Public health risks associated with the utilisation of wildlife products in certain regions of Africa

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Summary
The authors describe the public health risks associated with wildlife products in certain regions of Africa. Most of the information presented is obtained from the Republic of South Africa, particularly the Kruger National Park. There are no statutory requirements in South Africa regarding the general inspection of game carcasses prior to sale; however, current regulatory inspection requirements are explained. Game farming systems in southern Africa are generally extensive systems with wild herbivores living in a near-natural 'free-ranging' state. Several pathological processes and disease entities have been confirmed in wildlife carcasses and these are listed with zoonotic implications.

Keywords

Introduction
In South Africa, the carcasses of wild animals are generally not subjected to a formal meat inspection procedure prior to sale to the consumer. This situation arose mainly because most wild animals were legally classified as ownerless and the State allowed controlled hunting in certain seasons following the purchase of an appropriate hunting licence. More recently, however, with the development of a formal game ranching industry, the ownership of wild animals may be transferred to the landowner following the erection of suitable fences around the property, which entitles the farm to acquire 'exemption' status from the provincial nature conservation authorities. Subsequently, the game farmer may allow hunting on the property at any time of the year, and may set his own harvest quota. In addition, many years of protection of the resident indigenous fauna in many National Parks and game reserves have occasionally resulted in population growth of certain herbivores to levels which exceed the ecological carrying capacity of the protected area, and population management has become necessary. Thus, commercial harvesting techniques have developed and the sale of game meat is increasing progressively in South Africa, but as yet no statutory requirements with regard to the inspection of game carcasses prior to sale have been established.

The difficulty in establishing statutory requirements stems from the following factors:

a) African wild herbivores, unlike many farmed cervids elsewhere in the world, are not even partially domesticated.
b) Game farming systems in southern Africa are generally extensive systems in which wild herbivores live in a near-natural 'free-ranging' state.
c) Most game farms are located in remote rural areas with limited infrastructure.
d) As a result of factors a), b) and c), the harvesting of wild animals is executed mainly by use of firearms (free projectiles) from a distance and under primitive field conditions. This situation does not lend itself readily to any formal abattoir 'line' structure in which the carcasses, corresponding organs and head can be easily identified for inspection purposes.

Furthermore, few zoonotic diseases have been identified during extensive surveys on game carcasses. The main public health problem to be anticipated appears to be carcass contamination by enteropathogenic or toxigenic bacteria which may occur if the abdominal viscera are accidentally damaged by bullets or during evisceration.
Current regulatory requirements

In southern Africa, a range of pathological processes and disease entities have been confirmed in wildlife carcasses (34, 35, 36). These appear in Table 1, and some are described in detail below.

In South Africa, there are two categories of wildlife for which routine meat inspection is compulsory, namely:

a) All wildlife species routinely culled in the Kruger National Park (KNP): this is legislated in the 1992 Abattoir Hygiene Act, and was established for animal health considerations rather than for public health reasons, as the KNP is the only endemic foot and mouth disease area in South Africa. The inspection enforced by the Act serves to identify any epidemic outbreaks of this disease and to prevent the spread of potentially infected products. The veterinary public health aspects of inspection have, however, become much more important with the relatively recent introduction of two exotic and potentially zoonotic diseases into the KNP ecosystem, namely bovine brucellosis and bovine tuberculosis.

b) All wildlife carcasses destined for the export market: in this case, the public health requirements are stipulated by the importing country, and regulatory officials in South Africa ensure that these requirements are complied with.

Viral diseases

Crimean-Congo haemorrhagic fever

Crimean-Congo haemorrhagic fever (CCHF) is recognised as a sporadic but important potential pathogen of humans in southern Africa. In a survey conducted by Shepherd et al. in 1987, the prevalence of antibody was highest in large sized species: giraffe (Giraffa camelopardalis), rhinoceros (Ceratotherium simum and Diceros bicornis), eland (Taurotragus oryx), buffalo (Syncerus caffer), Burchell’s zebra (Equus burchelli), gemsbok (Oryx gazella) and greater kudu (Tragelaphus strepsiceros) (27). The considerably lower prevalence of CCHF antibody in wild carnivores, primates, smaller antelope and blue wildebeest (Connochaetes taurinus) is probably due to an innate resistance to parasitism by adult ticks (mainly Hyalomma spp.) in these animals. The zoonotic danger of CCHF results from the handling of a carcass of an animal slaughtered in the viraemic phase of the disease (R. Swanepoel, personal communication). In 1996, seventeen workers at an ostrich abattoir in South Africa became infected after being exposed to a carcass in the viraemic phase (16, 23).

