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Pilot study on the time profile and corresponding temperatures of game meat in the approved game meat chain in Austria

Pilotstudie zum Zeitprofil und den korrespondierenden Temperaturen in der Wildfleischkette in Österreich

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Summary

From 3200 carcasses of large game processed at an Austrian "approved game handling establishment" (AGHE), the following data were recorded: i) species; origin; ii) time from killing to evisceration (estimated as the time to examination by the trained person); and iii) time from killing to skinning and cutting. Additional information on cooling room temperatures and on the products' history from killing of large game to storage at the AGHE was retrieved. Data indicate that evisceration <3 h after killing is the rule (min. 86 % of carcasses), and that – despite the fact that carcasses are typically collected only once a week from the cooling chambers and subsequently transported to the AGHE –, the median time from killing to cutting was merely 8 days. Cooling room temperatures were in a range that would ensure that the legal limits for (internal) meat temperature are reached in due time, but it cannot be excluded that handling and transport would result in a rise in the meat surface temperature. Data allow to design time-temperature scenarios representative for the game meat chain from evisceration to meat cutting. Such scenarios can be useful when growth of contaminant bacteria on carcasses from large wild game has to be assessed.

Keywords: Meat from wild game, cooling facility, time-temperature profile

Zusammenfassung

In einem zugelassenen österreichischen Wildbearbeitungsbetrieb wurden folgende Angaben zu 3200 Wildtierkörpern (Großwild) erhoben: Wildart, Erlegungsort, Zeitspanne von der Erlegung zur Ausweidung (näherungsweise bestimmt als Zeit von der Erlegung bis zur Untersuchung durch die kundige Person); Zeitspanne von der Erlegung bis zur Enthäutung und Zerlegung. Weiters wurden Kühlraumtemperaturen von der Erlegung bis zur Lagerung im Wildbearbeitungsbetrieb ermittelt. Nach den ausgewerteten Angaben erfolgte die Ausweidung bei mind. 86 % der Tierkörper innerhalb von 3 Stunden nach der Erlegung und – obwohl die Tierkörper typischerweise nur 1x/Woche von den Kühlräumen gesammelt und zum Wildbearbeitungsbetrieb transportiert wurden –, betrug die Zeit von der Erlegung bis zur Zerlegung im Median nur 8 Tage. Obwohl die ermittelten Kühlraumtemperaturen geeignet sind, die Fleischinnentemperatur innerhalb einer angemessenen Zeitspanne unter die gesetzlichen Höchstwerte zu senken und zu halten, bestehen Zweifel, ob die Manipulation und der Transport der Tierkörper nicht zu einer Erhöhung der Fleisch-Oberflächentemperatur führen können. Aus diesen Daten können repräsentative Zeit-Temperatur Profile für die Wildfleischkette vom Ausweiden bis zur Fleischzerlegung erstellt werden. Solche Profile können zur Abschätzung des Wachstums von Bakterien auf der Oberfläche von Tierkörpern von Großwild dienen.

Schlüsselwörter: Wildfleisch, Kühleinrichtungen, Zeit-Temperaturverläufe

Introduction

Time-temperature history has a direct impact on autolytic processes in meat as well as on the activity of bacterial contaminants, and, thus, on meat spoilage and safety. European legislation stipulates that, after slaughter, carcasses are to be cooled down to temperatures of ≤7 °C in the case of large animals (bovines, small ruminants, horses and pigs) or ≤4 °C in the case of lagomorphs and birds. These maximum temperatures must not be exceeded in the subsequent steps in the meat chain, i. e. transport of carcasses, cutting and deboning, and transport and display of meat cuts (Reg. (EC) 853/2004). However, deficiencies in the cold chain may allow the meat surface temperatures to rise, and consequences for the growth of bacterial contaminants are under debate (EFSA, 2014). Monitoring of time-temperature profiles along the meat chain may allow to better understand the actual potential of bacterial growth and help to optimize cooling and transport of meat. For recording of time-temperature profiles, thermologgers with probes embedded into meat (e. g. poultry carcasses; Nagyová et al., 2014) are used.

