A REVIEW Asian Journal of Bio Science, Volume **9** | Issue 1 | April, 2014 | 109-112
Received : 13.12.2013; **Accepted :** 20.03.2014

Role of vacuum packaging in increasing shelf-life in fish processing technology

PURUSHOTAM KUMAR **AND SUBHA GANGULY**

Department of Fish Processing Technology, Faculty of Fishery Sciences, West Bengal University of Animal and Fishery Sciences, KOLKATA (W.B.) INDIA
Email : ganguly38@gmail.com

Vacuum packaging involves placing a product in a film of low oxygen permeability, the removal of air from package and the application of a hermetic seal. Exclusion of the air from the package and thus creating a vacuum is, in effect, a certain type of modification of the atmosphere. The little gaseous atmosphere likely to be present in the beginning in the package will undergo changes during storage because of the metabolism of the product and/or action of micro-organisms and all the volatiles produced as a result of the decomposition are sealed within the package.

Key words : Fish processing, Vacuum packaging, Shelf life, Storage, Preservation

How to cite this paper : Kumar, Purushotam and Ganguly, Subha (2014). Role of vacuum packaging in increasing shelf-life in fish processing technology. *Asian J. Bio. Sci.*, **9** (1) : 109-112.

INTRODUCTION

Vacuum packaging represents a static form of hypobaric storage which is widely used in the food industry due to its effectiveness in reducing oxidative reactions in the product at relatively lower costs. In vacuum packaging, the product is contained in a package made of a material having low oxygen permeability and is sealed air tight after evacuating the air.

The use of vacuum packing in gas impermeable and heat stable material has many advantages:

- No or low risk of post pasteurization contamination.
- Ease of handling.
- Inhibition of growth of aerobic spoilage organism.
- Inhibition or slowing of deleterious oxidative reaction in the food during storage due to oxygen barrier properties of the packaging material.

Characteristics of packaging film for vacuum packaging of fresh fish :

- Enough strength to prevent from breakage during handling.
- High barrier to oxygen.
- Water vapor barrier.
- Heat sealability.
- Oil resistance.
- Transparent.
- Chemical resistant.

Characteristics and nature of vacuum packaging :

Vacuum packaging represents a static form of hypobaric storage which is widely applied in the food industry due to its effectiveness in reducing oxidative reaction in the product at relatively low cost (Srinivasa Gopal *et al*., 1999). Huss (1972) compared the quality of the lowest oxygen content, the lowest bacterial count and the highest quality score and a six days extension of shelf life was obtained. Hansen (1972) found that Atlantic herring and trout stored directly in ice become rancid in 6 days. Fish stored in evacuated polyamide polythene bags did not become rancid during 20 days of storage, but they did develop an objectionable odor and flavor due to bacterial activity. Pretreatment before vacuum packaging has been studied to improve the shelf life of fresh seafood products.

Establishment of concept through researches on effect of vacuum packaging in processed fish :

Fillets were produced from fresh Atlantic cod (*G. morhua*) stored on ice for 0,3 and 6 days. Subsequent storage was in 10 lb plastic trays under hypobaric condition (20mm, 10mm or 6.2 mm Hg) at 1-2^{o}C. Fish were sampled every 3 days for total aerobic and anaerobic plate counts, TMA content, moisture,

raw quality assessment and taste panel analysis. Results from laboratory and physical analysis indicated that hypobaric storage at the pressure used in this study did not significantly extend the shelf life of cod fillets (Bligh *et al*., 1984). Eviscerated Atlantic herring and cod were held at 2-4^{0}C in air at 1 atm., and at 0.018-0.026 atm. in a hypobaric chamber. Fish held at low pressure retained a highly acceptable odour and appearance for approximately 3 days longer than those held in conventional refrigeration (Haard *et al*., 1979). Fillets of lean (cod) and fatty fish (Herring and Mackeral) were stored in a hypobaric chamber at -1.1 to -0.55^{o}C under a pressure of 10 mm of Hg. The atmosphere was changed twice hourly and had a relative humidity greater than 95 per cent. The growth of bacteria in the fillet was slowed and qualitative shift in the micro flora occurred, compared with fillet held at 0^{o}C on ice. The rate of development of rancidity in the fatty fillets was also decreased, the present study concludes, 10-15 per cent extension in keeping times of hypobarically stored fillets was observed at 0^{o}C.

