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The effect of storage conditions on the hygiene and sensory status of wild boar meat

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ABSTRACT

The aim of this study was to compare hygiene status of wild boar meat (shoulder and leg) stored up to 21 days at 0 °C, 7 °C or 15 °C.
The microbial counts increased gradually in the expected sequence of increasing storage temperatures, with TVC at the end of storage ranging from approx. 2 log CFU/g (0 °C) to 5 log CFU/g (15 °C). The lactic acid bacteria and psychrotrophic microflora didn't exceed 2 log CFU/g and 2.5 log CFU/g, respectively. Whereas odor of the meat stored at 0 °C and 7 °C was still acceptable at the end of storage, the odor of the meat stored at 15 °C was barely acceptable after only 7 d of storage and also the content of ammonia was significantly higher.
Game meat obtained from animals hunted in the correct way and stored at low temperatures had good microbiological and hygiene status which could be maintained for more than 15 days of storage.

1. Introduction

Game meat is a popular part of the menu, although consumption of game meat is relatively low in comparison with consumption of the meat of domestic animals. According to the Czech Statistical Office, consumption of game meat is around 1 kg per head per year in the Czech Republic. This is extremely similar to consumption of game meat in Austria, Germany and Switzerland (Atanassova, Apelt, Reich, & Klein, 2008). The main demands placed on game by the consumer are high quality and the corresponding culinary treatment that promotes its specific sensory properties. The demands of the consumer can be satisfied only if raw material of a high quality is assured, and this is influenced by a large number of factors, including the correct method of hunting and initial treatment, the rapid and correct assessment of the animal's state of health and, first and foremost, a suitable method of subsequent manipulation and storage of the hunted animal.

The Czech legislation allows for refrigerated game destined for direct sale in its skin to the final consumer to be kept for a maximum of 15 days after hunting at a storage temperature of 0–1 °C. At a higher storage temperature (0–7 °C) the carcass must be sold within 7 days after hunting (Decree No. 289/2007 Coll., as amended). The legislation in preparation will make it easier for hunting associations to sell game directly if the given conditions are met. This anticipates particularly portioning, packaging and further distribution of hunted animals by members of hunting associations, though understandably in limited quantities. Any further manipulation, in particular skinning and portioning by untrained persons, increases the risk of microbial contamination, shortens the shelf life and limits further distribution. Hunters who sell game to wholesalers or game processing companies are considered food business operators and are responsible for food safety. They are subject to the same hygiene regulations as game processing plants and other food business operators. Any failure to observe these procedures may result in impaired quality and violation of the safety of the game meat.

The sensory quality of meat is influenced by the physical, chemical and morphological composition of the meat and by subsequent post-mortem processes in combination with the storage technology used (Hofbauer & Smulders, 2011). The course of post-mortem processes in the muscle tissue depends, first and foremost, on the initial state of the raw material, though it is also strongly influenced by temperature. While the microbiological status of the fresh game meat is often very good (Atanassova et al., 2008), it changes during the course of storage and may lead to a complete spoilage. The ongoing processes are not directly observable as the animals remain unskinned which also represent a barrier to any bad odor. The occurrence of pathogenic or

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potentially pathogenic microorganisms is also variable, but in freshly shot large wild game pathogenic bacteria are seldom detected (Atanassova et al., 2008; Avagnina et al., 2012).

The quality and health safety of game is dependent on many factors, the most important of which includes the species of game, the method of hunting, the shot localization, the treatment of the game following hunting, the season of the year, the weather and the nature of the terrain. As a general rule, the muscle tissue of deer is less heavily contaminated than the muscle tissue of wild boar. This is primarily the result of the behavior of wild boars whose coat is usually much more soiled with mud than the coat of deer. The method of hunting deer is also generally different than that of wild boars. Furred game is hunted with guns alone, while the usual method of hunting wild boars is driven hunting with hounds. Pigs hunted in this way are not often killed on the spot, with the gun shot producing wounds that are often not fatal, allowing the animals to keep running which increases contamination levels. Shots to the head, heart, neck and spine result in rapid death and cause minimal damage to the meat, a low level of microbial stress and a short fleeing distance, and producing the best conditions for good microbiological quality (Atanassova et al., 2008). The game must be eviscerated after hunting, and a considerable increase in the microbial contamination of the surface of the muscle tissue may occur during this operation. A high level of microbial contamination is often associated with visible contamination of the carcass with soil or gut content and a large opening of the body cavity (Avagnina et al., 2012). Wet weather and hilly or inaccessible terrain, for example, may result in pigs fleeing for a considerable distance if the shot is incorrectly located, and it may take a long time before they are found and subsequently killed and eviscerated. A number of authors confirm the importance of hunting stress on meat quality and lipid stability (Avagnina et al., 2012; Cifuni, Amici, Contio, Viola, & Faqilla, 2014). The period of time elapsing between shooting and the evisceration of the animal and its subsequent treatment and chilling is also important. An increase to the total microbial contamination of the muscle tissue occurs if the animals are eviscerated more than 180 min after shooting (Avagnina et al., 2012).

