EQUALISING OF YOUNG BULL CARCASSES IN CHILL ROOM VS. REFRIGERATED LORRY - EFFECTS ON TEMPERATURE PROGRESS AND MICROBIOLOGICAL QUALITY

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Background

EU regulation requires that the carcass temperature has reached 7°C prior to dispatch from the meat plant chiller. The aim of the regulation is to ensure consumer health by low temperature in the meat resulting in low bacterial growth and long shelf life (EC, 1999). The regulations imply that carcasses cannot be dispatched for export or for boning plants until the second day after slaughter. The Danish Veterinary and Food Administration has up to now granted an exemption allowing loading for export of cattle carcasses with a core temperature of 15°C and a surface temperature of 7°C. However, this exemption will not be continued due to a future requirement by the EU, according to which the maximum core temperature permitted at dispatch is anticipated to be 10°C. For industry it has practical importance if transport must wait to the second day after slaughter rather than the first day, and the export customers will receive a day older carcasses. The regulations may be unjustified if the chilling in modern refrigerated lorries can progress like in the meat plant chiller. It is not expected that the change of regulations will influence neither food safety nor the shelf life of the beef. The current exemption allows the surface temperature to be max. 7°C. In practice the surface of the carcass and the air temperature is much lower than 7°C during transport. This allows the final chilling to take place during transport and to ensure that carcasses are unloaded at the customers' premises with a max. core temperature of 7°C in order to ensure a satisfactory shelf life.

Objective

To document the temperature progress and the microbiological quality of carcasses of young bulls during transport one or two days after slaughter. The carcasses were either fully chilled before loading or received final chilling during transport.

Methods

A refrigerated lorry (D1) with representative chilling capacity (4600W at –20°C) with trailer (D2) was used for transport of carcasses over 4 days from a Danish abattoir in Aalborg to Portugal. Specifications of technical data for both the vehicle and the chilling systems are given in detail by Madsen et al. (2000). The lorry (D1) was fully loaded with carcasses (mainly 78 half carcasses and 40 forequarters) from the slaughter of the previous day (core temperature 10-15°C), a total of 11,3t. The trailer (D2) contained mainly 52 half carcasses, a total of 6,7t all on the second day of slaughter (core temperature 2-5°C).

Microbiological verification was performed by taking 50 representative swab samples (moistened in FKP (0.9% NaCl+0.1% peptone) from the carcass surface (400 cm^2 of Round/Forequarter) at loading and at unloading. The time of analysis at DMRI after sampling was standardized (15-18h) where swabs were stomached for one min. with 50 ml FKP and then spread plated. Samples were examined for aerobic bacterial count (PCA, 20°C, 5 days, ANF-108-02), *E. coli* (Petri film method No. 66009-ANF-111-01), *Enterobacteriaceae* (RVB-g, 37°C, 18-24 hours, pour plate with covering layer, ANF-106-04, NMKL No. 144) and *Pseudomonas* (CFC –Oxoid, 20°C, 5 days – surface inoc.).

At loading carcasses had probes (precision ±0.5°C) fitted to record temperature (Grant Datalogger or Testo 175 with sensor probe type 613) during transport. Temperatures were measured on carcasses at the front and rear of the lorry and trailer in various positions: centre of the Round; centre of the Shoulder; Surface fat of the Short Loin; Air 3cm from the flank. Ambient air temperatures were recorded on the roof and the sides of the lorry. During transport a refrigeration programme giving an air temperature of 1-2°C was used.

Results and discussion

Chilling -The carcasses in the D1 and D2 groups were similar with no major differences in weight (app. 250kg), conformation (app. 6) or fatness (app. 2) between. In the abattoir chill rooms a refrigeration programme of 1-3°C was used. At loading core temperature (insertion probe) in the Round ranged from 10 to 15 °C in 26 carcasses for the D1 and 4-7 °C (n=25) for the D2 group. Ambient temperature varied between 10 and 45 °C during the transport.

In the D2 group temperature was measured in five carcasses in the front of the lorry and one in the rear. Temperature profiles were very similar, regardless of the position of the carcass in the lorry and the carcass weight. A typical profile is shown in figure 1. The air temperature was slightly higher when fitting the probes, but stabilised quickly after loading. Low temperatures of the Shoulder and the two measurements of the Round confirmed that carcasses were completely equalised at loading. The air temperature inside the vehicle was very stable at 1-2°C and not affected by the varying ambient temperature.

For D1 temperatures was recorded in three carcasses in the front of the vehicle and five in the rear. A typical profile is shown in figure 2. with an air temperature of the abattoir dispatch chill rooms of approx. 2°C. At the loading ramp, the temperature was approx. 12°C, which resulted in a short increase of both air and surface temperatures around the time of loading. After loading the air temperature stabilised around 1-2°C. At loading the core of the Round was 10-15°C depending on time of slaughter and carcass weight. The core temperature decreased at an even rate during transport. The constant air and surface temperature of 1-2°C throughout the transport documents that the refrigeration unit had no difficulty in meeting the requirements even though there was a need for continued carcass chilling; the ambient temperature varied considerably and the lorry was fully loaded. A core temperature of 7°C was reached after an unbroken chilling progress between approx. 28 and 45 hours after slaughter. On average it took 35 hours for all the carcasses. From figure 2 it is evident that the chilling progress in the carcass is similar in the lorry and the discharge chill rooms. This is documented by the profiles from "Round II", for which the temperature probes were placed several hours prior to

loading. These probes show identical unbroken progress compared to profiles from the probes in the Round placed when loading the lorry. Actually, when the surface temperature can be maintained at the low level, the method of chilling is not important as the equalising of temperature in the carcass occurs following a temperature gradient from the core. It was further more estimated that even with a constant ambient temperature at 40°C and 1°C required inside the lorry, a full load of carcasses with an average temperature of 11°C there would still be an excess chilling capacity of 0.6kW.