Implications and directives for use of vacuum packaging :

In this storage environment, the atmosphere is constantly vented, its pressure is reduced, the humidity is nearly saturated and the temperature is controlled. The reduced oxygen tensions slowdown the oxidation of lipid and the activities of some undesirable micro-organisms. Chilled lean fish such as cod is spoiled by the action of visceral ferments, endogeneous enzymes, and the microbial flora (Varga *et al*., 1980). The storage life of wet fish fillets is thus limited primarily by the activities of the bacterial flora, especially the proteeolyticpsychrophilic groups (Castell *et al*., 1949). Development of rancidity in chilled fatty fish such as herring and mackerel often appears earlier than the proteolytic spoilage of muscle tissue. Lipids of these fishes are highly unsaturated and subject to rapid auto-oxidation (Varga *et al*., 1980). The first products of oxidation are the hydro peroxides (Ke *et al*., 1977). These are further decomposed into various carbonyl compounds, which are responsible for the rancid flavor of the flesh (Ackman, 1967; 1974). The rate of microbial activity and lipid oxidation in the fish could be affected by storage in a hypobaric environment. A measurable change in the speed of these processes should influence the keeping quality of chilled fish flesh (Varga *et al*., 1980). Varga *et al*. (1980) observed that cod fillet stored in ice had low taste panel scores, and higher TMA-N and TVB-N values than fillets stored in the hypobaric chambers. Varga *et al*. (1980) also observed that the PV and TBA values were markedly lower in herring fillets (skin on) stored under vacuum compared to fillets stored in ice. The spoilage rate of herring fillets in low pressure storage was lower and the storage life was 9 per cent higher than for fillets stored in ice. The slower growth of bacteria and the slow oxidation of the lipid resulted in a measurable increase in storage life of fillets of lean and fatty fish held in the hypobaric environment. The storage life of cod and herring fillets in ice at 0^{0}C was 13 days and 13.3 days, respectively. The spoilage rate of fillets in the hypobaric chamber was further reduced and the storage life increased at storage temperature of -0.55^{o}C. A further lowering of the storage temperature in the chamber to -1.1^{o}C resulted in another extension of keeping time to 18 days for cod and 21 days for mackerel fillets. Quality stability of mackerel based burgers was investigated during 60 days of frozen storage. Burgers were (1) packed under normal (air) conditions (2) placed in vacuum packaging (3) made with added antioxidants and packaged. It was concluded from chemical and sensory analysis that vacuum packaging with added antioxidant was effective in preserving the quality of mackerel burgers during frozen storage for 60 days (Lee *et al*., 1993). Sensory and chemical analysis indicated that vacuum packaged sardine burgers could be stored for 90 days without significant losses of quality (Ihm *et al*., 1992). Protein solubility of cod fillets sealed under vacuum was significantly higher than this fillets sealed in the presence of air during 18 months storage study at -25^{0}C (Sirois *et al*., 1991). Wild salmon and farmed rainbow trout both packed in transparent vacuum skin packaging was followed during storage for 6 months at -17^{o}C. Rancidity developed faster in steaks of wild salmon, as compared to steaks of farmed rainbow trout (Andersen *et al*., 1990). Vacuum packaging was most effective in retarding oxidative rancidity and prolonged shelf life of fresh fish by suppressing growth of psychrotropic aerobes associated with spoilage (largely Pseudomonas) and samples became unacceptable organoleptically well before the point at which *C. botulinum* could be a problem at 4^{o}C (very slow toxin production at less than 10^{0}c temperature) (Hwang and Regerstein, 1989). It is emphasized that the success of vacuum packaging is completely dependent on the initial quality of the fish and adequate temperature control, throughout the storage period (Clingman and Hooper, 1986).

