Gases used in MAP

The three main gases used in MAP are O2, CO2 and N2. The choice of gas is totally dependent upon the food product being packed. Used singly or in combination, these gases are commonly used to balance safe shelf life extensionwith optimal organoleptic properties of the food. Noble or *inert* gases such as argon are in commercial use for products such as coffee and snack products, however, the literature on their application and benefits is limited. Experimental use of carbon monoxide (CO) and sulphur dioxide (SO2) has also been reported.

Carbon dioxide

Carbon dioxide (CO2) is a colourless gas with a slight pungent odour at very high concentrations. It is an asphyxiant and slightly corrosive in the presence of moisture. CO2 dissolves readily in water (1.57gkg□1 at 100kPa, 20°C) to produce carbonic acid (H2CO3) that increases the acidity of the solution and reduces the pH. This gas is also soluble in lipids and some other organic compounds. The solubility of CO2 increases with decreasing temperature. For this reason, the antimicrobial activity of CO2 is markedly greater at temperatures below 10°C than at 15°C or higher. This has significant implications for MAP of foods, as will be discussed later. The high solubility of CO2 can result in pack collapse due to the reduction of headspace volume. In some MAP applications, pack collapse is favoured, for example in flow wrapped cheese for retail sale.

Oxygen

Oxygen (O2) is a colourless, odourless gas that is highly reactive and supports combustion. It has a low solubility in water (0.040 g kg□1 at 100 kPa, 20°C). Oxygen promotes several types of deteriorative reactions in foods including fat oxidation, browning reactions and pigment oxidation. Most of the common spoilage bacteria and fungi require O2 for growth. Therefore, to increase the shelf life of foods, the pack atmosphere should contain a low concentration of residual O2. It should be noted that in some foods a low concentration of O2 can result in quality and safety problems (for example, unfavourable colour changes in red meat pigments, senescence in fruits and vegetables and growth of food poisoning bacteria), and this must be taken into account when selecting the gaseous composition for a packaged food.

Nitrogen

Nitrogen (N2) is a relatively un-reactive gas with no odour, taste or colour. It has a lower density than air, non-flammable and has a low solubility in water (0.018 g kg−1 at 100 kPa, 20°C) and other food constituents. Nitrogen does not support the growth of aerobic microbes and therefore inhibits the growth of aerobic spoilage but does not prevent the growth of anaerobic bacteria. The low solubility of N2 in foods can be used to prevent pack collapse by including sufficient N2 in the gas mix to balance the volume decrease due to CO2 going into solution.

Carbon monoxide

Carbon monoxide (CO) is a colourless, tasteless and odourless gas that is highly reactive and very flammable. It has a low solubility in water but is relatively soluble in some organic solvents. CO has been studied in the MAP of meat and has been licensed for use in the USA to prevent browning in packed lettuce. Commercial application has been limited because of its toxicity and the formation of potentially explosive mixtures with air.

Noble gases

The noble gases are a family of elements characterised by their lack of reactivity and include helium (He), argon (Ar), xenon (Xe) and neon (Ne). These gases are being used in a number of food applications now, e.g. potato-based snack products. While from a scientific perspective it is difficult to see how the use of noble gases would offer any preservation advantages compared with N2 they are nevertheless being used. This would suggest that there may be, as yet unpublished, advantages for their use.