TIME-TEMPERATURE IN DISTRIBUTION OF CHILLED MEAT AND POULTRY

MIE GUNVIG and
LEIF BØGH-SØRENSEN

Danish Meat Products Laboratory,
Ministry of Agriculture, Howitzvej 13,
DK-2000 Frederiksberg, Denmark.

INTRODUCTION

Previous surveys of time-temperature conditions during transport of chilled meat and meat products have shown that the prescribed temperature limits are frequently exceeded, as well during distribution as at arrival to supermarkets, i.e. until the chilled foods are placed in chilled store or in cabinet (Gunvig and Bøgh-Sørensen, 1987; Sørensen et al., 1985). In the chill cabinet, about 50% of the products in the upper/outer layers will be 5-10°C (Bøgh-Sørensen, 1980).

It was decided to examine the time-temperature conditions in distribution of chilled meat, because cutting of fresh meat in DK today takes place in the slaughterhouses rather than at retail level. Thus, fresh (unwrapped) meat is more vulnerable because of the increased degree of processing. Therefore, it is very important that the temperatures in the entire chill chain are kept at a low level, so the consumer is ensured delivery of fresh products. In Danish legislation there are 2 temperature limits for transport of chilled foods: In refrigerated vehicles containing chilled, fresh meat only, the temperature must not exceed 7°C. In mixed transports (fresh meat together with for example vegetables or meat products) the temperature shall be 5°C or below.

The purpose of the survey was to get knowledge about the time-temperature conditions in distribution (from producer to retailer) of fresh meat. This could make it possible to determine the influence of the actual time-temperature conditions on the quality and remaining storage life of chilled meat.

MATERIALS AND METHODS

Time-temperature conditions in distribution of chilled meat (pork) and poultry from 3 slaughterhouses to 14 supermarkets have been examined.

The size of the supermarkets varied from middle to very big. Smaller shops were not represented, because they seldom have their own butcher department.

From slaughterhouse A time-temperature conditions in two distribution systems to a total of 11 supermarkets have been recorded. One system is direct from the slaughterhouse to 3 supermarkets and the second system is via a fresh food terminal to 8 supermarkets. The transport times were 19 h and 7-9 h, respectively.

In transports direct from slaughterhouse A, loading took place at about 14 h. Until next morning the refrigerated vehicles were left at the slaughterhouse. Transport to the different supermarkets started at about 6 h.

In transports via fresh food terminal, loading took place in the evening/night, then 1 h journey to the terminal, where the fresh meat were stored until the next morning, and thereafter the transports began (at 4 to 7 h).

From slaughterhouse B the distribution was direct to 3 supermarkets. The total transport time was about 19 h which included 3 h sea voyage.

From slaughterhouse B the transport began at about 17 h. First, 1.5 h journey to the ferry where the vehicle was left for 5 h, then 3 h sea voyage. At about 3 h, the transport to 10-15 supermarkets began.

In all 3 distribution systems the meat cuts were placed in plastic boxes (with up to 30 kg of meat), in some cases covered with plastic.

The time-temperature measurements were carried out in the period June-October.

Concerning distribution of chilled poultry the time-temperature conditions were measured from one abattoir to 4 super-

markets. The total transport time was about 23 h. Air chilling (crust freezing) was used on the poultry slaughterhouse to chill the chickens. Unlike pork, the chickens were packed at the poultry slaughterhouse (foodtainer plus plastic overwrap) and placed in an open carton containing 8 chickens. The chickens were transported to a secondary depot, where the goods were left in the vehicle until the next morning, where reloading to other vehicles took place.

For the temperature measuring during distribution, Grant-dataloggers with 4 temperature sensors were used. A recording interval of 2 minutes was used in all cases. One sensor recorded the air temperature, 3 sensors recorded product temperatures. In distribution of fresh poultry, all 4 sensors recorded air temperatures because the method had to be non-destructive.