Influence of vacuum packaging on biochemical, microbiological and sensory properties of stored fish :

Individually frozen fish (*Coregonusclupeaformis*) rapidly develop oxidative off flavors when stored without packaging at -12^{0}C, but both vacuum packaging in barrier films and ice glazing significantly suppressed development of oxidized flavors through 24 weeks of storage. Polythene pouches significantly improved oxidative stability compared to those stored unprotected. However, vacuum barrier film packaging gave significantly better protection than polythelene at both -12^{0}C and -25^{o}C through 24 and 72 weeks storage, respectively (Josephson *et al*., 1985). Alternation in the pressure of gaseous composition during storage can be applied to reduce bacterial and oxidative spoilage of fresh fishery products. While oxygen

depletion is effective in retarding the growth of the typical spoilage bacteria, there is a possibility that if the product is temperature abused it may become toxic (Wilhelm, 1982). Studies on vacuum/ carbon dioxide flush packaging of fresh fish have shown that the technique introduces no toxicological hazard from *Clostridium botulinum*toxin (Bannar, 1979). Vacuum packaging may reduce counts and extend the shelf life (Daley and Deng, 1978). The complete removal of oxygen from a pack of fresh meat ensures longer preservation against microbial deterioration than packaging in oxygen. Using a packaging material of low oxygen permeability can reduce oxidation of meat. Vacuum packaging provides some increase in shelf life. But anaerobic condition can pose potential problem. Effectiveness of oxygen excluding atmosphere (vacuum, carbon dioxide and nitrogen) in inhibiting spoilage bacteria was documented for a variety of meat products such as pork, beef, ham, veal and pastrami (Lee *et al*., 1983; Laleye *et al*., 1984).Vacuum packaging of wholesale, fresh meat is increasingly being practiced by meat industry, as it reduces shrink loss, protects meat colour and delays microbial spoilage (Mendonca *et al*., 1989). Dalgaard (1993) reported that vacuum and MAP have been proved to extend the shelf life of beef, pork and poultry at refrigerated temperature. Currentlythere is a considerable interest in extending the shelf life of refrigerated, packed fish for supermarket trade (Meekin *et al*., 1982).

Micro-organisms play an important role in the spoilage of seafoods (Cann, 1977), bacterial flora are the function of the environment. Warm water fishes have more mesophilic and gram positive bacteria while coldwater carry predominantly Gram negative population (Shewan, 1977). The spoilage of fresh meat in chilled environment is caused by the superficial bacterial slime. The main bacteria are pseudomonas spp. When fresh meat is vacuum packed in carbon dioxide, the growth of *Pseudomonas* spp. is inhibited thus extending the shelf life. It is proved beyond doubt that spoilage of fish is primarily due to bacterial action (Liston, 1980). The changes can be correlated with endogenous and bacterial enzymes causing changes in the chemistry of the fish muscle. Up to 5-6 days, the spoilage odor is not seen and this corresponds to the lag phase and for the next four days the odor intensity became musty and the flesh became softer. This period corresponds to the logarithmic phase. In the last stage where bacterial growth begins to slow down, the flesh become sour, sweet or bready and the flesh is defiantly soft.

Conclusion :

Vacuum packaging has been shown to extend the shelf life for periods varying from six days onwards. However, even though the product may not develop rancidity in extended periods of storage, it may develop objectionable odors and flavors due to bacterial activity.

LITERATURE CITED

Ackman, R.G. (1967). The influence of lipids on Fish quality. *J. Food Technol.,* **2** : 169.

Ackman, R.G. (1974). Marine lipid and fatty acid in human nutrition. In : *Fishery products*, R. Kreuzer (Ed.), Fishing News (Books) London, UNITED KINGDOM.

Bannar, R. (1979). Vacuum packaging for fresh fish scaling the first hurdle. *Food Engg. Internat.,* **4**(1) : 56-58.

Bligh, E.G., Woyewoda, A.D., Shaw, S.J. and Hotton, C.H. (1984). Hypobaric storage of atlantic cod fillets (Godusmorhua). *Canadian Institute of Food Sci. Technol. J.*, **17**(4) : 266-270.

Cann, D.C. (1977). Bacteriology of shell fish with reference to international trade in prod Conf. handl. Proc mark trop. Fish Tropical Products Institute, 337-394.

Castell, C.H., Richards, J.F. and Wilmot (1949). *Pseudomonas putrefaciens* from cod fillets. *J. Fish Res. Bd. Can.,* **7C** (7) : 430-431.

