

5. PACKAGING OF FISH AND FISHERY PRODUCTS

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Introduction

Packaging is used to preserve food products during distribution, sales, and storage. Packaging plays a crucial role in protecting and ensuring the quality and safety of food products till it reaches the consumer. It involves safeguarding the product from factors like moisture, temperature, shock, vibration, compression, heat, oxygen, dust, and bacteria. It also helps to maintain the sensory properties and keeping quality of the product and thus shelf-life of the product is improved with the help of proper packaging.

Functions/Objectives of Packaging

The primary objectives of packaging are:

- To contain and protect the food
- To facilitate the convenience of handling and food preparation
- To provide protection from contamination, physical damage, moisture, and temperature
- To ensure proper hygiene for food
- To provide information about the food product to the end consumer
- To make the product more appealing and attractive to the end consumer
- To facilitate attractive display/presentation of the product to the end consumer in supermarkets and shops, making it help to stand out from similar products: Marketing tool/Silent salesman
- Provide information on the history of the preservation of the product to the end consumer

Packaging Types

- Flexible Packaging: Includes materials like paper, flexible laminates, and plastic films.
- Semi-rigid Packaging: Includes materials like Aluminium foil, laminates, paperboard, and thermoformed plastic.

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- **Rigid Packaging:** Includes materials like wood, glass, metals, and hard plastics.

Packaging Levels

In the context of packaging, there are different levels of packaging, each serving a specific purpose in the protection and distribution of products. Here are the main packaging levels:

- *Primary Packaging:* This is the innermost layer of packaging that directly comes in contact with the product. It is designed to provide a barrier and protection to the product and is often in direct contact with food. For example, the primary packaging of a food product can be a bottle, a can, a bag/pouch, or a blister pack for medicine.
- *Secondary Packaging:* This level of packaging surrounds the primary packages and is used to group them together for easier handling and distribution. It may also provide additional protection to the individual primary packages during transportation and retail display. Secondary packaging can include items like cardboard boxes, cartons, or shrink wrap, which are used to bundle individual items together.
- *Tertiary Packaging:* Tertiary packaging is the outermost layer designed for bulk handling and transportation of products. It is used to protect multiple secondary packages during distribution and warehousing. Tertiary packaging is typically larger and more robust, suitable for palletizing and shipping large quantities of products. Examples of tertiary packaging include wooden crates, pallets, and stretch-wrapped bundles.
- *Ancillary Packaging Materials:* These are additional materials used in packaging that may not fall into the primary, secondary, or tertiary categories but play a supporting role. These materials can include items like labels, stickers, inserts, fillers, cushioning materials, strapping, and tapes. Ancillary packaging materials aid in the presentation, protection, and proper handling of the products.

Packaging of fish and fishery products

Packaging of fish and fishery products plays a pivotal role in ensuring the quality, safety, and preservation of these perishable commodities throughout their journey from the source to the consumer's table. The importance of effective packaging cannot be overstated as it serves multiple crucial functions. Firstly, it helps to prevent spoilage and contamination, maintaining the freshness and flavour of the products. Proper packaging also extends the shelf life, allowing for longer storage and distribution periods, which is especially significant

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for products that need to be transported over long distances. Additionally, it safeguards against physical damage and maintains the product's shape and appearance, making it more appealing to consumers. Furthermore, clear and informative labelling on the packaging assists consumers in making informed choices regarding the product's source, nutritional information, and handling instructions, contributing to food safety and transparency in the seafood industry.

1. Fresh/Chilled Fish Packaging:

Packaging for fresh or chilled fish requires specific properties to ensure the product's quality and safety. The following are the main considerations in the packaging meant for fresh/chilled fish and fishery products:

- **Insulation properties:** The packaging should have good insulation properties to maintain the desired temperature of the fish. Fresh/chilled fish packaging should include materials that reduce the rate of ice melting.
- **Protection from dehydration and oxidation:** Proper packaging should reduce moisture loss (dehydration) and exposure to air (oxidation), both of which can lead to spoilage and deterioration of the fish.
- **Chemical contamination:** The packaging material should be food-grade and free from harmful chemicals that could contaminate the fish.
- **Preventing bacterial growth:** The packaging should be designed to inhibit bacterial growth, reducing the risk of foodborne illnesses.
- **Preventing dripping and odour:** The packaging should be leak-proof to prevent any dripping of fish liquids.

1a. Bulk Fish Packaging

For bulk packaging, the container used should have the following properties.

- The containers should be strong
- The weight of the container should be minimal
- It should have good insulation properties
- It should have good barrier properties

The containers commonly used are as follows.

