE (70µ)	5	18	25	115	–	–
25µ Polypropylene *	–	–	7	32	5	30

1. Accelerated conditions of 38°C± 1°C, 90% ± 2% RH
2. Standard conditions of 27°C ± 2°C , 65% ± 2% RH

* Not flushed with nitrogen gas

Studies on Cashew Kernels

India is a major exporter of cashew kernels and the leading import centre is U.S.A. Traditionally, cashew kernels were packed in 18 litre capacity (11.34 kg kernels) tinplate containers, which were vacuumised and flushed with carbon dioxide gas. Over a period of time, the traditional packaging method became outdated and specific problems surfaced with respect to health, hygiene and statutory requirements in the importing countries. It was in this context that an in-depth study of the existing packaging system and materials was undertaken with a view to bring in possible improvements and develop alternate packaging materials/systems, which would be cost effective to the Indian exporters and quality-wise acceptable to importers all over the world.

Development of New Generation Alternate Packaging System

The alternate packaging system essentially is a bag-in-box system comprising of an outer Corrugated Fibre Board (CFB) box with:

- An inner flexible multi-layered bag
- An inner semi-rigid plastic container (cubipack)

- **Bag-in-Box (Flexible System)**

  This system consists of a liner bag directly placed inside a corrugated fibre board box or the liner bag could be pasted inside a sleeve of corrugated fibre board, which is in turn pasted to the inner walls of the corrugated fibre board box. The liner bag could be flat pillow type or side gussetted. The CFB boxes (with liner bags) of 11.34 kg capacity (same size and shape as the traditional 18 litres tinplate containers) are to be filled with the product, vacuumised and then flushed with nitrogen gas and the liner bags are to be immediately heat sealed. The boxes are to be closed by folding the flaps and the application of pressure sensitive tapes. Two such boxes are then placed in an outer transport CFB box, which is also to be closed by application of pressure sensitive tape. Two synthetic straps are used to reinforce the pack.

- **Bag-in-Box (Semi – rigid system)**

  This system consists of an inner semi-rigid collapsible container of LLDPE with an outer corrugated fibre board box.

Shelf–life Studies for Selection of Inner Liner Bag

The selection of the inner flexible packaging material required an in-depth shelf-life study of the cashew kernels, as the product requires protection against a number of atmospheric factors to maintain its quality. Cashew kernels are affected by parameters such as moisture, oxygen and insect infestation. Cashew kernels need to be protected against moisture pick-up as increase in moisture beyond the critical level of 5% causes loss of crispness and change in texture. Oxygen from the air can affect the product, as the high fat content is prone to oxidation resulting in the product turning rancid. The product also needs to be protected against insect infestation.

Considering the above factors, extensive shelf-life studies of cashew kernels in a variety of commercially available flexible packaging materials were carried out. The studies were conducted in the following materials in pouches of 500 grams capacity.

- LLDPE-Tie-Nylon-Tie-LLDPE-130μ
- 12μ PET/12μ aluminium foil/80μ LD – HD

- 10μ PET/9μ aluminium foil/80μ LD – HDPE
- 12μ PET/12μ metallised PET/80μ LLDPE
- 12μ PET/155μ co-extruded LD-HDPE
- 12μ metallised PET/135μ co-extruded LD-HDPE
- 15μ metallised PET/155μ co-extruded LD-HDPE
- 15μ PET/135μ co-extruded LD-LLD-HDPE

All the pouches were flushed with nitrogen gas. Vacuum packs were also made but it was observed that the oil from the product appeared on the surface and the kernels were slightly deformed.

The shelf-life of the product in the above selected packs is given in table 3.

TABLE 3
Shelf-life of Cashew Kernels in Flexible Packaging Materials at Standard Conditions of 27°C ± 2°C, 65% ± 2% RH
(Nitrogen Flushed 500 grams Pouches)

Packaging Materials	Shelf-life in Days
LLDPE – Tie – Nylon – Tie – LLDPE (130μ)	344
12μ PET/12μ Al foil/80μ LD – HDPE	392
10μ PET/9μ Al foil/80μ LD – HDPE	370
12μ PET/12μ Met. PET/80μ LLDPE	364
12μ PET/155μ LD – HDPE	296
12μ Met. PET/135μ co-extruded LD – HDPE	306
15μ Met. PET/155μ co-extruded LD – HDPE	311
15μ PET/135μ co-extruded LD – LLD – HDPE	282

Shelf–life Studies (Bag–In–Box System)

Flexible

For selection of the inner bag material, based on shelf-life study results of smaller packs (500 gram), 5 materials were selected to conduct further studies for the shelf–life of cashews in 11.34 kg capacity bag-in-box systems.

The shelf-life studies were conducted by exposing the made up packages (11.34 kg) to accelerated conditions of storage (38°C±1°C, 90%±2% R.H.) and standard conditions (27°C±2°C, 65%±2% R.H.). The packages were nitrogen gas flushed.

