THE USE OF MODIFIED ATMOSPHERE FOR MEAT PACKAGING

M.J. Ansoborlo, L'Air Liquide, 75 Quai D'Orsay, 75321 Paris Cedex 07.

SUMMARY

Change of colour and microorganism growth are the two main factors responsible for meat alteration.

Modified atmosphere packaging (MAP) is an efficient method to avoid or slow down these phenomenons. It consists in modifying the atmosphere surrounding the product by using gas mixtures including:

- O_2 which reacts with the meat respiratory pigment (myoglobin) and helps the colouration preservation,
- CO_2 for its bacteriostatic effect.

INTRODUCTION

In order to get is best organoleptic qualities (tenderness, flavour, juiciness ...), the meat needs a certain time of maturation. During this period undesirable phenomenons such as growth of microorganisms, loss of water, change of colour take place.

The preservation of meat needs a packaging having an action on the microorganisms and the colour in order to have a shelf life as long as possible and to keep its organoleptic and hygienic qualities.

The modified atmosphere packaging (MAP) answers these requirements.

I - INTEREST OF MAP FOR THE PRESERVATION OF MEAT

1. Effects of gas mixtures on the meat colour

The colour of red meat depends on the composition of the surrounding atmosphere.

The muscle fibres of meat contain a respiratory pigment myoglobin. Myoglobin contains one atom of iron, and its molecules are in three forms:

- myoglobin (in which the iron is the Fe^{2+} state), producing the deep red colour deep inside meat;
- oxymyoglobin resulting from reversible oxygenation, the iron remaining in the Fe^{2+} state, producing the bright red colour of freshly cut meat;
- metmyoglobin produced by oxidation which is difficult to reverse, at very low oxygen pressures (approximately 4 mm Hg), the iron being converted to the Fe^{3+} state producing a brown colour.

When 40 to 50% of the myoglobin has been converted to metmyoglobin, the meat acquires a brown colouration which cannot be removed.

Experimental work and trials to investigate the effects of various gases have shown that the best method of preventing discolouration of meat is to maintain a high partial pressure of oxygen in the packaging atmosphere.

Different cases must be considered.

If the meat colour is one of the main factor influencing the consumer's purchase (O_2 will be required for most of the cuts meat : beef, pork, mutton, veal, lamb, offals), for big pieces of meat (muscles) and for most of the poultry it is not such a deciding element : microorganisms growth is much more important (CO_2 is then required and N_2/CO_2 mixtures are used).

2. Effects of gas mixtures on the microflora of meat

Microorganisms are the principal cause of deterioration of meat (cut meat is more contaminated than big pieces because of the dressing operation which extends contamination over the whole cut surface).

The principal, method used to prevent such deterioration of meat is refrigeration : Pathogenic bacteria (Staphylococcus, Salmonella, Clostridium) stop growing and secreting toxins at low temperature ($< 3°C = 32°F$).

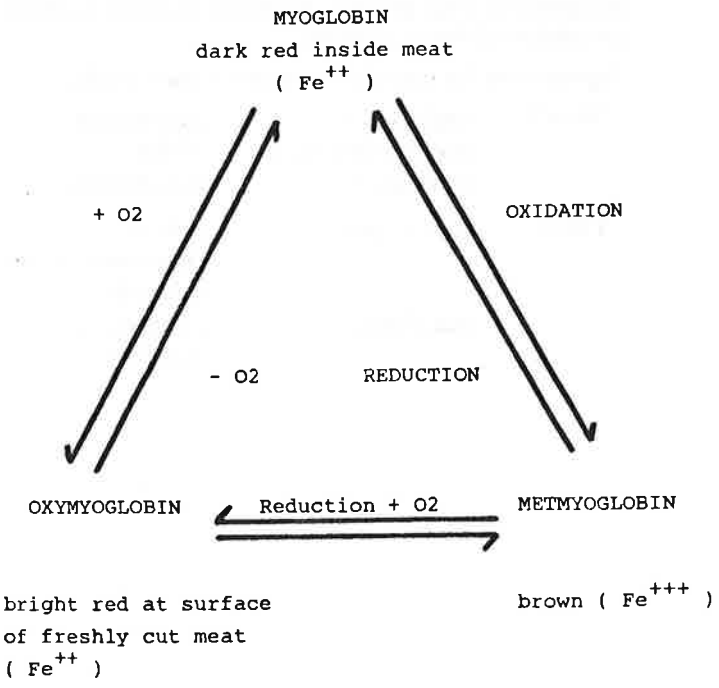
But the composition of the atmosphere inside the packaging is also of critical importance with regard to the microflora development.

