

Paper no.: 12

Paper Title: Food Packaging Technology

Module-19: Packaging of Dairy Products - II

19.1 Introduction

In this module, we will discuss regarding the packaging of butter, ghee, cheese and milk powder. Butter and ghee contains a high percentage of fat, so they are very susceptible to spoilage. So packaging material used should be selected in such a way that it possesses good grease resistance, and barrier properties against oxygen and moisture. Cheese is fermented dairy product, having low pH and comparative higher moisture content while milk powder is dried product, containing very low moisture.

19.2 Butter

It consists primarily of about 80% milk fat, 16% moisture and in table butter up to 3% common salt. Because of high moisture content butter is susceptible to mold growth and lypolytic rancidity

19.2.1 Characteristics of Butter

1. Due to high moisture content butter unlike solid fats is susceptible to mold growth.
2. Flavour and odour are easily absorbed by butter from its environment.
3. Deterioration of the butter may take place due to rancidity.
4. Butter has tendency to lose Moisture.

19.2.2 Requirement of Packaging:

1. Non toxic, not harmful to consumer's health.
2. It should be grease/moisture proof.
3. Shall be barrier for Oxygen.
4. Low metallic content as metals favor oxidation of fat.
5. Shall not transmit light.

19.2.3 Packaging Material

In India, butter is packed in bulk as well as in retail packages. For bulk packaging, there is no standard method, and generally polyethylene bags/parchment paper along with corrugated boxes are used.

Al-foil 0.09 mm thick, surface treated with lacquer for protecting against corrosion: Al-foil/parchment or glassine paper (40-42 gsm): PVC or cardboard with a parchment insert can be used.

Indian Standard 2034 - 1961 gives specifications for tin cans of 200 g and 400 g capacity that are to be used for package of butter. They specify tins thickness of 0.24 mm and 0.27 mm respectively and minimum tin coating of 17 g/m², besides many other requirements. Though tins containers are the best for product protection, owing to their high cost very little quantity of butter is packed in the tin containers. Flexible packaging materials like vegetable parchment paper or grease proof paper, aluminum foil, and paper board cartons which together give similar protection to the product are more commonly used.

Indian Standard 7161 - 1973 gives specifications for vegetable parchment paper or Grease Proof paper/ Aluminum foil laminate for wrapping butter. As vegetable parchment paper has good wet strength, generally paper of 45 gsm and above and aluminum foil above 0.009 mm thickness are used. As butter is highly susceptible to foreign odour, care must be exercised while choosing adhesive and printing inks used in the manufacture of the laminates.

Cartons protect butter while handling after packaging in primary Wrapper, in the distribution system. Since butter is stored in the refrigerator, cartons may be waxed with about 10 gsm wax on each side though it is not mandatory. Paperboard can be extrusion coated with PP. Injection-moulded pots and tubs of PP can also be used for packaging of the butter.

High-impact polystyrene or HIPS is also used in multilayer sheet extrusion with a variety of other polymers, like PE, PP, PET, PVDC and EVOH.

Large packs of 10, 20 and 50 kg butter are packed formerly in wooden barrels/boxes or parchment paper lined corrugated boxes. For better handling, easier storage, more efficient use of storage space and economy Fibre board boxes are introduced which are lined with parchment paper.

Latest packaging material that are being used are Shallow, 1-2 mm thick Al-foil trays with heat sealable PVDC-cellophane or other suitable barrier material. Aluminum PVDC/PS cups can also be used for butter. Butter chiplets are packed in lacquered Aluminum foil.

The standards for vegetable parchment paper used for the butter packing are:

Grammage: 41-45

Bursting strength: $1.8 \pm 0.2 \text{ kg/cm}^2$

Wet strength: $0.8 \pm 0.2 \text{ kg/cm}^2$

Grease resistance: Should pass the turpentine oil test

Acidity: 0.02% as H_2SO_4

pH of H_2O extract: not less than 5.0

Brightness: 79.

19.3 Ghee

It is usually 100 per cent fat with little moisture (< 0.3 %), obtained by boiling butter at 110°C till all water is evaporated with a grainy texture and a characteristic flavour.

The product needs to be protected from chemical spoilage and rancidity caused by oxygen, light, heat, moisture and metal ions.

