PACKAGING FRESH & CURED MEAT

SESSION I: METABOLISM OF MEAT IN THE PACKAGE

D. E. HOOD
Meat Research Department, The Agricultural Institute, Castleknock, Co. Dublin

One of our main objectives when we originally drew up a programme for the 20th European Meeting of Meat Research Workers was to have a range of research topics which would be relevant, not only to research workers in Ireland but also to the Irish meat industry as a whole, and a major consideration was to attract papers in those fields which currently are of greatest interest to us. The general theme of today's sessions is Packaging Fresh & Cured Meats. Although both are important, fresh meat packaging must be our primary consideration since fresh meat accounts in one way or another for so much of our total agricultural production and of our total exports from this country.

As the principal commodity in a largely agricultural economy beef is singularly the most important product of Irish industry. In 1972 the value of beef exported from Ireland was £63,000,000 equivalent to 25 per cent of agricultural exports and 9.7 per cent of total exports from the country. In addition, the value of live sheep and cattle in 1972 was £72,000,000 equivalent to 29 per cent of agricultural exports and 11.1 of total exports respectively. By far the greatest proportion of meat is shipped without processing (live cattle) or with only limited processing (carcass trade) and a huge source of raw material is therefore lost to Irish industry. This enormous growth potential can be realised through diversification by the industry and especially through the manufacture of a wide range of value-added meat products. Successfully exploiting this situation in the future would lead to a substantial increase in profit margins and would provide many more jobs for Irish workers.

As a major meat exporting country Ireland is unique in its proximity to enormous meat buying markets in the U.K. and Europe and because of this we can produce a high standard of quality for fresh meat which exporting countries competing with us cannot achieve. The Irish beef industry, who would obviously wish to exploit this advantage in the future,have the ultimate objective of exporting branded prepackaged beef direct to supermarkets and other retail outlets. We have not forgotten about the potential of freezing in relation to meat marketing but we realise the strength of consumer preference for fresh meat in the retail market and we would be happy if we could meet the latter demand for the moment. Before this can be achieved, however, there are some difficult technical problems to be overcome.

New developments in the field of fresh meat packaging are therefore of major importance to this country and it was on this basis that so much time was originally allocated in the programme of the Meeting to this topic. We were somewhat disappointed at the response we received from delegates but this perhaps only emphasises our particular interest in meat packaging research!

There has been a significant development recently in the production of chilled meat in vacuum packs. Various attempts have also been made to break the carcass further and to centralise cutting and prepackaging operations in meat plants for subsequent distribution and sale to retail outlets. It is important to examine continuously the technical developments in this field and to exploit those which promise to improve the efficiency of the operation or the quality of the final product.

One of the most interesting technical possibilities in this context is the use of modified gas environments to store meat. Commercial application of gas packaging techniques to meat has been slow in spite of the claims made for the advantages of the system, made principally, it should be added, by manufacturers of gas packaging equipment. The lack of commercial interest at the present time may be a reflection of the costs involved, but it may also mean that the value of gas packaging with respect to meat has been overstated and the advantages of the system exaggerated. We would like to know more about these questions.

The composition of the atmosphere within a food package is not static. It changes as a result of the gas permeability of the packaging film and other physical factors such as solubility, and of chemical reactions and bacteriological changes taking place within the system. The delicate balance which exists in the indigenous microflora can be affected by many factors relating to the food, packaging system, storage conditions etc. Food that is packaged behaves differently to food that is not packaged!

As far as meat is concerned the composition of the environment controls not only the colour of the meat but also its storage life, since the atmosphere within the package determines the course which microbiological spoilage will take. The gaseous environment within a meat package changes as a result of respiration, utilising oxygen and forming carbon dioxide, and also because the package itself does not prevent the exchange of gases completely. Thus, the atmosphere within the package is an equilibrium condition depending on the meat and rate of respiration as well as barrier properties of the packaging film. The objective of gas packaging meat is to create an atmosphere which controls deteriorative changes in fresh meat during storage, chiefly with respect to appearance and keeping quality.

The requirements of fresh meat packaging are basically different from those of cured meats for retail presentation and sale. Bacon, for example, needs extremely high impermeability to maintain the natural nitrosomyoglobin pigment of cured meat and prevent oxidation. A trace of oxygen is sufficient to cause the formation of metmyoglobin. On the other hand fresh meat requires a free supply of oxygen to produce the characteristic bright red colour of fresh beef which is demanded by the meat shopper.

With fresh meat there are a number of basic approaches to gas packaging. First of all one can use an inert atmosphere such as carbon dioxide or nitrogen which replaces the air surrounding the meat. Normally this replacement of one atmosphere with another takes place as part of a vacuum packaging process, air being drawn off first before the introduction of the inert gas.

