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Game Meat Hygiene in Focus

Organised by the International Research Forum on Game Meat Hygiene (IRFGMH)

Central European Institute
of Wildlife Ecology, Brno – Vienna – Nitra

Institute of Wildlife Ecology
of the University of Veterinary
and Pharmaceutical Sciences Brno

Institute of Meat Hygiene,
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Trichinellosis in Wild and Domestic Pigs and Public Health – a Serbian Perspective

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ABSTRACT

General background

Trichinellosis is a foodborne parasitic zoonotic disease caused by nematode worms of the genus *Trichinella* including *T. spiralis*, *T. native* (including its genotype *Trichinella* T6), *T. britovi*, *T. pseudospiralis*, *T. nelsoni*, *T. murrelli*, *T. papuae* and *T. zimbabwensis* (EFSA, 2004). All the species of the genus are known to infect mammals (mostly carnivores), rodents and omnivores including pigs, and occasionally also herbivores (e.g. horses), but *T. pseudospiralis* also can infect birds and both *T. papuae* and *T. zimbabwensis* also can infect reptiles (EFSA, 2004). Only the larval stage of the parasite is infectious; the infection occurs only *via* the ingestion of the muscle tissue containing the larvae. Normally, infected animals do not show clinical signs of the disease. In contrast, infected humans develop serious and life-threatening disease. Consequently, in most EU member states and non-EU European countries, slaughter pigs, horses, wild boar and other wildlife intended for human consumption are tested for *Trichinella* at meat inspection.

The European Union perspective

In the EU in 2007 (EFSA, 2009), total of 779 confirmed human cases of trichinellosis were reported. The highest number of cases was recorded in Bulgaria, Poland and Romania. Bulgaria and Romania became EU member states in 2007, thus their contribution has resulted in a higher number of recorded cases of trichinellosis compared to previous years. In 2007 in the EU, 69.1% of confirmed human cases the *Trichinella* species was not reported – but where reported, *Trichinella spiralis* was the most common species (28.2% of all cases).

In the EU in 2007 (EFSA, 2009), *Trichinella* was reported in <0.1% of 220,680,358 examined domestic pigs (EFSA, 2009) and in 0.4% of 6,615 examined farmed wild boar. The highest number of *Trichinella*-positive slaughter pigs was reported by Poland, Romania and Spain. In 2007, Denmark was assigned the status as a region where the risk of *Trichinella* in domestic pigs is officially recognised as negligible in accordance with Regulation (EC) No 2075/2005. This is the first time this status has been granted to any EU member state. Countries with this status are allowed to use risk-based monitoring programme for *Trichinella* and testing for this parasite at meat inspection is no longer mandatory for slaughter pigs reared under controlled housing conditions in integrated production.

In the EU in 2007 (EFSA, 2009), the reported *Trichinella*-positive wildlife animals included 0.1% non-farmed wild boars (of 443,890 examined), 4.5% bears (of 403 examined), 2.6% foxes (of 6,680 examined), 19.6% lynxes (of 224 examined), 19.4% racoon dogs (of 222 examined) and 21.8% wolves (of 55 examined).

The Serbian perspective

Total number of reported human cases of trichinellosis in Serbia during the 1994–2007 period varied between 117 and 791 with the incidence varying roughly between 0.001% and 0.01%, respectively. With respect to source attribution for the human cases, the published data is limited and does not allow detailed related analysis. Nevertheless, anecdotal evidence from many such cases points to home-made traditional meat products (fermented sausages and/or cured-and-dried meat products) originating from pigs slaughtered under home-made arrangements and which were not subjected to post-mortem veterinary inspection – as the common scenario leading to human trichinelosis. Those meat products are not subjected to heat treatment during the lengthy production processes, so contain uncooked meat, and represent a ready-to-eat food.

Total number of reported *Trichinella*-positive slaughtered domestic pigs in Serbia during the 1994–2007 period varied between 153 and 1,698 with the incidence varying roughly between 0.004% and 0.04%, respectively. Available information for domestic pigs in Serbia indicate that very small farms, most often holding only few pigs ("backyard"; often with access to outdoor) to be slaughtered on-farm and for own consumption pose the main risk that is much higher than that posed by industrial farms with good-controlled farming practices (EFSA, 2005). This is supported by data for 2004 year (Mirilovic, 2005) showing that the mean number of pigs on positive farms in Serbia was 13.2, with 40.4% of the positive farms having only 1–7 pigs. The Serbian experience is that the farm level epidemiological situation (i.e. farm-level) within a given region could be more relevant for the prevalence of *Trichinella* in domestic pigs than the geographically defined region itself (EFSA, 2005).

Trichinellosis is endemic and prevalent in the wildlife in Serbia. Total number of reported *Trichinella*-positive wild boars was 14, 14, 29 and 27 in years 2005, 2006, 2007 and 2008, respectively. Occasionally, meat from hunted wild boar is mixed with meat from domestic pigs so to make the home-made raw, fermented sausages mentioned above, which certainly increases the trichinellosis risk, as epidemiologically indicated in some cases of human infection in Serbia. Published data for *Trichinella* in wildlife other than wild boar in Serbia is scarce.

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Microbiological Safety and Quality of Meat Cuts and Meat Products from Game

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From a food legislation viewpoint, meat and meat products from game are only one type among a variety of foods and thus, have to fulfill certain (microbiological) safety criteria. There are quite different ways how game is "harvested" and processed into food: from (semi-)industrial scale and semi-domesticated or farmed game to the small-scale traditional hunting techniques in Central Europe, and this obviously influences composition and magnitude of microbial contamination.

This contribution will focus on hunted free-range game in Central Europe, where the mode of production is not well standardized and, thus, the quality of the final product is sometimes not really predictable.

Based on the most relevant (in terms of numbers of hunted large game) distribution pathway in Austria, the microflora of game meat and products thereof is studied along the food chain. Particular attention is paid to the effect of observance of "Good Hygiene Practice" (GHP).

It is accepted, that the location of the shot wound, the time-temperature profile from wounding to evisceration of large game and the technique of evisceration will substantially influence the (surface) contamination of carcasses. In this contribution, the role of the microbiological condition of the primary product (i.e. the eviscerated carcass) and the impact of further processing is studied. It is demonstrated that – even in a GHP scenario –the ambient temperature from the time of evisceration to the onset of cooling is crucial. Also, that visual examination of "cleanliness" of carcasses is effective to separate highly contaminated from acceptable material. Finally, the different options for cutting and deboning (hanging carcass, extent of trimming before breaking down the carcasses into primal cuts) are evaluated and the consequences for training of hunters and the staff in game meat handling establishments are discussed.

Hunting and processing of small game differs from large game with respect to the wounding pattern, and the time to evisceration. For wild birds, as pheasants, uneviscerated storage for several days will usually not present a microbiological problem (this does not mean that sensorily adverse alterations will occur), when cooled properly. Despite the multiple wounding and contamination of muscle tissues, the adherence to GHP allows the production of meat cuts with acceptable shelf life.

The final consideration is, that game meat and meat products must comply with microbiological requirements for meat from farm animals (food safety and process hygiene criteria). Current hunting and processing practices in Central Europe will often result in products which fulfil these specifications. Further applied research will help to improve the commitment of the stakeholders in the game meat chain, by education, training and motivation.

Zoonotic Diseases and Direct Marketing of Game Meat; Aspects of Consumer Safety in Germany

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Game meat consumption is of economical relevance. Game meat consumption in Germany amounts to about 73,000 tons per year and meat supply from large wild game has approximately a dimension of 35,000 tons. The monetary worth is about 150,000,000 Euro.

One half is distributed through commercial game handling establishments, the other half is sold directly to consumers (oral communication EPEGA, 2009).

Since 2006, European food law regarding game has also changed. Hunters as food traders are responsible for the safety of their products. National legislation also considers aspects of responsibility and traceability. The intension is to provide as high a level of food safety as possible, therefore, measures of hygienic game meat production and handling under advantageous conditions (e.g. boning in adequate rooms, chilling as soon as possible to +7°C) are included and required.

Nonetheless, increasing quality standards, human cases of infections relating to game meat occurs. Examples of zoonotic agents considered in relation with human infections after consumption of game meat are *Trichinella*, *Escherichia coli* (STEC), *Salmonella*, Hepatitis E and *Francisella tularensis* in wild game population.

Elements of safety strategies in handling game meat are efficient surveillance, (further) education of hunters, respective hygiene and zoonotic pathogens, traceability of products by means of documentation and manageable markets, and well-equipped facilities.

As a result of these strategies, 11% of all shot large wild game in 2007 was inspected by fficial veterinarians. 114,000 hunters in Germany participated in further education and were certified as „trained persons“. The attachment of identification marks on each carcass is obligatory in addition to documentation on special forms when game is brought to market.

It can be concluded, that direct marketing of game meat is of increasing importance in Germany even though zoonotic diseases have relevance concerning consumers safety. The level of knowledge is increasing and therefore the awareness that hygienic handling is important for the safety of game meat (cooling etc.) consolidates.

Epidemiology of wildlife diseases in Italy, with particular reference to zoonotic agents

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This presentation deals mainly with diseases occurring in wild animals of Lombardy and Emilia-Romagna, two regions in northern Italy. Lombardy is bordered by Switzerland to the north and by other Italian regions to the west, east and south, while Emilia-Romagna is located south of Lombardy and is bordered only by Italian regions. Additional information on major diseases occurring in wildlife in other Italian regions is also presented.

Wildlife in Lombardy and Emilia-Romagna include several species of wild ruminants (e.g., roe deer, red deer, Alpine chamois, Alpine ibex), wild boar, red fox, mustelids (badger, pine marten, beech marten, weasel, stoat), lagomorphs (European hare, mountain hare, European rabbit), and rodents.

Several species of wild birds can also be found, including Anseriformes (*Anatidae*: ducks, swan), Charadriiformes (gulls, waders), Galliformes (*Phasianidae*: partridge, quail), Passeriformes (*Corvidae*: hooded crow, jay, magpie, jackdaw) and birds of prey (e.g., owl, buzzard, kestrel).

Wildlife diseases are monitored through testing carried out in a network of region-based governmental laboratories, i.e. the Istituti Zooprofilattici, in the Universities, and in the laboratories of other institutions. Samples are collected both from carcases of dead animals and from selectively hunted animals.

Data presented here refer to diseases detected in the last five years (2004–2008).

- Tuberculosis has been detected through the years in the wild boar and red deer. By far, *Mycobacterium microti* has been identified as the main etiological agent, while *M. bovis* and *M. avium* have been found occasionally. This is different from other Italian regions, where *M. bovis* has been detected more frequently.
- Evidence of infection with *M. avium* subsp. *paratuberculosis*, both as seropositivity and direct detection of the organism, has been found in the red deer and, to a lesser extent, in the roe deer.
- Seropositivity to *Leptospira* has been often detected through the years in wild boar, with about 5–15% positive samples on average, and mostly against serovars Australis and Bratislava. Specific antibodies have been also detected, albeit less frequently, in coypu and roe deer.
- Seropositivity to *Brucella* has been occasionally found in the wild boar.
- *Salmonella* spp. have been often isolated from wild boars, and also occasionally from roe deer, red deer, fox, and from birds (hooded crow, heron).
- *Francisella tularensis*, the agent of Tularemia, has been detected in the European hare, both in autochtonous and in imported animals, while specific antibodies have been found very occasionally.

