

PACKAGING OF PICKLES, SAUCES, JAMS AND JELLIES

Pickles, sauces, jams and jellies are products made from fruits and vegetables by employing preservation methods to make the product shelf-stable at ambient conditions. The preservation process generally used includes dehydration and drying, salting, fermentation, use of additives, heating, sugaring etc.

Food products are susceptible to spoilage since these are nutrient sources for a range of microbes. Most food preservation techniques create conditions in food, which completely arrest any possible multiplication of microbial cells. These techniques are normally applied alone, however, many are increasingly being used in combination that are additive or synergistic in their effects on microbial growth.



Packages for Pickles & Sauces

Packaging of Pickles

“Pickle” may be defined as an edible product that has been preserved and flavoured in a solution of brine, vinegar or oils and spices. Pickles also include products such as pickled onions, olives, cabbages (sauerkraut) etc. Pickle is amongst a few adjuncts, which are eaten by the rich and poor alike. This product finds a place in the poor man’s meal as well as in the parties hosted by the richest in the country. They are manufactured and consumed in every part of the world. Although, the recipe may differ, in general they are sour, salty and spicy. Pickles are not the main meal itself but used with the main meal or some course to increase the pleasure of eating.

Millions of tonnes of mangoes, lemons, chillies and other items are used in India to prepare a variety of pickles. It is estimated that in our country numerous varieties of pickles are available for which the total annual market is valued at Rs. 40,000 million.

Product Characteristics and Spoilage Factors

Pickles are generally of the following three types:

- Pickles in vinegar
- Pickles in citrus juice or brine
- Pickles in oil

Besides the basic fruit/vegetable, the substances that are generally added to pickles are vinegar, sugar, salt, oil and spices. The presence of these ingredients, make the product highly acidic in nature. Due to the acidic nature and/or the presence of oil in the pickle, the package to be used should be oil and acid resistant. For a pickle to have a fairly long

shelf-life, the composition should be:

- Salt : over 12 per cent, best is >15 per cent
- Acidity : >2 per cent of which minimum 0.5 per cent should be acetic acid (titratable)
- pH : below 3.5 (high acid)
- Moisture : below 50 per cent
- Oil : to cover the top completely
- Preservative : optimal and well mixed

The spoilage of pickles could be due to microbial contamination or oxidation/rancidity of the oil used in the manufacture. A good package for pickles should have the following attributes:

- Aroma retention
- Excellent protection against light, moisture and oxygen
- Excellent seal integrity for containment
- Grease and oil resistance
- Acid resistance
- Good aesthetics and appearance

Types of Packaging for Pickles

Traditionally, the practice was to prepare pickles at home and store in ceramic or earthenware jars. Gradually over the years, pickles are manufactured and commercially marketed in the country, as branded products.

In our country, still large quantity of pickle is sold loose. The shopkeeper displays various types of pickles in large glass jars, and weighs out desired quantity of pickle to his customers. The customer trusts the shopkeeper for the quality and not the brand name. However, gradually pickle packed in glass bottles under different brand names, appeared in the market and became popular. The trend started in Maharashtra and Gujarat. Glass bottled pickles are almost double in cost because of heavy packing and transportation costs. They looked hygienic and appealed to the brand conscious upper class.

With the advent of plastics, pickles packed in HDPE (high density polyethylene) and later PET (polyethylene terephthalate) jars were introduced. HDPE jars are usually used for packing 1 kilogram and more. They are opaque so do not provide visibility of the pickle, but are convenient, as they do not break in transit. The PET jars are transparent, with good eye appeal and safe for pickle. PC (polycarbonate) bottles are best for pickles but they are still very costly.

Over the last few years, cost effective flexible pouches of co-extruded and laminated structures have replaced glass jars. The pouches could be flat pillow pouches or stand-up pouches, which have a good display value. They are light in weight and hygienic. However, in flexible pouches, the sealant layer selection is very critical, as the contact layer needs to be acid and oil resistant. Failure of seals or surface stickiness can render the pack ineffective and un-saleable.

