

# Packaging technology for seafood goes hi-tech

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Among the different categories of food, seafood ranks third with respect to consumption. This more than explains the importance of fish. Fish is a vital source of nutrients for people across the globe. It is the most important single source of high-quality digestible protein, providing approximately 16 per cent of the animal protein consumed by the world's population. By any measure, fishes are among the world's most important natural resources.

Fish is also one of the highly perishable items which will damage if sufficient care is not taken. Various preservation methods have been in place to overcome the spoilage of fish. Proper packaging along with appropriate preservation methods will help in improving the keeping quality of fish. Packaging is considered as an important aspect for improving the shelf life and marketability of the fish and also packaging is one of the most dynamic, competitive, and developing markets.

The age of passive protective barrier functions that packaging was originally designed for is over. It is now time to be more functional and innovative. Consumers demand increased product information, traceability, and innovations in the packages.

## Traditional packaging

Traditional packaging for seafood was designed to provide the four primary functions of protection,

communication, convenience, and containment. Packaging protects the food product inside from environmental contamination and influences. Packaging communicates ingredients, nutritional facts, and marketing—which are all displayed on the exterior. Packaging also provides convenience for the consumer such as dispensing and resealing features, ease of handling, product visibility, and uniqueness as well as extra features, like the ability to cook and eat the product within its specific packaging. Packaging offers cost effective containment during transportation and storage that maintains food safety and minimizes environmental impact, while complying with industry requirements and meeting consumer demands.

## Smart Packaging Technologies

Conventional packaging concepts are limited in their ability to prolong the shelf-life of fish products. They offer limited protection and communicate only through the labelling. It will not provide any information about the quality and safety of the product.

ACTIVE AND INTELLIGENT PACKAGING, WHICH IS REGARDED AS SMART PACKAGING TECHNOLOGIES, ARE ADVANCED PACKAGING TECHNIQUES.

Active and intelligent packaging, which is regarded as smart packaging technologies, are advanced packaging techniques. This is finding its way in the preservation of various food systems including fish and shellfish. Active and intelligent packaging enhances the protection and communication functions, respectively. The market for active and intelligent packaging systems are fast growing and their demand is projected to reach USD 10.5 billion by 2021, fuelled by the development of new generations of products and more cost competitive prices. This will definitely spur greater market acceptance for many products.

## Active Packaging

Active packaging is an innovative concept that can be defined as a type of packaging that changes the condition of the packaging and maintains these conditions throughout the storage period to extend shelf-life or to improve safety or sensory properties while maintaining the quality of packaged food. Active packaging (AP) performs some desired role other than providing an inert barrier between the product and external conditions and combines advances in food technology, bio-technology, packaging and material science, in an effort to comply with consumer demands for 'fresh like' products. This involves incorporation of certain additives into the packaging film or within packaging containers with the aim of maintaining and extending product shelf life. Active packaging technique is either scavenging or

## SPECIAL PAPERS

emitting systems added to emit (e.g., N<sub>2</sub>, CO<sub>2</sub>, ethanol, antimicrobials, antioxidants) and/or to remove (e.g., O<sub>2</sub>, CO<sub>2</sub>, odour, ethylene) gases during packaging, storage and distribution.

and the generation time of spoilage microorganisms.

A carbon-dioxide generating system can be viewed as a technique complementary to Modified



*Oxygen scavenger sachet*

**O<sub>2</sub>-scavengers:** Fish products are highly susceptible to oxygen as it leads to the growth of aerobic microorganisms and oxidation which causes undesirable colour changes (like discolouration of pigments such as myoglobin, carotenoids), off-odours and flavours (as in rancidity as a result of lipid oxidation) and leads to loss of nutrients (for example oxidation of vitamin E, beta-carotene, ascorbic acid).

All these adversely affect the quality. Therefore, control of oxygen levels in food package is important to limit the rate of such deteriorative and spoilage reactions in foods. By use of an O<sub>2</sub>-scavenger, which absorbs the residual O<sub>2</sub> after packaging, quality changes of O<sub>2</sub>-sensitive foods associated with low residual oxygen levels can be minimised.

**CO<sub>2</sub>-emitters:** High CO<sub>2</sub>-levels (10–80 per cent) are desirable for moist food products like fish, shellfish and meat products, which inhibit surface microbial growth and thereby extend shelf-life. The overall effect of CO<sub>2</sub> is to increase both the lag phase

and the generation time of spoilage microorganisms. The potential of CO<sub>2</sub> in MAP and more recently generation of CO<sub>2</sub> inside the packaging system have been explored in relation to a number of commodities for their

successful preservation. Such systems are based on sodium bicarbonate, ferrous carbonate, ascorbate, citric acid etc.

**Moisture regulators:** Seafood products are wet food, which has a high vapour pressure. If it is not removed, this moisture will be absorbed by the product or condense on the surface, which cause microbial spoilage and inferior consumer appeal. Controlling of this excess moisture in packages is important to lower the water activity of the product, thereby suppressing microbial growth. Apart from this, removal of drip from chilled fish and melting water from frozen fish and shellfish makes the package more attractive to the consumer. An effective way of controlling excess water accumulation in a food package is the use of high barrier film material to water vapour permeability and use of moisture scavenger, such as silica gel, molecular sieves, natural clays, calcium oxide, calcium chloride or modified starch. Such drip-absorbent sheets consist of a super absorbent polymer in between two layers. The

preferred polymers for absorbing water are polyacrylate salts and graft copolymers of starch.