- *Yersinia enterocolitica* has been detected in the roe deer.
- Antibodies to *Borrelia burgdorferi*, the agent of Lyme borreliosis, have been often found in different population of roe deer in both Lombardy and Emilia-Romagna, and in the chamois.
- Pasteurellosis has been sometimes observed in the European hare, chamois and red deer, while *Mannheimia* sp. has been isolated from the chamois.
- *Corynebacterium pseudotuberculosis* has been detected in the chamois.
- Chlamydial infections have been detected in birds (rock partridge, hooded crow) and mammals as well (ibex, chamois).
- Avian Influenza viruses have been detected in anatids (mallard, common teal) in areas of both Lombardy and Emilia-Romagna. Not surprisingly, strains belonged to different subtypes, including H5 and H7, and were classified as Low Pathogenicity Avian Influenza (LPAI) viruses.
- In the wild boar, seropositivity to Aujeszky's Disease virus, as well as to Encephalomyocarditis virus, has been found in animals of several areas.
- The West Nile Disease virus has been detected in wild birds (magpies, hooded crows, jays, pigeons, gulls, cormorants) in Emilia-Romagna, following the investigation of an outbreak of clinical disease in horses.
- Extensive testing of thousands of samples each year did not allow to detect the Rabies virus in red foxes of Lombardy and Emilia-Romagna. However, very recently (October 2008) the virus was detected in the red fox, badger and roe deer of another region of northern Italy (Friuli Venezia Giulia).
- In the red deer, evidence of Chronic Wasting Disease has never been found.
- *Toxoplasma gondii* has been found in the European brown hare by direct detection, and specific antibodies to the parasite have been detected in the wild boar.
- *Trichinellosis* has been detected in the wild boar in Lombardy and in the red fox in Emilia-Romagna. Typing has been carried out in some cases, leading to the identification of *Trichinella britovi*.
- *Echinococcus multilocularis*, the agent of alveolar echinococcosis/hydatidosis, has never been detected in Lombardy nor in Emilia-Romagna, but foci of infection in red foxes have been reported in Trentino-Alto Adige, a region to the east of Lombardy, since 2002.

Influence of Climate Change on Diseases of Wild Animals

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Wild animal habitats as well as habitats from infectious agents and vectors/reservoirs are greatly influenced by climate, geographical location, structure, fauna and flora. There are several examples for the impact of climate change on enzootic infections. The spread of special bacterial, viral as well as helminthic infections, partly zoonoses, is influenced by factors of climate change (especially temperature and distribution of precipitation).

- Influence of climate change on diseases of (wild) animals (risks factors):
- Influence on infectious agents (tenacity)
- Increase of populations (wild boar, vectors, …)
- Increase of temperature in alpine regions
- Decrease of habitat quality for alpine animal species (immunosuppression)
- Heatwaves, heat stress, water shortage
- Hygienic problems in feeding of wild animal species (red deer, row deer, wild boar)
- "New" infectious agents
- Increase of host range of some infectious agents
- Global trade with animals and food of animally origin

Example: Tularaemia

The fundamental relationship between bacterial infectious diseases, such as tularaemia, and climate parameters can be identified by the ambient conditions required by the pathogen. Bacteria reproduce at moderate, rising temperatures, are destroyed at elevated temperatures and are resistant to cold. In addition, the population density of host animals and the abundance of potential disease vectors (ticks, gnats) also play a decisive role. The infection is transmitted to animals and humans by direct contact with infected animals and vectors or by inhalation of pathogens.

A total of 271 cases of tularaemia in hares has been recorded in the investigated area (Lower Austria, Burgenland, Styria) in the period from 1994 to 2005 and geo-referenced according to sender postal code. Temperature and precipitation data for the selected region were available from 30 meteorological stations of the Central Institute for Meteorology and Geodynamics in Vienna. These data provided the basis for calculating an altitude dependent temperature distribution for suitable monthly mean values and period sums. The areal distribution of precipitation was calculated using the geo-statistical universal kriging method without taking into account the influence of altitude. These data were used for a two-step analysis. The first step led to boundary values for the spatial distribution of tularaemia. These boundaries were used to estimate the distribution of tularaemia in the year 2035. The second step explained the different annual incidences using actual climate data**.**

First step – finding spatial boundary values and estimation of the areal distribution of tularaemia until 2035. A high incidence probability, based on the local isoline encircling the study area, was obtained for annual precipitation totals below 720 mm, summer precipitation below 180 mm, winter temperatures above 0.5 °C and mean May temperatures above 14 °C. These limit values allowed a calculation of the diseases' spatial distribution for current and future conditions. A warming of 2 to 4° C having been induced by climate change was assumed for predicting the distribution area of the disease in 2035, with warming expected to be more intensive in higher altitudes than in lowlands. Figure 1 shows the possible spatial distribution of tularaemia in 2035 following a rise in mean annual temperatures. Precipitation was not taken into account due to the lack of a suitable scenario. Under these conditions, tularaemia will slowly spread from the eastern lowlands via the Danube valley to the west and via southern Styria proceeding to the south. Additional incidents of the disease could also occur in inner-alpine areas providing favourable climatic conditions.

Second step – explaining coherences between climate parameters and incidence: Inside tularaemia zones a clear correlation between the two climate parameters and local disease incidence was established, which can be represented by the following linear regression model.

Number of cases per year = 52.12 + 4.08 x (average of monthly mean temperatures for December, January and February) – 3.46 x (monthly mean temperature for May) + 0.26 x (precipitation total for June and July)

This formula does not allow to calculate absolute numbers of incidence in nature, because it is based on sample data of one specific region. Of special note, however, is the highly significant ($p< 0.05$) influence of the parameters selected of the incidence rate of the disease and the coefficient of determination obtained (R^2 = 74.6 %). It becomes clear that about 3/4 of inter-year differences can be explained by temperature and precipitation conditions: warm winter temperatures result in an increase in incidence, while warm May temperatures lead to a decrease; high precipitation in summer has an increasing effect again. The ideal conditions for the spread of the disease are thus warm winters combined with low temperatures in May and high precipitation in summer. The result represents a feasible development of hares. Warm winter increases the population of hares. Low May temperatures and wet summers degrade the leverets. Thus, bacteria causing tularaemia find better conditions to increase. This correlation has been derived from observations and of course does not apply to arbitrary temperature and precipitation values.

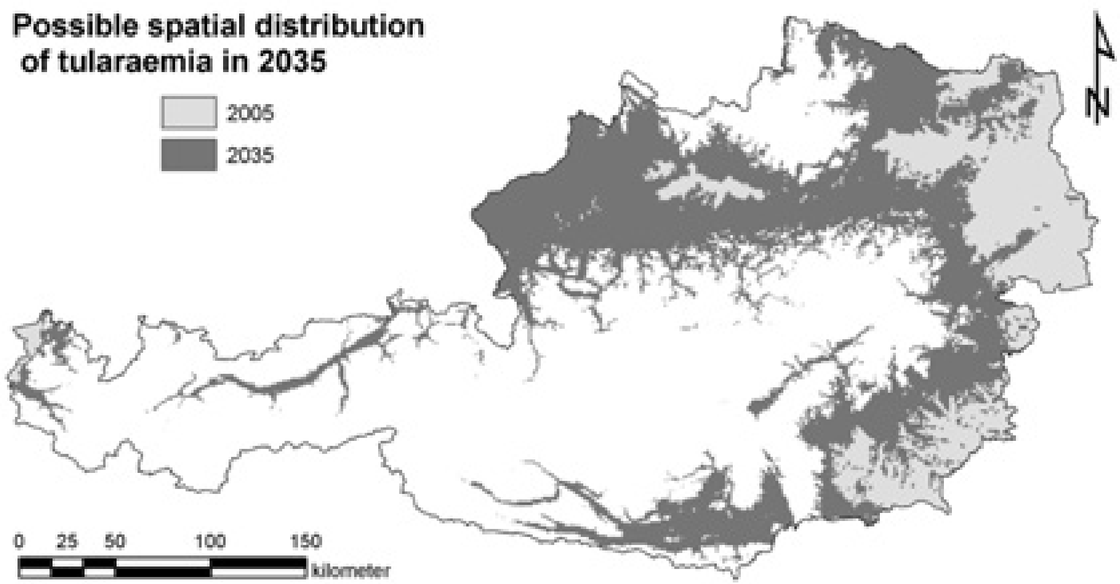

Fig. 1: Possible spatial distribution of tularaemia in Austria in 2035 following a rise in mean annual temperatures

Official- and Self-Controls; Complementary Approaches to Assure Safety in the Game Meat Chain

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Introduction

Meat from wild game is a highly valued product with favourable composition and sensory characteristics. It is also attractive for consumers who are concerned about ethical and sustainable aspects of food production, similar to products from organic farming. Careful inspection of game before killing and post mortem examination of carcass and organs, as well as the strict adherence to certain rules of good hygienic practice along the food chain ("From forest/field to fork") are necessary to assure that all quality traits are preserved and that game meat is not a source of hazards to the consumer. Although the quantity of meat produced by hunting is small compared to pork or beef, it is estimated that in Austria the total carcass weight (eviscerated, skin-on) of game is ca. 9 million kg /year.

In this field of meat production, own-checks form an essential part of food safety. In Austria, considerable effort is spent to train and to motivate hunters and trained persons, also by providing continuous education and voluntary evaluation schemes. This system allows the risk-based use of (limited) inspection capacities of the competent authority.

Current three-step inspection system in Austria

The current inspection system was established in 1994, and had to undergo only minor modifications to ensure compliance with the "new" EU "hygiene package". The inspection system involves three categories of personnel, and their involvement depends on (1) the way of marketing and (2) the presence of certain abnormities detected during ante- and post-mortem inspection or the suspect of environmental pollution (Table 1). In 2008, there were ca. 110.000 licensed hunters in Austria, of which ca. 22.000 were active as trained persons.

Table 1: Ways of marketing of meat from wild game and involved inspection personnel

	hunter (Step 1)	**trained person (Step 2)**	**official veterinarian (Step 3)**
self-supply	-	-	**
local trade*	+	+	**
intra-community trade	+	+	+
Export	+	+	+

* ...i.e. direct supply to consumers or to food businesses supplying directly to the consumer;
\+ … mandatory; ** ... only in case of serious suspects (as defined in Reg.(EC)854/2004, Annex 1, Sect. IV, A, Par. 3., lett. (a), (d), (e).

For education and training, a series of textbooks exist and they provide the basis for uniform and consistent training courses in Austria. The basic training (mandatory for all hunters to pass the exam for the first hunting license) includes diseases of wild game and good hygiene practice during primary production (evisceration, cooling, storage of the carcass) and is addressed in the "Österreichische Jagdprüfungsbehelf".

For trained persons, a textbook on game meat inspection ("Wildbrethygiene", WINKELMAYER et al., 2008) and one on hygiene during primary processing and fresh meat production ("Wildbretdirektvermarktung", WINKELMAYER et al., 2007) are provided. The latter textbook also serves as a "Guide to Good Practice" for processing of game meat.

Training of official veterinarians in hygiene of meat from wild game is done in the course of the periodical "evaluation", with training material provided by the Federal Ministry of Health ("Modul D, Lebensmittelsicherheit").

Notably, all abovementioned training materials originate from the same team of authors, which contributes to consistency in contents as well as presentation. This consistency forms an important part of the "forest/field to fork" principle.

Trichinella-inspection

Federal legislation allows the use of trichinelloscopy by specially educated trained persons, for wild boars destined for local trade. This option has been, however, not implemented by all provinces. In addition to a primary training course, voluntary evaluation schemes / proficieny tests are offered. If these possibilities are not used, the competent authority will evaluate the trained person.

Self-control and own-checks

Own-checks of the hygiene have to be implemented at all steps in the food chain. In this context, the maintainance, cleaning and disinfection and effective operation of cooling rooms for the freshly shot game have to be checked regularly and deviations have to be documented and corrective measures to be taken. This can be a problem when several hunters share one cooling facility and the responsibilites for maintainance and cleaning are not clearly defined.

Checklists for own-checks are developed by recognized experts and subject to approval of competent authorities. Currently, checklists are available for:

1. Shared cool-rooms for game carcasses;
2. temporary premises for hunters supplying small quantities of game meat to the consumer and to local retailers, restaurants etc.;
3. permanent premises for hunters supplying small quantities of game meat to the consumer and to local retailers, restaurants etc.;
4. trained persons performing trichinelloscopy (checklist for equipment).