For meat from free-living game, the same temperature requirements exist; however, the pathways from evisceration of free-living game to meat cutting to meat cutting in an approved game handling establishment are more variable than those for slaughter of farm animals. In a pretrial with thermologgers (Thermochron i-button, Maxim, USA) embedded between thigh muscles and under the skin of roe deer immediately after evisceration (unpublished data), we observed that such animals were handled by hunters and game meat traders with more care, and that not the routine, but "best" practices were applied instead. Thus, we tried to obtain information on time profiles by retrospective analysis, with the rationale, that – although less detailed – data would be unbiased.

Data allow to design time-temperature scenarios representative for the game meat chain from evisceration to meat cutting. Such scenarios can be useful when growth of contaminant bacteria on carcasses from large wild game has to be assessed. Possibilities and limitations of such an approach are discussed.

Materials and Methods

In the period 05/2013-09/2014, an Austrian approved game handling establishment (AGHE) was visited during 37 working days. Typically, game carcasses were collected once a week from cooling rooms. These cooling rooms were either associated with hunting areas (primary production; named as "CR" in Fig. 1) or from approved cooling rooms where large wild game carcasses of different provenances were stored ("ACR" in Fig. 1). Carcasses were then transported to the AGHE by company-owned refrigeration trucks. At the AGHE, an initial sanitary and identity control was performed and carcasses were then stored in a chiller ("CR at AGHE" in Fig. 1) until being processed. Carcasses were processed on demand and not on a first-in-first-out basis. Processing started with skinning, whereafter veterinary inspection took place and the health mark was applied. Cutting, deboning and packing was performed in the subsequent hours.

From the total of 3200 carcasses of large game being processed during the study period, the following information was obtained from the attached certificate on inspection by hunter and trained person ("Wildbretbescheinigung"): i) animal species, ii) date (day and time) of killing; iii) date (day and time) of inspection by the trained person, and, iv) place of killing (four-digit postal code or a five-digit village identifier). In addition, the date of veterinary inspection was recorded. Incomplete data sets (e. g. some fields left blank or illegible) were included in the study. Time from killing to evisceration was assessed indirectly, by comparing the date of killing with the date of examination by a trained person. As this examination can take place only on already eviscerated carcasses, this time period can be longer, but by no means shorter than that from killing to evisceration.

Time from killing to cooling was estimated by interviewing 20 hunters supplying game to the respective AGHE. Four options could be chosen: <3 h, 3–6 h, 6–12 h; >12 h.

Time from killing to cutting was assessed by comparing the date of killing specified on the documentation of the carcass with the day of meat inspection (which activity took place before the cutting process).

At each day, temperatures in the cooling room of the AGHE were recorded 3 times in 1-h intervals.

In addition, temperatures were recorded in 5 selected approved cooling chambers (ACR in Fig. 1) for collecting

