Chapter: 05

MODIFIED ATMOSPHERE PACKAGING (MAP) AS AN INNOVATIVE TECHNIQUE

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DOI: ***https://doi.org/10.52458/9788196897437.nsp.2023.eb.ch-05***
Ch.Id:-GU/NSP/EB/RTFP/2023/Ch-05

ABSTRACT

The chapter on Modified Atmosphere Packaging (MAP) explores this innovative method for extending the shelf life of perishable foods. It involves adjusting the gases inside a package to create an ideal environment for food preservation. The chapter covers MAP principles, including gas control and barrier properties, as well as the use of ethylene and carbon dioxide absorbers. It also discusses the application of MAP in preserving fresh-cut fruits and vegetables and high-value goods, reducing food waste, and meeting consumer demands for quality products. This chapter serves as a concise guide to understanding the science and benefits of MAP in modern food packaging.

Keywords: *Food packaging, preservation, Modified Atmosphere Packaging.*

1. INTRODUCTION

In the ever-evolving landscape of food packaging, one innovative technique has emerged as a game-changer in extending the shelf life of perishable goods and ensuring food safety—Modified Atmosphere Packaging, commonly known as MAP. This sophisticated packaging technology represents a pivotal advancement in the way we store, transport, and consume our food, revolutionizing the preservation and quality maintenance of a wide range of products. MAP is a method designed to create a modified atmosphere within the packaging, effectively altering the composition of gases surrounding the food product. By adjusting the levels of oxygen, carbon dioxide, and nitrogen, MAP retards the degradation of food, slows down the growth of spoilage microorganisms, and inhibits the oxidation processes responsible for the deterioration of flavor and texture. This preservation technique not only ensures the longevity of perishable items but also minimizes food waste, a critical concern in our world today.

MAP's applications span the entire food supply chain, from manufacturers and processors to retailers and consumers. It has allowed the global food industry to distribute perishable goods over vast distances, enabling consumers worldwide to enjoy fresh produce and other items year-round. This technology has further minimized the need for chemical preservatives and additives, aligning with the growing consumer demand for minimally processed, natural foods. In this age of convenience and sustainability, MAP has proven to be a valuable ally, supporting the demands of modern life while reducing food wastage and environmental impact. In this comprehensive exploration of Modified Atmosphere Packaging, we will delve into its underlying principles, the science behind it, and its multifaceted applications across various food categories. Through case studies and real-world examples, we will showcase its significant role in ensuring food safety, prolonging shelf life, and meeting the ever-evolving expectations of consumers. As we delve deeper into the world of MAP, we will uncover its continued evolution, challenges, and its promising future in shaping the way we package and consume food.

2. PRINCIPLES OF MAP

The concept behind MAP has roots in nature and history, dating back to when our ancestors stored food in caves or submerged it underwater, inadvertently creating conditions that preserved it for extended periods. However, the formalization of MAP as a packaging technology began in the mid-20th century, coinciding with the dawn of the modern food industry. Since then, it has been refined and adapted to accommodate a wide variety of products, from fresh produce and meats to bakery goods and dairy items.

MAP is a sophisticated food packaging technique designed to extend the shelf life of perishable products by altering the composition of gases within the packaging environment.

It relies on several key principles to achieve its objectives:

- **Gas Composition Control:** At the heart of MAP is the precise control of the gas composition inside the packaging. The atmosphere within the package is adjusted by manipulating the levels of oxygen (O_2), carbon dioxide (CO_2), and nitrogen (N_2) to create an environment that inhibits the growth of spoilage microorganisms and slows down chemical reactions that lead to food degradation. The specific gas composition is tailored to the type of food product being packaged.
- **Gas Barrier Properties:** MAP packaging materials, such as films and trays, must possess excellent gas barrier properties to prevent the unwanted exchange of gases between the package and the external environment. This is crucial to maintaining the desired atmosphere within the package throughout the product's shelf life.
- **Seal Integrity:** A crucial aspect of MAP is ensuring the hermetic seal of the packaging. Leaks or breaches in the packaging can allow the entry of oxygen or the escape of the modified gases, compromising the preservation effect. Quality control measures are employed to verify the seal integrity of MAP packages.
- **Microbial Growth Inhibition:** By reducing the oxygen content and increasing the carbon dioxide levels within the packaging, MAP creates an environment where many spoilage microorganisms cannot thrive. This inhibits the growth of bacteria, molds, and yeasts, which are responsible for food spoilage and decay.

- **Enzyme Activity Reduction:** Some foods undergo quality deterioration due to enzymatic reactions. MAP slows down these reactions by reducing the availability of oxygen, which is often required for enzymatic processes. This helps maintain the taste, texture, and color of the packaged food.
- **Preservation of Product Quality:** MAP aims to preserve the sensory and nutritional qualities of food products, including their appearance, flavor, and nutritional content. By creating an optimal atmosphere, MAP helps retain the product's freshness and extend its shelf life.
- **Customization for Specific Products:** Different food products have unique respiration rates and gas exchange requirements. The principles of MAP are applied with flexibility to cater to the specific needs of each product category. For example, fresh produce may require higher humidity levels in addition to modified gases.
- **Monitoring and Quality Control:** Continuous monitoring of the gas composition within MAP packages is essential to ensure that the desired atmosphere is maintained throughout storage and distribution. Advanced packaging technologies often include sensors and indicators to provide real-time feedback on the package's integrity and gas composition.