When collecting the dataloggers in the supermarkets, the temperature of the meat was measured with a conventional thermometer (= temperature at arrival). For meat boxes, mean temperatures (n = 4) of the bottom, the middle and the surface layers were measured. For chickens, surface temperatures only were measured.

RESULTS

Time-temperature conditions during distribution

Table 1 shall be read in the following way: From slaughterhouse A, via terminal to 8 different supermarkets, the time-temperature conditions were measured in 112 transports. The product temperature was below 5°C in the whole period in one transport. In one transport the temperature exceeded 5°C in 1-50% of the time; in 31 transports the temperature exceeded 5°C in 50-99% of the time, and in 79 transports the product temperature exceeded 5°C during the whole transport. The temperatures in the last 2 columns are the mean product and air temperatures, respectively.

Transport via terminal:

As described above, 79 out of 112 transports exceeded the temperature limit during the whole transport, i.e. 8-9 h.

The mean product temperature was 6.6°C, and the highest recorded was 12°C. In 97 out of 112 transports the initial temperatures were above 5°C at loading at the slaughterhouse.

TABLE 1. Temperature conditions during transport of fresh pork (in 3 different distribution systems) and of fresh poultry.

Distribution system	No. of super-markets	No. of transports where temperatures >5°C: 0-1% of time	1-50% of time	50-99% of time	100% of time	Total	Mean product temp.	Mean air temp.
Via terminal* (A)	8	1	1	31	79	112	6.6	6.6
Direct* (A)	3	3	26	4	1	34	3.8	3.2
Direct* (B)	3	0	6	27	5	38	6.1	5.9
Via secondary depot**	4	11	5	5	0	21	-	2.2
Total		15	38	67	85	205		

* = fresh meat; ** = fresh poultry; (A) = slaughterhouse A; (B) = slaughterhouse B

The main reason seems to be insufficient chilling or too short time in the chiller. An extra chilling after deboning and cutting could probably solve the problem. Other reasons can be insufficient insulation of the vehicle, the extra reloading at the terminal or insufficient chilling capacity in the vehicle.

8-9 hours at 6-7°C is clearly a severe treatment for fresh meat, especially when it is in the first part of the distribution. The quality and the remaining storage life of the meat will presumably be reduced markedly.

Transport direct from slaughterhouse:

The temperature exceeded 5°C in 31 out of 34 transports from slaughterhouse A - in 26 cases for about 4 h; the average transport time was 19 h. In 5 transports the temperature exceeded 5°C for more than 50% of the transport time. The mean product temperature was 3.8°C.

During temperature abuses the average temperatures were 7-8°C. The highest recorded temperature was 13°C.

In 30 out of 34 transports the initial temperatures were too high at loading and while the vehicles were waiting at the slaughterhouse. Thereafter, the temperature generally was below 5°C. Increasing temperatures were not recorded, which is in agreement with the temperature at arrival at the supermarket (<5°C), see fig. 2 and table 2.

In 27 out of 38 transports (71%) from slaughterhouse B (direct transport including 3 h sea voyage) the temperature exceeded 5°C in about 15 h and in 5 transports (13%) during the whole transport. The total transport time was 16-17 h.

The mean temperature (both air and product temperature) was about 6°C which is not especially alarming, but 15 h at 6°C can reduce the remaining storage life. The highest recorded temperatures were 15°C. In 23 out of 38 transports, the initial temperatures were too high at loading and in the first part of the transport.

The high temperatures in delivery direct from slaughterhouse seem to be caused by insufficient chilling at the slaughterhouse. According to Danish legislation the chilling shall take place at the slaughterhouse instead of in the vehicle. As shown in fig. 2 (transports direct from slaughterhouse A), the chilling capacity of the refrigeration machinery in the vehicles seems to be sufficient, as the temperature decreased. An efficient chilling of the product at the slaughterhouse would mean that the transport temperature could be reduced to below the prescribed limit.