19.3.1 Characteristics of Ghee

1. Easy to absorb flavour from its environment
2. Easily prone for oxidation
3. Prone for adulteration.

19.3.2 Requirements of Packaging Material

1. Good fat resistance
2. Barrier properties against oxygen and moisture.
3. It shall be temper proof.

19.3.3 Packaging Material

A major portion of ghee is packed in lacquered tins of capacities ranging from 200 ml to 15 litres / kilograms. Since the product is very sensitive to oxygen, the tinplate containers are filled to the brim without any air gap. Ghee packed in tinplate containers is fairly stable and has a shelf-life of about one year.

Alternate packages, which are plastic based, are now gradually replacing tins. For shorter shelf-life, 200 ml, 500 ml and 1 litre capacity pouches made of polyethylene film, multi-layer co-extruded films of LDPE/HDPE are used, which are economical. Aluminium foil laminate standby pouches are also commonly used for packaging ghee.

For long – term storage, stainless steel containers or tinplate cans are desirable. Ghee is also marketed in lined cartons with flexible laminated plastics as inner liner materials and in tetrapaks. In both these packs long shelf-life is achieved. Laminated pouches of metallized polyester based films are also used. Generally, plastic pouches are filled on automatic FFS machines. However, if the sealing surface is contaminated with the product, sealing of the pouch becomes difficult.

Recently, it is packed in certain laminates and Bag - in - Box containers which comprises of a pre-sealed bag made of polyethylene and polyamide laminates fitted with a spout and cap housed in a CFB / Duplex board box. The bag consists of two plies which is sealed together on all four sides and the spout and cap assembly is heat sealed onto it. The bag is vacuum filled and inserted manually into the box. Seven layer Nylon containing self standing pouch with closure is also used. A laminate of HDPE / LDPE is used for packing ghee.

Another form is consisting of a multi-ply collapsible bag with a tap which can be housed in a rigid outer container. The container can be a box, a crate or a drum whose capacity varies between 3 and 200 liters. The bags and boxes are in collapsible form.

19.4 Cheese

Cheese is enzymatically coagulated and fermented dairy product, having pH between 5.0 to 5.5 and contains around 35 to 80% moisture depending on the type of cheese. Hence, it is prone to mold growth on the surface.

19.4.1 Packaging material

Any material to be used for packaging natural cheese must give general protection, prevent moisture loss, improve appearance, protect against micro organisms and prevent oxygen transmission.

Cheese is essentially a product with high fat and moisture content. Therefore, package used for cheese should prevent oxidation and mould growth. It should also have fat and grease resistance and be able to protect against micro organisms. Oxygen is eliminated by packing cheese in hermetically sealed containers in vacuum or inert gas atmosphere. Processed cheese is usually packed in aluminum foil in cubes with different shapes. Tinplate cans are used for 200 g and above quantity. PVDC coated plastic films are suitable for cheese packaging as they provide good oxygen and moisture barrier properties.

Cream cheese is packed in foil lined card board boxes of heat stable plastic packs. Saran is used as wrapping material for Neufchatel cheese. Air evacuation and gas flushing is used for cottage cheese, green cheese is packed by waxing and paraffining or alternatively vacuum packed in polyethylene. Ripened cheese is packed in laminated cellophane film. Cheese consumer packs

are generally consists of Lacquered metal cans of laminated consisting of Nylon / PVDC Copolymer or polyster/ PVDC copolymer or Nylon / Polyethylene copolymer. Processed cheese is packaged hot metallic containers. Wax coated cellophane, aluminum foil, polypropylene, PE, PVDE material is also used for packing processed cheese.

19.5 Milk Powder

The shelf life of a dehydrated product is influenced to a large extent by the packaging, which must conform to certain special criteria.

These are:

- Protection of the dehydrated product against moisture, light, air, dust microflora, foreign odour, rodents etc.
- Strength and stability to maintain original container properties through storage, handling and marketing.
- Size, shape, appearance to promote marketability of the product.
- Composition of the container must be approved for use in contact with foods.
- Lower cost.

19.5.1 Selection of packaging materials

Dehydrated dairy products are generally hygroscopic in nature and even slightest increase of the moisture content will decrease the shelf life considerably. Hence, the packaging material should be impervious towards water vapour and such property is to be considered important for packing such products. When retention of low moisture content is the limiting factor of the shelf life of the product, the tests required to be made for determining the shelf life are:

- Determination of the normal moisture content of the product
- The moisture content of the product at which the product becomes unacceptable to the consumer and
- The R.H. and temperature of the surrounding atmosphere at which the equilibrium moisture content is maintained in the product. Initial level to the level of unacceptability is calculated. From this data along with requirement for gas permeability etc. and utilizing the published data for different packaging material, the suitable packing material is selected.

