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Intelligence

Seafood packaging, part 1

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Packaging materials, traits

Each packaging material has advantages and drawbacks. Plastic films block moisture and most gases, and offer a tight fit.

Although packaging innovations in the seafood industry are evolving at a rapid rate, much seafood is still sent to retail and institutional markets unpackaged. Whole or dressed fish and some shellfish are packed in ice and marketed in bulk containers. At the market, the products are displayed and offered for sale – still unpackaged – on a bed of ice.

In many cases, the switch from wooden to waxed or plastic corrugated boxes, and metal or plastic tubs as bulk shipping containers has been the sole innovation in packaging. Meanwhile, prepackaged meats and poultry have come to dominate the largely fishless self-service meat counters.

Frozen seafood products have progressed further with packaging than fresh products, judging from the large selection of attractively packaged products available in supermarket frozen food sections. Unfortunately, the appearance of some packages is better than their ability to protect product quality.

The continued expansion of farmed seafood sales will require the movement of product through longer and more-complex distribution chains to reach consumers. Packaging therefore will become increasingly important to ensure high quality, good sales appeal and consumer satisfaction.

Protecting product

Even when under refrigeration, fishery products are among the most perishable of all products. Three biochemical and biological factors contribute to the rapid loss in quality.

The primary factor is bacteria, since fishery products are an excellent nutrient source for bacterial growth. Bacteria convert many natural components into off-odors or off-flavors, and sometimes produce toxic compounds.

Second, the lipids in fishery products are highly unsaturated compared to those of other muscle foods and are easily converted into rancid compounds. Third, several digestive and muscle enzymes actively break down muscle proteins, which can result in soft, mushy textures.

The action of enzymes can only be controlled by maintaining the product at very low temperatures. Packaging does not retard enzyme deterioration except in serving as an insulator during distribution. Packaging is a barrier to product contamination and assists in retarding lipid oxidation as a barrier to oxygen. Additionally, packaging can help prevent or reduce freezer burn.

The permeability of gases and water through packaging material is determined by its chemical composition. Today, high-barrier films, which may be laminated or coextruded, consist of two or more layers of materials that differ in composition. In this way, several properties such as gas permeability, heat sealing ability and flexibility at cold temperatures can be built into a single film to meet packaging needs.

Packaging materials

The objectives of packaging are to protect fishery products from dehydration, oxidation and contamination. A good package has:

- **Moisture proofness.** Loss of water during frozen storage results in a condition often referred to as freezer burn. The loss of water dries and toughens the food, and promotes oxidation. Freezer burn and oxidation are always accompanied by off-flavor, off-odor and off-color.
- **Low permeability.** Permeability is the rate at which packaging material permits vapors and gases to pass between the product and the surrounding atmosphere. There are large differences in the permeability of varied packaging materials and films.
- **Tight fit.** A tight-fitting package is essential to prevent moisture loss inside the freezer package. In a loose-fitting package, moisture evaporates from the fish and condenses as ice crystals on the inside surface of the package. If the product is warmed slightly during defrosting or when the freezer door is opened, moisture can move from the package surface back to the food surface. When the package cools again, the cycle is repeated. This can continue until a large quantity of water is removed from the food, causing severe dehydration.
- **Practial qualities.** Packaging materials must also be strong, easy to apply and relatively inexpensive. See Table 1 for a comparison of packaging materials.

Flick, Characteristics of freezer packaging materials, Table 1

Material	Permeability Water	Permeability Air	Tightness of Fit	Strength	Cost
Polyvinylidene chloride (saran)	Low	Very low	Very good	Medium low	Low
Polyvinyl chloride	Low	Very low	Very good	Medium	Low
Polyester bags, sleeves	Very low	Low	Good	Very high	Low
Ice glaze	Low	Low	Excellent	Very low	Low
Polyethylene wrap, bags	Medium	High	Poor	High	Low
Aluminum foil	Low	Low	Fair	Very low	High
CellophaneWaxed paper, cartons	Very high	Medium	Fair	Low	Low
	Very high	High	Poor	Adequate	Low

Table 1. Characteristics of freezer packaging materials.

Flexible packaging

Unfortunately, it is difficult to find packaging materials possessing all the desirable qualities listed. Each material has its advantages and drawbacks.

