MAP packaging for good-looking red meat

Afrox, through its Foodfresh® brand of gases, has developed a wide range of modified atmospheric packaging (MAP) solutions for keeping fresh food unspoilt, attractive and appetising while on supermarket shelves. In this article, Hans Strydom, Afrox's Production Quality manager, talks about the unusual requirements for packaging red meat.

The Afrox Foodfresh® range is designed to enable providers of fresh produce to increase sales and reduce costs while satisfying the ever-growing demand for fresh and naturally preserved food. "Primarily, the role of modified atmospheric packaging is to extend the shelf life of fresh foods – without artificial additives, chemicals, freezing, preservatives or processing – while retaining those fresh food tastes, texture and appearances," begins Strydom.

"We work closely with food research institutes, food-processing customers and suppliers of packaging materials and machines to create the best gas atmosphere for each individual application. This is influenced by a number of factors such as: microbial activity; hygiene requirements; pre-packaging delay; temperature; permeability of the packaging material; the free gas volume within the package; and the residual oxygen level," he notes.

For most food products, oxygen (O_2) levels in MAP package are kept as low as possible, typically by substituting the air surrounding the food with gases such as carbon dioxide (CO_2) and/or nitrogen (N_2).

"Red meat products, however, are an exception and oxygen is an important constituent of the packaging gas. Oxygen reacts with myoglobin in red meats to give it its rich red colour," continues Strydom.

"When fresh meat is first exposed to oxygen it 'blooms' to a bright red colour, making it look fresh and appetising on supermarket shelves. But oxygen eventually leads to browning of the meat surface and to the growth of spoilage bacteria, rendering it unacceptable to consumers after a few days, even when it is held near 0°C," Strydom explains.

Myoglobin is a protein found in muscle tissue and this governs the colour of fresh meat. It has three main forms. Deoxymyoglobin is the deoxygenated form responsible for the purple colour of freshly cut meat, vacuum packed meat or meat stored in oxygen-free (anaerobic) conditions.

When exposed to oxygen, deoxymyoglobin is transformed into oxymyoglobin, changing the colour from purple to the bright red colour associated with freshness.

The third form, metmyoglobin, is brown and it is formed due to the further oxidation of oxymyoglobin. The brown surface colour, which is irreversible, is perceived by consumers as a loss of freshness and is therefore undesirable.

The formation of metmyoglobin can be delayed by either excluding O_2 completely – by using vacuum packaging or a low-O_2 MAP gas mix – or by maintaining much higher O_2 levels in the MAP gas, along with CO_2 to selectively inhibit the growth of spoilage bacteria.

"The main MAP gases used for red meat are oxygen, carbon dioxide and nitrogen. Oxygen and carbon dioxide are most significant and the relative proportions of each of them directly affect how the colour changes over time," Strydom reveals.

While the O_2 promotes the red oxymyoglobin formation, the CO_2 dissolves into the food's liquid and fat phase, reducing its pH value and penetrating the muscle meat, causing changes in permeability and function and creating an environment that inhibits the growth of the microorganisms that would usually occur in high-oxygen atmospheres.

Nitrogen, the third constituent in oxygen-rich MAP gas mixes for red meat, is non-reactive and its role is solely to protect the package structure. Since CO_2 dissolves into the meat, the gas volume inside the packaging reduces over time, causing the package to collapse. The low solubility of nitrogen in meat helps to prevent package collapse by maintaining the internal gas volume.

A typial MAP packaging machine.

Three packaging approaches

The three generally adopted approaches for modifying the environment of packs of fresh meat include: high-O_2 MAP; low-O_2 MAP; and dual-layer processes, which combine the advantages of both techniques.

To retard metmyoglobin formation and browning and to preserve microbiological quality under high concentrations of O_2, MAP gas mixtures of 60-80% O_2 and 20-40% CO_2 are commonly used. "Temperature control is critical to the success of this application, however, and poor cold-chain control will lead to the growth of spoilage organisms and premature browning of the meat," Strydom warns.

Low O_2/high CO_2 MAP is a second option, which fully exploits the inhibitory effects of CO_2 on spoilage bacteria. It is ideal for products that have to be transported long distances or stored for several weeks. The MAP gas used can be CO_2 alone, although the addition of N_2 to prevent the pack collapsing is more common. Gas mixtures used in these MAP solutions will often contain greater than 65% CO_2 with the balance volume being nitrogen.

Long storage life of, typically, over 12 weeks at 0°C is possible when using high CO_2 MAP mixture. As with vacuum-packed meat, however, the oxygen-free atmosphere keeps the meat purple and prevents it from blooming.

Overcoming the drawback of the purple colour are the dual layer solutions. Retail cuts can be placed in pre-formed plastic trays and, immediately after the surrounding air has been replaced with a high-CO_2 MAP gas mixture, a dual-layer film is applied to seal the pack.

Underneath the peelable film is a semi-permeable layer. When the meat packs are removed from storage for presentation and the peelable film is removed, oxygen is allowed into the package so that the meat can begin to bloom.

Dual layer processes allow retail meat cuts to be stored for much longer periods of time prior to display than high-O_2 MAP solutions, while still enabling excellent visual presentation in supermarket fridges.

"But beef, lamb and pork all require different MAP gas mixtures and packaging solutions," says Strydom.

"Over the years, we at Afrox have collected vast amounts of knowledge about what works best in terms of food science, gas mixtures and packaging materials and we pride ourselves on being able to find a Foodfresh® solution that can safely extend the shelf life of any meat product – the natural way," he concludes. ❑