Carbon dioxide is known to extend the storage life of fresh meat[1], keeping quality being improved by the reduction in activity of normal meat spoilage microorganisms, such as pseudomonas and achromobacter ahd the enhanced growth of microaerophilic lactobacilli[2,3,4]. The latter produce a less objectionable form of spoilage which takes place at a reduced rate under refrigerated storage conditions.

An atmosphere enriched with carbon dioxide might therefore be considered an advantage of practical importance. However, from a commercial point of view gas flushing is of limited value because long shelf-life is possible for vacuum-packaged meat without gas flushing, provided the meat is packed hygienically and then held at a low temperature. In our own work at the Agricultural Institute we have repeatedly achieved a shelf-life of more than ten weeks for vacuum-packaged meat that has been hygienically prepared and packaged and then stored at $0^{o}C$. It does not appear therefore that any useful advantage can be gained by initially flushing the pack with carbon dioxide, thereby producing a concentration of the gas at the start of the operation which has an immediate inhibitory effect on bacterial action. In any case CO_2 develops by respiratory activity within vacuum packs, reaching a level of more than 20% after a few days storage[5].

I would like to have the views of other delegates who have experience in this field. Do they feel that gas flushing of sub-primal cuts in the manner I have outlined has a commercial future or do they feel that vacuum packaging is likely to remain for this particular operation since it produces a sufficiently long shelf-life and is economically cheaper to operate?

Our main interest is in a rather different aspect of gas-packaging and that is the possibility of using an inert atmosphere to store and transport meat that has already been prepackaged, or indeed to store and transport smaller cuts of meat in any form. Because of the relatively large specific surface area of small cuts of meat the problem of drip loss increases considerably as the size of the piece of meat is reduced. Any physical stress or pressure which accentuates this problem must be avoided and hard vacuum is not suitable under these circumstances.

The system envisaged is one in which prepackaged joints and steaks would be placed in sealed containers where an inert atmosphere such as carbon dioxide or nitrogen, or a specially modified environment containing one or both of these gases in addition to oxygen, can be maintained. In a commercial application of this development the meat would be removed from the modified environment at the retail store and if necessary allowed to 'bloom' by exposure to normal atmospheric conditions prior to sale.

Another possible application of a gas modified atmosphere is to subject the meat to higher concentrations of oxygen than atmospheric. The red colour of meat depends on the thickness of the surface layer and this is increased with increase in oxygen concentration[6]. The stability of the red colour is also improved because metmyoglobin, which is the brown pigment responsible for discolouration, is formed initially further from the surface of the meat and is therefore less noticeable. Again these are areas of research which I would like to hear discussed and I would welcome comments, not only from the research point of view but also in relation to the immediate or long-term commercial application potential of these and other gas packaging methods.

Turning now to quite a different topic which is always an important consideration in experimental biology - namely the variability of biological material. This of course is a major consideration in all meat research work but it is particularly relevant in meat packaging where differences in appearance are especially noticeable.

Biochemical properties as well as differences in physical structure and eating characteristics contribute to the overall variability in muscular tissue and there is an enormous difference among various muscles in these fharacteristics. In spite of this, the exact source of meat used in research work is sometimes not clearly stated and the muscle chosen for a particular application or study is not always the most suitable for that purpose. The selection of a muscle for meat research is not invariably made on the basis of its physiological function, biochemical properties or quality attributes. Sometimes it may be simply that it is convenient or accessible in the carcase. A good example of this is the use of *M. longissimus dorsi* in meat colour stability work[7,8,9]. This muscle, on the contrary, has much better colour stability than other muscles[10] and it is untypical of meat in general. Conclusions regarding colour stability which are based on studies of *M. longissimus dorsi* should therefore not be extended to other muscles. There seems to be little point in using *M. longissimus dorsi* exclusively to study effects on meat colour stability just as there is little point in using *M. psoas major* in studies of meat tenderness. Both muscles are useful as controls but are hardly the muscles which are likely to provide the most useful information.

Prepackaging tends to exaggerate differences in appearance of meat because individual muscles are often packaged separately and then displayed together e.g. on a supermarket meat display cabinet. As prepackaging techniques develop, the practical importance of individual muscular differences becomes increasingly significant and the need for more specific information is increased.

An objective of our own research work in the field of gas packaging is to examine the effect of various gas atmospheres recommended in the literature[6,11,12,13] as suitable for storage of fresh meat on a range of muscles which we have previously found to show considerable variation in colour stability. This work is of a preliminary nature in a programme of research on gas packaging which we plan to carry out in the future. The initial work is described in Paper 12 by O'Keeffe et al.

Work on gas packaging, as I have indicated above, is sometimes on meat from an unspecified source or from a muscle whose colour stability is intrinsincally good. In the work reported in Paper 12 special attention is paid to *M. psoas major* and *M. gluteus medius* which invariably have poor colour stability[10].