Furthermore, infected ticks of the genus Hyalomma on the skins of culled wild ungulates or ostriches may transfer to and feed on culling team members or abattoir workers and transmit the infection.

<table>
<thead>
<tr>
<th>Animal species</th>
<th>Disease</th>
<th>Zoonotic importance</th>
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</thead>
<tbody>
<tr>
<td>Impala (Aepyceros melampus)</td>
<td>Foot and mouth disease</td>
<td>0</td>
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<tr>
<td></td>
<td>Papillomatosis</td>
<td>0</td>
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<td></td>
<td>Cysticeriosis</td>
<td>X</td>
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<tr>
<td></td>
<td>Sarcoptes</td>
<td>?</td>
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<tr>
<td></td>
<td>Bluetongue</td>
<td>?</td>
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<td></td>
<td>Staphylococcal abscesses (focal)</td>
<td>+</td>
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<tr>
<td></td>
<td>Actinomycosis</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Anthrax (cyclical outbreaks)</td>
<td>++</td>
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<tr>
<td></td>
<td>Brucellosis</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Sarcoptic mange</td>
<td>+</td>
</tr>
<tr>
<td>Buffalo (Syncerus caffer)</td>
<td>Foot and mouth disease</td>
<td>0</td>
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<td></td>
<td>Rift Valley fever</td>
<td>++</td>
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<td></td>
<td>Q fever</td>
<td>+</td>
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<tr>
<td></td>
<td>Papillomatosis</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Cysticeriosis</td>
<td>++</td>
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<tr>
<td></td>
<td>Sarcoptes</td>
<td>?</td>
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<tr>
<td></td>
<td>Schistosomiasis (adults)</td>
<td>0</td>
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<tr>
<td></td>
<td>Pantostomiasis (larval)</td>
<td>+</td>
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<td></td>
<td>Theileriosis</td>
<td>0</td>
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<td></td>
<td>Coccidioides</td>
<td>+</td>
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<td></td>
<td>Hydatidosis (rare)</td>
<td>?</td>
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<tr>
<td></td>
<td>Sarcoptic mange</td>
<td>+</td>
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<td></td>
<td>Parainfluenza</td>
<td>0</td>
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<tr>
<td></td>
<td>Tuberculosis</td>
<td>++</td>
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<tr>
<td></td>
<td>Brucellosis</td>
<td>++</td>
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<td></td>
<td>Anthrax (cyclical outbreaks)</td>
<td>++</td>
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<tr>
<td></td>
<td>Leptospirosis</td>
<td>+</td>
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<tr>
<td>Blue wildebeest (Connochaetes taurinus)</td>
<td>Cysticeriosis</td>
<td>X</td>
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<tr>
<td></td>
<td>Pentastomiasis</td>
<td>+</td>
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<tr>
<td></td>
<td>Malignant catarrhal fever</td>
<td>0</td>
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<td></td>
<td>Sarcoptic mange</td>
<td>+</td>
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<td></td>
<td>Anthrax (Highly resistant)</td>
<td>+</td>
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<tr>
<td>Elephant (Loxodonta africana)</td>
<td>Anthrax (cyclical outbreaks)</td>
<td>++</td>
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<tr>
<td></td>
<td>Encephalomyocarditis (rare)</td>
<td>++</td>
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<tr>
<td>Lion (Panthera leo)</td>
<td>Echinococcosis</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>Pentastomiasis (linguatus)</td>
<td>+</td>
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<tr>
<td>Leopard (Panthera pardus)</td>
<td>Trichinellosis</td>
<td>?</td>
</tr>
<tr>
<td>Spotted hyena (Crocuta crocuta)</td>
<td>Nocardiosis</td>
<td>+</td>
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<tr>
<td></td>
<td>Echinococcosis</td>
<td>++</td>
</tr>
<tr>
<td>Jackal (Canis mesomelas)</td>
<td>Rabies</td>
<td>++</td>
</tr>
</tbody>
</table>

0: none
X: unlikely
+: limited
++: significant
? : unknown

Ebola virus infection

The first identified outbreaks of Ebola fever in humans were reported in the Sudan and Zaire. Epidemiological investigations indicated that the initial cases were sporadic and that inter-human transmission was responsible for most of the 651 cases (with a mortality rate of 69%) reported during 1976 and 1977 (1). Reports that 5%-8% of the human population possesses antibodies to Ebola virus in different countries of tropical Africa would suggest that the virus is
endemic in this region. In a bid to identify a sylvatic maintenance host, more than a thousand animals (mainly mammals) in the Sudan and Zaire were unsuccessfully screened for the presence of the virus or for antibodies. In Kenya, however, 3 of 184 baboons sampled showed significant antibody titres. Furthermore, experimental infection of primates was found to result in a mortality rate of 100% (17).