Initially, the flexible packaging of pickles commenced as a simple LDPE (low density polyethylene) pouch, which neither provided protection from oxygen nor did it give an effective

heat seal, as LDPE is not compatible with oil, causing failure of pouches. Gradually multi-layered co-extruded pouches and laminated pouches were introduced. The typical structures are:

- 100 μ HD – LD – HDPE
- 140 μ LD – HDPE
- 110 μ LLDPE – BA – Nylon – BA – LLDPE
- 20 μ BOPP / 50 μ LD – HD (or Cast PP or EAA)
- 12 μ Polyester / 75 μ LD – HD
- 12 μ Metallised Polyester / 100 μ LD – HD



Flexible Plastic Pouches for Pickles

The capacity of the pouches range from 200 grams to 1 kilogram. The pouches could be flat pillow type or stand-up pouches for shelf display.

To sum up:

- For catering / institutional packs – 5 or 6 kilograms - HDPE or PET jars. 20 kg HDPE jars are also available and used for the purpose
- For consumers – 400/500 grams glass jars or PET jars
- For cost conscious housewives - printed pillow or stand-up pouches
- For portion packs – polystyrene or polypropylene injection moulded containers with flexible heat-sealable, peelable lids

Shelf-life of Pickles in Flexible Plastic Pouches: An IIP Study

Shelf-life studies of pickles (two varieties) were conducted in four flexible packaging materials at conditions of $38^{\circ}\text{C} \pm 1^{\circ}\text{C}$, $90\% \pm 2\%$ RH.

Based on the physical and physico-chemical properties of the packaging materials, the following four structures were selected for the study:

1. 15 μ PET / 15 μ Al foil / 55 μ poly
2. 15 μ PET / 15 μ metallised polyester / 55 μ poly
3. 12 μ PET laminated to EVOH based co-extruded film
4. 12 μ PET laminated to Nylon based co-extruded film

The first two materials are laminates of three layers and the last two are co-extruded films laminated to Polyester (PET) film. The two varieties of pickles studied are:

- Mango pickle in oil
- Mixed pickle in oil

Both the above varieties were packed in the four selected structures by using three different packaging systems viz.:

- Normally packed and heat sealed
- Packed with nitrogen (N_2) gas and heat sealed
- Packed under vacuum and heat sealed

The made up packs were stored at the test conditions of 38°C, 90% RH. Samples were drawn at regular intervals of time to assess the keeping quality of the pickles with respect to the parameters listed below:

- Percentage acidity
- Colour
- Texture
- Flavour (organoleptic assessment)
- Salt percentage
- Benzoic acid content
- Acceptability (based on above criteria)

The tables 1 and 2 gives an overall picture of the shelf-life obtained of mango and mixed pickles at the test storage conditions.

TABLE 1
Shelf-life of Mango Pickle in Plastic Pouches

(in days)

Sr. No.	Material	Ordinary Packaging	Nitrogen Flushing	Vacuum Packaging
1	15µ PET/15µ Aluminium foil/55µ Poly.	130	79	131
2	15µ PET/15µ Metallized PET/55µ Poly.	130	136	131
3	12 µ PET laminated to EVOH based co-extruded film	71	77	74
4	12 µ PET laminated to Nylon based co-extruded film	71	66	74

TABLE 2
Shelf-life of Mixed Pickle in Plastic Pouches

(in days)

Sr. No.	Material	Ordinary Packaging	Nitrogen Flushing	Vacuum Packaging
1	15µ PET/15µ Aluminium foil/55µ Poly.	129	79	131
2	15µ PET/15µ Metallized PET/55µ Poly.	129	136	131
3	12 µ PET laminated to EVOH based co-extruded film	74	70	82
4	12 µ PET laminated to Nylon based co-extruded film	74	70	82

Analysis

The results of the study indicate that the mango and mixed pickles can be preserved between 66 days and 136 days at 38°C, 90% RH (accelerated conditions) depending upon the packaging material and the packaging system.

When packed, normally under ordinary conditions, a shelf-life of 71 days and 74 days is achieved in materials (3) and (4) for mango and mixed pickles respectively. The shelf-life is comparatively longer (130, 129 days) in materials (1) and (2) for mango and mixed pickle respectively. Nitrogen flushed packages have shown a better performance only in the case of material (2) whereas for materials (1), (3) and (4), there does not seem to be any appreciable difference in shelf-life in both the pickles.