Waxed paper, waxed cartons, cellophane and polyethylene bags offer little protection to seafood products. Aluminum foil is a wrap to be used with caution. Foil is impermeable to gases, but difficult to seal properly, thus allowing easy passage of water vapor and air. Additionally, aluminum foil is not a tight-fitting wrap and is easily punctured.

Of the plastic films, polyester, polyvinylidene chloride (saran) and polyvinyl chloride (PVC) are all good barriers to oxygen and rank high in most other desirable characteristics of an ideal package. Both saran and PVC adhere to fresh fish and provide a good fit if air bubbles are crowded out. However, saran is not strong at very low temperatures. It is a good idea to overwrap saran packages with a protective paper.

Polyester bags and sleeves are widely used for commercial packaging. However, air must be evacuated from the bags by a vacuum pump or heat shrinking. Polyester is most suited for expensive, difficult-to-hold items such as cooked shrimp, salmon and crab, where the high value of the product offsets the relatively costly package.

Caution is required when removing oxygen from a container with vacuum packaging, since the resulting oxygen-free environment can promote conditions suitable for the growth and toxin production of anaerobic pathogens such as *Clostridium botulinum*. Toxin production is most likely to occur when the product is temperature abused for an extended time period. However, substantial research has shown that product spoilage usually occurs prior to toxin formation.

Additionally, the suppression of aerobic spoilage organisms can create conditions favorable for the growth of pathogenic aerobic bacteria such as *Listeria monocytogenes*, *Bacillus cereus* and *Aeromonas hydrophila*, and enterotoxigenic Escherichia coli. Therefore, vacuum packaging may selectively favor the growth of obligate and facultative anaerobic pathogens. If a product is vacuum packaged in an oxygen-impermeable film, it is advisable to open or remove the package prior to defrosting.

Modified atmosphere

The environment in modified-atmosphere packages is altered in order to reduce microbial growth and enzymatic degradation, and extend product shelf life. The principal gas used in modified-atmosphere packaging (MAP) is carbon dioxide. However, other gases, such as oxygen, are often added to prevent undesirable color changes.

Several factors influence the antimicrobial effects of carbon dioxide in modified-atmosphere packages. These include the initial microbial load, concentration of gas, temperature and film permeability. To be effective against aerobic spoilage microorganisms, 20-60 percent carbon dioxide is required within the headspace of modified-atmosphere packages.

Under these conditions, a variety of spoilage organisms including Pseudo-monas, Acinetobacter and Moraxella species are inhibited, but Brochothrix thermosphacta and lactic acid bacteria will continue to grow slowly. While there is the opportunity for pathogen growth as previously discussed for vacuum-packaged products, the risks presented by MAP may be no greater and could be frequently less than those associated with aerobically stored foods.

Controlled-atmosphere packaging (CAP) conditions are defined as the alteration of a gaseous atmosphere over a food product regardless of environmental or temperature fluctuations encountered by the product throughout its distribution. CAP, which creates a constant atmosphere irrespective of the product respiration and leakage, has been primarily used for fruits and vegetables, not fishery products. CAP extends the microbial lag phase, depresses microbial growth and inhibits the growth of certain spoilage microorganisms.

Rigid packaging

Rigid packaging materials include cans, glass containers and plastic composites. These types of packaging present a physical barrier to outside contaminants such as air and the ability to withstand fluctuations in heat, cold and pressure.

Metal cans are constructed from tinplate, aluminum or combinations of the two metals. Metal cans are used for packaging processed products because of their strength, speed of manufacturing, ease of filling and closing, and ability to withstand the high temperatures and pressures of canning or pasteurization processes. However, the limitations of metal cans include their weight, inability to reuse or reclose, disposal and the need to implement effective can closure quality control.

Glass containers do not appreciably deteriorate with age and are excellent barriers to solids, liquids and gases. Their main disadvantages as packaging are weight, fragility and disposal requirements. When using glass, light can affect product quality, thermal shock can cause product loss and transportation can result in breakage. One of the greatest impediments to glass is the reluctance to ice the product during transportation, since breakage can be increased.

Rigid plastic containers can be constructed from polyethylene, polystyrene, polyvinyl chloride, polypropylene and cellulose acetate. The type of plastic chosen is dependent upon food compatibility, cost, ease in processing and storage requirements. Disadvantages include low barrier qualities, lack of compatibility to heat or pressure, fragility at low temperatures and disposal.

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