

Role of Active packaging and Modified atmosphere packaging for food preservation

Sanasam Angousana^{1*}, Pooja Aditya², Kumari Sushma Mahto³ and Seedari Balu Mahendra⁴

Abstract: -

The traditional role of food packaging is continuing to evolve in response to changing market needs. Current drivers such as consumers demand for safer, healthier and higher-quality foods, ideally with a long shelf-life; the demand for convenient and transparent packaging and the preference for more sustainable packaging materials, have led to the development of new packaging technologies, such as active packaging (AP) and MAP. In response to the dynamic changes in current consumer demand and market trends, the area of Active Packaging (AP) is becoming increasingly significant. MAP is a packaging system that involves changing the gaseous atmosphere surrounding a food product inside a packaging materials and formats with an appropriate level of gas barrier to maintain the changed atmosphere at an acceptable level for preservation of the food. Rapid expansion of modified atmosphere packaging (MAP) for horticultural produce has occurred during the last 10 years, especially for fresh cut (minimally processed) products, but limitations to further expansion reside in both responses of products and available technology.

Keywords: Active packaging, food, shelf life, modified atmosphere packaging, packaging etc.

INTRODUCTION:

Active packaging has been used with

many food products and is being tested with numerous others. The mechanism by which

Sanasam Angousana^{1*}, Pooja Aditya², Kumari Sushma Mahto³ and Seedari Balu Mahendra⁴

¹PhD Research Scholar, Department of Pomology and Post Harvest Technology, Uttar Banga Krishi Vishwavidyalaya, West Bengal, India

²PhD Research Scholar, Department Agricultural Statistics, Uttar Banga Krishi Vishwavidyalaya, West Bengal, India

³Ph.D. Research Scholar, Department of Plantation Crops and Processing, Uttar Banga Krishi Vishwavidyalaya, West Bengal, India and

⁴PhD Research Scholar, Department of Horticulture & Postharvest Technology, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal

food deteriorates needs to be understood before applying any type of active packaging solution. The shelf life of a food is dependant on numerous factors, such as the intrinsic nature of the food, e.g. acidity (pH), water activity (aw), nutrient content, occurrence of anti-microbial compounds, redox potential, respiration rate and biological structure; and extrinsic factors, e.g. temperature, relative humidity (RH) and the surrounding gaseous composition. These factors will directly influence the chemical, biochemical, physical and microbiological spoilage mechanisms of individual food products and their achievable shelf lives. Unlike traditional packaging, which must be totally inert, active packaging is designed to interact with the contents and/or the surrounding environment. Microbial and physiological degradation of food during marketing, storage, and transportation is the cause of post-harvest deterioration (Angousana *et al.*, 2025). Active packaging refers to the incorporation of additives into packaging systems with the aim of maintaining or extending meat product quality and shelf-life. Active packaging systems discussed include oxygen scavengers, ethylene scavengers, flavour and odour absorber/releaser, antimicrobial and antioxidant packaging technologies. Modified atmosphere packaging (MAP) may be defined as ‘the enclosure of food products in gas-barrier materials, in

which the gaseous environment has been changed in order to inhibit spoilage agents and therefore either maintain a higher quality within a perishable food during its natural life or actually extend the shelf-life. Modified atmosphere packaging (MAP) is an integral part of the food industry. The effects of MAP on product shelf life, safety and nutritional value are briefly discussed. Modified atmosphere packaging (MAP) requires little introduction to any reader of the postharvest literature. However, commercial utilization of MAP for storage and transportation of horticultural products has been limited to a few commodities. Principal MAP systems include those that involve oxygen scavenging, moisture absorption and control, carbon dioxide and ethanol generation and antimicrobial. Packaging plays critical role in the food supply chain. The primary function of packaging is to serve as a container for the food enabling efficient transport within the whole supply chain, preventing any physical damage, and protecting against manipulation and theft. Packaging also meets the fundamental need to maintain food quality and safety from production to final consumption by preventing any unwanted chemical and biological changes.

Examples of active packaging system (Prasad and Kochhar, 2014)

Active packaging system	Food and beverage application
Oxygen scavenger	Bakery goods – bread, cakes Prepared foods – sandwiches, pizza, ready meals, cured meats and fish, dried foods and beverages
Carbon dioxide scavenger	Coffee, yeast-based goods
Carbon dioxide emitter	Bakery goods, prepared foods
Ethylene scavengers	Fruit, vegetables
Ethanol emitter	Bakery goods – cakes, bread
Moisture absorber	Meat, poultry, fish, fresh fruit and vegetables
Flavour and odour absorber	Fruit juices, meat, poultry, fish

Methods of Active Packaging (Kader *et al.*, 1989)

- 1) Oxygen Scavengers
- 2) Moisture-Absorbing and Controlling Systems
- 3) Liquid water absorption
- 4) Humidity buffering
- 5) Carbon Dioxide Generating Systems
- 6) Antimicrobial Migrating and Non-migrating Systems
- 7) Ethylene Scavengers
- 8) Moisture absorbers
- 9) Flavour /Odour absorbers
- 10) Antioxidant release

Regulatory issues, consumer acceptability and equipment considerations

Originally, packaging was deemed a method for protecting food from contamination, from spoilage and enabling transportation. The regulations related to food contact of packaging detailed that packaging should be inert and not release substances into food that pose a risk to human health; it should

not release substances into food that change the taste, odour and composition of the food. However, active packaging can release substances into the food, so in 2004, the food contact materials legislation was revised to include active and intelligent packaging. Active packaging may release substances into food but only under certain specified conditions.

