

WANT TO KEEP YOUR FISH FRESH LONGER?

Adopt Reduced Oxygen Packaging (ROP) Technologies.

Remya, S^a., Mohan, C. O^b., Ravishankar, C. N^b., Srinivasa Gopal, T. K^b., and Venkateshwarlu, G^c

Focal Points at a Glance: Explaining that Reduced Oxygen Packaging of fish will keep the fish fresh for a longer duration. The author provides particulars thereof (in respect of Reduced oxygen packaging, Vacuum packaging, Modified Atmosphere Packaging, Controlled Atmosphere Packaging and cook - chill and Sous-vide Packaging for the benefit of the processors).

Introduction

Fish is a highly perishable food commodity. This is so because of its unique biological composition. The keeping quality of fish is limited in the presence of atmospheric oxygen. This is due to the undesirable chemical changes like lipid oxidation and growth of aerobic spoilage micro-organisms. Different preservation methods have been adopted by the industry to minimise these unwanted effects. Reduced Oxygen Packaging (ROP) i.e., reducing the oxygen content within the package either completely or partially has led the revolution of fresh and minimally processed food preservation as is in existence for the last two decades. High levels of oxygen present in food packages may facilitate microbial growth, off-flavours and off-odours development, colour change, and nutritional losses, thereby causing significant reductions in the shelf life of foods. Therefore, control of oxygen level in food packages is important to limit the rate of these deteriorative and spoilage reactions in foods.

Reduced Oxygen Packaging (ROP)

The expression 'Reduced Oxygen Packaging (ROP)' conveys the meaning - 'removal, displacement, replacement or controlling the oxygen content' in a package below the 21% normal oxygen concentration. To say in a different way, ROP is defined as the reduction of the amount of oxygen in a package by

removing oxygen; displacing oxygen and replacing it with another gas or combination of gases. In other words, it is a method of controlling the oxygen content at a level below level that is normally found in the surrounding atmosphere, i. e., 21%.

Types of ROP: These are of four types: 1) Vacuum Packaging (VP), 2) Modified Atmospheric Packaging (MAP), 3) Controlled Atmospheric Packaging (CAP), and 4) Cook-chill (CC) and Sous-vide (SV) Packaging.

1. Vacuum packaging (VP)

In vacuum packaging, air is removed from the package and the package is hermetically sealed so that vacuum is maintained inside the package. The product is packed in a flexible packaging film with good moisture and oxygen barrier properties and it can be easily sealed. Fish is an important part of human nutrition because of the high content of polyunsaturated fatty acids (PUFAs), especially of the n-3 series. But the unsaturated fatty acids in the fish are prone to lipid oxidation, leading to flavour changes and loss of nutritional quality. Vacuum packaging is one of the best methods for effectively delaying fat oxidation as it limits the availability of oxygen molecule for oxidation. The product kept under a lower O₂ atmosphere, with less than 1%, inhibits the growth of aerobic spoilage micro-organisms, compared with the normal atmospheric packaging. Many studies

have proved the effectiveness of vacuum packaging for prolonging the keeping quality of fish by slowing down the lipid oxidation and microbial growth. For example, Arashisar *et al.*, (2004) reported lower microbial counts in vacuum packed rainbow trout, Pantazi *et al.*, (2008) observed an increased shelf life in Mediterranean swordfish and Rajesh *et al.*, (2002) found that vacuum packed seer fish (*Scomberomorus guttatus*) steaks had an extension of 10 days of storage life compared with those kept in air.

The vacuum packaging technology is very simple to use and cost effective, compared to other available technologies. No special training is required to use the vacuum sealing machine which is easy to maintain. The cost of vacuum packaging machine varies from Rs 2 to 6 lakhs depending on the manufacturer. Although vacuum packaging is advantageous, it suffers from few drawbacks. It is not a viable technology for products with crisp and delicate nature and sharp edges. It requires strict maintenance of temperature as anaerobic conditions created in this method will help in the growth of pathogens like *Clostridium botulinum* and *Listeria monocytogenes*.