19.5.2 Properties of dried milk products relevant to packaging

1. **Hygroscopicity** is the principal requirement which is important in small packs size where ratio of pack surface area to product is high. In tropical countries, because of the high humidity prevailing, this is the important factor.
2. **Cohesivity** or the Cohesion of product is the serious stickiness problem particularly in high speed packaging lines. In case of powder, observations made on cohesivity are:
 - a. Cohesion increases with decreasing particle size.
 - b. It is independent of fat content in the range of 20-40% Fat.
 - c. A small amount of surface fat is sufficient to give cohesion to WMP.
 - d. Increasing the moisture from 2 to 4%, cohesion first decreases and beyond 4% cohesion increases very fast.
3. **O₂ Sensitivity**: Preheating releases the -SH groups which protect against oxidization. However still there are chances of oxidation. Therefore for Fat containing products prevent the gas diffusion by employing either Vacuum or N₂ flushing.

4. **Light sensitivity:** Powder exposed to light for long period bleaches the surface and thereafter it accelerates Fat oxidation.
5. **Heat sensitivity:** Affects Flavour and Solubility. Ideal storage conditions are 18-19°C temperature and dry atmosphere.
6. **Bulk Density** is very important because Packaging size is affected. The Free flowing properties improve with increased Bulk Density.
7. **Odour pick up:** Product containing Fat is prone to pick up odour. High Fat powders pick up odour from packaging materials, surrounding atmosphere, stores, water and houses. The off flavour problem is encountered from kraft paper, PE film, CFB, fiber board cases and even from rubber sealing compositions.
8. **Static electricity:** The problem is difficult to resolve. The plastic packaging materials are also important where antistatic agents are added e.g. Glycol alkyl esters (prevent electrical charge accumulated on the film surface).
9. **Bacterial aspects:** Powders of normal moisture and RH do not give rise to bacterial problem.

19.5.3 Requirements of package for dried milks

1. **Adequate mechanical strength** to withstand damage during packaging, handling, transportation and storage is necessary.
2. **Resistance to climatic hazards:** The material should be resistant to damage by exposure to high / low temperature and humid atmosphere. This is more important in tropical countries.
3. **Convenient closure:** Sealing is of supreme importance. Simple, effective re-closure is also desirable.
4. Bulk packages should be **light in weight, easy to handle and stack** during transport and storage. Empty packages should occupy minimum storage space before use.
5. **Very low Water vapour and gas permeability:** Dried milk absorbs moisture very easily. Powder with > 5 % moisture gets deteriorated during storage. The stale and gluey flavours result from Maillard reaction. It results in losses of solubility, colour change; lumping and free flowing properties are affected.
For long storage, vacuum and N₂ flushing is essential especially in hot climate. An impervious container is needed which should also be odour-proof.
6. **Impermeability to light:** To avoid surface bleaching and fat oxidation.
7. Inertness, durable, safe, utilizing minimum space, identification of product and directions for use, easy availability at reasonable cost are the other requirements.

19.5.4 Packaging materials available

1. Glass: Bottles, barrels, jars, etc.
2. Metal: Cans, barrels, drums, bins, etc.
3. Wood: Drums, bins, cask, barrels, etc.
4. Paper and paper derivatives
5. Metal foils
6. Thermoplastics and their derivatives
7. Composite films
 - a. Co-polymer film

- b. Coated film
- c. Co-extruded plastic film
- d. Laminates

19.5.5 Flexibles for powder

1. Cartons lined with Al-foil-PE:
 - a. Bag-in-box: Coated Al-PE bag or plastic coated paper inside cartons.
 - b. Modified Atmosphere Packaging -80% N₂ and 20% CO₂ where O₂ content is reduced to 3.0%.
2. Long storage: Lacquer/print/print pre-lacquer, Al-foil (10 gsm)/Adhesive coated paper (40 gsm)/PE (30 gsm).
3. Shorter Keeping quality: Al-foil may be omitted. Paper thickness increased to ~ 70 gsm and coated with PVDC (30 gsm).
4. Bulk Packaging: Sacks made of craft paper laminates, parchment, polyethylene, Al, Cellophane, bitumen, wax or paraffin. Even cast films now are used recently. Most common types:
 - a. WMP: Laminates of paper, PE, Foil, Metallized, BOPP/PE or PET.
 - b. SMP: HDPE or LDPE or Laminates of HD, LD, LLD, Nylon, Saran (coating), EVA. PE coating or wrinkling- Bag-in-box paper board/lined with paper, Al or Metallized/PE
5. Powder packaging materials:
 - a. Number of Kraft paper layers for strength required is 3-6 for 25 kg wt.
 - b. Outer Kraft paper bag strength 70 gsm, Second Kraft paper bag with paper alone. PE lined (95 gsm).
 - c. WMP: 4-6 ply kraft paper, 3 mm PE
 - d. SMP: 2-4 ply kraft paper 2 mm PE
 - e. Separate PE liner/inner bag – 0.04 mm for 25 kg & 0.05 mm for 50 kg.
 - f. PE varies in thickness from 0.02 to 0.08 mm as inside layer.