Vacuum packaging has helped to increase the life marginally between 1 day and 8 days, for both pickle varieties.

The results of the above studies indicate that the packaging material, which is having **metallized polyester film, was found to be suitable for all the filling methods** as well as for preservation of both the products viz. mango and mixed pickle, as compared to the other packaging materials followed by aluminium foil laminated material. The multi-layer structures rank next to the above two materials.

Among the package filling systems used in the exposure studies, vacuum packaging system was found to give better life, followed by normal filling and then by gas packaging.

Results

The results of the studies, on analysis, have led to the following observations:

1. The three most important parameters of packaging material in case of arriving at shelf-life should be:
 - Water vapour transmission rate
 - Sealing layer compatibility with oil
 - Oxygen transmission rate
2. Other details:
 - The laminate or multi-layer structure to be used needs to have a WVTR of not more than 1.0 gm/m²/24 hours, at accelerated condition.
 - The sealing layer should be compatible with oil and should be above 40µ, to give a strong seal.
 - The OTR should be not more than 150 ml/m² / 24 hours at NTP.
3. The laminate or multi-layer film could be a two or more layered structure conforming to above conditions.

Packaging of Sauces

Sauces are liquids, made from pulped fruit and/or vegetables with the addition of salt, sugar, spices and vinegar. They are pasteurized to give the required shelf-life, but the basic principle of preservation is the use of vinegar, which inhibits the growth of spoilage and food poisoning micro-organisms. Other ingredients such as salt and sugar contribute to the preservative effect and the correct Preservation Index ensures that the product does not spoil after opening and can be used little at a time. Some sauces may contain a preservative such as sodium benzoate, but this is not necessary if an adequate Preservation Index is achieved. Sauces can be made from almost any combination of fruit or vegetables, but in practice the market in many countries is dominated by tomato sauce, chilli sauce and to a lesser extent, mixed fruit sauces such as 'Worcester' sauce, which contains apples and dates in addition to tomatoes.



Bottles for Sauces

Sauces should contain 3 per cent acetic acid (to ensure its storing quality) and 15 per cent to 30 per cent sugar according to the kind of sauce made from fruits and vegetables. Most salad dressing is oil based. Sauces may be thick (ketchup) or thin (Worcestershire).

Source of Contamination [Spoilage Factors]

The major source of sauce contamination is micro-organisms. The microbial load on the product before and after storage should, therefore, be carefully studied in order to avoid deterioration of product. Bacterial flora, fungal growth and yeast are some of the micro-organisms frequently observed in packed sauces. As it is an acidic product, ketchup and sauces do not spoil easily. In order to maintain the product's quality more effectively, it is suggested that sauces (and any other processed food) be refrigerated after opening because refrigeration retards spoilage.

Package Criteria

Packaging enhances the life span of many perishable food items. The package should offer sufficient barrier against light, moisture, gases, and other environmental factors. Apart from this, it should also protect the organoleptic characteristics (quality attributes) of sauces viz. colour, flavour, taste and overall acceptability. The package should prevent emission of off-flavours. The package must be "chemically clean and inert", and it should be able to perform at high processing speeds. In order to protect leaching out of powerful flavor ingredients through film structures thereby causing de-lamination, chemical resistant adhesives and primers can be used to assure packaging integrity.

Types of Packaging for Sauces

Presently, sauces are widely available in glass bottles, small flexible pouches (sachets), stand-up pouches and plastic bottles, generally, PET bottles are being used. **The glass bottles are**

heavy and costly and are being replaced by plastic bottles of HDPE and PET, which are lighter, hygienic and cost effective.

Latest Developments

- **Flexible Sachets:** One of the recent developments in this field is the introduction of a film/foil packet structure for a green pepper sauce. This packet structure is one of the first applications featuring a polyester-based extrusion coating on a film. This structure combines reverse printing, adhesive lamination, extrusion lamination and co-extrusion coating processing techniques to create an entirely new flexible material. The portion-controlled packet prevents emission of off-flavours in the green sauce, scalping or leaching, as well as de-lamination that would occur with other films.

