Effects of Changing CO_2 Levels in MAP Food Packs 19 June 2018

It has recently become apparent that there is an issue with the supply of CO_2 into the UK food industry. This gas is a common component of some modified atmosphere packs (MAP), as such it may have an effect of the microbiology of the food within the pack. This effect must be considered before making any change in gas composition within MAP packs.

Effects of gasses

Nitrogen (N_2)
An inert gas, this will have no direct effects on the microorganisms within MAP packs besides that of replacing oxygen in low oxygen MAP. Its only microbiological effect would be the creation of anaerobic conditions which would inhibit the growth of an aerobic microflora.

Oxygen(O_2)
Tends to be used in fresh red meat MAP packs to help retain the red colour of the meat. Such packs tend to have a short shelf life.

Carbon dioxide (CO_2)
Elevated levels CO_2 can exert an antimicrobial effect in MAP packs. It tends to be used at various concentrations together with Nitrogen as a balance gas. As noted previously nitrogen has no direct antimicrobial effect besides helping create an anaerobic environment.
The concentration of CO_2 within MAP packs may therefore play an important part in maintaining the shelf life of a product. Lower levels of CO_2 may result in a reduced shelf life.

Spoilage

In low oxygen chilled MAP packs which contain N_2/CO_2 mixtures, a faster growing aerobic microflora (e.g. Pseudomonas spp) is inhibited, being replaced by a slower growing flora usually composed of Lactic Acid Bacteria.

The replacement of any of the CO_2 by N_2 may result in a reduction in shelf life of such products as the lactic acid spoilage flora can grow more quickly.

On occasion some ambient stored products also use a high CO_2 environment to extend shelf life (e.g. some baked goods), in this case N_2/CO_2 mixtures are used to slow or prevent mould growth. As noted previously whist nitrogen is inert, CO_2 is antimicrobial. Therefore any reduction in CO_2 could reduce life of such products, and an assessment of risk should be done before considering this approach.

Safety

The key organisms to be considered in the context of food safety in MAP chilled foods are *Listeria monocytogenes* and psychrotrophic *Clostridium botulinum.* If either of these organisms are considered to be a potential hazard in an MAP packed product, the following sections are important.

Listeria

CO_2 influences the growth rate of *L. monocytogenes,* with lower levels potentially allowing a slightly faster growth rate. This can be best seen in the predictive microbiology programme Combase Predictor. This has a model for *L. monocytogenes* that includes the effects of CO_2. Users can see the effects of changing gas levels on growth of this organism.

This may have an effect on any product in which shelf life has been set using the hypothesis of the presence of *L. monocytogenes* at low level, and a slow growth rate that does not cross the EC Regulation 2073/2005 criteria of <100/g at end of shelf life. Lower CO_2 could increase growth rates and result in the criteria being exceeded more quickly.

Clostridium botulinum

Psychrotrophic strains of *C.botulinum* can grow at temperatures as low as 3°C. CO_2 could have an influence on the growth rate of this organism and subsequent toxin production. In products that have Psychrotrophic *C.botulinum* controls that are based on either: (1) pH<5, (2)Aw <0.97, (3)salt concentrations of >3.5%, (4) are processed at temperatures of 90°C for 10 minutes (or equivalent) or (5)have a shelf life of 10 days or less; then any change in CO_2 will not affect the food safety risk associated with this organism. For products which have shelf life more than 10 days, in which the shelf life has been set in other ways (modelling that does not include CO_2 within the model, or challenge testing where the challenge was done in one particular concentration of CO_2), then the shelf life of products may be shortened if CO_2 concentration is reduced.