Risk Management of Game: From Theory to Practice

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Definitions

In the context of risk management of game relevant definitions can be found in legislation. Regulation (EC) No 178/2002 defines **'risk'** "as *a function of the probability of an adverse health effect and the severity of that effect, consequential to that hazard;"* **'risk management'** as "*the process, distinct from risk assessment, or weighing policy alternatives in consultation with interested parties, considering risk assessment and other legitimate factors, and, if need be selecting appropriate prevention and control options;"*

Game is defined in Regulation (EC) No 853/2004 as "**1) 'wild'** *ungulates and lagomorphs, as well as other land mammals that are hunted for human consumption and are considered to be wild and are considered to be wild under the applicable law in the Member State concerned, including mammals living in enclosed territory under conditions of freedom similar to those of wild game.'* ***2)*** **'farmed'** *"farmed ratites and farmed land mammals"*

Hazards

Theoretically there are many biological, chemical and physical hazards that may be in or on live animals, or in or on game meat. The question is which are significant and what are their consequences for public health? The majority of hazards (e.g. *Salmonella, Campylobacter*) are not visible unless symptoms and/or lesions are observed, so in many cases risk managers need to rely on reports, surveillance data and other sources of data.

Risk management

Risk management is an integral part of risk analysis, along with risk assessment and risk communication. Risk managers are generally assumed to be officials of a national food safety authority – however the responsibility to manage the risk lies with everyone.

The WHO (FAO) "Food safety risk analysis/A guide for national authorities" (Rome 2006) describes a generic framework for risk management as consisting of:

1. Preliminary risk management activities

- Identify the food safety issue(s)
- Develop a risk profile
- Establish the goal(s) of risk management
- Decide on the need for risk assessment

- Establish risk assessment policy
- Commission a risk assessment, if necessary
- Consider results of the risk assessment
- Rank risks, if necessary

2. Identification and selection of risk management options
- Identify possible options
- Evaluate options
- Select preferred option(s)

3. Implementation of risk management options
- Validate control(s) where necessary
- Implement selected control(s)
- Verify implementation

4. Monitoring and review
- Monitor the outcomes of control(s)
- Review control(s) where indicated

Practical risk management

Risk in game meat is managed proactively by an effective application of procedures based on HACCP principles where hazards are prevented, eliminated or reduced to an acceptable level. Post mortem inspection, as a regulatory requirement, supplements the control of hazards.

However, in some cases the above principles may not be applicable (e.g. game killed for private consumption), or sufficient to control the hazards and manage the risk effectively, (e.g. where there is an emergence of new pathogens or a change in the circumstances of existing hazards). A brief practical example will be given, looking at how the Croatian Authority (with the initial assistance of UK Food Standard Agency officials) have dealt with the positive findings of heavy metals (lead, cadmium, mercury) in wild boar and deer in Croatia.

To conclude:

- Risk management cannot be seen in isolation from risk assessment and risk communication.
- **Everyone in the food chain,** from production to consumption, plays an important role in practical risk management, including consumers, industry, scientists and legislators (a multidisciplinary approach).
- Whilst there are some commonalities between cases, each case is different.
- In practical risk management, among many other challenges, it is important to use simple language to define and explain objective(s) and manage expectations.

Game harvesting procedures and their effect on meat quality: the Africa experience

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This paper discusses the major methods employed to harvest game on a commercial basis in South Africa and Namibia. These two countries are presently the major exporters of game meat from southern Africa. The methods employed are determined by the specific species as well as the terrain where these are found. Presently there are seventeen species harvested in South Africa and six in Namibia for export. Although these species differ in their behaviour, they can be grouped according to the terrain that they occupy and thus the terrain is the major factor determining the methodology employed in the harvesting. The major species harvested and exported in both South Africa (70% of game animals harvested in 2008) and Namibia (80% of game animals harvested in 2008) is springbok (*Antidorcis marsupialis*). Springbok together with blesbok, black wildebeest, Oryx and zebra are all plains game and are therefore more suitable for night harvesting. These species also form large flock / herds, making them suitable for efficient off-take rates. Although some day harvesting has been conducted on these species, this is not as successful as the flock/herd tends to move off more rapidly. The major disadvantage of night harvesting is the fact that it is limited to dark nights when the moon is small – only two weeks per month. Another disadvantage of night harvesting on the plains is that this activity is predominately in winter when there are strong winds blowing. Light caliber rifles are normally used by the sharpshooters and this wind can blow the bullets off course, especially when the distances are far. This aspect is exasperated when day culling is done as the distances where in the animals are shot is further due to their flight distances being longer in the day than at night. Helicopter culling has been tried but has proved too expensive. Also the bullet damage is not always confined to head shots (a prerequisite for export). A microbiological analysis of both night and helicopter culling has shown no difference between these two methods.

Some of the game species occur in hilly terrain where two methods are used – day shooting from a vehicle or helicopter shooting. Although the later is more successful, it is also more expensive. Once more the problem of bullet placement becomes an issue as shotguns are normally used. There is also the problem of removing the carcasses off the hills down to the field depot for dressing. This damages the hide and sometimes the flesh.

The species occurring in the bushveld areas are either culled from vehicles at night or are captured in a boma wherefrom they are then shot. If the bushes are not too dense, the use of vehicles is very efficient and costs less than boma culling. However, when the bush is too dense, the animals are chased into a boma by a helicopter where after the animals are shot inside the boma. One of the advantages of the latter is that the animals to be shot can be selected whereas night culling does not allow for selection of the animals, especially when both sexes are horned. A new tendency to cut down costs is to use a passive boma catching technique although this procedure requires careful planning to ensure that the animals are available when the harvesting team arrives. In this method, a boma is built around a water hole and when the required species and number of animals are present, the boma is closed.

The effect of the various harvesting methods on the meat quality of the game species is also discussed further.

Where this paper has focused on the methodologies employed for the harvesting of the different game species, the next paper will discuss the supply chain of these species as value is added as well as highlight some of the food safety management points.

The supply chain of game meat in South Africa and essential food safety management points

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Although the game industry is expanding in all areas, the game meat supply chain in South Africa has not yet been analysed and described. Information to better understand the supply chain was obtained through a desk top study, observation of processes from farm to consumer in the local market as well as during export activities and analysis of questionnaire responses from game farmers, hunters, butcheries, municipalities and consumers. The description of the supply chain and factors influencing compliance with legislation and standards can assist policy-makers, law enforcers and the industry in identifying possible breaches in meat safety control that would require the necessary interventions. The results can contribute to ensuring that consumers receive game meat that is safe for human consumption.

Key words: Game meat, supply chain, traceability, sustainable utilisation, hunting, harvesting.

1. Introduction

The game meat supply chain differs from the supply chain of meat from domesticated animals in that game animals are killed and partially dressed on the game farm by removing the viscera of the thorax and abdomen, the head, feet, reproductive organs and lactating udders. A further difference is that meat from hunted game animals are also reaching the consumer through the local formal and informal markets of which some is not inspected or approved. However, the supply chain for game meat in South Africa has not been systematically described before and it was therefore not clear what all the relevant links of the complete chain entail. In developing food safety interventions for game meat control purposes it is critical to understand the dynamics of the supply chain from the farm to the fork that also include the export of game meat to relevant countries. In addition to this it was also necessary to determine the factors influencing compliance with food safety standards and to indicate the essential food safety management points that will ensure a safe game meat product to the consumer.

2. Methodology

The study assumed a three-pronged approach with quantitative and qualitative dimensions: (1) a desktop review of relevant subject material; (2) observations made during harvesting and hunting events in order to understand the supply chain of game meat, especially from the farm to the formal market, whether it is an abattoir, wholesaler or the retail market; and (3) separate questionnaires designed for the respective target groups which included game farmers, hunters, butcheries, authorities and consumers.

3. Results

3.1 Game meat supply chain

A schematic representation was compiled to depict the supply chain for game meat in South Africa. This supply chain and a clear understanding thereof can assist policy makers, law enforcers and the game meat industry in identifying possible meat safety breakdowns or loopholes that would require control interventions. Proper and appropriate policies and legislation based on the results of the study can then be drafted.

3.2 Factors influencing compliance with legislation and standards

The following factors were found to influence compliance to legislation and standards:

3.2.1 Consumer demand and expectations

Consumers mainly expect game meat to be derived from wild free-ranged and hunted animals. However, consumers are mainly concerned about zoonotic diseases, disease causing micro-organism that might be present in meat as well as presence of internal parasites. This concern can be ascribed to the fact that consumers are very aware of diseases such as the recent swine flu that are of animal origin.

3.2.2 Food control policies

At present game meat safety is regulated and managed on a reactive basis through the Meat Safety Act (Act 40 of 2000) that does not adequately provide for the game industry. Further the legislation ruling game, hunting or harvesting and the subsequent handling of game meat is fragmented in the different levels of government and departments and therefore no uniform system that manages meat hygiene and safety from the "farm to the fork" exists for the whole of South Africa. It is therefore concluded that there is no integrated food safety plan for the game meat industry in South Africa.

3.2.3 Knowledge and training

There is a large variation in the levels of knowledge amongst the respective stakeholders towards aspects such as legislation, foods safety systems, hygiene management systems and inspection skills. It is therefore concluded that there is a high proportion of unfamiliarity of these aspects with all stakeholders in the game meat industry.

3.2.4 Practices

Game meat is derived from hunting or harvesting on game farms where game is killed by leisure hunters, trophy hunters, specie hunters or professional hunters. The meat of harvested game mostly goes through a formal and well controlled process which includes a field primary inspection on the farm by qualified meat inspectors followed by a final inspection at a registered abattoir prior to export. The meat from hunted animals are mostly processed on the game farms in unregistered farm abattoirs or taken to local butcheries where the carcasses are processed on the hunters' behalf. Some of the meat and meat products reaches the local public through the sale of the meat to butcheries, restaurants and wholesalers while very little control is done by the relevant authorities.

3.2.5 Communication

Currently there is no single forum where the authorities from the different national departments on all levels of government as well as the industrial stakeholders of the supply chain can make an input to game meat control. The lack of such a forum leads inconsistencies in application of control strategies.

4. Conclusion

The nature of the game meat supply chain and the extent, to which it differs from the traditional meat supply chain for red meat species, clearly sets challenges to the game meat industry in so far as hygiene and safety of game meat destined for the local and export markets. It is therefore imperative to develop a comprehensive food safety plan for the game meat industry. A well developed food safety plan for game meat in South Africa will:

- Assist in the obtainment and formulation of uniform policies on all levels of government and the game and game meat industry
- Improve the current safety levels of game meat

An aspect that warrants further investigation is the description of a strategy on which activities can be developed to prevent potential food safety breakdowns in the supply chain for game meat.

The muscle biological background of meat quality

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Summary

Striated muscle is composed of muscle bundles packed in connective tissue envelopes that – via the terminal tendons and other collagen structures – convey the contractile forces generated inside the muscle to the bones allowing the movement of an animal. Whereas *in vivo* energy (ATP) production is achieved both aerobically (Krebs cycle) and anaerobically (glycolysis), obviously only the latter metabolic pathway prevails in post mortem muscle. Upon slaughter the muscle's energy reserves (above all glycogen) are broken down, which is associated with a pH decline from physiological values around 7–0 to varying (species dependent) ultimate pH values generally around 5.4 to 5.8.

This pH decline plays a crucial role in determining the physical chemical properties of post mortem muscle (meat). Firstly, myofibrillar proteins – most of which have an isoelectric point (= pH value at which their electric charge is neutral) around 4.8 – will be less able to hold the (bipolar) water molecules, secondly the density of the myofibrillar matrix is increased ('lateral shrinkage'). Both mechanisms cause drip to be released. At the moment around 80% of all muscle fibres have insufficient ATP to make muscle fibres relax again (note that relaxation is also an energy requiring process) actin and myosin remain irreversibly bound and rigor mortis becomes noticeable in the carcass.