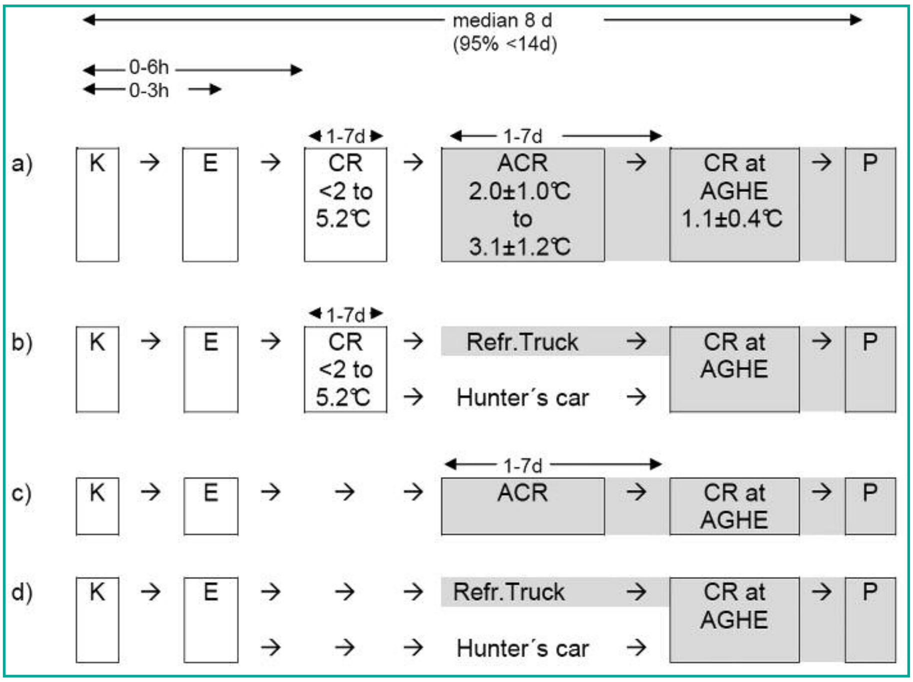

FIGURE 1: *Pathways in the approved game meat chain, with representative time and temperature data. K: killing; E: evisceration; CR: cooling room at hunting ground; ACR: approved cooling room for collecting game carcasses; CR at AGHE: cooling room at an approved game handling establishment; P: processing (skinning, cutting, deboning); Refr.Truck: refrigerated truck of approved game handling establishment; grey shaded areas indicate the part of the game meat chain under veterinary control.*

game carcasses. These ACRs were operated by middlemen. Data were collected by thermologgers (Thermochron i-button, Maxim, USA) in November 2013 and June 2014, over 4 days with 1-h intervals.

Information on temperatures in cooling chambers belonging to hunting grounds (CR in Fig. 1) was retrieved by interviewing 20 hunters in Lower Austria. In the course of these interviews, the various pathways from the killing of game to delivery to the AGHE were identified.

Results and Discussion

Provenance of carcasses and animal species

The 3200 carcasses studied originated from 422 villages (i. e. 422 different postal codes) in 7 Austrian provinces. The majority of carcasses (94.6 %) were from east – central Austria (i. e. Lower Austria, Vienna, Burgenland, Styria, Upper Austria). As regards species, 80 % were roe deer, 12.6 % wild boar, 5 % red deer, whereas chamois, mouflon and fallow deer accounted for 0.8 % each. This reflects roughly the 2013/2014 hunting bags for large game in these provinces, which would be composed of 76 % roe deer, 11 % wild boar, 10 % red deer, 2 % chamois, 0.6 % mouflon and 0.3 % fallow deer (calculation based on data from Statistik Austria, 2015).

Time from killing to evisceration, cooling and cutting

For 2741 carcasses, all killing and examination dates were clearly legible on the attached documentation, and for these carcasses reported time from killing to examination of carcass and viscera by a trained person was <1 h in 62 %, or <3 h in 86 %. Obviously, this does not necessarily mean that the remaining 14 % of carcasses were eviscerated ≥3 h post killing. The results, however, generally comply with those reported by Riemer and Reuter (1979), Bandick and Ring (1995), Brodowski and Beutling (1998) and Deutz et al. (2000, 2006). Whereas EU legislation (Reg. (EC) 853/2004) just requires that evisceration of hunted wild game must be done “without undue delay”, and that signs of delayed evisceration will render the carcass unfit for human consumption (Reg. (EC) 854/2004), national recommendations specify that this action should be undertaken not later than 2–3 h after killing (e. g. Winkelmayer et al., 2013). This timeframe seems to be derived from the studies of Lenze (1977). “Soft shots” (i. e. shots rupturing intestines) may cause spread of bacteria and prompt for earlier evisceration. In addition, evisceration of game with soft shots is more likely to result in higher bacterial numbers on the carcass surfaces (Atanassova et al., 2008). This is a relevant issue at drive hunts, where a higher frequency of inexpert shots and a fixed – and limited – timeframe for collecting and eviscerating the corpses constitute a conflicting situation (Deutz et al., 2006; Atanassova et al., 2008). Also, it is often overlooked that the cooling phase in large game actually starts with evisceration, since with the removal of offal, a heat source is removed from the carcass and the exposed surfaces of the body cavities will dissipate thermal energy by convection as well as by evaporation.

Time from killing to the onset of cooling of carcasses will have an effect on bacterial numbers on the meat surfaces (Paulsen and Winkelmayer, 2004; Maahs, 2010). In our study, this time was estimated from the interviews with 20 hunters, with the following distribution: 0–3 h: 5/20; 3–6 h: 14/20, and 6–12 h: 1/20. This means that active cooling would start typically <6 h post killing, which is in the timeframe reported by Maahs (2010). However, other studies indicate that it would take typically ca. 3 h from evisceration to onset of active cooling (Deutz et al., 2000; Atanassova et al., 2008).