It is an easy-tear packet with structure of multi-layer polyester/co-extrusion coated polyester blend sealant/aluminium foil/polyester, reverse printed flexographically in three colours on the outermost polyester layer. The co-extrusion coated polyester sealant technology is revolutionary in that it is not only convenient and cost-effective, but also “chemically clear and inert”. The pack’s foil layer acts as a barrier, while an opaque white film layer provides a suitable background for printing and for a proprietary, polyester-based, chemical-resistant sealing layer that is co-extrusion coated. The chemical-resistant sealant layer protects the foil and offers a durable, hermetic heat seal. Product-compatibility issues associated with the aggressive, spicy pepper composition of the sauce could potentially have their way with packaging films. The powerful flavour ingredients have been known to leach through film structures and de-laminate them after filling. Chemical-resistant adhesives and primers also help ensure packaging integrity. Bonding is important between the pack layers. The multi-layer structure is put together in such a way so as to ensure a proper bond between all the layers and to work well with the pepper sauce.

- **PP/EVOH/PP Bottle:** A new barbecue sauce is introduced in a co-extruded multi-layer bottle. An Ethylene Vinyl Alcohol Copolymer material is sandwiched and blow moulded in a controlled density for proper product protection for extending shelf-life of products by locking out oxygen and other gases, while preventing moisture losses.

The lightweight, squeezable bottle also features a liner-less PP dispensing closure of proprietary design. The screw on the base, features a restricted orifice, which serves as the dispensing spout. The matching over-cap has a moulded plug in its centre, which fits into the dispensing orifice as it snaps into place and reseals the sauce.

The bottle is available in a variety of shapes and can be designed for squeezing and dispensing thick products, said to be ideal for products subject to flavour losses in conventional plastic bottles. The barrier layer provides protection against oxygen permeation and helps to lock in flavour and aromatics. The material has a strong tolerance to heat and does not lose its properties at elevated temperatures.

The co-extrusion technology allows a variety of lower cost material including PP and HDPE or LDPE to be combined with more expensive barrier middle layer depending upon the product requirement.

- **Heat Set Tomato Sauce Bottle:** This is an exciting and innovative packaging development - a unique new product in the European packaging market. The 250ml heat set PET tomato sauce container is believed to be the first small container of its kind in Europe suitable for high temperature hot-fill process conditions. The container has a crystallized neck and base, suitable for hot-filling up to a maximum temperature of 92°C followed by immediate cooling, and has a maximum pasteurization process temperature of 75°C.

The pack, which is produced using a standard preform, weighs 35 grams and has a 43mm crystallized neck. It utilizes standard heat set blowing at 850 bph/ mould and features base thermal crystallization.

The container is ideal for children - particularly because it is unbreakable.

- **Pinched-grips, Easy-grip PET Container:** A polyethylene terephthalate pinched-grip jar (PET), injection stretch/blow-molded, the jar has a 63-mm finish.

The jars have an induction-sealed foil membrane that comes inside an injection-molded polypropylene liner-less closure. A special coating is developed for the foil so that it would provide a reliable hermetic seal at “near 90°C” temperatures. Also significant is the edge-seal feature moulded into the closure that keeps water from being drawn between the container’s neck finish and the closure during cooling.

Recent Developments

Introduction of stand-up pouch for sauce packing is one of the innovations in the packaging field. This type of packing was designed with the objective to provide a cost effective and consumer friendly alternative to lay flat pouches with easy-pour-out and re-closing facilities. Some important features of the stand-up pouch are:

- Value addition through packing
- An easy to use pack, which incorporates easy pourability and re-closing in its design
- Unique stand-up format providing greater display capabilities and brand imaging
- Automatic packing

This stand-up pouch is made up of 6 colour reverse printed laminate structure of a 10 μ PET / 120 μ -3 layer PE film, structurally providing the pack contents with physical, chemical and biological protection.



*Stand-up Pouch for
Sauce Packaging*

Packaging of Jams and Jellies

“Jam” is a solid gel made from fruit pulp or juice from a single fruit or from a combination of fruits. “Jellies” are crystal-clear jams that are produced using filtered juice instead of fruit pulp and “marmalades” on the other hand are produced

mainly from clear citrus juices (including lime, orange, grape, lemon and orange) and have fine shreds of peel suspended in the gel. The correct combination of acid, sugar and pectin is needed to achieve the required gel structure and rapid boiling is necessary to remove water quickly, to concentrate the mixture before it darkens and loses its ability as a gel.