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- Insulated moulded plastic containers made using HDPE or PP - Polyurethane insulation sandwiched between the inside and outside layers.
 - They are durable and lightweight.
 - They have a lifespan of more than 5 years.
 - They are easy to clean and provide good insulation.
- Moulded containers made from Expanded Polystyrene.
 - Such boxes have minimal weight and provide good insulation. They are easily stackable and easy to handle.

1b. Fresh Fish: Retail Packaging

- Shallow trays made of molded pulp, foam polystyrene, or clear polystyrene are commonly used.
- It can be wrapped in plastic film or from above with a pressed sensitive label.
- Generally, food-grade polyvinyl chloride (PVC) films are used as overwraps.

2. Packaging of Frozen Fish Products

Packaging plays a vital role in ensuring the freshness and durability of frozen products. It provides the necessary strength and resistance to preserve the product's quality. For frozen fish packaging, the ideal material should possess the following characteristics:

- Moisture and aroma protection: The material should protect the frozen fish from moisture and aroma loss, ensuring the product's quality and freshness are maintained.
- Oxidation and rancidity prevention: It should prevent the fish from getting oxidized or rancid, helping to preserve its taste and nutritional value.
- Durable and tear-resistant: The packaging material should not become brittle or torn easily during freezing, storage, and transportation.
- Low water vapor permeability: The material should have low water vapor permeability to prevent moisture from entering the package and causing freezer burn.
- Low oxygen permeability: It should have low oxygen permeability rates to minimize the risk of oxidation and spoilage.
- Odour retention: The material should retain the fish's odour inside the package, preventing cross-contamination with other foods and ensuring the product's quality and taste remain intact.

Packaging levels of frozen products

- **Primary packaging:** In the primary packaging of frozen fish and fishery products, low-density polyethylene (LDPE) is commonly used. Some exporters opt for using an LDPE pouch or bag as an alternative to a wrapper. The LDPE used for wrapping is typically 100 gauge, while a thicker 200-gauge LDPE is used for the bag. In certain cases, High Molecular High-Density Polyethylene (HM-HDPE) film, available in 60 and 120-gauge thicknesses, is also used as a cost-effective option. However, this material is not transparent like LDPE film. These packaging materials are chosen for their protective properties and ability to maintain the quality and freshness of frozen seafood products during transportation and storage.
- **Secondary packaging:** Paper board/Duplex board cartons are used as secondary packaging materials.
- **Tertiary packaging:** Corrugated Fibreboard boxes are used as master cartons/tertiary packaging

2a. Raw Frozen Fish Products:

2a1. Block Frozen Products

- Fish is frozen in blocks.
- Low-Density Polyethylene (LDPE) lined duplex board cartons are used to pack the fish.
- Subsequently, these cartons are packed into 5 or 7-ply corrugated fibreboard boxes, known as master cartons.

2a2. IQF (Individually Quick Frozen) Products

In the primary packaging of individually quick frozen (IQF) frozen fish, shrimp, and cuttlefish, a plastic unit pouch or wrapper is commonly used. These pouches come in various capacities, ranging from 200 grams to 10 kilograms, depending on the quantity of the frozen seafood product.

- Mono film, co-extruded film, or laminated pouches.
- Unit pouches can be packed into unit/intermediate cartons or packed directly into master cartons.
- 10-micron Biaxially Oriented Polypropylene (BOPP) is the most effective film.

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- Unit/intermediate cartons made of duplex or 3-ply corrugated fibreboard.

The materials used for constructing the unit pouches include:

- Monolayered LDPE or LLDPE (Linear low-density polyethylene) film
 - Co-extruded LLDPE - LDPE, which is a two-layered film
 - Co-extruded LLDPE - B - polyamide - B - LLDPE, a multi-layered film
 - Five-layered film is likely to contain different combinations of polymers to enhance strength and barrier properties.
 - Polyester / LDPE laminate, which combines the properties of both materials.
- Additionally, some processors use plastic trays made of Expanded Polystyrene (EPS) or Polyethylene Terephthalate (PET) for specific seafood products like head-on shrimps, lobsters, and butterfly shrimps. These trays are either placed in a plastic pouch, which is heat-sealed or in printed paperboard cartons with see-through windows.
 - For butterfly shrimps, after the product is placed on the EPS tray and frozen, they are skin packed with a high-barrier plastic film to provide enhanced protection and preservation during storage and transportation.

2b. Packaging for Battered and Breaded Products

During storage, the packaging of value-added products may experience changes, such as dehydration, colour variation, rancidity, and other alterations.

- Thermoformed trays made from food-grade materials
- Trays made using PVC, HIPS (High Impact Polystyrene), and HDPE (High-Density Polyethylene) remain unaffected by lower temperatures during frozen storage while effectively preserving the product content.