Therefore, the principles of Modified Atmosphere Packaging involve precise control of gas composition, effective gas barrier properties, seal integrity, microbial growth inhibition, enzyme activity reduction, and the customization of packaging parameters to suit the specific needs of various food products. By leveraging these principles, MAP significantly contributes to food safety and quality preservation while minimizing the need for chemical preservatives and additives.

3. METABOLISM AND CHEMISTRY

Modified atmosphere (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. In the case of passive MA, it relies on the natural behavior of the food. For example, fruits and vegetables "breathe" by taking in oxygen and giving off carbon dioxide. If we use the right packaging material that lets oxygen in and allows carbon dioxide to escape at the same rate the food is using and producing these gases, we can create the desired modified atmosphere inside the sealed package. However, it's crucial to get this balance just right. If there's too much carbon dioxide or not enough oxygen, it can harm the food or create conditions where harmful microbes can grow.

This process typically needs to happen within 1 to 2 days after packaging to ensure the food stays fresh without any issues.

Because of the limited ability to regulate a passively established atmosphere, actively establishing the atmosphere is becoming more preferred. This can be done by pulling a slight vacuum and replacing the package atmosphere with the desired gas mixture. This mixture can be further adjusted through the use of absorbing or adsorbing substances inside the package with the respiring commodity that scavenge O_2, CO_2, and/or ethylene (C_2H_4). While setting up an active establishment system for modified atmosphere packaging (MAP) may involve some initial additional costs, it offers a significant advantage by ensuring the rapid creation and maintenance of the desired atmosphere within the packaging. This controlled atmosphere is crucial for preserving the freshness and quality of various food products. Two key components of active establishment systems are ethylene absorbers and carbon dioxide absorbers, each serving a specific purpose in extending the shelf life of perishable goods.

Ethylene absorbers play a pivotal role in delaying the climacteric rise in respiration and the associated ripening process for certain fruits. Ethylene is a natural plant hormone responsible for fruit ripening, and by removing it from the packaging environment, ethylene absorbers help prolong the period during which fruits remain in an unripe state. This delay in ripening is especially valuable for fruits that are susceptible to overripening during storage or transportation. On the other hand, carbon dioxide (CO_2) absorbers serve to prevent the buildup of CO_2 to injurious levels within the packaging. In some instances, passive modification of the package atmosphere can lead to an excess of CO_2, which can be detrimental to the quality and safety of the enclosed food products. Carbon dioxide absorbers effectively maintain CO_2 levels at a safe and optimal range, ensuring that the food remains in the best possible condition. Additionally, some food products benefit from atmospheric oxygen (O_2) levels, which exceed the typical atmospheric concentration of 21%. This approach is used in conjunction with fungistatic CO_2 levels (>15%) for specific commodities that do not tolerate elevated CO2 atmospheres when combined with regular air or low O_2 environments. By providing elevated O_2 levels along with fungistatic CO_2 concentrations, the packaging can effectively extend the shelf life of these commodities while preserving their quality and freshness.

However, the implementation of an active establishment system in MAP may involve initial costs, its advantages are clear. Ethylene absorbers delay ripening, carbon dioxide absorbers prevent harmful CO_2 buildup, and the strategic use of superatmospheric oxygen levels and fungistatic CO_2 levels offers tailored solutions for preserving various food products. These technologies collectively contribute to reducing food waste, extending product shelf life, and ensuring that consumers enjoy high-quality, fresh food items.

4. RECENT ADVANCES IN MAP TECHNOLOGIES

Modified Atmosphere Packaging (MAP) is mainly used for fresh-cut fruits and vegetables and for items that spoil quickly and have high value, like cherries, figs, raspberries, and strawberries. It helps keep these products fresh for longer periods, preserving their quality and reducing waste. Many different types of plastic films are available for packaging, but only a few are commonly used to wrap fresh fruits and vegetables. These include materials like low-density polyethylene, polyvinyl chloride, and polypropylene. While some other materials like polystyrene have been used, materials like polyvinylidene and polyester are less common because they don't allow gases to pass through easily. However, for products with low gas needs, like ones that don't release many gases, small holes can be made in these materials to make them work. Recently, advancements in making these plastic films have allowed them to be customized for specific fruits, vegetables, and their products, depending on how much gas they produce.

5. CONCLUSION

An active establishment system in modified atmosphere packaging offers substantial benefits by swiftly creating optimal packaging conditions. Ethylene absorbers preserve fruit freshness by preventing premature ripening, while carbon dioxide absorbers maintain safe gas levels. In some cases, a customized mix of extra oxygen and carbon dioxide is used, ensuring food stays fresh without compromising quality. These methods reduce food waste and guarantee consumers enjoy longer-lasting, higher-quality products, making the investment worthwhile for both producers and consumers.

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