Package Criteria

The primary packages for jams and jellies must have the following characteristics:

- It should allow heat transmission. Heat transmission i.e. heat transfer is very fast during heating and cooling.
- It should be heat-resistant i.e. it should have resistance towards high filling temperature.
- It must be able to achieve and maintain vacuum and thereby prevent contamination with moisture, air and micro-organisms by assuring vacuum sealing.
- It should be sturdy in order to prevent handling and storage hazards.
- “Product quality maintenance” i.e. the package should not react with and change the properties of the product over a given period of storage and preservation.
- It should have resistance towards sunlight, storage temperature and atmospheric humidity.

Packages for Jams and Jellies

For packaging of jams and jellies, various packaging materials can be used. Glass is in major use and also among plastics-HDPE, PVC, PS, PP, Aluminium foil, etc. are being used.

- **Metal Containers - Lacquered:** Tin containers are also used namely, “Open Top Sanitary cans (OTS cans)”. The tinplate used for this is a low carbon mild steel base plate suitably coated with a thin layer of tin metal. Tin plate must have a very low sulphur, phosphorus and copper content. For preservation and processing, tin is an ideal container for jams and jellies packaging. It is hermetically sealed thereby avoiding contamination. The only disadvantage with tin cans is that it slowly reacts with the contents over a period of time leading to “corrosion”. To overcome this, inside lacquered or resin-coated tin cans are used for food containing high acid content and sulphur content.
- **Glass Jars with Lug Caps:** Basically, glass is better than other materials for packaging of jams and jellies for few reasons viz. it is very much chemically inert, aesthetic appeal



Packages for Jellies



Plastic Pouches and Pouch in Cartons for Jellies

in glass is much better and the product has long shelf-life in glass than any other material. But on the other hand, the major drawbacks associated with glass are that they are heavy in weight, fragile, and require sterilization before refilling of product thereby increasing the production cost.

- **Plastic Containers:** Plastic jars are already making in-roads into this market because of their light weight and resistance to breakage. High density polyethylene, polyvinyl chloride and some of the newer acrylics have been used for this purpose.



Plastic Packages for Jams

HDPE has a linear structure. **The promising properties of HDPE, which make it suitable for jams and jellies packaging, are its good moisture barrier properties, its excellent resistance to a wide range of chemical compounds, good tensile characteristics and good high temperature resistance.**

Injection moulded containers of PP or HIPS are also used for packing 200 grams of the product. Unit servings of jellies and jams are packed in injection moulded plastic cups. They are closed with peelable membrane lids. Plastic cups are moulded from polystyrene, polyethylene, polypropylene or polyvinyl chloride. Closures can be foil laminates, clear plastic film or metallized plastic film. The type of plastic used must be capable of heat-sealing or the membrane must have a suitable peelable adhesive or heat-seal coating, the selection of which will be governed by the material used to form the cup. In the selection of a suitable heat-seal formulation, note must be taken of the temperature of jelly fill.

Jellies are filled hot (82.2°C or higher) and the actual degree of peelable seal does not become evident until it has “set” for 24 hours. Problems revolving around membrane formation i.e. heat-seal coating separating from the inner foil ply, are a frequent plague to the material supplier. The foil used must be clean and free from oily residues to prevent separation of the laminate plies.

- **Flexible Packs:** Jams and jellies are also packed in 2-3 layered co-extruded polyolefinic pouches of 200 and 400/500g capacities. The individual pouches are further placed in printed paperboard or E-fluted corrugated cartons.

Conclusion

The current changing trend in packaging indicates that products such as pickles, jams and sauces, which were earlier packed using conventional materials such as metal and glass have now gradually moved to plastics packaging. The versatility of plastics offer advantages of lighter weight, cost competitiveness, ease of handling and variety of shapes and sizes as compared to the conventional packs. This trend of plastics packaging is on the rise and is likely to continue.

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