The preliminary investigation indicates that at a temperature of 0°C

1. The colour of meat stored in oxygen plus CO_2 enriched atmosphere remains acceptable longer than meat stored in air and the extension of the keeping time increases with concentration of oxygen in the atmosphere. An important question to answer in this context is the concentration of oxygen above atmospheric required to give a required extension in shelf-life. I wonder if we might have opinions on the shelf-life required for prepackaged meat, in terms of colour stability and drip loss, to carry out an economically viable central prepackaging operation?
2. The modified gas atmospheres used in this work markedly increase the keeping time of meat from muscles which normally have unstable colour characteristics such as *M. psoas major*.

3. Finally, it is found that the keeping time of meat can be extended in an environment containing 100% nitrogen for several days and then re-exposing the meat to air. On re-exposure it 'blooms' again to an acceptable red colour. This sort of finding may have commercial application in the future as a means of distributing and storing prepackaged cuts prepared centrally and then held as required for subsequent sale in retail outlets. Again this is an aspect of gas-packaging, particularly with future developments in mind, which I would like to hear discussed by the meeting.

Both of the other papers in Session I deal with characteristics of meat products during storage and they are included in this session for this reason, although in other respects they might have been better placed in Session E.

Paper I 1. by Dimitrova et al of the Meat Technology Research Institute, Sofia, deals with the storage characteristics of a ground meat which has been preserved by ionising irradiation. It is not clear exactly what this product is since it is not described in detail. The translation of the original name is 'hash' and it is briefly described as containing 60% or pork and 40% beef with 2% added salt. There is no indication of fat content or details about preparation but I take it that it is basically a ground meat product containing a small amount of salt possibly similar to fresh sausage meat with a high meat content. In their introduction the authors comment on the short shelf-life of this product due to high microbial loads which normally occur and the object of irradiation is therefore to reduce bacterial counts and extend shelf-life. It would be interesting to know the microbial levels involved and the effectiveness of the stated irradiation doses in reducing the level of contamination but these are not given. 0.2 and 0.4 Mrad are relatively low dose levels of irradiation and particularly in this context it would be important to know how effective the irradiation process has been from a bacteriolgical point of view.

Organoleptically, the irradiated product is acceptable after 25 days storage and there does not appear to be a large difference between the 0.2 and 0.4 Mrad dosages although statistical data are not presented. Control samples are discarded after 7 days storage.

The authors find that the chemical analyses which they have carried out show that there are small changes taking place in irradiated samples throughout the storage time but they conclude that these are not capable of affecting the organoleptical properties. Units of measurement are not always quoted e.g. TBA values presented in Table 1.

<u>Paper 13</u> by MacDougall is concerned on the one hand with curing at different levels of nitrite in the curing brine and without nitrate, and on the other with storage life characteristics of the packaged bacon. The author finds that a brine containing 250 ppm nitrite, used to produce bacon by the Wiltshire cure, was insufficient to ensure uniform colour in the finished product and also that at this level of nitrite the bacon spoiled. He makes the interesting point that it is bacteriological stability rather

than colour stability which defines the lowest limit of nitrite to be used in curing. The colour of bacon made with brine containing 500 ppm nitrite was indistinguishable from the colour of bacon made with 2000 ppm nitrite brine. However, there is a risk of spoilage with the 500 ppm nitrite brine. Paper G4 by Shaw which deals with this work has already been discussed.

One point which is not absolutely clear from Dr MacDougall's paper is whether or not the same brine was used for both immersion and pumping of the bacon. It would not be usual to use a mature brine, with its concomitant microflora for pumping sides of bacon. It is more probable that the brines containing 500, 1000 and 2000 ppm which were matured for 8 or 12 weeks were used for immersion only and that a freshly made up brine with a similar chemical composition was used for the pumping operation each time. However this point is not clear and a little more information would be welcome.

From the point of view of this session the more important aspects of Dr MacDougall's paper are the changes which take place during storage in the pack. Dr MacDougall discusses the formation of nitrosomyoglobin after packaging from residual metmyoglobin already formed due to oxidation. Metmyoglobin is also reduced in fresh meat under vacuum conditions, in this case to the purple myoglobin form of the derivative. It would be interesting to know if the same reducing mechanisms exist in bacon as in fresh meat. M. longissimus dorsi in fresh beef has a strong metmyoglobin reducing activity[10]. Do other bacon muscles retain the ability to reduce metmyoglobin?

The uniform bright pink-red colour is reported to be stable under fluorescent light and the colour to be stable for the entire 5 week storage period although much of the meat had obviously spoiled after this time. It is important that the package used in this case is Metathene X, which is an extremely impermeable barrier film; the stability of bacon colour under these conditions is an indication of the efficient barrier properties of this particular material. Any oxygen gaining access to the meat surface by permeation through the vacuum pouch causes acceleration in oxidation and brown discolouration. However, there seems little point in going to this extent to achieve the ultimate in barrier properties if the bacon only looks good and is unacceptable from the organoleptical point of view when the pack is opened!

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