The main sensory quality traits of meat (i.e. those properties that are noticeable and appreciated by the consumer) include juiciness (related to water-holding), colour, flavour, and above all tenderness.

The *waterholding capacity* of meat is determined by various mechanisms: i) water immobilized by molecules, ii) electrostatically bound water (held by electric charges on proteins; see above), and iii) structurally bound water (present in the myofibrillar matrix, the density of which determines its capacity to harbour water molecules)

Meat colour (apart from cytochrome, the pigment of any living cell) is determined by i) its myoglobin content (and marginally of residual haemoglobin), which determines the ability to absorb light, ii) the degree to which myoglobin is oxygenated (generating oxymyoglobin responsible for the desirable cherry-red appearance of fresh meat) or oxidized (generating metmyoglobin causing the meat to appear grey-brown) and, last but not least, iii) the waterholding capacity of meat (water released to the meat surface causing increased light reflection, resulting in meat with a paler appearance).

The *flavour* of meat is determined by i) its lactic acid content (dependent on the ultimate pH), which accentuates the intensity of all prevalent flavour compounds, ii) the presence of ATP metabolites – equally dependent on ultimate pH – which is responsible for the 'typical' meat flavour, iii) fat-soluble

aroma components (e.g. carbonyl compounds), iv) glycogen residues (a ‘natural’ sweetening agent), v) compounds released when decomposition starts (notably NH_3 and H_2S, indicating beginning spoilage), and, finally (particularly relevant after preparation) vi) compounds like pyrazins formed in the crust of heated meat.

Meat tenderness relies on the following mechanisms. i) fibre size, small fibre diameters generally yielding the most tender product, ii) collagen content and solubility, responsible for the so-called ‘background toughness’, iii) fat content, in that fat ‘dilutes’ the matrix, although it seems to relevant only at extremely low fat levels (< 1%) , iv) myofibrillar density (= degree of muscle contraction), i.e. shorter sarcomere lengths leading to tougher meat, and v) proteolysis (under usual refrigeration regimes primarily caused by the sarcoplasmic calpains, in delayed chilling regimes also by the lysosomal cathepsins).. In addition, tenderness can be manipulated during fresh meat processing by techniques such as electrical stimulation (above all to prevent cold shortening), boning techniques (e.g. hot boning), pelvic suspension (i.e. prevention of muscle contraction by stretching muscle) etc,

The relevance of the afore-mentioned general muscle biological mechanisms is different for the various animal species (e.g. compare ruminants vs. monogastric mammals), breeds (e.g. Landrace vs. Hampshire pigs), animals of differents age (e.g. with respect to collagen solubility) and sex (e.g. boar taint in pigs).

Muscle biological and biochemical ramifications of farmed game husbandry with focus on deer and reindeer

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Background

The young deer farming industry in New Zealand and the traditional Saami reindeer husbandry culture in Fennoscandia (Sweden, Norway and Finland) lead the world in commercial venison (deer meat) production from semi-domestic or farmed deer species, red deer (*Cervus elaphus*) and reindeer (*Rangifer tarandus tarandus*) respectively. Production systems are based on natural pastures but include pre-slaughter handling routines and a slaughter process similar to that of domestic species like beef and lamb. However, reindeer husbandry is performed in a less intensive way than red deer farming, with the reindeer free ranging (and not enclosed in fenced areas) in forests and on the mountain tundra. Nevertheless, at times reindeer are fed during winter to prevent starvation and to improve body weight and condition. In 1986, parts of the reindeer pasture areas in Sweden were affected by radioactive fallout from the accident in the Chernobyl nuclear power plant, and therefore feeding is still used in these areas as a measure to reduce radioactive caesium in the reindeer and thereby in the meat. Many deer farmers in New Zealand also feed their animals a variety of supplements during winter to provide extra nutrition when pasture is inadequate.

Consumer opinion is increasingly important to meat industries worldwide, and consumers value attributes such as flavour, tenderness and nutrient content when evaluating the quality of meat. Although the quality preferences of different consumer groups may vary, producing consistent quality is critical: the quality of every purchase should be the same. Production systems like reindeer husbandry and deer farming, where the animals graze during most of the year, are usually considered more animal-friendly and ethical compared with the standard commercial production of beef, pork or poultry. Venison is also attractive to the health-conscious consumer for its low fat content, favourable fat composition and high mineral content.

Meat quality, glycogen and pH

Meat pH is related to shelf life, tenderness, colour and water-holding properties, and is therefore a good indicator of meat quality. A pH value of 5.5–5.7 is within the normal range, while values over 5.8 result in reduced shelf life, especially for vacuum-packaged meat. Meat with high pH, so called DFD (Dark, Firm, Dry) meat, is a persistent quality defect found in all meat species. Meat pH values are directly correlated to the levels of muscle energy (glycogen) at the time of slaughter. If the glycogen stores in the muscles are low, meat pH will be elevated. Low muscle glycogen stores might result from poor physical condition, intense physical activity or stress during pre-slaughter handling. It has been demonstrated that deer and reindeer in good physical condition produce meat with optimal pH values, whether they were fed a commercial feed mixture or grazed.

Two comprehensive surveys of meat pH for deer (n=3,600; New Zealand) and reindeer (n = 3,400; Sweden) demonstrated DFD frequencies (meat pH > 6.2 measured in *M. longissimus dorsi* at the last rib) of 1.5% for red deer and 6% for reindeer. In the New Zealand study there was no indication of a relationship between pH and the stress parameters studied (fighting or agitation in lairage or unsettled behaviour in the lead-in race to stunning). It was suggested that other factors besides physical exertion at the slaughter plant affected meat pH; for example effects of transport, yarding and handling at the farm were not studied. On the contrary, the Swedish results clearly showed that selecting reindeer for slaughter using a lasso had the most negative effect on meat pH. In both surveys it was highlighted that there are possibilities to improve pre-slaughter handling routines for reindeer and red deer and thereby further reduce the frequency of DFD carcasses.

Tenderness, chemical composition and flavour

Variation in meat pH and glycogen content can give rise to considerable variation in meat tenderness in species such as beef and lamb, and similar results have been found for red deer venison. Within the normal pH range, values around 5.5 have been reported to yield more tender venison than those in the 5.8–6.0 range. This intermediate pH venison was tougher than normal pH even after ageing and also more variable in tenderness (*i.e.* of less consistent quality) than normal pH venison. In contrast, reindeer venison has been found to be extremely tender regardless of meat pH. Both red deer and reindeer venison is generally much more tender than beef, which has been demonstrated in studies of both types of venison, and explained by higher activity of proteolytic enzymes in venison compared with beef.

Natural or managed pastures (grasses, herbs and bushes) contain high levels of poly-unsaturated fatty acids (PUFA) and are also rich in different antioxidants. Grain-based feeds are higher in saturated fatty acids (SFA), and antioxidants like vitamin E are often added to commercial feed mixtures. When animals are grazing pasture or if they are fed grains, the fatty acid composition in their muscles/meat will change towards the composition of their feed. Fatty acid profiles in red deer and reindeer venison related to feed-type have been thoroughly investigated and linked to venison flavour. Similar results have been found for both species; deer/reindeer grazing pasture produced PUFA-rich venison with more "grassy", "gamey" and "wild" flavours, while the grain fed animals gave meat with "mild" and "beef-like" flavour. These flavour differences were demonstrated using both trained sensory panels and consumer tests. New formulations for grain-based reindeer feed mixtures, where ingredients like linseed cake and fish meal were included, verified that the higher PUFA content in the feed was reflected in the meat, so that the fat composition of reindeer venison from animals fed the new formulation was very similar to that of reindeer venison from grazing animals. As it is important to include more food with high PUFA content – like grass-fed venison – in human diets, it is essential to keep these natural PUFA sources.

Conclusions

The introduction of new venison production systems such as intensive farm-based management, industrialised slaughter and meat processing, use of commercial feed mixtures and possibly new ingredients used to supplement or replace pasture can alter venison quality. The deer studies from New Zealand and the reindeer studies from Sweden suggest that there may be several pre-slaughter conditions that could be improved for deer and reindeer, leading to a more consistent venison quality. It is also of interest for the venison industries world-wide to recognise the quality differences related to different feeding regimes. For example, venison with more or less “wild” flavour could be directed to specific markets based on information about production system/feeding regime and consumer preference. One topic of central importance for venison is the image as a natural, free-range origin, clean and healthy product. Concerns about how this image could change when new feeding regimes are introduced have to be balanced against the need of using these feeds as supplements or replacements when pastures cannot provide enough nutrition for maintenance and growth.

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Literature Survey: Investigations of the incidence of verocytotoxigenic E. coli strains (VTEC) of roe deer in a part of Germany (Hessen)

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Verotoxigenic *Escherichia coli*-strains (*E. coli*) can cause the clinical pictures of the haemorrhagic colitis (HC), haemolytic uraemic syndrome (HUS) und thrombotic-thrombozytopenic purpura (TTP) in humans. The production of verotoxins (shigatoxins) is seen as a primary virulence-factor of this pathogenic group, so they are also summarized as verotoxin-producing (shigatoxin-producing) *Escherichia coli* (VTEC/STEC). Humans are mostly become infected with VTEC via the oral route.

As a source of infection with VTEC, especially farm animals, such as cattle, sheep and goats, where in the focus of research. Wild animals, especially wild ruminants, were already discussed as a primary reservoir. However according to the **F**ederal **I**nstitute for **R**isk **A**ssessment (FIRA) of Germany, their importance as a source of infection for humans has been clearly underestimated; which is pointed out by more recent investigations in Germany.

In the years 2002 until 2006 an increased number of VTEC positive wild animal-samples were tested in the reference laboratory for zoonosis at the FIRA. Within this study the number of burdened game meat samples was higher than in beef. In 2005 14,8 % of the samples were positive. Furthermore VTEC-serovars, such as O26:H11, O128:H2 and O103:H2 where detected, which are already proven as the cause of severe illnesses of humans (BfR, 2007).

On account of these investigations wild ruminants are seen as a potential reservoir for the transmission of *E. coli*-strains to domestic ruminants and humans in Germany and are therefore – especially since the investigation of the FIRA – in the enhanced focus of interest.

A horizontal transmission of the infection in farm- and wild ruminants is possible throughout the usage of the same pasture. Whereas humans get infected by consuming VTEC contaminated foodstuffs, such as not properly heated game meat, not correctly ripened wild products (Busch et al., 2007) and herbal foodstuffs, which got in contact with droppings of wild animals (Thoms, 1999; Akashi et al., 1994). On account of this questionability roe deer of a part of Germany (Hessen) will be investigated for VTEC.

Roe deer is one of the most common wild ruminants in Germany and represents a high amount of the game meat. Furthermore, on account of its loose connective tissue, roe deer is seen as particularly "shot-smooth" (Deutz, 2000). Because of that, visceral-shots lead to a very fast invasion of bacteria in the muscular system. This circumstance, in connection with the hunting method, the location of the shot, the skills and the hygienic requirements of the hunter, play a decisive role for the game meat hygiene and hence also for the transmission of the pathogen. Especially these data were relevant for the selection of roe deer as the research focal point. The high amount of roe deer was important for the sampling, since an appropriate number of representative samples ($n \geq 300$) of this species in the federal state of Hessen should be taken. Only then a statistical statement concerning the prevalence of VTEC in the investigated population (Hessen) is possible. The sampling of the roe deer will be done with blanked coverage over all regions of Hessen to be able to calculate the prevalence of verotoxin-producing *E. coli* in association with the geographical background for this Federal State.

Within the project roe deer will be investigated culturally, immunologically and molecular biologically for the appearance of VTEC (O157 und NON-O157 VTEC). The analyzed matrices will be faeces and rumen content of freshly killed and dead game.