The duration of the cooling phase until delivery to the AGHE was 1 to 7 days (typically the carcasses were collected once a week for delivery to AGHE). Maximum time for transport of carcasses from cooling rooms to AGHE was 8 h; exact data on durations of transports of carcasses could not be retrieved.

Time from killing to cutting as assessed by comparing the date of killing to the date of meat inspection by the official veterinarian (which activity took place before and during the skinning process), was 8 days (median), with 5 %- and 95 %-quantiles of 3 and 14 days, respectively (for distribution, see Fig. 2). Since the carcasses were processed (i. e. skinned, deboned and cut) on demand, storage period ranged from 0 to 21 days.

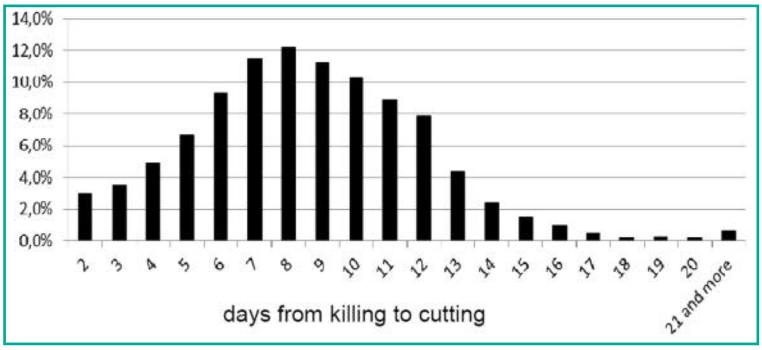

FIGURE 2: *Frequency distribution for the time (in days) from killing of large free-living game to cutting of carcasses in an AGHE; n = 3200.*

Temperatures in cooling rooms

„Typical“ temperatures (i. e. settings of the temperature control for cooling chambers belonging to hunting grounds) were reported to range from <2 to 5.2 °C. Approved cooling facilities for collecting game carcasses had average temperatures of 3.1±1.2 °C in June, and 2.0±1.0 °C in November. At the AGHE, the temperatures in the cooling room ranged from 0.3 to 3.1 °C, with an average of 1.1±0.4 °C. No information was available if forced convective cooling was applied in the refrigeration cabinets at the hunting grounds neither on dimensions of the cooling room, on how the carcasses were actually hung and on how often “fresh” warm carcasses were hung next to already cooled carcasses.

Pathways from killing to cutting

Pathways of eviscerated carcasses from large free living game from killing to delivery to AGHE were found to be quite variable. The most common variants are presented in Figure 1. The typical pathway (Fig. 1, variant „a)“) should be the delivery to the cooling chamber of the hunting area, from which the carcass is transported to an approved cooling room for collecting carcasses and from there delivery to the AGHE. It must be noted that this route involves two transports of the already cooled carcass, whereby the first transport from the cooling room of the hunting area to the approved cooling chamber is done without refrigeration vehicles. Pathways b) and d) involve transport during several hours either without (hunters vehicles) or with cooling (AGHE vehicles), and will end in an approved cooling room with permanent temperature control. Few studies report on the effects of cooling regimens on the internal meat temperature of large game carcasses (Hadlok, 1984; Hadlok and Bert, 1987; Maahs, 2010). The variation of conditions studied by these authors ultimately reflects the variations actually found in practice. For small species, as roe deer, it is reasonable to assume that, in practice, internal meat temperatures <7 °C are reached not later than 48 h after killing. The results of the present study suggest that temperatures in cooling facilities are low enough to ensure that core temperatures will subsequently remain below the legal limit until meat processing. However, it is rather questionable if the various handling and transport events in the game meat chain will not effect an increase of the surface temperature of the carcasses.

Conclusions

The approach we chose in generating the data set has obvious limitations, but only requires minimum compliance of stakeholders and should yield unbiased results. It could be confirmed that evisceration <3 h after killing is the rule rather than the exception, and that – although carcasses are typically collected only once a week from the cooling chambers and then transported to the AGHE –, the median time from killing to cutting is generally merely 8 days. The variants found in the path from killing to arrival at AGHE deserve further study, so as to assess the potential of contaminant bacteria to multiply to unacceptable levels. Admittedly, such assessments would need to consider additional factors such as water activity on meat surfaces and pH of the meat.

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Conflict of interest

The authors declare that no conflicts of interest exist.

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