Intelligent Packaging

The headspace of food packages undergoes changes in their composition over time. Devices capable for identifying, quantifying, and/or reporting changes in the atmosphere within the package, the temperatures during transfer and storage and the microbiological quality of food are the basis of intelligent packaging.

- i.) Time-Temperature Indicators
- ii.) Seal and Leak Indicators
- iii.) Freshness and/or Ripening Indicators

Modified atmosphere packaging (MAP)

Modified atmosphere packaging (MAP) is an integral part of the food industry. Modified atmosphere packaging (MAP) requires little introduction to any reader of the postharvest literature. The concept of using polymeric films that will allow development, and/or maintenance of atmospheres other than air, dates from the first availability of plastics. However, commercial utilization of MAP for storage and transportation of horticultural products has been limited to a few commodities for reasons that are described below. However, in recent years, a rapid growth of MAP for preservation of fresh cut (minimally processed) products has occurred. MAP is especially important for these products because of their greater susceptibility to water loss, cut surface browning, higher respiration rates, enhanced ethylene biosynthesis and action and microbial growth. MAP, for example has allowed marketing of value-added produce such as broccoli florets (*Brassica oleracea* L. *Italica* Group) and asparagus tips (*Asparagus officinalis* L.) (Lange, 2000).

Principles of MAP

The objectives of MAP are to extend the shelf life of food products and to prevent (or at least retard) any undesirable changes in the wholesomeness, safety, sensory characteristics, and nutritive value of foods. MAP achieves the above objectives based on three principles:

- 1) It reduces undesirable physiological, chemical/biochemical and physical changes in foods
- 2) It controls microbial growth
- 3) Just like any other packaging technique, it prevents product contamination

MAP alters the internal atmosphere of a package to extend shelf life, mainly by reducing oxygen: (Church *et al.*, 1995)

- 1) Vacuum Packing
- 2) Gas Packaging
- 3) Oxygen
- 4) Carbon dioxide
- 5) Nitrogen

Current applications of MAP technology for fresh and minimally processed products

MA can be created inside a package either passively through product respiration or by actively by replacing the atmosphere in the package with a desired gas mixture. With commodity-generated or passive MA, if product and film permeability characteristics are properly matched, the desired. MA can passively evolve within a sealed package through consumption of Oxygen and production of carbon dioxide by respiration. The gas permeability of the selected film must allow Oxygen to enter the package at a rate offset by the consumption of Oxygen by the commodity. Similarly, CO₂ must be vented from the package to offset the production of

CO₂ by the commodity. Many types of plastic films are available for packaging, but relatively few have been used to wrap fresh produce. Low-density polyethylene, polyvinyl chloride, and polypropylene are the main films used to package fruit and vegetables. Polystyrene has been used, but polyvinylidene, and polyester have such low gas permeabilities that they would be suitable only for commodities with very low respiration rates. Recent advances in the technology of manufacturing polymeric films have permitted tailoring films for specific gas diffusion needs of some fruit, vegetables, and their products.

Benefits of film packaging, other than creation of MA conditions can include maintenance of high relative humidity and reduction of water loss; improved sanitation by reducing contamination of the products during handling; minimized surface abrasions by avoiding contact between the commodity and the material of the shipping container; reduced spread of decay from one produce item to another; use of the film as carrier of fungicides, scald inhibitors, ethylene absorbers, or other chemicals; facilitation of brand identification and providing relevant information to the consumers.



Fig.1: MAP Meat



Fig.2: MAP of Fish and Shellfish



Fig.3: MAP Bakery products



Fig.4: MAP of Fruits and Vegetables

Effect of MAP on micro-organisms - safety issues

The extension of product shelf life by low oxygen atmospheres also results in the control of aerobic bacteria, which are mainly responsible for spoilage. Moreover, high concentrations of carbon dioxide also extend the shelf life of MAP foods. The antimicrobial effect of carbon dioxide occurs at or near a 10% level, and increases with higher concentrations. Using 20% carbon dioxide can control the growth of several aerobes, including *Pseudomonas* and *Moraxella*, but higher concentrations in the ranges of 20-40% usually give better results. However, very high concentrations of carbon dioxide may stimulate the growth of the anaerobe *Clostridium botulinum*.

Combination of MAP with other technologies

- ☞ Refrigeration
- ☞ Edible coatings
- ☞ Biological control

Depending on your product and your specifications, different MAP packaging technologies can be employed. Below are the most popular:

- ☞ Gas flushing
- ☞ Barrier packaging films
- ☞ Scavenger or desiccant packs
- ☞ On-package valves

CONCLUSION

The objective of this technology is to maintain sensory quality and extend the shelf life of foods while at the same time maintaining nutritional quality and ensuring microbial safety. Advances in the last decade have seen active systems incorporated into the main packaging of the product rather than as separate or loose components in the pack. These systems will become more efficient and multifunctional and can be used with a wider range of foods to improve quality and extend shelf life. Active packaging is an emerging and exciting area of food technology that can confer many preservation benefits on a wide range of food products. Active packaging is a technology developing a new trust because of recent advances in packaging, material science, biotechnology and new consumer demands. Atmosphere Packaging is suitable for a wide range of food product. While traditionally mainly dairy products, meat products or bread were packaged under protective atmosphere, now MAP is more and more used for other foods like fish, coffee, fruit or vegetables. In addition, Modified Atmosphere Packaging is driven by the growing popularity of ready-made meals and convenience products. Modified atmospheres are not only used in packaging. This packaging under a protective atmosphere preserves the quality of fresh produce over a longer period of time, prolongs shelf-life, and gives food

producers access to a geographically larger market for perishable products. Carbon dioxide (CO₂) and nitrogen (N₂) are mainly used as protective gases in food packaging.

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