19.5.6 Retail packages

1. Thick laminated paper (45 gsm) – Al-foil (9 μ) – PE (25 μ) having Bursting strength 179 KPa (1.83 kg.f/ cm²) and very low WVTR & GTR.
2. PET (12.5 μ)/Al-foil (9 μ) / PE (64 μ), Bursting strength 290 KPa (2.95 kg.f/ cm²).
 - a. Form – Fill – Seal: 17 μ PET / 9 μ PE – 9 μ foil – 70 μ PE
 - b. Metallized film is also used. Lined cardboard – Adhesive / Coating of PVDC or RHC – Metallized PET / Al-foil / PE.
 - c. Metal/Plastic laminate – Retain O₂ content of 0.5 % even after 13 numbers. Bulk: Heavy gauge PE used mainly for sea voyage (passing through tropics).
3. PE is used to much lesser extent as a separate bag within or as a liner for (a) Card board cartons, (b) Calico bags, (c) Jute bags with paper, (d) Liner between jute and PE.
4. Alternative material to PE:
 - a. Multi walled paper sack may incorporate one layer of waxed paper which is more satisfactory than paper alone but is inadequate for long storage.

- b. Multi wall sack may include a layer of bituminized paper, often the outer layer with 4-5 inner kraft layers. This is a good packaging material used even for export but is slightly inferior to PE.
5. Perfect closure is required:
- a. Metal is completely impervious but closure is a weak point.
 - b. Sack is sealed by sewing threads which makes holes and therefore it is covered by H₂O proof tape.
 - c. Gas packaging by mixture of N₂ + H₂ + Palladium as a catalyst and if kept impervious can have up to 10 years of storage life.

19.5.7 Whole milk powder and baby food

Generally packed in Lacquered tins under N₂ gas packaging. Whole milk powder is packed in 15 kg tins. For retail milk powder s packed in laminate bags made of PET /Al / PE.

19.5.8 Skim milk powder

Skim milk in bulk quantities of 25 kg is packed in kraft paper bags with inside polyethylene bag. Skim milk powder for retail is packed in HDPE bottles and HDPE bags.

19.5.9 Malted milk food

The malted food beverage industry is popularly known as the health beverage sector. Historically, malted beverage has a strong association with milk. The Indian health beverages market is divided into white and brown health drinks. White beverages contribute about 65% of the market.

Malted milk foods are highly sensitive to moisture and are prone to oxidative changes in the presence of light, heat and oxygen. Aroma retention of the product and prevention of moisture and oxygen ingress are important and therefore are very critical in protecting the product, and in selection of the right packaging material.

Malted milk foods are packed in quantities of 200 grams to 1 kilogram in a variety of packages. The types of packages used conventionally are glass jars, tinsplate containers, which are now slowly being replaced by plastic containers and flexible laminated pouches. Though glass containers are hygienic and safe and offer the advantage of a long shelf-life, it has the disadvantage of being heavy, fragile and costly. Tinplate containers though provide good protection from gases and moisture, are likely to rust at body welding or at top and bottom seams. Tinplate containers are also expensive.

The plastic containers used are blow moulded HDPE or HM– HDPE or stretch blow moulded PET containers / jars, for brown and white malted milk food products for capacities ranging from 200 grams to 2.5 kilograms. The plastic containers are light weight, sturdy, unbreakable and hygienic, and have a good shelf appeal.

Besides the plastic containers, the trend is also to use flexible pouches, which may be with or without paperboard cartons. This type of pack has an advantage of low cost compared to plastic bottles. Moreover, the storage space requirement is low and the filling operation is comparatively faster.

Some of the typical structures of flexible materials used are:

1. 50 and 100 grams
 - a. 12 μ PET/12 μ metallised PET/38 μ LDPE
2. 500 grams
 - a. 12 μ PET/20 μ metallised BOPP/50 μ LDPE
 - b. 12 μ PET/12 μ metallised PET/50 μ LDPE
3. 1000 grams
 - a. 12 μ PET/12 μ metallised PET/65 μ LDPE