2. Modified atmosphere packaging (MAP)

In modified atmosphere packaging, the atmosphere of a packed food is modified so that its composition becomes different from air. However, the

^aFish Processing Division, CIFT, Veraval Research Centre, Veraval, Gujarat 362 269, India

^bFish Processing Division, CIFT, Matsyapuri P.O, Willingdon Island, Cochin 682 029, India

^cCentral Institute of Fisheries Education, Andheri (W), Mumbai, Maharashtra 400 061, India

*Corresponding author: Remya, S, Scientist, Fish Processing Division, Central Institute of Fisheries Technology, Veraval Research Centre, Veraval, Gujarat 362 269, India

Tel.: +91 2876 231297; Fax: +91 2876 231576; E-mail: remya03cof@gmail.com

atmosphere may change over time due to the permeability of the packaging material or the respiration of the food (Hintlian & Hotchkiss, 1986).

It is well documented that the shelf life of marine products can be extended by MAP. But the extension in the keeping quality of fish depends on the raw material quality, temperature, gas mixtures and packaging materials (Davis, 1993). It is a critical job to optimise the gas mixture composition in MAP so as to ensure both product quality and safety (Møller *et al.*, 2000). Various atmospheres have been studied in fish packaging. Nitrogen (N₂), oxygen (O₂) and carbon dioxide (CO₂) are the main gases used commercially in seafood (Randell *et al.*, 1997; Gimenez *et al.*, 2002), although trace gases, such as carbon monoxide, nitrous oxide, sulphur dioxide, argon, and xenon are mentioned as possible gases for MAP in meat, fruits, and vegetables.

Argon is a very important one among the new gases as it is very similar to nitrogen but denser and more soluble in water than nitrogen and oxygen (Spencer & Humphreys, 2003), which could have relevant consequences on its effect on shelf life. However, it is very costly and maintenance is not very easy.

Oxygen: It causes oxidative rancidity in fatty fish. So, O₂ is reduced in gas mixtures for fatty fish. Oxygen stimulates growth of aerobic bacteria and inhibits growth of strictly anaerobic bacteria in seafood. However, O₂ may be used in low concentrations in fish products to retard the anaerobic conditions and to avoid the outbreak of strictly anaerobic pathogens, such as non proteolytic *C. botulinum*, while the lower O₂ condition may be effective for proliferation of psychrotrophic, facultatively anaerobic bacteria like, *L. monocytogenes* and *Shewanella putrefaciens*.

Nitrogen: N₂ is an inert, odourless, and tasteless gas. Nitrogen delays oxidative rancidity and inhibits the growth of aerobic micro-organisms by displacing the oxygen in packs. It is used as a filler to prevent package collapse, because of its low solubility in water and fat in gas packaging.

Carbon dioxide: From the microbiological point of view, the most important gas is CO₂. It acts as an antimicrobial agent because of its bacteriostatic and fungistatic properties. It inhibits the growth of micro-organisms during the logarithmic phase and extends the lag phase. CO₂ is able to dissolve into the liquid phase in muscle, which is associated with the increased carbonic acid. The bicarbonate ion, a

dissociation product, changes cell permeability, and affects metabolic processes. Different concentrations of CO₂ has some effects on bacteria. This explains: weak acids are known to have anti-microbial activity in their undissociated form. Hence carbonic acid is unique as a microbial inhibitor since at pH values near neutrality at least one half of the acid is in the undissociated form.

The ratio of the volume of gas and volume of food product (G/P ratio) may need to be twice the volume of fish meat for adequate microbial retardation, although CO₂ is dissolved and absorbed into the fish meat surface during storage. Furthermore, the carbonic acid may lower pH, resulting in slight flavour changes in fish, and its absorption by the product may also cause package collapse. It was reported that high concentrations of CO₂ for fish should be avoided since it dissolves into the fish flesh and deforms the package. A high CO₂ content causes a higher exudate loss. This may be due to a greater loss of the water holding capacity of the muscle protein at lower pH values. However, the use of a MAP with an enhanced carbon dioxide level has been found to extend the shelf life of fresh fishery products by retarding microbial growth. MAP with CO₂-enriched atmosphere retards respiratory organisms and dominates *Photobacterium phosphoreum* and lactic acid bacteria (LAB). Under MAP conditions, the higher growth rate of lactic acid bacteria compared to other species could be attributed to the tolerance to carbon dioxide. The growth of LAB was concomitant with the increase in lactic acid concentration and bacteriocin, which is a natural antimicrobial agent. The formation of lactic acid may have led to the inhibition of other bacteria in seafood products. Generally, the spoilage flora would be replaced, probably to a large extent, by CO₂ resistant organisms, e.g. LAB and *Brochothrix thermosphacta*.

