THE IMPORTANCE OF STATIONARY AND TRANSPORT CHILLING PRACTICE FOR THE HYGIENE STATE OF FRESH MEAT

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Keywords: stationary and transport chilling of fresh meat, Council Directive 64/433/EEC as amended by Directive 91/497/EEC, psychrotrophic bacterial pathogens

Background: Council Directive 64/433/EEC as amended by Directive 91/497/EEC Chapter XIV states that "fresh meat must be chilled immediately after the post mortem inspection and kept at a constant internal temperature of not more than 7°C for carcasses and 3°C for offal". Derogations from this requirement may, for technical reasons relating to the maturation of meat, be granted on a case basis for the transportation of meat to cutting rooms or butcher shops in the immediate vicinity of the slaughter house, provided that such transportation takes not more than one hour.
Although most food-associated pathogens like *Salmonella* or bacteria species involved in food spoilage do not multiply at the temperatures mentioned above, some microorganisms, like *Yersinia enterocolitica* or *Listeria monocytogenes*, may still replicate at temperatures as low as 0°C and therefore have to be considered as potential health hazards for the consumers.

The refrigeration capacity of cooling units in stationary plants (abattoirs) required to extract heat from hot carcasses (41 °C) received directly from the slaughter line, is much greater (600–1200 KW) than that of cooling units fitted to lorries (14 KW) carrying refrigerated meat sometimes for two or more days. It has to be ensured that the cooling of meat during transport fulfills all legal demandments and does not influence the meat in a negative way.

Objectives: The aim of this study was to evaluate the efficiency of transport chilling facilities under standardized conditions and to compare the results obtained with data from stationary chilling trials. Another question was if chilling of meat during transport presents an alternative to stationary cooling.

Material and Methods: A total of three chilling trials was performed in cooperation with the TÜV Bau- und Betriebstechnik, Munich, Germany.

For these trials lorries equipped with very efficient and powerful cooling units were loaded with 32.5 tons of meat (Trial 1: pig carcasses in halves; Trial 2: mainly forequarters of beef and some beef hindquarters; Trial 3: hindquarters of beef) of an internal temperature of 20°C. The outdoor temperature was 28°C. During the trials the temperature inside the lorry and the superficial and internal temperature of the meat were recorded. In addition the air humidity inside the lorries was surveyed.
Before the beginnining and after the end of the trials samples of the meat were taken and examined microbiologically and sensorically. Total aerobic plate counts were determined and the prevalence of spoilage bacteria and potential food-associated pathogens was examined (e. g. *Enterococcaceae, Micrococcaceae, Vibrionaceae, Staphylococcus spp., Moraxella, Acinetobacter, Alcaligenes*).

Results: The three chilling trials revealed that the efficiency of transport chilling facilities is three to five times less than that of stationary cold-storage plants.
The results of trials No. 1 and No. 2 are shown in the figures presented below; data of the microbiological examinations are summed up in tables 1 to 3.
Enterobacteriaceae (up to $9.2x10^5$ cfu/g) and *Bacillus spp.* (up to $3.8x10^5$ cfu/g) were frequently found and so were yeasts (up to $7.1x10^3$ cfu/g), which are able to grow at temperatures even below 0°C.

Discussion and Conclusions: There are two reasons why lower temperatures reduce the growth of microflora on and in the carcasses: a) the lag phase of the bacteria is extended and b) their rate of growth is reduced. Therefore the sooner meat or other food is chilled to low temperatures (at least 7°C) the less time there is for microorganisms to cause spoilage or to replicate to numbers that might present potential health hazards for the consumers. The results of our study show that multiplication of bacteria does occur during chilling of meat in transport cooling facilities which were proven to be three to five times less efficient than the ones used in stationary cold-storage plants. We therefore can not recommend the direct chilling of freshly slaughtered meat in transport lorries, not even in the ones equipped with very powerful cooling units.
Temperatures below 7°C as demanded by legal regulations do not prevent growth of all foodborne pathogens or spoilage bacteria. Therefore lowering the storage temperature of fresh meat and keeping it as near as possible to 0°C improves the hygienic quality and prolonges the shelf life. The efficiency of the commercially available cooling facilities can easily match the lower temperatures. For economical, technological and especially hygienic reasons an deep muscle temperature of 3°C or less should be demanded.

Acknowledgements:
We thank the Federal Minstry for Health, Bonn, Germany for funding this project and the TÜV Bavaria (Association for technical surveillance), especially Dipl.-Ing. B. Schrempf, Dipl.-Ing B. Brunnhuber and Dipl.-Ing. J. Holzer, Munich, Germany for technical support.

Data:

Tab. 1: Microbiological data from refrigeration trial No. 1

	maximum aerobes whole body count (cfu/g)	mimimum aerobes whole body count (cfu/g)	mean values of aerobes whole body count (cfu/g)	maximum aerobes HBC blood (cfu/g)	maximum aerobes HBC blood (cfu/g)	mean values of aerobes HBC blood (cfu/g)
before the trial	$8.7x10^4$	$1.6x10^4$	$3.87x10^4$	$6.1x10^4$	$1.1x10^4$	$3.84x10^4$
after the trial	$9.5x10^5$	$1.1x10^5$	$5.96x10^5$	$4.3x10^6$	$1.7x10^5$	$8.40x10^5$

Tab. 2: Microbiological data from refrigeration trial No. 2

	maximum aerobes whole body count (cfu/g)	mimimum aerobes whole body count (cfu/g)	mean values of aerobes whole body count (cfu/g)	maximum aerobes HBC blood (cfu/g)	maximum aerobes HBC blood (cfu/g)	mean values of aerobes HBC blood (cfu/g)
before the trial	$7.6x10^2$	$1.7x10^2$	$4.87x10^2$	$1.8x10^3$	$3.2x10^2$	$6.04x10^2$
after the trial	$7.5x10^3$	$1.8x10^3$	$4.17x10^3$	$1.9x10^4$	$3.8x10^2$	$2.82x10^4$

Tab. 3: Microbiological data from refrigeration trial No. 3

	maximum aerobes whole body count (cfu/g)	mimimum aerobes whole body count (cfu/g)	mean values of aerobes whole body count (cfu/g)	maximum aerobes HBC blood (cfu/g)	maximum aerobes HBC blood (cfu/g)	mean values of aerobes HBC blood (cfu/g)
before the trial	$2.5x10^3$	$4.1x10^2$	$1.24x10^3$	$2.1x10^4$	$5.9x10^2$	$5.00x10^3$
after the trial	$5.8x10^3$	$6.2x10^2$	$3.48x10^3$	$1.2x10^4$	$2.2x10^3$	$5.34x10^3$

Fig. 1: Temperature curves of chilling trials No. 1 and 2