### Antimicrobial packaging:

Antimicrobial packaging is a fast-developing active packaging technique, especially for fish and meat products. Since microbial contamination of these products occurs primarily at the surface, due to post-processing handling, the use of antimicrobials in packaging can be advantageous to improve safety and to delay the spoilage. The principle action of antimicrobial films is based on the release of antimicrobial entities into the food, which extends the lag phase and reduces the growth phase of microorganisms in order to prolong shelf life and to maintain product quality and safety. To initiate antimicrobial activity, antimicrobial agents may be coated, incorporated, immobilised or surface modified onto package materials. The classes of antimicrobials range from acid anhydride, alcohol, bacteriocins, chelators, enzymes, organic acids and polysaccharides. Apart from these, various plant derivatives and derivatives from shellfish waste like chitosan can be incorporated into the packaging system as antimicrobials. This technology is not as widely accepted or utilized, due to strict regulations surrounding the use of antimicrobial substances for human consumption.

### Intelligent Packaging

Intelligent Packaging monitors the food and environment inside the package and communicates the relevant information regarding quality, whether that is to the end consumer or anywhere throughout the flow of seafood in the supply chain. It is functional and it records, detects, senses, traces, and communicates information about the food product to extend shelf-life, improve quality, and identify any safety concerns. The three major types of Intelligent

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Packaging are indicators, sensors, and data carriers.

### Indicators

Indicators can only provide qualitative information about the food inside the package, most commonly in the form of an irreversible colour change that provides data to the consumer. Different types of indicators include



*Freshness indicator for seafood*

freshness indicators, and time temperature indicators (TTI), all providing information about the quality and safety of the food within the package. TTIs have become very common as many food manufacturers and distributors are including these on the boxes or inner packaging of refrigerated and frozen products to track mishandling and temperature abuse through the supply chain.

### Time-temperature indicators (TTI)

TTIs work on the principle that the quality of food deteriorates more rapidly at higher temperature due to biochemical and microbial reactions. Operation of TTIs is based on mechanical, chemical, electrochemical, enzymatic or microbiological change usually expressed as a visible response in the form of a mechanical deformation, colour development or colour movement. The visible response gives a cumulative indication of

the temperatures to which the TTI has been exposed. TTIs consist of small tags or labels that keep track of time-temperature histories to which a perishable product like fish is exposed from the point of production to the retail outlet or final consumer. Their use in fishery products offers enormous opportunities where monitoring of the cold distribution chain, microbial safety and quality

are of paramount importance.

### Freshness indicators

Freshness indicators are based on the detection of volatile metabolites produced during ageing of foods, such as CO<sub>2</sub>, diacetyl, amines, ammonia and hydrogen sulphide. Freshness indicators provide direct product quality information resulting from microbial growth or chemical changes within a food product. Normally, the freshness indicators are incorporated into the packaging film, which reacts with volatile amines and other indicating agents produced during the storage of fish and other seafood, and the freshness is indicated by a colour change.

### Sensors

The sensing part of a sensor is often referred to as the receptor and is capable of quantitative measurement, whether that is

activity, concentration, composition, etc. The receptor sends its data signal out to a transducer, which measures the result. Transducers can be either passive, which do not require external power for measurement or active, which require power. Determination of headspace gases provides a means by which the quality of a fish and meat product and the integrity of the packaging in which it is held can be established rapidly and inexpensively. The monitoring of these gases in the package helps in establishing the food quality. Portable headspace gas analysers use minimally destructive techniques but are not applicable to real-time, on-line control of packaging processes. An optical sensor approach offers a realistic alternative to such conventional methods. They can be used as a leak indicator or to verify the efficiency of O<sub>2</sub>-scavenger, CO<sub>2</sub>-emitter or MAP systems. Most of these indicators assume a colour change as a result of a chemical or enzymatic reaction.

### Data Carriers

The most common and simplest type of data carrier is a bar code, which has been used on packaging for decades. Barcodes are still used for identification, but have progressed to QR codes and the more advanced radio frequency identification (RFID). RFID tags have a microchip attached to an antenna and communicate through electromagnetic waves. RFIDs can be passive (no battery, powered by electromagnetic waves emitted by the reader); semi-passive (use a battery to emit electromagnetic waves or store information); or active (powered by an internal battery to run internal data management and broadcast it to a reader). Originally designed as tracking devices used for identification, traceability, counterfeit protection, and warehouse automation, RFIDs have advanced tremendously and progressive technology combining sensors with RFID technology are



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resulting in monitoring capabilities allowing food quality to be recorded and communicated throughout the supply chain. This ensures freshness, quality, and safety of the food products.

### Conclusion

Seafood packaging has to provide the essential functions to the seafood for which it was originally designed. But with the recent advances in technological



*Data carrier tag on Tuna*

breakthroughs, smart packaging is fast evolving and becoming main stream. By combining the existing technologies of active and intelligent

packaging, a new and exciting field of smart packaging can be emerged, which can provide a complete solution to the sea food industry by monitoring both the product and its environment in real-time. Smart packaging can also be a valuable tool in seafood safety risk management. As the technology behind these packaging techniques continues to advance at a rapid pace, simultaneously driving costs down, what once seemed out of the realm of possibility will become a standard practice in the seafood industry.



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