A number of studies have considered the evaluation of the hygiene standard of game meat in terms of both the total microbial contamination of game meat and the occurrence of pathogenic microorganisms (Avagnina et al., 2012; Membré, Laroche, & Magras, 2011; Paulsen & Winkelmayer, 2004; Sales & Kotrba, 2013). Nevertheless, these studies have considered merely the microbiological evaluation of hunted game immediately following shooting and evisceration, and have not monitored the effect of temperature or length of storage.

The aim of this study was to determine the course of autolytic and proteolytic changes in the leg and shoulder muscle of wild boars and their influence on the overall quality and shelf life of game meat by means of modern analytical methods. Selected sensory parameters of game were also monitored and evaluated with a view to temperature and length of storage.

2. Material and methods

2.1. Sampling and storage conditions

Carcasses of 30 correctly hunted free-living wild boars obtained from collection points no more than 24 h after hunting were included in the study. The individual pigs weighed 18–39 kg and were up to one year of age; no differences in dependence on gender were observed. Three of the animals were examined immediately following delivery (Day 0 of storage); the remaining 27 whole carcasses were stored in the refrigeration premises of the slaughterhouse of the University of Veterinary and Pharmaceutical Sciences Brno unskinned for 21 days following hunting under three different temperature regimes. Temperature regime A (0 °C) represented the ideal method of storage, with the longest expected shelf life of more than 14 days; temperature regime B (7 °C) was chosen as an alternative with a shorter shelf life of a maximum of 10 days. The final temperature regime C (15 °C) simulated an incorrect method of the treatment and storage of carcasses in outdoor conditions or frequent changes of storage temperature.

Muscle tissue samples were collected on Days 7, 14 and 21 of storage from the leg and the shoulder of six different carcasses (n = 6 samples from each storage temperature group and period of storage). The leg was separated from the body and skinned and samples were taken from the depth of the muscle after singeing of the surface.

2.2. Microbiological analysis

A sample of meat from the shoulder or from the hind leg (10 g) was transferred to a stomacher bag and homogenized with 90 ml of saline solution for 60 s in a stomacher (Lab Blender 400, UK). Appropriate 10-fold serial dilutions were used for enumeration of: 1) total viable count (TVC) on Plate Count agar (PCA, Merck, Germany), incubated at 30 °C for 72 h (EN ISO 4833-1); 2) psychrotrophic microorganisms on Plate Count agar (Merck), incubated at 7 °C for 10 days (EN ISO 17410); 3) lactic acid bacteria (LAB) on De Man Rogosa Sharpe agar (MRS, Merck), incubated at 30 °C for 72 h (ISO 15214); 4) coliform bacteria and *Escherichia coli* simultaneously on chromogenic Coliformen agar ES (Merck), incubated at 37 °C for 24 h; 5) *Brochothrix thermosphacta* on STAA agar with STAA selective supplement (Oxoid, UK), incubated at 25 °C for 48 h (ISO 13722); 6) *Pseudomonas* spp. on *Pseudomonas* agar with CFC selective supplement (Oxoid), incubated at 25 °C for 48 h (EN ISO 13720).

2.3. Physical–chemical analysis

2.3.1. Dry matter

The content of dry matter was determined by a reference method by drying the sample (10 g) to constant weight in a dryer at 103 ± 2 °C in accordance with the Czech standard CSN 57 6021.

2.3.2. Cooking loss

The samples were weighed after thawing and subsequently after heat treatment and chilling (see Chapter 2.5.2.). The weight loss during cooking was calculated in % from the resulting weight differences.

2.3.3. pH

The values of pH in the shoulder and leg muscle were measured with a pH 3110 digital pH-meter (WTW GmbH, Germany).

2.3.4. Ammonia

The content of ammonia in muscle tissue was determined by Conway's micro-ammonia method (Conway, 1962). Ammonia is displaced from an extract of meat in a Conway cell and absorbed into the internal space of the cell with boric acid, after which it is titrated with sulfuric acid using ethanolic solution of bromocresol green and methyl red as an indicator.

2.4. Sensory analysis

Sensory assessment was performed by a panel of ten trained assessors (according to EN ISO 8586) under the same laboratory conditions

Table 1
Sensory assessment scale.

Indicator	Assessment				
Color hue	Brown	Red–brown	Red	Pink–red	Red
Chroma	Too dark	Dark	Optimal	Light	Too light
Odor	Excellent	Satisfactory	Acceptable	Poor	Very poor
Numerical transformation	5	4	3	2	1