Gas mixtures containing CO₂ and O₂ have also extended the shelf life of fishery products. It has been reported that 40% CO₂ and 60% O₂ significantly inhibited the microbial growth in cod fish. 35–100% CO₂ and O₂ or N₂ mixtures in packed shrimp, and 50–100% CO₂ in them also greatly inhibited the microbial growth in MAP compared to air in spotted shrimp. It has been recommended that gas mixtures for the lean fish and fat fish should be 40% CO₂+30% N₂+30% O₂ and 60% CO₂+40% N₂, respectively. However, for the maximum microbial inhibition 100% CO₂ has been used in cod fillets. Yesudhason *et al.*, (2009) had reported that there was an extension in shelf life of seer fish steaks

stored in 60% CO₂:40% N₂ atmosphere. The shelf life of fish steaks packaged in MA was 21 days whereas air-stored samples had a storage life of 12 days only in chilled storage.

MAP technology can be applied to any fish varieties; however, the gas combinations have to be optimised for better results. The technology is simple and easy to adopt after obtaining adequate training. The cost of the MAP equipment varies from Rs 4 lakhs (for single gas MAP) to Rs 12 lakhs (for 2-3 gases MAP). As CO₂ is used in the MAP which creates anaerobic conditions favouring the growth of most harmful pathogens like *Clostridium botulinum* and *Listeria monocytogenes*, measures have to be taken to control these pathogens by strictly maintaining the temperature.

3. Controlled Atmospheric Packaging (CAP)

Controlled atmosphere packaging, in which the atmosphere of a packed food is modified so that, until the package is opened, its composition is different from air, and continuous control of that atmosphere is maintained. This is achieved either by using oxygen scavengers or a combination of total replacement of oxygen, non-respiring food, and impermeable packaging material.

Oxygen Scavengers: Oxygen can cause significant negative effects on food quality. So, Oxygen scavengers can help in maintaining the quality of the food product by decreasing food metabolism, reducing oxidative rancidity, inhibiting undesirable oxidation of labile pigments and vitamins, controlling enzymic discoloration and inhibiting the growth of aerobic micro-organisms.

The different mechanisms of action of oxygen scavengers are: a) Oxidation of iron and iron salts; b) Oxidation of photosensitive dyes; c) Oxidation of ascorbic acid; d) Oxidation of unsaturated fatty acids (oleic, linoleic); e) Oxidation of rice extract; and f) Oxidation of immobilised yeast on a solid substrate.

Typical oxygen absorbing systems are based on the oxidation of iron powder by chemical means or scavenging of oxygen through the use of enzymes.

Oxidation of Iron powder: The most well known oxygen scavengers used will be in the form of small sachets containing various iron based powders combined with a suitable catalyst. This is the most widely used mechanism today and one of the most



effective. These chemical systems often react with water present in the food to produce a reactive hydrated metallic reducing agent that scavenges oxygen within the food package and irreversibly converts it to a stable oxide. So, the iron which is kept in a small sachet is oxidised to iron oxide. The iron powder is separated from the food by keeping it in a small, highly oxygen permeable sachet that is labelled 'Do not eat'. The main advantage of using such oxygen scavengers is that they are capable of reducing oxygen levels to less than 0.01% which is much lower than the typical 0.3–3.0% residual oxygen levels achievable by modified atmosphere packaging (MAP). The type and amount of absorbent that needs to be used in a sachet is determined by the initial oxygen level in the package, the amount of dissolved oxygen present in the food, the permeability of the packaging material, the nature (size, shape, weight, etc.), and the water activity of the food. The oxygen scavenger using iron oxidation suffers from disadvantage like : it cannot pass the metal detector in a process line.

Non-metallic oxygen scavengers have also been developed to alleviate the potential for metallic taints being imparted to food product. The problem of inadvertently setting off in-line metal detectors is also alleviated even though some modern detectors can now be tuned to phase out the scavenger signal whilst retaining high sensitivity for ferrous and non-ferrous metallic contaminants.