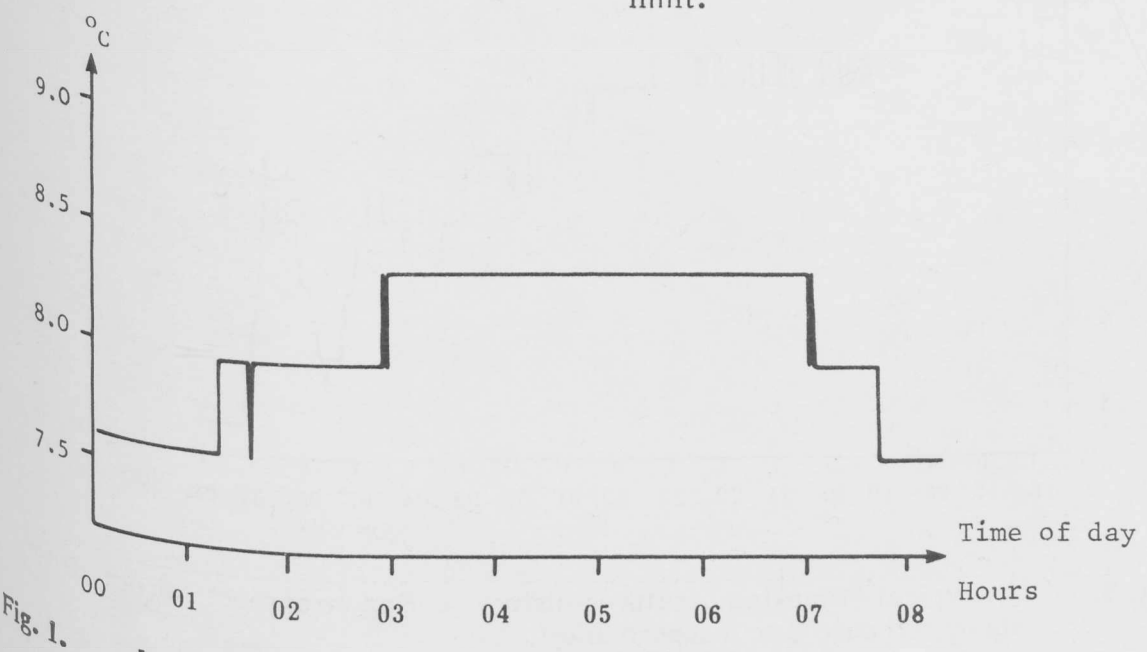

Fig. 1. A typical time-temperature history during distribution via fresh food terminal to a supermarket.