The aim of this study is to answer the question whether roe deer is a natural VTEC-reservoir and if the proven VTEC strains belong to serovars, which have already been associated with illnesses of humans. Furthermore the detected VTEC-strains of the roe deer shall be compared with the VTEC-types of the farm ruminants to see whether there is an interdependence transmission. The parallel analyzing of the faeces and rumen content will be done to see, whether the intestinal passage has an influence on the detection of verotoxin-producing *E. coli.*

A Method for Evaluation of Hemoglobin and Myoglobin in Meat

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Objective:

To evaluate suitability of a method for residual blood evaluation in (poultry) meat.

Material:

- Standard poultry carcasses (6) bought at a supermarket (A).
- Poultry carcasses (6) rejected from human consumption due to insufficient bleeding (B).
- Tools: Freezer, cutting board, knife, blender, dishes and spoons, scales (0,001 g), test tubes and appropriate racks, homogeniser, centrifuge, disposable syringes (10 ml) with a plastic tube), pipettes (10 ml, 25 ml), adjustable micrpopipetes (20 μl, 200 μl), volumetrick flasks, colorimeter, stop watch, statistical software, computer.
- Chemicals: Water, 50Mm Tris-HCL buffer (pH 8,0), glacial acetic acid, ethanol, o-Tolidine, hydrogen peroxide, sodium acetate, bovine blood hemoglobin (Sigma).

Procedure:

- Extraction (based on [1])
- Frozen muscles breast and thigh muscles were blended, homogenized and centrifuged to get muscle extract containing aliquots of hemoglobin and myoglobin.
- Hemoglobin estimation (based on [2])
- 10 μl of the supernatant was added to a test tube containing 1ml of o-Tolidine solution and 1 ml of H_2O_2 solution and exactly after 2 minutes absorbance at 630 nm was measured against blank.
- Concentration of the total heme was calculated from a calibration dependance formula calculated on the basis of absorbance measurements made with known hemoglobin concentarations (4–24 mg/l).
- 2 ml of the supernatant was saturated with 75% ammonium sulphate to precipitate the hemoglobin and the precipitated hemoglobin was separated by centrifugation.
- Concentration of the myoglobin in the supernatant was estimated as for total heme.
- Concentration of the hemoglobin was calculatedas: hemoglobin = total heme – myoglobin.

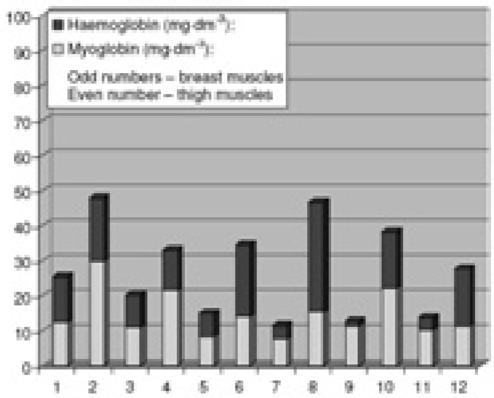
Results:

See the Graphs 1 and 2 (the subzero levels were calculated because of impurities on used glassware that interfered with the enzymatic reaction).

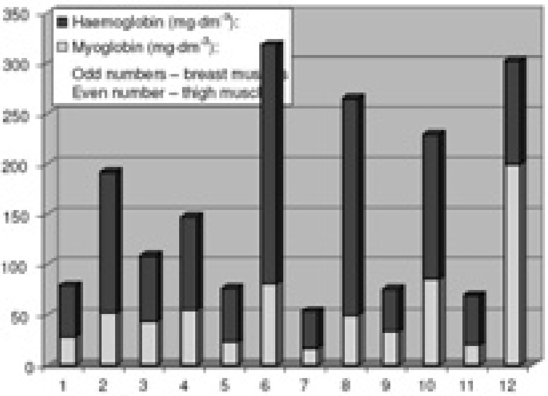
Discussion:

The method is easy to perform and provides results precise enough to estimate residual blood content in the meat to be used at decision about the use of meat.

Graph 1
Levels of myoglobin and hemoglobin in the standard chicken carcasses



Graph 2
Levels of myoglobin and hemoglobin in the improperly bled chickens



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Approaches to game hygiene in Belluno province (Italy): from training to meat microbiology

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Abstract

In the last decades, in the Italian Alps the number of animals shot in the regular hunting seasons has dramatically increased, mainly regarding wild ungulates. In these areas, game could be considered as an important source of meat. Nevertheless, the culture of game meat hygiene still appears at the beginning in our country, and much work will be needed to reach the aim of a true perception of the importance of this topic by hunters and consumers in general. In the present work, we summarize different and complementary approaches to game meat hygiene, carried out in the territory of Belluno province, in the Italian Eastern Alps.

Sanitary surveillance has been considered one of the first topics to ensure, together with a better mangement of wildlife and livestock, quality and safety of game meat. To be effective, sanitary surveillance should involve different stakeholders in the territory: hunting associations, authorithies for animal and human health and for wildlife management, laboratories and research institutes, with the aim to work out a surveillance system. In Belluno province, a passive surveillance program has been carried out in 2009, by developing a specific vademecum and cards for data collection. This activity has also implied training for hunters and gamekeepers, consisting in basic lessons about game anatomy and physiology, game pathology, good practices in game meat handling and conservation, main alterations of game meat, eco-epidemiology of disease in game, regulations about game and game meat, terminal ballistics. A practical session was also held for game anatomy and pathology.

In Belluno province, data about game meat microbiology were also available. Microbiological analyses were performed on 90 muscle samples from different wild ungulate species (39 roe deer, 27 red deer, 11 chamois, 8 moufflons and 5 fallow deer). No pathogens such as *Salmonella* spp. or *Listeria monocytogenes* were isolated, the Total Viable Count being mainly represented by spoilaging gram negative bacteria, such as faecal coliforms. A substantial difference in spoiling level was found between carcases correctly stored (in cold rooms at 0–4°C) and carcases stored in other places, such as cellars, generally at temperatures of 7–14°C depending on the season. In fact, spoiling resulted definitely higher in the latter case.

Structure, training and product range in direct supply of game to consumers and retailers in Lower Austria: Implications for food hygiene and safety

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Introduction

From official statistics, it can be estimated that in Austria 1/3 to 2/3 of the yearly hunting bags are – either as fresh meat or as meat products – marketed from the hunter directly to the consumer or to local food retail establishments. It is conceivable that the fraction of game meat traded via this "local marketing" had been in the same magnitude before a legal framework was established. This indicates that there must already be considerable experience in handling of meat from wild game. As there are no records that such meat or meat products had been involved in foodborne disease incidents, these empirical practices seem to have provided a certain level of safety. The establishment of a legislation addressing specifically this food sector started in 1994, and underwent a revision in 2006, to ensure that direct marketing was regulated in compliance with the EU "hygiene package".

Concurrently with this specific legislation, empirical meat handling practices have been evaluated and adjusted to comply with science- and risk-based food safety. It is not surprising that most of the research work is funded by hunters associations, as these associations have a vital interest that game meat is "safe" food.

Current legal framework in Austria

Only parts of EU legislation apply to local marketing of fresh meat from wild game; most relevant are Reg. (EC) 178/2002 and, when carcasses are broken down into meat cuts, Reg. (EC) 852/2004. Austrian legislation provides an act on direct marketing. This act governs the hygienic conditions for direct and local marketing of small quantities of certain primary products of vegetable (berries, mushrooms) or animal origin, such as milk, eggs, carcasses of rabbit, poultry, wild game; in addition, this legislation covers also meat cuts from wild game.

This legislation is very "lean", in the sense that only few binding limits are specified and it is obvious that it appeals to the self-responsibility of the food business operators. For example, the term "local" is not explicitly defined, which means that "local market" could be the entire area of Austria; and small quantities are explicitly defined only for rabbits and poultry, which are slaughtered at and sold directly from the farm (5000 and 10000 per year, respectively).

For meat products, another act sets parts of Reg. (EC) 853/2004 into force.

Good Hygiene Practice and Documentation

Sector-specific "Guides to Good Practice" are suggested in EU food hygiene legislation for the different branches of food industry. These guides can be designed by food industry and are then subject to approval of competent authorities. They are a recognized tool to establish GHP, and also for HACCP based food safety assurance systems. GHP and HACCP implementation guides have been issued in several EU countries. Recently released textbooks in Austria on inspection and on processing of wild game were designed to address all relevant issues laid down in EU food hygiene legislation (Winkelmayer et al., 2007, 2008). Particular emphasis is put on the requirements for food premises which are temporary or used primarily as a private dwelling house (in he sense of Reg. (EC) 852/2004, Annex II, Chapter III). The minimum documentation recommended for hunters running a temporary food premise is: 1. a signed copy of the guide for personal hygiene; 2. a master data sheet and 3. a two-pages checklist for each workday which includes personal hygiene, condition and cleanliness of the premise and food-contact surfaces, condition of cooling facilities and maintainance of the required temperatures, results of the inspection of the game carcassses, water quality and disposal of waste/by-products. Hunters operating permanent food premises are offered separate checklists addressing individually the chapters in Annex II of Reg. (EC) 852/2004. these checklists are based a system already operational for meat industry (slaughterhouses, butchers etc.) in Austria.

Education and training

Food safety is the primary responsibility of the producer. In order to enable the producer to fulfill this obligation, training courses for direct marketing of fresh meat and meat products from wild game are offered in Lower Austria. These courses have a modular structure and rely on a basic training in game inspection and hygiene.

Preliminary results of a survey on structure and product range

In December 2008, a survey was initiated on the direct markting of meat and meat products from game in Lower Austria. All hunters which had undergone training courses on direct marketing, or which had registered as direct suppliers of game meat, received a questionnaire, to collect basic information of infrastructure, hygiene level and products (fresh meat or meat products), see Table 3. These ca. 500 persons represent ca. 1.6% of licensed hunters in Lower Austria (Pontasch, 2008). All participants submitting a completed questionnaire were entitled to send up to 15 samples (fresh meat or products from wild game) for microbiological examination in the year 2009. The examination covers food safety criteria as defined in Reg. (EC) 2073/2005 and other criteria laid down in specifications of fresh meat from slaughter animals (AMA, 2004) and a collection of microbiological limits for meat products (Eisgruber and Bülte, 2006).

Selected findings from the 109 questionnaires returned by May 2009 are presented in Table 1.

Table 1: Preliminary results of a survey on the structure of local marketing of meat from wild game in Lower Austria (n=109; data in %)

Specific education of hunters:	%	Assistance of		Cool room*	
Training courses	83	None	42	Own room	59
Professional meat worker	17	Professionals (butchers..)	38	Shared room	41
Study of literature	36	Non-professional help	20	Refrigerator**	47

Production of		Meat species		Fresh meat		Supply to	
Fresh meat	100	Roe deer	97	Sold frozen	54	Own use	86
Meat products	43	Red deer	41	Sold refrigerated	93	Directly to consumer	79
		Wild boar	70			To restaurants	32
		Small game	43	Vacuum-packaged	71	To butchers	8

* for game carcasses; ** for meat cuts or meat products

Instrumental measurement of sensory quality traits of wild boar meat

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Instrumental measurement results in objective data, which are related to sensory meat quality traits. In this poster, measurement of pH, shear force, drip loss and cooking loss is described. Data for wild boar meat are presented.

Preliminary results indicating game meat is more resistant to microbiological spoilage

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ABSTRACT

The aim of this study was to whether game meat has an inherent antimicrobial activity. To test this, game samples from impala, nyala, warthog, wildebeest, ostrich, zebra and as controls; beef, mutton and pork were challenged with S. aureus and the growth determined after overnight incubation at 37 °C. Concluded from the results of this study, meat from game animals repressed growth of S. aureus much stronger than that of domestic animals. Further studies to determine whether this phenomenon is applicable to other animals are in progress.