Cingman, C.D. and Hooper, A.J. (1986). The bacterial quality of vacuum packaged fresh fish. *Dairy & Food Sanitation*, **6**(5) : 194-197.

Dalgaard, P., Gram, L. and Huss, H.H. (1993). Spoilage and shelf life of cod fillets packed in vacuum or modified atmosphere. *Internat. J. Food Microbiol*, **19** (4) : 283-294.

Haard, N.F., Mortins, I. and Newbury, R. (1979). Hypobaric storage of Atlantic herring and cod. *Canadian Institute Food Sci. & Technical J.*, **12**(2) : 84-87.

Hansen, P. (1972). Storage life of prepackaged wet fish at 0^0C. IItrout and Herring, *J. Food Technol.,* **7** : 21-26.

Huss, H.H. (1972). Storage life of prepacked wet fish at 0^oC. Plaice and Haddock, *J. Food Technol.,* **7** : 13-19.

Hwang, K.T. and Regenstein, J.M. (1989). Protection of menhaden mince lipids from rancidity during frozen storage. *J. Food. Sci.,* **54**(6) : 1120-1124.

Josephson, D.B., Lindsay, R.C. and Stuiber, D.A. (1985). Effect of handling and packaging on the quality of frozen white fish. *J. Food Sci.,* **50** (1) :7-14.

Ke, P.J., Ackman. R.G., Linke, B.A. and Nash, D.M. (1977). Differintial lipid oxidation invarious part of frozen mackerel. *J. Food Technol.,* **12** (1) : 37-47.

Laleye, L.C., Lee, B.H., Simard, R.E., Carmichael, L. and Helley, R.A. (1984). Shelf life of vacuum or nitrogen packed pastrami: Effect of packaging atmospheres, temperatures and duration of storage on physiochemical and sensory changes. *J. Food Sci.,* **49** : 832.

Lee, B.H., Simard, R.E., Laleye, L.C. and Helley, R.A. (1983). Microflora, sensory and exudates changes of vacuum or nitrogen packed veal chunks under different storage conditions. *J. Food Sci.,* **48** : 1537.

Lee, E.H., Kim, J.S., Chang, B.A., Dong, S.J., Chung, S.L. and Kuang, T.S. (1993). Processing and quality stability of precooked frozen foods. IV. Quality stability of mackerel based burger during frozen storage. *J. Korean Agric. Chemical Sec.,* **36**(1) : 58-63.

Liston, J. (1980). Microbiological in fishery science. In : *Advance in fish science and technology*, Connell J.J. (Ed.), p: 138-157. Fishing news books Ltd., England.

Meekin, T.A., Hulse, L., and Bremmer, H.A. (1982). Spoilage association of vacuumpacked sand flathead (*Platycephalusbassensis*) fillets. *Food Technol. Austrialia,* **34**(6) : 278-282.

Mendonca, A.F., Molins, R.A., Kraft, A.A. and Walker, H.W. (1989). Effect of potassium sorbate , sodium acetate and sodium chloride alone or in combination on shelf life of vacuum packed port chops. *J. Food Sci.,* **54** : 303-306.

Varga, S., Keith, R.A., Michalic, P., Sims, G.G. and Reiger, L.W. (1980). Stability of lean and fatty fish fillets in hypobaric storage. *J. Food Sci.,* **45**(5) : 1487-1491.

Shewan, J.M. (1977). The bacteriology of fresh and spoilage fish and the biochemical changes induced by bacteril action. In; Proceeding of the conference on handling processing and marketing of tropical fish. Tropical Products Inst., London : pp. 51-66.

Sirosis, M.E., Slabyi, B.M., True, R.H. and Martin, R.E. (1991). Effect of vacuum packaging on changes association with frozen cod fillets. *J. Muscle Food,* **2**(3) : 197-208.

Srinivasa Gopal, T.K., Joseph, J. and Balachandran, K.K. (1999). Development of fish products employing hurdle technology., In : *Preservation of food by Hurdle Technology*. P, 93-103., DFRL, Mysore (KARNATAKA) INDIA.

Wilhelm, K.A. (1982). Extended storage of Fishery products with modified atmosphere : A survey, Marine fisheries Review, *National Oceanic & Atmospheric Administration*, **44**(2) : 17-20.