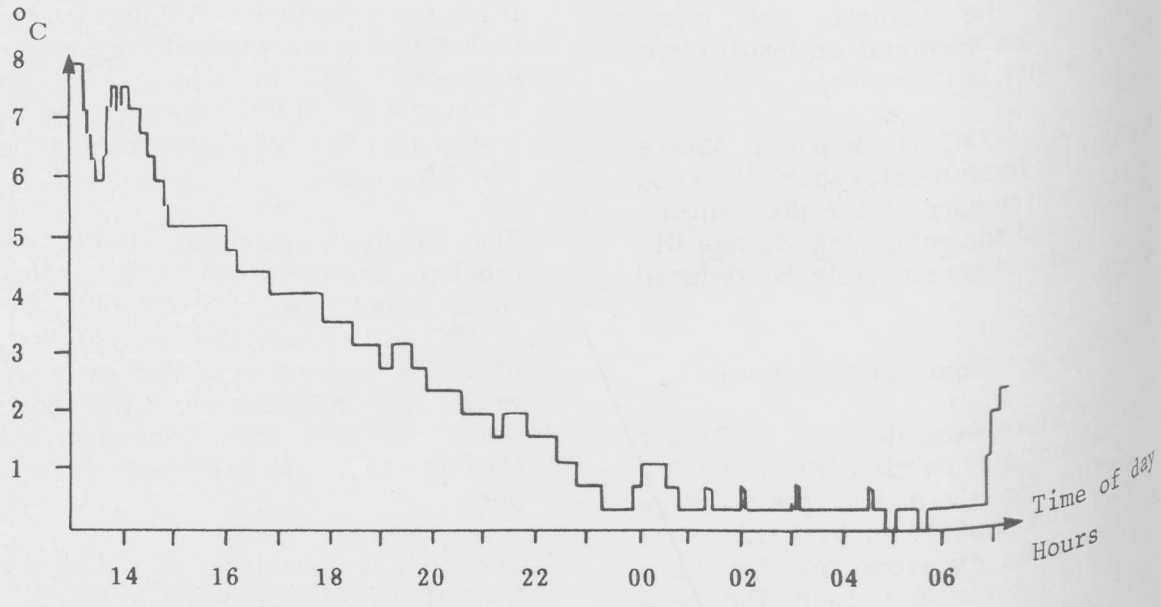

Fig. 2. A typical time-temperature history during transport direct from slaughterhouse A to a supermarket.

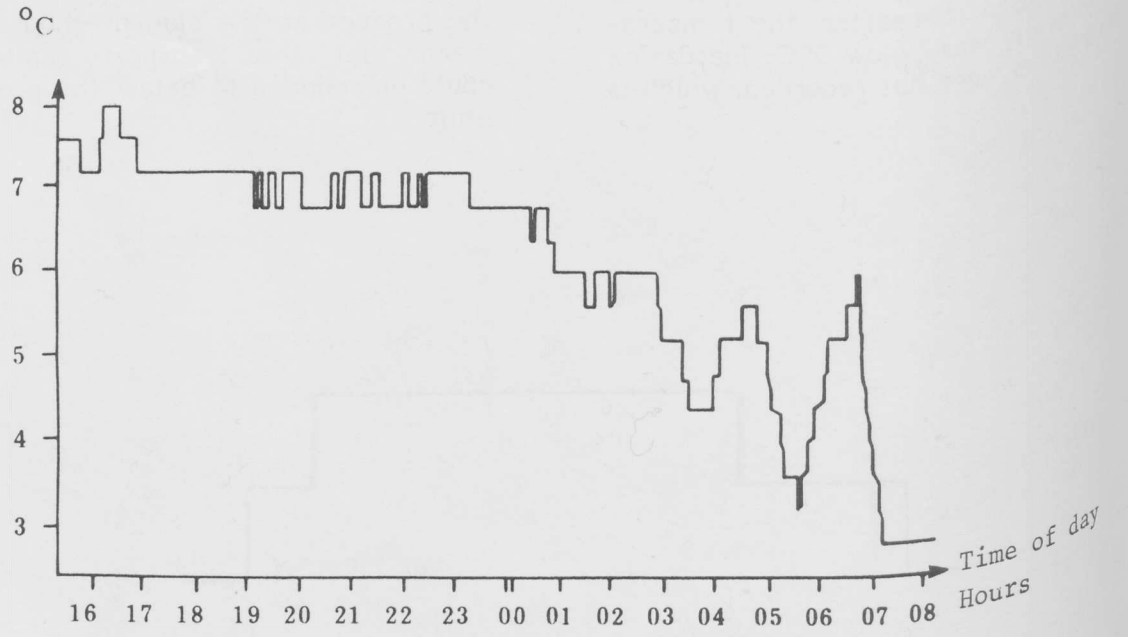

Fig. 3. A typical time-temperature history during transport direct from slaughterhouse B to a supermarket.

Transports of fresh poultry:

The temperature measurements showed that the temperature during distribution could be above 5°C as well as below 0°C, i.e. a temperature variation of 6-7°C. Most of the temperature abuses lasted shortly. The temperatures below 0°C occurred mainly in the beginning of the transport, probably because air chilling (crust freezing) was used for chilling the chickens. Crust freezing means that the outer layers are frozen to a temperature about -2°C in a freezing tunnel. Then temperature equilization takes place, e.g. during transport, and the mean temperatures of the chickens were 0-5°C.