During the exposure period, samples were drawn periodically to assess the keeping quality of the product in different packaging materials and behaviour of the pouch/pouch materials as well. The drawn samples were checked for the following parameters:

- **Product**
  - Moisture content
  - Physical changes/spoilage/insect infestation
  - Organoleptic characteristics (taste, odour, colour)
- **Pouch/Pouch Materials**
  - Visual observation for changes
  - Vacuum loss/gas retention
  - Seal/bond efficacy

Semi-rigid

This system consists of an inner semi-rigid collapsible container of LLDPE with an outer corrugated fibre board box. The capacity of the pack selected for the study is of 30 litres (18 to 19 kg of cashew kernels). The inner semi-rigid container has a 150-mm diameter mouth, which can be closed with a lid after vacuumising the pack and then flushing it with nitrogen gas. The CFB box is closed by folding the flaps and by application of pressure sensitive tape and reinforced with two synthetic plastic straps. Shelf–life studies were carried out in this pack along with the above packs (bag-in-box-flexibles) in a similar manner.

The observations at the end of 12 months are given in the table 4.

TABLE 4
Storage Studies of Cashew Kernels
in Bag-In-Box Systems
At 27°C±2°C, 65%±2% R.H.

Package Type *	Observations after 12 Months	
	Percentage Moisture Content	Percentage Oxygen Content
1. CFB box with liner bag of LLDPE – Tie – Nylon – Tie – LLDPE (130μ)	4.72	1.8
2. CFB box with liner bag of 12μ PET/ 12m Al. foil/ 80μ LD – HD	4.22	1.0
3. CFB box with liner bag of 10μ PET/ 9μ Al foil/ 80μ LD – HD	4.36	1.3
4. CFB box with liner bag of 12μ met. PET/ 135μ LD – HD	4.47	1.5
5. CFB box with liner bag of 12μ met. PET/ 155μ LD – HD	4.49	1.4
6. Cubipacks (moulded LLDPE semi-rigid containers)	4.22	1.4

Pack Capacity -11.34 kg x 2 packs for Serial No. 1 to 5, 30 liters (18 to 19 kg) for Serial No. 6.

All the packs were flushed with Nitrogen gas. Critical moisture content is 5.0%

Based on the shelf-life studies and laboratory transport trials the most suitable flexible packaging materials for inner liner were recommended as:

- Laminate of 12µ polyester/12µ aluminium foil/80µ LD-HD co-extruded
- Laminate of 12µ polyester/12µ metallised polyester/ 80µ LD-HD co-extruded (or LLDPE)
- Co-extruded film of 130µ LLDPE – Tie – Nylon – Tie - LLDPE

The semi – rigid bag-in-box system with moulded LLDPE inner container was also found to be suitable.

The bag-in-box (flexible) system with the above three inner liners and the semi-rigid bag-in-box when flushed with nitrogen gas offers the product a shelf-life of more than 12 months at standard storage conditions of 27°C±2°C, 65%±2% R.H. At the end of the storage period, the quality of the product in these packs was found to be acceptable – the moisture levels were within the specified upper limit, there was no change in organoleptic properties, no rancidity and no insect infestation.

The oxygen content in all the above packages was also checked after 12 months and was found to be around 1 per cent. The cashew kernels were also tested by the processors for roasting and salting and the results indicated that the cashews from these packs were crisp and performed well for roasting and salting.

Commercial Adoption

Currently, a large number of exporters have partially or completely substituted the traditional tinplate packaging systems by the recommended new generation alternate bag-in-box system (moulded vacuum pack). The alternate system has been successfully adopted and is promoted by the Government of India/CEPC (Cashew Export Promotion Council of India) by providing incentives to the cashew exporters to install the packaging machinery for the new system. Initially, some of the machines were procured from overseas sources. However similar machines are now manufactured within the country and have been installed by a significant number of exporters.

Moulded Vacuum Packs for Nuts

Main Features of New Generation Alternate Packaging System

- The recommended packaging materials for the new packaging system are available globally.

- Adoption of the new packaging system does not involve major changes in the traditional filling system.
- Packaging machinery is available for vacuumising/nitrogen flushing and sealing the packages.
- The new alternate packages are lighter in weight as compared to traditional tinplate containers.
- The alternate packages are collapsible when empty and therefore storage requires less space.
- In the alternate packaging system, the materials used are eco-friendly and recyclable.
- The problem of lead solder has been overcome, so also the problem of sharp edges, making the system operator friendly, safe and hygienic.
- Economically beneficial by 10 -15% compared to traditional packaging.

Based on a recent study conducted at IIP similar packaging system has been recommended for export of walnut kernels.

Conclusion

Emerging trends in the snack food and ready-to-eat food market industry has given wide scope for development of a variety of innovative packaging media depending upon the required shelf-life and performance of wrapping machines. Plastic films and laminates are the most popular choice as a packing media, replacing traditional waxed paper and aluminium foil. Flexible plastics, composite containers and tinplate containers are commonly used for a variety of snack food packaging. Snack food industry has seen immense growth in the past few years. MNC's and large domestic companies venturing in local as well as international markets have led to innovative packaging solutions in plastics. The ability of plastics to pass all selection criteria as an effective packaging media has led to very high quantum of polymeric material being used in the snack food packaging industry.

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