Enzymatic oxidation: An enzymic oxygen scavenger system is one of using either glucose oxidase or ethanol oxidase which could be incorporated into sachets, adhesive labels or immobilised onto packaging film surfaces. In enzymatic oxygen scavenging systems, an enzyme reacts with a substrate to scavenge oxygen. These systems are more expensive than iron-based systems, due to the cost of enzymes used for the oxygen scavenging purpose. Enzymatic oxidation systems are also usually very sensitive to temperature, pH, water activity, and to solvent/substrate present in the sachet, thus limiting the widespread use of these enzyme-based systems.

The Oxygen scavengers were first developed and introduced to the food packaging market in Japan in 1976 by the Mitsubishi Gas Chemical Co. Ltd under the trade name Ageless™. Since then, several other Japanese companies including Toppan Printing Co. Ltd and Toyo Seikan Kaisha Ltd have entered the market but Mitsubishi still dominates the oxygen

scavenger business in Japan. It should be noted that oxygen scavenging sachets suffer from the disadvantage of possible accidental ingestion of the contents by the consumer and this has hampered their commercial success. However, in the last few years, the development of oxygen scavenging adhesive labels that can be applied to the inside of packages and the incorporation of oxygen scavenging materials into laminated trays and plastic films has enhanced and will encourage the commercial acceptance of this technology.

Pack collapse or the development of a partial vacuum can also be a problem for foods packed with an oxygen scavenger. To overcome this problem, dual action oxygen scavenger/carbon dioxide emitter sachets and labels have been developed, which absorb oxygen and generate an equal volume of carbon dioxide. These sachets and labels usually contain ferrous carbonate and a metal halide catalyst although non-ferrous variants are available.

Mohan *et al.*, (2009) reported that O₂ scavenger was effective in reducing the O₂ content of the pack up to 99.95% within 24h and it extended the shelf-life of seer fish (*Scomberomorus commerson*) steaks upto 20 days compared to only 12 days for air packs during chilled storage.

4. Cook-chill (CC) and Sous-vide (SV) Packaging

New definition of ROP includes cook chill and sous vide packaging. There were some earlier misunderstandings whether CC and SV were in fact ROP. Cook chill packaging, in which cooked food is hot filled into impermeable bags which have the air expelled and are then sealed or crimped closed. The food placed in a bag is rapidly chilled and refrigerated at temperatures that inhibit the growth of psychrotrophic pathogens. Sous vide packaging is similar except that the food is cooked in the bag after sealing and not before sealing as is done in cook chill packaging. Sous vide is often confused with the cook chill technique used to prepare food that is later reheated in water. One problem is that both techniques use a plastic bag and water for reheating and this has added to the confusion. However, there are important differences in the production techniques and the resulting products. The cook chill food is cooked by conventional methods, and generally cooked before being transferred to plastic storage bags.

Sous vide cooking differs from traditional

cooking methods in two fundamental ways: the raw food is vacuum-sealed in heat-stable, food-grade plastic pouches and the food is cooked using precisely-controlled heating. Vacuum-sealing has several benefits: it allows heat to be efficiently transferred from the water (or steam) to the food; it increases the food's shelf-life by eliminating the risk of recontamination during storage; it inhibits off-flavours from oxidation and prevents evaporative losses of flavour volatiles and moisture during cooking and reduces aerobic bacterial growth which results in especially flavourful and nutritious food.

Sous-vide is a French word for "under vacuum" and sous vide cooking is defined as "raw materials or raw materials with intermediate foods that are cooked under controlled conditions of temperature and time inside heat-stable vacuumised pouches. *Sous-vide* products are typically heated at relatively mild temperatures (65–95°C) for a long period of time followed by rapid cooling to attain a temperature of 3°C in the centre of the product. The heat treatment and vacuum packaging techniques used in *sous-vide* technology delay the oxidation of lipids and muscle pigments while slowing down the microbiological spoilage of cooked foods during refrigerated storage (Douglas, E. B. 2011).