3. Packaging of fish pickle

Packaging fish pickle in glass bottles is a traditional and well-established choice, primarily due to the desirable properties of glass. Glass containers are known for their inertness, which means they do not react with the contents, preserving the taste and quality of the fish pickle. They are non-toxic and do not leach harmful substances into the product, ensuring food safety. Glass is also highly durable and provides excellent protection against environmental

factors like moisture and gases that can compromise the pickle's shelf life. However, it's important to note that glass containers have some drawbacks. They are heavy, making transportation more costly. Glass is also brittle, making it more susceptible to breakage during handling and transportation, which can result in product losses and safety hazards. Additionally, glass bottles tend to be bulkier and may take up more space compared to other packaging options, and they can be relatively expensive to produce and transport.

The development of new flexible packaging materials for fish pickles, such as polyester-based materials laminated with LDPE-HDPE co-extruded film or Nylon/Surlin or LD/BA/Nylon/BA/Primacore, represents a significant advancement in packaging technology. These materials are considered passive, meaning they do not interact with the product, ensuring that the fish pickles remain uncontaminated and safe for consumption. The flexibility of these materials allows for the creation of attractive stand-up packaging, enhancing the product's shelf presence. Moreover, the reverse side of the polyester film can be printed with relevant information, branding, and attractive designs, making it more appealing to consumers. Specifically, the combination of Nylon/Surlin or LD/BA/Nylon/BA/Primacore provides an excellent packaging solution for dry fish pickles, as it offers safe storage of the product at ambient temperatures for an extended period, up to 14 months. This extended shelf life is essential for preserving product quality and ensuring that the fish pickles reach consumers in optimal condition. The innovative packaging materials and their long shelf-life capability contribute to the convenience, safety, and attractiveness of fish pickle products in the market.

4. Packaging of thermally-processed fish products

4a. Packaging of thermally-processed fish products in cans

Packaging of thermally-processed fish products in cans presents a variety of options to choose from. These options include vacuum-deposited Aluminium in standard tin plates, lightweight tin plate cans, double-reduced tin plate cans, tin-free steel (TFS) cans, and steel & polymer-coated tin-free steel cans. Metal cans offer several advantages as packaging solutions. They are known for their exceptional strength, allowing for the safe containment of products. The manufacturing process for metal cans is highly efficient, enabling rapid production. Moreover, they facilitate easy filling and dosing process, making them a preferred choice for many food manufacturers. However, there are some drawbacks associated with metal cans. They tend to be heavier, which can impact shipping costs and

overall product weight. Additionally, metal cans can pose challenges for consumers when it comes to resealing after opening, and they may present disposal issues due to their recyclability and environmental impact.

4b. Packaging of thermally-processed fish products in retort pouches

Packaging of thermally-processed fish products in retort pouches involves the use of flexible laminated materials designed to meet various packaging needs. These pouches typically come in either three or four-layer configurations. In a standard three-layer retort pouch, there is an outer layer made from polyester, a middle layer composed of Aluminium that serves as a barrier against external elements, and an inner layer made from cast polypropylene, ensuring the safe containment of the fish product. Additionally, nylon is sometimes included as an extra layer for specific applications.

5. Packaging of dried fish products

The packaging for dried fish products should fulfill several key requirements. It must effectively protect against oxygen exposure to maintain product freshness. It should also be moisture-resistant to prevent spoilage. Odor resistance is essential to preserve the product's quality. Additionally, the packaging should be designed to prevent insect and rodent infestations. It should be lightweight for ease of handling, user-friendly for both packaging and unpacking, simple to store, and cost-effective to ensure affordability.

To meet the packaging requirements for dried fish products, several options can be considered. Palm leaf baskets and straw baskets provide a natural and cost-effective choice. Packaging of dried fish in paper can be an economical and lightweight solution with some inherent odour resistance. Alternatively, dry fish in flexible plastic film provides excellent oxygen and moisture protection and is easy to handle, use, and transport. For enhanced performance, dried fish packed in laminated films is a premium choice, offering superior protection against oxygen, moisture, and odour. Regardless of the material chosen, maintaining a clean storage environment is crucial to deter insect and rodent nuisance and preserve the quality of the dried fish products.

5a. Bulk packaging: For bulk packaging of dried fish, typically baskets reinforced with plaited straw or palm sheath are used for internal distribution. For export and long-distance transport, an additional layer of reinforcement is added using gunny fabric. However, these packaging methods are susceptible to insect and rodent intrusion. Among the various

packaging materials examined, gusseted bags woven with HDPE and laminated with 100-gauge LDPE have proven to be an ideal choice for bulk packaging of dried fish. This choice enhances the protection of the product during transit, reducing the risk of pests and maintaining product quality.