Introduction

Most foodborne diseases are caused by pathogens such as Escherichia coli, Salmonella, Campylobacter, Clostridium botulinum and Staphylococcus aureus (Abee et al., 1995). Some of these microbes originate from soil, water, the intestinal tract of humans and animals. S. aureus is almost always present in the nose, mouth and skin (Gill & Newton, 1978).

The purpose of this study was to determine whether game meat, in comparison to that of domestic farm animals such as beef, mutton and pork, had an inherent antimicrobial activity.

There are a number of factors that could cause this apparent phenomenon. The first is the ultimate pH (pH_{ult}) of the meat (Gill & Newton, 1981), which is subsequently the result of the amount of lactic acid produced from glycogen during anaerobic glycolysis (Aidoo & Haworth, 1995). When glycogen levels of muscles are depleted due to ante-mortem stress the meat has a high pH_{ult} and this increases likelihood of meat spoilage (Gregory, 1996). Meat with a high ultimate pH is also classified as dark firm and dry (DFD) and has a high water binding capacity (Scanga et al., 1998). Game meat that has been stressed ante-mortem show signs of DFD and a strong water binding capacity (Hoffman, 2000). The correlation between meat water content and microbiological spoilage is well-documented (Gill & Newton, 1981).

Materials and Methods

A naturally occurring Gram- and Catalase-positive isolate from pork, positively identified as S. aureus was used in the experiments. Approximately 1g grounded meat samples from nine different animals (sourced from a commercial game meat processor) were each inoculated with 10^5 cfu/g (200 µl) of the isolate and 400 µl of sterile distilled water. As controls, 1g of each meat sample (beef, mutton, pork, impala, nyala, warthog, wildebeest, ostrich and zebra) was inoculated with sterile distilled water (600 µl). The samples were then incubated at 8 °C for 24h and tested for the proliferation of the isolate. After incubation every sample was vigorously mixed with 9 ml sterile distilled water and serial dilutions were made in duplicate. Dilutions were plated out onto Baird Parker agar, a selective medium for the identification of S. aureus. Cell counts were determined after overnight incubation at 37 °C.

Results and Discussion

After determining the cfu/g in each sample on the appropriate medium, the data was plotted (Figure 1) to reveal the proliferation of the pathogen present in the meat.

In this study beef was taken as the comparative standard, although mutton or pork could also be chosen. This is done to compare the results obtained from game meat with that of domestic farm animals. The difference in cell numbers of the S. aureus inoculated beef before and after 24 hours was designated a value of 100. The resistance of the other meat samples was then compared with that of beef. Of the other two domestic animals the mutton had a value of 130 and pork 60. Wildebeest had a value (76) between that of beef and pork. Ostrich displayed a slightly better value (67). Nyala (44) was fairly better to that recorded for pork. The impala (31), zebra (17) and especially the warthog (1), showed surprisingly high resistance to the proliferation of this pathogen.

Concluded from the results the meat samples did not contain high numbers of S. aureus before inoculation. The values recorded at time zero were thus considered negligible.

It would also seem from the results that game meat has a stronger ability to naturally preserve itself than that of domestic farm animals. It was thought that possible ante-mortem stress might be an influencing factor, but MacDougall et al. (1979) could not find any difference in microbiological spoilage of farmed young red deer exposed to different levels of ante-mortem stress.

It would appear that the reticulo-endothelial system in some species is more effective than in others, since venison can be hung for a considerable period without any submission to decreased temperature or other precaution methods (Lawrie, 1985). Gill et al. (1976) confirmed that the surviving action of the reticulo-endothelial system destroys bacteria entering the lymphatic system from the intestines up to 24 hours post-mortem.

This phenomenon clearly requires further elucidation.

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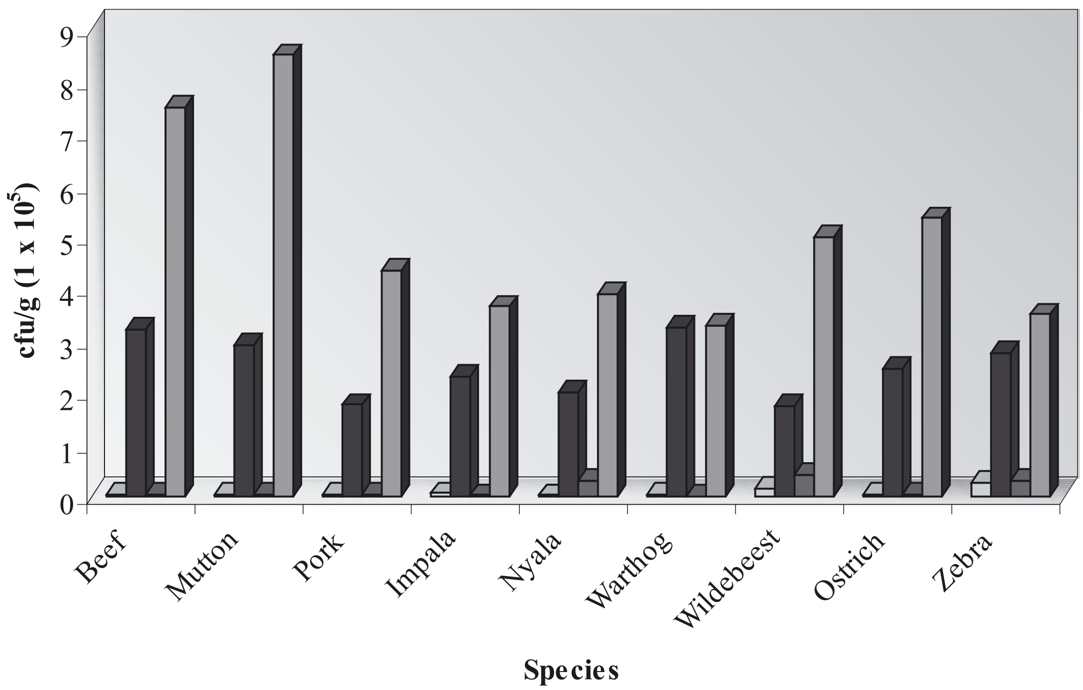

Figure 1: Meat experiments done with Baird Parker Agar. The yellow bars (1) represent the meat sample plus H_2O at 0 hours. The blue bars (2) indicate the meat sample plus H_2O plus the isolate (S. aureus) at 0 hours. The meat sample plus H_2O after 24 hours is indicated by the red bars (3), and the green bars (4) indicate the meat samples plus H_2O plus the isolate after 24 hours.

The use of GIS in the study of tuberculosis distribution in wild boars and red deers in Central Portugal

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Summary

Zoonoses are a matter of concern to the public health and to the economy. The role of wildlife in the epidemiology of these diseases is an issue of increasingly interest and importance and its surveillance among wildlife is a research and public health challenge. Among these diseases, Tuberculosis in major game animals has assumed, in the last few years, an increasing significance. With respect to Portugal, Tuberculosis in major game it is often found in the central region, mainly in wild ungulates such as red deer (Cervus elaphus) and wild boars (Sus scrofa), which requires a rapid intervention by the Veterinarian Competent Authorities in order to reduce the prevalence.

Geographical Information Systems (GIS) enables the incorporation of different spatial data like geographical, farm locations and diseases distribution, and facilitate the epidemiological relationship analyses among these variables, which is of major importance to the epidemiological investigation of wildlife disease. In addition, output data generated by GIS in map format has the particular advantage of allowing implicit representation of spatial dependence relationships in an intuitive manner. For all these reasons, GIS technology is becoming an essential component of modern disease surveillance systems, and it was used in this study in order to evaluate the geographical distribution of Tuberculosis in major game in Central Portugal.

In order to create the GIS, sampling plots were mapped by means of a GPS (Global Positioning System) receiver in Idanha-a-Nova county (lat 39° 55' N: long 7° 14' W) from November 2008 to February 2009. 526 animals were analysed for tuberculosis lesions (337 red deer Cervus elaphus; 29 fallow deer Dama dama; 18 muflon Ovis musimon; 142 wild boar Sus scrofa) in 20 battues, and 73 (13,88%) presented compatible lesions, which were later confirmed after laboratorial analysis.

Data collected during fieldwork were assigned to each sampling plot location, in order to enable geostatistical analysis. The calculation was performed using Geostatistics Analyst 2.0 for ArcGIS 9.x., in order to extent the results to all study area and to create continuous disease intensity maps (Figure 1) represented by a colour intensity degree scale. The percentage values presented in the maps represent the affected TB animals in the total of hunted animals per battue.

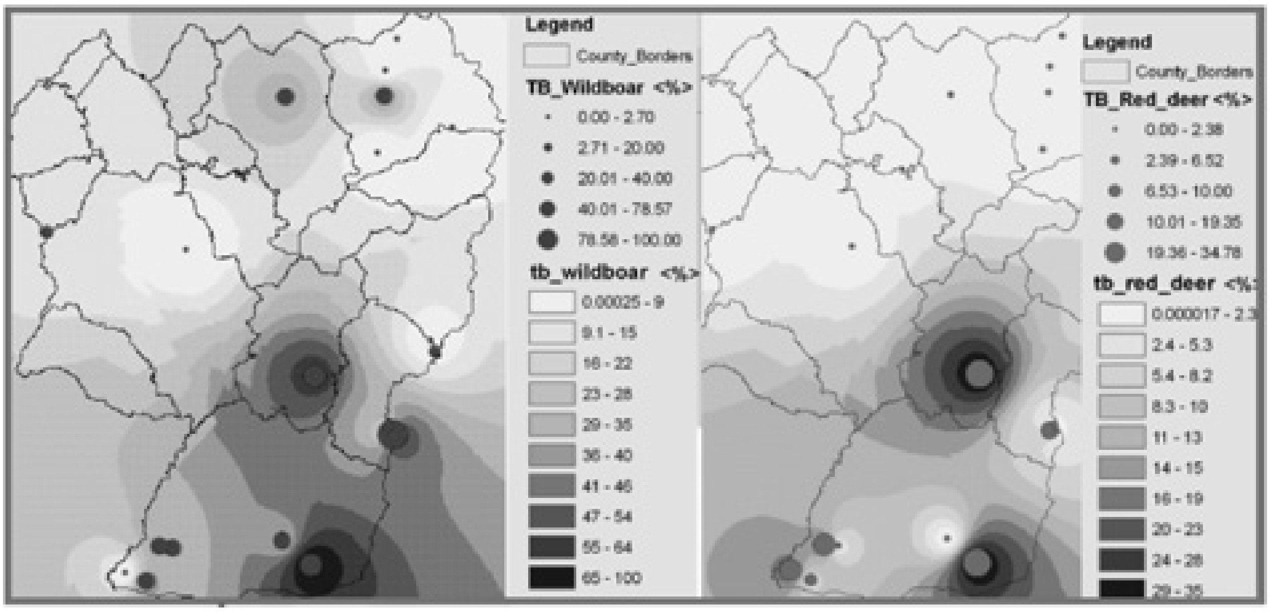

Figure 1 – Tuberculosis (TB) intensity map for wild boar and red deer hunted in Central Portugal.

As Figure 1 (left) shows, tuberculosis in wild boars is scattered throughout the county (circle dimension). After geostatistical calculation (grey gradient), it is possible to see a major vector from South – Southeast to North direction, indicating an important level of Tuberculosis spread.

Analysing tuberculosis in red deer, Figure 1 (right), it can be seen that it's confined to South – Southeast area. In both cases, the analyses of the previous maps, allows us to state that the main affected areas with TB (large number of TB hunted animals) in wild boars and red deers, were located at the Southeast area of the county. These areas should be the first ones to be under veterinarian concern in order to control or reduce disease spread and prevalence. GIS provided an important tool to define objective strategies to prevent the spread of the infectious disease.

Evaluation of dog bite in hunted major game. A hygienic and an economical problem for game meat production

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Summary

Dogs are an important resource on a major game battue. However, dog game action can add a negative contribution when excessive bites are applied while grabbing, causing severe damage to the hunted animals.