Microbiological results The development of the aerobic bacterial counts and *Pseudomonas* counts are shown in figure 3 and 4. The data have been analysed by means of a two-sided analysis of variance in SAS (Lifereg procedure). During transport the aerobic bacterial counts increased approx. 1 log unit ($p<0.0001$). This is shown by an increasing number of samples having a bacterial count of 3-4 and >4 log cfu per unit. No significant differences were found between the bacterial counts for Groups D1 and D2 neither in Aalborg nor in Portugal.

Samples showed as anticipated growth of *Pseudomonas* over the time between loading and unloading at the prevalent air and surface temperature. This is illustrated in figure 4 with a significant increase of *Pseudomonas* of 2.8 log units ($p<0.0001$). The level of *Pseudomonas* for Groups D1 and D2 was not different, neither at loading in Aalborg nor at unloading in Portugal.

Only a few samples examined for *E. coli* and *Enterobacteriaceae* were above the detection limit both at loading and unloading. It is therefore not possible to prove, whether chilling during transport influences the growth of *E. coli* and *Enterobacteriaceae*. However, since no differences were found between the D1 Group and the D2 Group with respect to growth of aerobic bacteria and *Pseudomonas*, it is highly unlikely to be the case with respect to *E. coli* or *Enterobacteriaceae*.

Conclusion

The chilling of bovine carcasses, not fully equalised at loading into a refrigerated lorry, continued at a steady rate during transport. Surface temperature (1-2°C) was maintained while the core temperature equalized at an even rate. After four days of transportation there was no difference between the microbiological condition of the surface of carcasses loaded into the lorry on the day after slaughter (with a core temperature of 10-15°C) or two days after slaughter (with a core temperature of 5°C).

References

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EC, 1999. Cooling of carcasses during transport. Opinion of the Scientific Committee on veterinary measures relating to public health. 15-16 March. EUROPEAN COMMISSION, DG-XXIV.UnitB3.

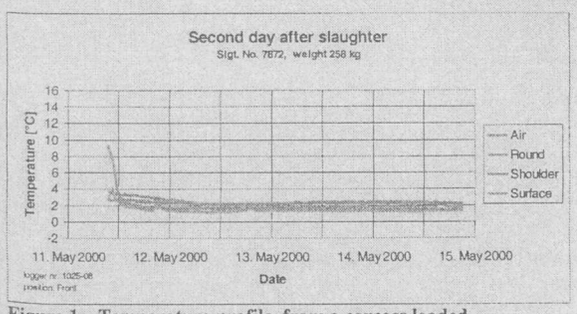

Figure 1. Temperature profile from a carcass loaded the second day after slaughter

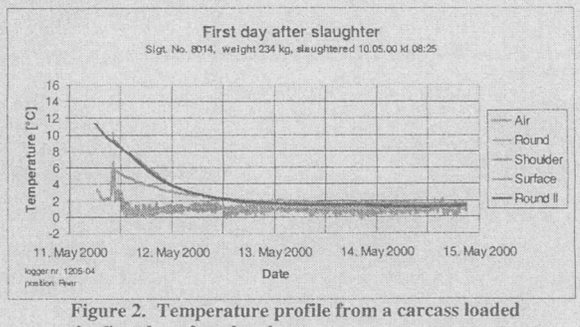

Figure 2. Temperature profile from a carcass loaded the first day after slaughter

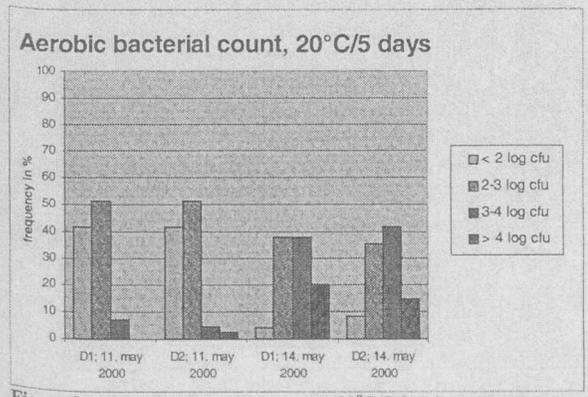

Figure 3. Aerobic bacterial counts (20°C/5 days) on a carcass at loading in Aalborg and at unloading at destination 4 days later. Bacterial counts stated as log cfu/unit (unit = 8 cm^2).

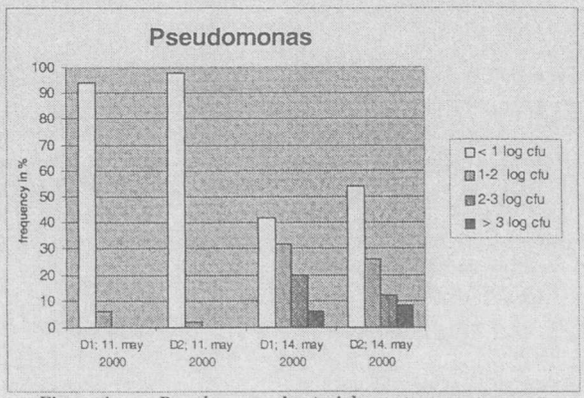

Figure 4. *Pseudomonas* bacterial counts on a carcass at loading in Aalborg and at unloading at destination 4 days later. Bacterial counts stated as log cfu/unit (unit = 8 cm^2).