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MEAT RESEARCH LABORATORY,

P.O. BOX 12 (CNR CREEK AND WYNNUM ROADS) CANNON HILL, BRISBANE, QLD 4170 TELEPHONE 95 4006 TELEGRAMS FOODPRES BRISBANE

SURFACE DRYING OF MEAT AND ITS EFFECT ON STORAGE LIFE OF CHILLED CARCASES

The storage life of meat is determined by the initial contamination it receives during slaughter and by the conditions under which it is chilled and stored after slaughter. Although care in holding of stock and in the procedures used in slaughtering, dressing and handling can minimise the initial contamination, this, unless controlled, will rapidly develop and result in a reduced storage life and ultimate spoilage of the carcase.

The rate at which the microorganisms grow depends largely on the temperature and moisture content of the surface where the organisms are located.

During chilling, provided adequate refrigeration has been applied, both temperature and moisture content of the surface tissues fall leading to a significant decline in the growth rate of microorganisms. Bacteria grow best on wet surfaces and removal of water will therefore inhibit the growth of organisms, but it also leads to shrinkage or weight loss. Consequently if it is desired to keep chilled carcases for a reasonable length of time, some weight loss has to be tolerated.

Investigations are now being made to obtain a better understanding of the interplay of cooling and evaporation during the chilling and storage process and some general principles can be stated:

EVAPORATION OF WATER FROM CARCASE SURFACE DURING CHILLING

The rate of drying of the carcase surface will depend on the differences between the rate of evaporation and the rate of diffusion of moisture from the deeper layers of tissue. This diffusion rate will depend on the proportion of tissue, muscle, fat or connective tissue in the carcase.

During chilling, the evaporation of water from the surface depends on:

(a) the supply of heat within the carcase, i.e. the temperature differences between the carcase surface and the surrounding air. Evaporation decreases markedly as the temperature of the meat surface and the air come closer together. Fast chilling with low air temperatures, compared to slow chilling, gives a faster rate of weight loss but, because of the shorter chilling time, produces a lower total weight loss. This of course is desirable from a weight loss point of view and air temperatures in chillers should be initially as low as possible without causing freezing of the carcase surface.

Because of the slower rate of cooling, it is not difficult to remove sufficient moisture from beef carcases. However, the surface temperature of lamb, mutton and calf carcases, and the thinner areas of any carcases, such as necks and flanks, comes down much more quickly and the water content is comparatively high in these areas. Spoilage difficulties are therefore more common in these meats. With these small carcases a high rate of drying must be obtained during the beginning of the chilling phase to remove the surface water. Once the surface temperature has come down to the air temperature, rapid removal of excess water is difficult under most plant conditions.

In experiments with beef sides, it has been shown that surface water content on the thick muscles around the aitch bone is always much lower than on the thin muscles of the neck and flank. In fact, the numbers of microorganisms on the aitch muscle area are often reduced during the first 10 hours of cooling. This is associated with slower cooling and fairly high surface meat temperatures which give rise to a high rate of drying.

(b) the drying power of the air, which depends on its temperature and relative humidity. The higher the relative humidity the less the weight loss. However, humidity has only a comparatively minor effect on the rate of evaporation in the earlier stages of chilling.

(c) the speed of air movement. A higher velocity will give rise to a faster cooling rate on the surface of the carcase. The overall effect of velocity is a very complex one and most workers

support the theory that high initial velocities followed by lower velocities in the later part of the chill give rise to a desirable fast initial rate of weight loss together with a low total weight loss.

Because of the speed at which the surface temperature drops in lamb and mutton (i.e. smaller carcases), a faster air speed is needed for these than for the larger beef sides.

(d) meat quality factors. Fat meat loses less weight than lean meat. Weight loss decreases with increased carcase weight (because of the decrease in surface area per unit weight). Carcases with large areas of cut surfaces have a high weight loss from the exposed muscles.

MICROBIAL GROWTH DURING STORAGE OR HOLDING OF CARCASES

During chilling the deeper tissues of meat attain a temperature close to that of the air in the chiller.

After this period the rates of evaporation fall to a very low level. When the rate of diffusion of water from the deep to the surface layers exceeds the rate of evaporation, the water content of the surface tissues will increase. Condensation from the air may also occur. However, microbial growth during this storage phase may be controlled by minimising the increase in surface water contents through the maintenance of sufficiently high drying power of the air. The drying power depends upon the relative humidity and air speed over the carcase surface. The difficulty is often to restrain excessive evaporation during storage and a relative humidity in the range 87% to 91% and air speeds of about 10ft/min at the surface are considered satisfactory. While polythene or stockinette bags will protect carcases from dirt and decrease weight loss, it should be remembered that these can lead to faster growth of bacteria and decreased storage life.

RECOMMENDATIONS:

1. Plan the operation of chilling and holding to ensure that the weight loss is no more than needed to give the desired storage life.

2. Remove water from the surface of the washed carcase as quickly as possible by either mechanical means or by evaporation:

(i) load promptly into chiller.

(ii) load carcases so that they are not touching and there is adequate air circulation between them. Where surfaces are in

contact, the air circulation is poor, and cooling and moisture removal slow. In a case examined recently after overnight chilling, moist areas in contact with each other had counts of 60 million to 600 million coliform organisms per square inch while non-touching drier areas only ½" away had only 60 to 600 per square inch.

(iii) do not put hot carcases in a chiller with partially chilled carcases. This would not only slow down chilling of the cold carcases but may also produce condensation of moisture on them. Keep the chiller closed to avoid entry of hot air which may condense on the carcases.

(iv) Apply cold temperatures with high air velocities as early as possible in the chilling stage, but ensure that the surfaces do not freeze. If practicable, pre chill the room to low temperatures before the commencement of loading.

(v) Ensure that the refrigeration design is adequate to cope with the removal of the excess water vapour.

3. When the surface temperature of the meat has dropped almost to the desired final carcase temperature, the air velocity should be reduced and the relative humidity raised slightly to produce conditions which keep evaporation as low as is consistent with the desired storage period. Remember that it is necessary to make a compromise between weight loss and keeping quality. Increasing the weight loss will retard microbial spoilage.

4. Keep records of temperatures in chillers and holding rooms and of weight losses during chilling and storage. Relate these results to the appearance and storage life of your product.

5. Ensure that the principles involved are understood by the appropriate staff and that your decisions based on these are consistently carried out.

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NEWS JOTTINGS:

As part of its research programme, the Meat Research Laboratory is studying aspects of the chilling process. Equipment has been developed for measuring histories of carcase weight and temperature, air temperature, relative humidity and velocity. This will permit collection of data in works chillers in a form suitable for computer processing. It is hoped that this information will lead to the design of better methods of chilling to reduce weight loss and retain satisfactory keeping quality, colour and tenderness.

REMOVING HAIRS FROM CARCASES

Industrial vacuum cleaners which remove hairs from cattle and calf carcases are available. The name of a firm which supplies vacuum equipment designed for the meat industry can be obtained by writing to the Meat Research Laboratory.

Next Issue will be The Use of Packaging Films.