Dogs bite in game meat may cause important quantitative and qualitative losses. The first type of losses, results from rejection of the affected areas and, the second one, is related to the decrease of hygiene level and microbiological profile of the produced meat. Furthermore, excessive bites can increase chances of dog infection by diseases shared by these animal, such as Tuberculosis, Aujesky's and parasitic disorders (equinococosis, cisticercosis), some of them also pathogenic to Humans. The affected animal can also contribute for the diseases dissemination trough other geographic regions affecting other wild or domestic animals.

For all this reasons, the authors defined as the main objective of this study the knowledge of dog bite occurrence in game meat and the evaluation of the damage level. To reach this objective, from November 2008 to February 2009, 20 battues and a total of 526 animals were evaluated: 337 red deer (C*ervus elaphus);* 142 wild boar (*Sus scrofa);* 29 fallow deer *(Dama dama)* and 18 muflon (*Ovis musimon)*, in hunting zones located in Idanha-a-Nova county (lat 39° 55'N: long 7° 14'W).

In each battue, after game and before sanitary inspection, the hunted animals were visually evaluated and classified according to the level of dog bites based on the scale presented in Figure 1.

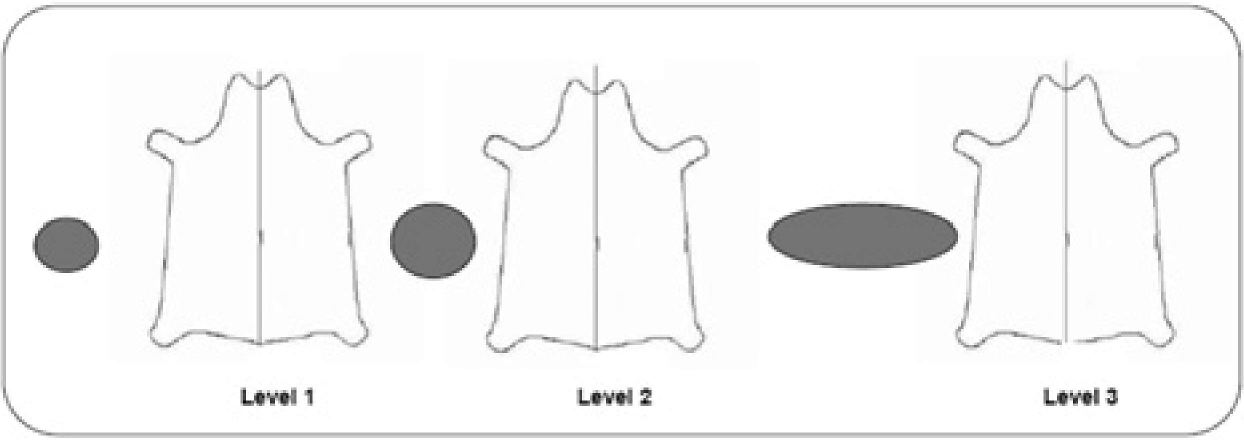

Figure 1 - Dog bites level.

From the 526 animals analysed, 100 (19,01%) presented dog bites. From those, 64 were classified as level 1, 20 as level 2 and 16 as level 3. All the affected animals from level one and two were submitted to partial rejection of the affected and surrounded areas, and the animals from level three were totally condemned for human consumption.

This study reveals a large percentage (19 %) off carcasses affected by dog bites, which emphasises the importance of this problem in the game meat production: reduction of game meat hygiene and in economical losses secondary to meat rejection for human consumption. According to several authors, the dog' teeth harbour a considerable amount of bacteria that pass to game meat during their bites. When the hunted animal it is already death, the bacteria stays in the bitted area but, when dog bites occur while the hunted animal heart still's beating, all the bacteria present on the dog's teeth can enter to the blood flow and can be spread to the entire organism compromising the microbial profile of the all carcass. These situations, associated to a deficient, technical and hygienically preparation of game carcass (that occurs in almost all the cases) favour carcass contamination and reduce its shelf life. It is important to reinforce attention to the game meat production in order to develop hygienic rules to improve the level of consumer protection with regard to food safety, as it is highlighted expressed in the European Regulation 853/2004 that lays down specific hygienic rules for foodstuffs.

The authors believes that the results reached in this study will allow to persuade the persons involved in game hunting process in order to improve dog behaviour during game battue with the objective to promote game meat hygiene and quality.

Detection of Alaria spp. mesocercariae in game meat in Germany

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In 1896 the mesocercarial stage of the trematode *Alaria alata*, an intestinal parasite of some carnivores, was described as *Distomum musculorum suis* (DMS) by Duncker ("Duncker'scher Muskelegel"). Recent incidental background findings of *Alaria alata* mesocercariae in meat of wild boars during official *Trichinella* inspection initiated a re-assessment of the potential human health risk as posed by this parasite; a detailed review is given by Moehl et al. (2009). Experimental infection of primates in mid-20th century demonstrated that *Alaria* mesocercariae can cause severe damages within paratenic hosts closely related to humans and since 1973 several reports about human larval alariosis in North America have been published. The parasite infestation in humans manifests itself in various clinical signs which range from low-grade respiratory and cutaneous symptoms to a diffuse unilateral subacute neuroretinitis (DUSN), and to an anaphylactic shock with lethal consequence. Nearly all cases of human alariosis could be linked to consumption or handling of game meat and/or frog legs. Overall pathogenicity is correlated to high infestation densities, in particular after repetitive intake of mesocercariae. Nevertheless, the risk for humans was generally ignored or at least postulated to be negligible until this issue re-emerged in Europe: Jakšic et al. (2002) and Große & Wüste (e.g. 2006) published results on repeated incidental findings of DMS in meat of wild boars during routine *Trichinella* inspection in certain areas of Croatia and Germany respectively. In view of their findings, deficiencies in methodology, lack of data on prevalence, and the human DMS cases which were reported in the meantime, they were the first to point out that the human DMS exposition risk is not negligible and would merit increased scientific attention. The Federal Institute of Risk Assessment (BfR 2007) concluded that meat which contains *Alaria alata* mesocercariae should be regarded as unfit for human consumption. A final statement concerning the health risks for consumers could not be given due to the lack of information about both the prevalence of DMS and the suitability of *Trichinella* inspection methods to detect this parasite in wild boar meat. Against the backdrop of a general lack of knowledge in relevant areas of *Alaria* biology the own studies concentrate on the most pressing questions of (i) the optimization and/or development of methods for reliable *Alaria* mesocercariae detection, (ii) the distribution of the mesocerariae within their paratenic hosts, i.e. identification of potential predilection sites, particularly in wild boars, and (iii) their prevalence in sylvatic populations of animals with respect to their introduction into the human food chain. Here, we present first results from the methodological parts (i, ii) of our research project which is financially supported by the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV), Germany.

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Evaluation of some parameters of post mortem changes in pheasant *(Phasianus colchicus)*

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Abstract

The *post mortem* changes were evaluated in 99 pheasants (*Phasianus colchicus*) derived from the hunting grounds of the University of Veterinary Medicine in Košice. They were randomly collected from approximately 350 pheasants hunted on a single occasion.

The pheasants were divided into three basic groups. A control group (group I) was created by regularly slaughtered and bled pheasants (n = 33). Two groups were constituted on the basis of X-ray examination performed from latero-lateral and dorso-ventral body projection of hunted pheasants. In second group (group II) were included pheasants (n = 33) with one or multiple shots in the muscle tissues, but not in the body cavity, and group III included pheasants (n = 33) with shots in both, muscle tissues and the body cavity. Each group was divided into two subgroups, when uneviscerated pheasants were stored at 0 °C, and at 4 °C, for maximum 14 days. Samples of pheasants, from each subgroup (n = 4), were chosen randomly and examined on days 0, 3, 7, and 14.

Post mortem changes in the muscles of pheasants were evaluated in following way: pH value (in water extract), amount of lactic acid, and ammonia content.

Significant differences ($P < 0.05$) between pH values in breasts muscles of the pheasants in group I (control group) and group II (without shots in body cavity) were found. Statistically significant differences (comparison of groups I and II, and groups I and III) were showed in pH values of thigh muscles stored at both 0 and 4 °C.

A ideal relationship between lactic acid concentrations and pH values was observed in breast muscle at both storage temperatures (on day 3, pH values decreased and lactic acid concentration increased; on day 7, pH values increased and lactic acid concentration decreased; on day 14, the both were slightly changed). In the connection between pH values and lactic acid concentration, the mean concentrations of lactic acid were higher in the breast than in the thigh muscles. Statistically significant difference was found between lactic acid concentrations in breast muscles (4 °C), namely between groups II (without shots in the body cavity) and III (shots in the body cavity).

The highest mean concentrations of ammonia in the breast muscle (day 14) were determined in the group III (4 °C), and the lowest in the control group (4 °C). The highest mean concentrations of ammonia in the thigh muscles were in the group III (0 °C), and the lowest in the control group (0 °C). Statistically significant differences ($P < 0.05$) were observed between groups I and III (thigh muscles) stored at 0 °C.

The achieved results showed that post mortem changes in the meat of the pheasants were influenced by method of killing and storage conditions. The damage of muscles (groups II and III) and higher storage temperature (4 °C) negatively influenced development of post mortem changes.

Microbial Quality of Venison Meat at Retail in the UK in Relation to Production Practices and Processes

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Venison is a popular game meat in the UK with steadily increasing sales. Several approaches are taken in the slaughtering and dressing of deer for venison. Deer can be wild, kept in parks or farmed. This affects whether the deer is shot in the open or slaughtered indoors, and the distance the carcass needs to be transported for dressing affects whether evisceration is undertaken outside or inside and the time before the carcass can be chilled. Our work aims to identify hygienic best practice from the different methods used to produce venison in the UK. We have visited five major UK producers of venison and recorded the production practices and processes employed at their plants. We have also examined the microbiological quality of venison (diced venison and steaks) at retail that are produced from both wild and farmed/park deer with the aim of relating the product hygiene status with the production practices employed. All venison products have been free from *Salmonella* contamination; however *Escherichia coli* was isolated from all samples from wild deer but from only 16% of samples from farmed/park deer. Levels of *E. coli* and Enterobacteriaceae isolated from each group of products from wild deer were higher than those from farmed/park animals.

Slaughter and evisceration of deer within a specialised environment enables a level of control to be exerted on factors that influence product hygiene. In the field the increased likelihood of sub-optimal slaughter and evisceration may be compounded by delays between slaughter and chilling and/or breaks in the cold chain prior to further dressing. Each of these factors may account for the higher levels of enterobacterial contamination found in products originating from wild deer. The outcomes of this project will allow informed decisions to be made on procedures which could be implemented, from a HACCP viewpoint, to produce venison of good microbiological quality and with a low risk of bacterial pathogens.

Health-related bacterial conditions on game carcasses intended for the local South African market compared to conditions on carcasses intended for export markets

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Introduction

The growing search for natural, organic and healthier food has contributed substantially to the global development of the game meat market. In South Arica the export market ascribes through regulation, to the requirements of its countries of export (mainly European) for the last 30 years. However similar regulation of the traditional local game meat market in South Africa has not yet been implemented. Although only sporadic reports on diseases related to game meat were noted locally for the last 60 years, the local game meat market has rapidly expanded following the effective expansion and availability of game for trophy, hunted as well as harvested game carcasses to the local markets. Since no control mechanisms are applied locally, it is not clearly understood what the safety of the game meat might be in terms of human consumption. This study measured in terms of human health, the related quality of the meat using the export products as a benchmark.

The question

What are potential differences in the game meat hunted under inadequately controlled conditions for the local meat and game meat harvested, under rigorously controlled conditions, for export markets?