A large body of experimental work in this area has shown that carbon dioxide has an inhibiting effect on the development of bacteria, how soon it is applied, varying according to its concentration, temperature, and the meat contamination extent at the outset. CO_2 is efficient at contents greater than 20% in the atmosphere (percentage required after dissolution and equilibrium with aqueous phase).

The inhibiting effect caries with the microbe species. *lactobacillae* are the most resistant, whereas *Pseudomonas* and *Achromobacter* are particularly sensitive to the action of carbon dioxide.

3. Choice of gas mixture

It is thus apparent that the two factors to be mastered, namely the colour of the meat and control of the action of bacteria, are closely associated : gases having a favourable effect with regard to colour being



unfavourable from the bacteriological point of view and vice versa.

The optimal bacteriostatic effect as well as the ability to retain the red colour are obtained with gas mixtures having:

- a CO_2 concentration greater than 20% for slowing down the microorganisms growth; and
- an O_2 percentage between 45 and 80% for maintaining the red colour.

Two types of atmosphere are currently used:

- a binary mixture 80% O_2 - 20% CO_2

As the carbon dioxide easily dissolved into the water of the product and reduces the pressure within the packaging, the film can collapse and come into contact with the meat: the colour may deteriorate.

This collapse can be reduced by:

- making a partial vacuum and then injecting a binary mixture (this method reduces the final CO_2 content),
- using a ternary mixture comprising a certain proportion of nitrogen 66% O_2 25% CO_2 9% N_2

II - PACKAGING SPECIFICATION

The gas tightness of packaging is a crucial factor in the success of the modified atmosphere method. In fact it would be pointless to choose suitable atmosphere without being able to maintain it throughout storage.

Trays :

Impermeability is not the only quality required for the tray. The material must be withstanding relatively high deformations, being manufactured using a thermoforming method.

The shape of the tray is also important. The base invariably includes grooves or raised losses for optimum circulation of the gas mixture.

Typical complex materials currently is use include,

TRAY:	upper layer:	polystyrene
	intermediate layer:	PVDC
	inner layer:	polyethylene
FILM:	upper layer:	polyester (impermeable and printable)
	inner layer:	polyethylene (weldable)

permeability: 10 $cm^3/m^2/24$ h

III - RESULTS

1. Meat portions (french regulation)

2. Poultry

Pink :

- with skin: 50% N_2/50% CO_2
- without skin: ternary mixture (colour)

White :

- 50% N_2 - 50% CO_2 mixture

Shelf life :

- 10 days between 0 and 3°C.

1. Meat portions (french regulation)

PRODUCT	STORAGE	SHELF-LIFE	
		AIR	GAS PACKED PRODUCT
BEEF CUTS	0-3° C	4 DAYS	10-12 DAYS
PORK CUTS	0-3° C	4 DAYS	6-9 DAYS
MINCED MEAT	0-2° C	2-3 DAYS	4-6 DAYS
OFFALS (liver)	0-3° C	1-2 DAYS	≥ 6 DAYS

CONCLUSIONS

From the distributors point of view, increasing the possible storage time would enable stocks to be held centrally and the packaging of individual meat portions and joints to be carried out on a more centralised basis. This would offer the following benefits:

- introduction of more regular patterns of work,
- avoidance of products becoming sold out due to unexpected peak buying,
- increased productivity as a result of synchronising the work of cutting and jointing the meat with packaging,
- reducing the number of deliveries to self-service stores.

From the consumer's point of view, the packaging of meats in individual portions and joints makes for speedy selection and offers the possibility of comparing weights and prices.