5b. Consumer packaging: Consumer packaging commonly utilizes materials such as low-density polyethylene (LDPE) or polypropylene because their cost-effectiveness and wide availability. However, these materials come with several drawbacks, including a high transmission rate for water vapour and gases, susceptibility to damage from sharp objects like thorns, and the potential for odours to escape, limiting the shelf life of the packaged products. In response to these limitations, laminated polyester-polyethylene bags are considered a viable alternative. These bags offer a combination of polyester's strength and durability with polyethylene's barrier properties, providing improved protection against moisture, gases, and external damage. This makes them an excellent choice for packaging products requiring an extended shelf life and better containment of odours.

Advanced packaging techniques for fish and fishery products

1. Vacuum packaging

Vacuum packaging is a method where a vacuum is created inside the packaging by removing air and then sealing it hermetically. This process, which eliminates the presence of oxygen within the packaging, offers several advantages for preserving the quality and shelf life of various products. To meet the requirements of impermeability and heat stability, multi-laminated plastics, typically made from materials like polyester-polyethylene or nylon-polyethylene, are commonly used. Polyester and nylon provide the packaging with strength and serve as effective barriers to oxygen, while polyethylene possesses strong heat-sealing properties and resistance to moisture penetration. Vacuum-sealed foods maintain their freshness and flavour significantly longer, typically three to five times more than conventional storage methods, as they remain shielded from oxygen. This method also prevents the growth of microorganisms like bacteria, mold, and yeast in the absence of air. Moreover, vacuum packaging helps prevent freezer burn by keeping foods from dehydrating when exposed to cold, dry air, particularly benefiting moist or wet foods. It also prevents dry and solid foods from hardening, as they are shielded from moisture absorption in the surrounding air. Furthermore, foods high in fat and oil remain protected from going rancid due to the absence of oxygen, which can lead to an unpleasant taste and odour.

2. Modified Atmosphere Packaging (MAP)

Modified Atmosphere Packaging is a technique used to alter the composition of the atmosphere within food packaging to extend the shelf life of various food products, including seafood. However, the atmosphere inside the packaging may change over time due to factors like the permeability of the packaging materials or the respiration of the food itself. Studies have demonstrated that MAP can effectively prolong the shelf life of seafood products. The choice of gas mixture for MAP can vary, and it largely depends on the specific type of fish being packaged. A recommended gas mixture for lean fish typically consists of: 30 % oxygen, 40 % carbon dioxide and 30 % nitrogen. A general recommendation for fatty and oily fish includes: 40% nitrogen and 60 % carbon dioxide. In addition to gas composition, the choice of packaging materials is crucial in MAP. Some common packaging materials used for MAP of seafood and other food products include: Nylon/suril laminates, Moulded PVC trays laminated with polyethylene and Polyester/LDPE film.

3. Active packaging

Active packaging is a specialized type of packaging that goes beyond traditional passive packaging by actively interacting with the contents to change or maintain their conditions. The primary goal of active packaging is to increase the shelf life, enhance safety, or improve the sensory properties of the packaged products. Active packaging systems come in two main categories: scavenging/absorbing systems and releasing systems. Scavenging systems work to remove or reduce specific substances or gases that can negatively impact the quality and safety of the packaged products, such as oxygen, carbon dioxide, and ethylene. Releasing systems, on the other hand, release specific substances into the package environment, like carbon dioxide, ethanol, antimicrobials, antioxidants, sulfur dioxide, and pesticide emitters, to enhance safety or quality.

4. Intelligent packaging

Intelligent packaging, often referred to as smart packaging, is an advanced approach to packaging to enhance the functionality and information provided by the packaging itself. Intelligent packaging for fish and fishery products represents an innovative approach to ensuring the quality, safety, and traceability of seafood throughout its journey from catch to consumer. These packaging solutions incorporate various technologies, such as sensors, QR codes, or RFID tags, which enable real-time monitoring of factors like temperature, humidity, and freshness. By providing data on the product's condition, intelligent packaging allows for

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better decision-making in the supply chain, reducing the risk of spoilage and ensuring compliance with quality standards. Moreover, it enhances consumer trust by offering transparency and information regarding the product's origin and handling practices. In this way, intelligent packaging not only extends the shelf life of fish products but also contributes to a more sustainable and reliable seafood industry.

Conclusion

In sum, the packaging of fish and fishery products is indispensable for preserving product quality, ensuring food safety, and meeting the diverse needs of consumers, producers, and the supply chain. From primary to tertiary packaging levels and ancillary materials, the seafood industry has a range of options to choose from, each tailored to the unique needs of different product types and distribution scenarios. Moreover, advanced packaging techniques like vacuum packaging, modified atmosphere packaging, active packaging, and intelligent packaging are reshaping the industry by enhancing preservation, transparency, and convenience. As the seafood market continues to evolve, innovative packaging solutions will remain essential in ensuring that fish and fishery products reach consumers in optimal condition, contributing to a more sustainable and resilient seafood sector.