Dishes are stored at temperatures below 3.3°C to prevent the growth of *Clostridium botulinum*, *Bacillus cereus* and other pathogenic microbes resistant to the pasteurisation. However, refrigerated sous vide meat can suffer spoilage by the action of lactic acid bacteria, which produce sour off-flavours and off-odours, milky exudates, a slimy texture and CO₂, which may cause swelling of the pack and/or greening. Moulds and yeasts can also grow in refrigerated sous vide meats. In addition, meat prepared by this method may undergo proteolysis, lipolysis and enzymatic and chemical oxidation during refrigerated storage, leading to changes in texture, colour, odour and flavour, sometimes accompanied by a loss of firmness, darkening, rancidity, sourness and other off-odours and off flavours. The UK Advisory Committee on the Microbiological Safety of Food recommends for cooked-chilled products with an extended shelf-life of more than 10 days a heat treatment at 90°C for 10 min or equivalent lethality and strict chill conditions to control *Clostridium botulinum*. In order to eliminate non-spore forming pathogens such as *Listeria monocytogenes*, a heat treatment at 70°C for 2 min or an equivalent heat process is required.

Conclusion

Reduced Oxygen Packaging technologies have become increasingly popular by causing major changes in the storage, distribution, and marketing of raw and processed fish products in many countries. ROP along with intelligently applied gentle hurdles will have a synergistic effect in further improving the shelf life and organoleptic quality of fish and fish products. It is expected that the fast changing Indian life style will open up new avenues for ROP food products in the near future.

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Centre's Ban on Removal of Fins from Sharks for Export

The ban on the export of shark fins by the Centre is unlikely to deeply hurt the country's marine products exports, says Seafood Exporters Association of India President, AJ Tharakan.

"Shark fin is a minuscule part of India's seafood exports and hence the ban shall not cause any major impact", the President is reported to have observed, pointing out that of the nearly \$5 billion value of seafood exports in 2014-2015, shark fins would be only around \$3 or \$4 million. He said that the ban was a conservation measure to prevent the rapid depletion of the shark population in Indian waters.

The Union Ministry of Commerce and Industry has prohibited the export of fins

of all species of shark. A Ministry notification on February 6 said that it had inserted a new entry in Chapter 3 of Schedule 2 of ITC (HS) Classification of Export and Import Items. The new entry (31A) resulted in the ban on export of all shark fins.

India is the second largest producer of sharks, after Indonesia. Around 75,000 tonnes of sharks are caught each year. Last year, India banned shark 'finning', a fishing practice whereby a shark's fins are chopped off, while they are still alive.

The rest of the body is dumped back into the sea where, unable to swim, they die a slow death or eaten by other fish. Worldwide, about 70 million sharks are estimated to be killed every year for

their fins.

Shark fin is the main ingredient of 'shark fin soup', an expensive delicacy eaten mainly in China. Though shark finning has been banned by many countries, the ban has not been very effective because of the high demand.

India, though a big catcher of sharks, is not a big exporter of fins.

Also, since the seafood exports have been booming in the last few years and exports is expected to touch \$5 billion. The exports are riding on the back of vannamei shrimps which have huge demand in Japan and Far Eastern countries as well in the US.

Indian P.M. discussed problems of Indian fishers fishing in the 'Srilankan' waters

In a top-level visit that came after 28 years by the Prime Minister of India, he is reported to have reached out said in Sri Lanka, the security of the two countries is "indivisible" and favoured a life of equality justice and dignity for Tamil fishers

The first Indian PM to visit the island after Rajiv Gandhi's trip in 1987, Mr. Modi met President of Srilankan Maithripala Sirisena and expressed his "admiration" for his efforts to build future for Sri Lanka-

India fishing co-operation. The Prime Minister referred to the significance of his visit, saying "helps us to understand each other better, finds solution to mutual concerns and move our relationship forward.

Mr. Modi, who discussed the fishermen's issue - a major irritant in bilateral ties - with Mr. Sirisena, said this complex question involves livelihood and humanitarian concerns on both sides.

"We should handle the issue from this perspective. At the same time, we need to find a long-term solution to this issue," he is reported to have said following Premier Ranil Wickremasinghe's controversial statement recently that intruding Indian fishermen would be shot by Sri Lankan Navy. The Prime Minister suggested that fishermen's association of India and Sri Lanka should meet at the earliest to find a mutually acceptable arrangement.