Methods

The study focused on the process of obtaining game carcasses on the farm and the transport to secondary processors. Two time slots for testing were focussed on; immediately after killing and 72 hours post mortem. Samples taken from the "local" carcasses were compared to the results obtained from "export" carcasses.

Samples were obtained from "local" as well as "export" carcasses from the same geographical area in the same hunting season using similar criteria for bacterial, pH and temperature assessments of the carcasses. Logistical factors in the handling of the local versus the export carcasses required the two variations in the assessment times. Export (reference) carcasses were transported unskinned from the ranch under refrigeration to the export abattoir for dressing and meat inspection. The local (case) carcasses were skinned directly after the hunt and transported unrefrigerated, usually on open vehicles to the processors.

Post-mortem blood was sampled using 10-ml vacuum glass tubes with heparin (to prevent blood coagulation), and analysed for the total heterotrophic bacterial count. These tests were done to establish the corresponding bacterial condition of the reference and case groups. Temperature reading and pH values were simultaneously noted. After 72 hours the surfaces of the dressed carcasses were swabbed tested for the total bacterial count as well as specific pathogens; *E. coli, Salmonella and Staphylococcus areus.* Temperature and pH readings were again noted. The samples analysed by an accredited laboratory.

Results

No statistically significant differences were found in the bacterial quality of the heart blood from both the case and reference group. Similar results were observed for the pH and temperature taken from the carcasses immediately post mortem. However after 72 hour post mortem the results for the case group showed significant contamination and growth of pathogenic and other bacteria. No differences were observed in the pH values 72 hour post mortem. The temperature difference was significant because of the refrigeration.

Discussion / Conclusion

The skin protects the carcass in terms of the bacterial load. The influence of pH on the bacterial quality of the meat was not evident and could in these circumstances probably only have an effect onthe sensory quality on the meat. This work demonstrated the effect of refrigeration and dressing on the bacterial load on game meat carcasses intended for the local market. This has implications for the health-related safety of the meat and subsequently for infection of the consumer. A well-maintained cold chain can reduce the risk of bacterial (and quite possibly the risk of microbial infection) and could ensure safe game meat for the local market.

Important is that this work provided some insight into the possible over-regulatory legislation (current in draft format in South Africa) for game meat intended for the local market as only a few regulatory aspects of the reference group was identified, used and applied to the case group. Many other aspects with regard to the slaughter facility, independent meat inspection and hygiene systems currently in draft legislation for the local market need to be assessed and the practical application tested on the case group.

Hygiene management systems of commercial game harvesting teams in Namibia

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Abstract

There are more than two million game animals in Namibia, with numbers increasing at a rate of 20–40% per annum. Around 90% of the country's wildlife is located outside formally proclaimed conservation areas whilst more than 80% of the larger game species are found on privately owned farms comprising 44% of the surface area of the country. The Namibian wildlife sector offers a commercially viable alternative for generating farm income. The quality of the meat harvested from game meat depends on several factors such as the skill and attitude of the hunter, the health of the game animal before being shot, the position of the shot and the hygienic handling after shooting. Quality aspects further rely on the time before cooling and the transport and treatment of game carcasses as well as the period prior to cooling. Food business operators must therefore establish, implement and maintain hygiene control procedures based on HACCP (Hazard Analytical Critical Control Points) principles (Regulation (EC) No. 852, Article 5, par 1) before exports of game meat to international countries are approved.

1. INTRODUCTION

Namibia is well-known for its high quality game meat and game meat products. Tourists often praise this attribute of Namibian game meat, as it is often offered on the menu in restaurants, guest houses and lodges. Namibia has a number of regulations that apply to the sustainable use of game animals which are applicable when the harvesting of game animals for commercial game meat production is used to remove excess animals (Nature Conservation Ordinance no. 4 of 1975). Countries importing game meat, such as South Africa and the European Union, also lay down specific rules and regulations whereby countries willing to export game meat, must abide. Only harvesting teams registered with the Namibian Directorate of Veterinary Services and the Ministry of Environment of Tourism are allowed to harvest for the commercial export of game meat.

Each of the harvesting teams should have a well documented and implemented Hygiene Management System, as required by the importing country, in place, before the meat harvested will be allowed to be exported by the competent authority, which is the Directorate of Veterinary Services in Namibia. Game may only be harvested from the OIE recognized FMD free zone without vaccination. The fresh meat should be obtained from areas free of Foot and Mouth Disease and Rinderpest (Kamwi, 2007).

2. HYGIENE MANAGEMENT SYSTEMS

The primary responsibility for food safety rests with the food business operator (Regulation (EC) No. 852, Chapter I, Article I, par 1) and it is necessary to ensure food safety throughout the food chain, starting with primary production. Food business operators must therefore establish, implement and maintain hygiene control procedures based on HACCP principles (Regulation (EC) No. 852, Article 5, par 1). This is applicable to the harvesting of game for meat exports to the European Union and other countries such as South Africa (Meat Safety Act no. 40 of 2000).

2.1 Standard operational procedures (SOP'S)

Hunters must be trained in health and hygiene and must have sufficient knowledge of the pathology of wild game, and of the production and handling of wild game and wild game meat after hunting, to undertake an initial examination of wild game on the spot (Regulation (EC) 854/2004, Section 4, Chapter 1, par 1–5).

Ante-mortem inspections must be carried out by the hunter prior to hunting (Codex Alimentarius CAC/RCP 29-1983, Rev.1, 1993). Only head shots are allowed for commercial harvesting. This is essential to limit decay and contamination of the meat (Van Rooyen *et al*., 1996). Game killed with thoracic and abdominal shots are subject to secondary inspection (Meat Safety Act no. 40 of 2000, Part V, Section 11.(1)(h), par 61). A farmer may only employ a night harvesting team for commercial purposes (Nature Conservation Ordinance no. 4 of 1975).

Game intended for commercial purposes must be bled within 10 minutes of being shot. Blood is an ideal growth medium for bacteria and when not well-bled, a carcass will deteriorates faster (Van Rooyen *et al*., 1996). Carcasses must be transferred from the collecting vehicle to a clean slaughter frame in such a manner as to avoid contamination. Labels must be provided for the identification of each carcass and its organs (Ebedes & Meyer, 1996). Animals should be partially eviscerated within 20–30 minutes of harvesting. Partial evisceration, normally restricted to removal of the intact gastrointestinal tract, serves to reduce the weight and bulk of the carcass and to speed cooling.

Chilling must begin within a reasonable period of time after killing, preferably within 12 hours after the harvest. When the ambient temperature is more than 12 °C, carcasses must be chilled within 4 hours (Meat Safety Act no.40 of 2000). Veterinary maturation of meat destined for the European market is necessary. This is a control process whereby the Foot- and Mouth virus is deactivated. Carcasses must be submitted to maturation at a temperature above +2 °C and below 7 °C for at least 24 hours before de-boning (Council Decision 79/542/EEC).

Game meat can only be marketed commercially if it was transported in a refrigerated truck to a registered game handling establishment as soon as possible after harvesting. The viscera must accompany the body and must be identifiable as belonging to a given animal (Regulation (EC) 854/2004, Chapter II, par 3).

2.2 Sanitation Standard Operational Procedure (SSOP's)

Hygiene Management Systems for game harvesting teams comprise of sanitation standard operational procedures for pre-, during and post-operational cleaning and sanitation. Sterilizers used to sanitize knives contain 10 ppm free chlorine derived from a chemical sterilizer. Drinking water is adjusted to a free chlorine level of 1–2 ppm. All equipment, including the trucks used for harvesting, are cleaned and sanitized.

2.3 Good Hygiene Practices (GHP)

Employees handling the game carcasses wear outer garments suitable for hunting and in such a manner that the clothing protects against contamination. This include PVC shoots, aprons, rubber boots and hair nets. Employees undergo medical check-ups regularly and abide by a strict hygiene code. At least one team member is trained as a game meat inspector and also keeps the records of the Hygiene Management System.

2.4 Critical control points (CCP's)

A hygiene risk assessment is used to determine critical control points for the game harvesting process. Typical critical control points defined are;

- Checks on the potability of the water from the farms where the harvesting take place;
- Checks of faecal contamination of the partially dressed carcasses
- Checks on temperatures of the carcasses after being loaded into the refrigerator trucks.

The treatment of water to an acceptable chlorine level is essential since most of the time untreated water from the farms is used during the harvesting of game. Faecal contamination can results in unacceptable pathogenic bacterial growth. Maturation of the meat (between 2 °C and 7 °C in 24 hrs) is critical regarding quality (Council Decision 79/542/EEC). Conditions before shooting may increase metabolism (Kappelhof, 1999). The detection of metal fragments from bullets is not considered as a critical control point. It is controlled by the standard operational procedure where only head shots are accepted for commercial harvesting. A study undertaken by Haldimann *et al*. (2002) concluded that frequent consumption of game meat has no significant effect on blood lead levels.

3. CONCLUSION

Hygiene Management Systems assist game harvesters and processors in ensuring that all harvesting, transporting, dressing and processing procedures are done under hygienic conditions. Micro-organisms are mostly responsible for causing severe food poisoning in humans who eat contaminated meat. Game meat however, has an inherent resistance to contamination by micro-organisms and thus gives it a competitive edge towards other types of meat (Ebedes & Meyer, 1996).

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Salmonella spp. in wild boar *(Sus scrofa):* A public and animal health concern.

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Summary

Wild boar (*Sus scrofa*) can act as a potential reservoir and a spreader of zoonotic agents, including *Salmonella* sp., which could represent a source of infection for animals (wild and domestic) and for human.

Salmonella spp. shed in their faeces may be ingested, by other wild animals or by domestic livestock animals, either trough direct contact or by food (specially pastured livestock) or water cross contamination when these resources are shared. Human health risk from wild boar infected with *Salmonella* sp. arises indirectly from agricultural areas and vegetable products contamination, through direct animal contact, during hunting process and carcass manipulation, or directly from ingestion of faecal contaminated meat or meat products.

To date, knowledge of *Salmonella* sp. epidemiological distribution in wild boars (*Sus scrofa*) is very limited and, regarding to Portugal, no bibliographic references were found. According to previous state and considering the importance that wild boars have as a major game hunting in Northern Portugal, the evaluation of *Salmonella* sp. and serovars prevalence in wild boars harvested by hunters, was defined as the main objective of this study. During 2006 hunting season, 77 rectal faecal samples from animals shot by hunters in Northern Portugal, were collected and analysed by means of standard culture methods, according to annex D of ISO norm 6579:2002 applied to *Salmonella* detection in animal faeces**.**

Salmonella isolates were serotyped according to the Kauffmann-White scheme (Popoff, 2001) in the LNIV – National Reference Laboratory for *Salmonella.* The results showed that 17 samples (22.1%) were positive to *Salmonella* sp. From those, the most prevalent serovar was *Salmonella* Typhimurium, identified in 11 (64.7%) isolates, followed by *Salmonella* Rissen in 6 (35.3%). The present study represents the first report of *Salmonella* sp. identification in faecal samples of wild boars in Portugal, and the reached prevalence highlights the importance of the wild boar as reservoir and as a faecal shedder of *Salmonella* sp. Also, the notorious expression of *Salmonella* Typhimurium that was identified in 64.7% of the positive samples must be underline since, this serotype, it is considered pathogenic for animals and humans and presents an high resistance rate to antibiotics.

The results reached in this study, emphasise the importance that wild boar can assume as a vehicle of pathogenic serovars of *Salmonella* to humans and animals. Wild boars are used for human consumption and, in almost all the cases, after a deficient, technical and hygienically, preparation that favour carcass

faecal contamination. The results reached in this study, suggested that it is important to reinforce attention to the game meat production in order to improve and promote its safety and also that systematic serological and bacteriological surveillance of wild boar populations should be improve in order to better understand and minimize the impact of such diseases on wild and domestic animals as well as in humans.
Key words : Wild boar, *Salmonella*, zoonosis, game meat, wildlife, food safety



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