Temperatures at arrival

As shown in table 2, the temperatures at arrival is in good agreement with the temperatures measured during transport. Low temperatures (<5°C) were measured at arrival in supermarkets with direct delivery and high temperatures were measured in supermarkets with delivery via terminal (5.5-8.0°C).

For deliveries via terminal, the temperature was highest in the bottom and at the surface of the meat, while the temperature in the middle was a little lower. It seems that during transport via terminal, heating of the outer layer of the box occurred. In deliveries direct from the slaughterhouse, no difference between the layers were found.

In deliveries of poultry the temperature generally was 2-3°C, which is in agreement with the measurement during transport.

Handling of chilled meat at retail level

In addition to high product temperature in the first part of the chill chain and in transports via fresh food terminal, some generally accepted guidelines are violated. For example it was often seen that the driver delivered the chilled products on a platform where it was left direct in the sun for a longer period.

Frequently repacking of chilled meat occurred, especially the expensive cuts.

TABLE 2. Temperatures (± standard deviation) at arrival to supermarkets in 3 distribution systems for pork, and in one distribution system for fresh poultry. The temperatures are indicated for the bottom, the middle and the surface layers of the box.

Distribution system	Number of supermarkets	Mean temp. in bottom layer	Mean temp. in the middle	Mean temp. in top layer
Via terminal* (A)	8	7.2 (± 1.0)	6.8 (± 0.9)	7.7 (± 1.7)
Direct* (A)	3	4.2 (± 1.6)	3.7 (± 1.2)	3.9 (± 1.7)
Direct* (B)	3	5.2 (± 1.8)	5.6 (± 1.3)	4.8 (± 1.6)
Via secondary depot**	4	-	-	2.6 (± 2.0)

* = fresh meat; ** = fresh poultry; (A) = slaughterhouse A; (B) = slaughterhouse B

This means that some fresh meats can be stored up to 7 days before it will be purchased by the consumer. In DK repacking is only allowed if the meat is cooked.

The chill cabinet is often overloaded (= above the load line) and in the upper layer the product temperatures can be up to 9°C (Gunvig, 1989) or even higher.

Sometimes you can see the butcher himself - smoking on a cigarette with 2 cm ash - leaning over the bowl with minced meat.

These examples show that it is very important that the employees in all parts of the chill chain should have better training and knowledge in handling chilled foods.

CONCLUSION

The prescribed limit in DK of 5°C (7°C for transport of chilled meat only) is often exceeded in distribution of fresh meat. The main reason seems to be insufficient chilling at the slaughterhouses. Distribution via terminal resulted in temperatures which were often above 5°C during the whole transport. Besides insufficient chilling at the slaughterhouse, high temperatures could be caused by inferior chilling equipment or insufficient insulation of the refrigerated vehicle.

During distribution of fresh poultry no serious temperature abuses occurred, probably because air chilling (crust freezing) was used at the poultry slaughterhouse.

It is very important that the employees in all parts of the chill chain know the consequences of inappropriate handling of chilled meat and other types of chilled foods.

The influence of the recorded temperatures on the quality and remaining storage life is not known in detail, but there is no doubt that quality and storage life is being reduced by the relatively high product temperatures in the chill chain.

ACKNOWLEDGEMENTS

The present research was supported by the National Technological Board.

REFERENCES

Bøgh-Sørensen, L. (1980): Product temperatures in the chilled cabinets. Proceedings from the 26th European Meeting of Meat Research Workers. Paper No. N-22. Colorado Springs.

Gunvig, M. and Bøgh-Sørensen, L. (1987): Temperaturforhold under køletransport (in Danish). Report 43.37. Danish Meat Products Laboratory.

Gunvig, M. (1989): Temperaturforhold i kølediske (in Danish). Report 43.38. Danish Meat Products Laboratory.

Sørensen, I.-M. J., Mosbak, S. and Bøgh-Sørensen, L. (1985): Kølede kødprodukter (in Danish). Danish Meat Products Laboratory.