More recently (February 1996), the World Health Organisation reported an outbreak of Ebola disease in the village of Mayibout in Gabon (25). Twenty cases of the disease were recorded in this outbreak, of which thirteen are known to have died. All the victims had been involved in the handling, butchering and eating of a chimpanzee (Pan troglodytes). Reports of the presence of other dead animals in the forest at that time, including another chimpanzee, three gorillas (Gorilla gorilla), an antelope and a wild cat, remained unconfirmed. A Swiss researcher also contracted Ebola disease after performing an autopsy on a dead chimpanzee found in the Tai forest near the border between the Côte d'Ivoire and Liberia. Thirty chimpanzees had apparently been found dead in the Tai forest at that time (24).

The search for a wild reservoir host for this disease continues. Suggestions have been made that the host may be found in arboreal rodents or Colobus monkeys (Colobus satanas) which are hunted and eaten by chimpanzees.

Consequently, a primate link appears to exist in Central and West equatorial Africa. Veterinarians, biologists and local villagers should be informed of the potential dangers of handling primate carcasses and raw primate derived 'bush meat', especially when the animal has been found dead.

Encephalomyocarditis virus
Encephalomyocarditis virus infection has recently been diagnosed in free-ranging African elephant (Loxodonta africana) in the KNP (13). Elephants are culled regularly in this National Park, so there is a risk of zoonotic transfer of this disease to culling teams and abattoir workers. However, whilst seropositivity has been found to develop in humans, most infections appear to be subclinical.

Rabies
Rabies has been diagnosed sporadically in a wide variety of free-ranging canids, mustelids, felids and particularly in small viverids in southern Africa (22). An epizootic in free-ranging kudu has also been described in Namibia (2). Once again, the handling of infected carcasses constitutes a finite risk for zoonotic transfer.

Rift Valley fever
The presence of significant levels of Rift Valley fever antibody in the sera of many free-ranging African buffalo in the KNP indicates that this arbovirus is circulating within the buffalo population (P. Howell, personal communication). The handling of buffalo carcasses during culling operations in the field or abattoir processing could constitute a zoonotic risk to the personnel involved.

Bacterial diseases

Anthrax
Anthrax has been diagnosed in various free-ranging wildlife populations in southern Africa. De Vos et al. reported cyclical epizootics of anthrax in the KNP during which thousands of animals succumbed to the disease (8). Buffalo and kudu were the most frequent victims, although positive cases were diagnosed sporadically in most other species. Endemic anthrax has also been reported in the Etosha National Park in Namibia where sporadic cases were reported in elephant, Burchell's zebra and wildebeest (21). Confirmed cases of the intestinal form of anthrax have been reported in humans from the Oshakati hospital (northern Namibia) following the consumption of zebra meat (H. Ebedes, personal communication). Sporadic cases of anthrax, predominantly in kudu, have also been reported on game farms in the north-western Cape and western Transvaal. The ostrich is also susceptible and the potential public health risk due to the increase in ostrich farming in South Africa should be recognised (16). The public health implications of handling or consuming products of infected wild animals is self-evident.

Bovine brucellosis
Bovine brucellosis has been reported in several free-ranging species of wild animals. Positive serological test results have been obtained from African buffalo, impala (Aepyceros melampus) and hippopotamus (Hippopotamus amphibius) (7). Gradwell et al. succeeded in isolating Brucella abortus biotype 1 from the cotyledons of 3 out of 68 pregnant buffalo cows (12) and Condy et al. isolated the same organism from a waterbuck cow (Kobus ellipsiprymnus) (5). The presence of this disease at significant prevalence levels (11%-23%) constitutes a definite zoonotic risk for workers involved in culling operations and the processing of game carcasses (15).

Bovine tuberculosis
Bovine tuberculosis has been diagnosed in several free-ranging wild mammals in southern Africa, including African buffalo, warthog (Phacochoerus aethiopicus) greater kudu, Kafue lechwe (Kobus leche kafensis), common duiker (Sylvicapra grimmia), chacma baboon (Papio ursinus), lion (Panthera leo) and cheetah (Acinonyx jubatus) (4, 11, 14, 19, 28, 29, 30, 31). A significant proportion of these reported cases occurred in combination with miliary disease (18) and in kudu, fistulating abscessed lymph nodes are commonly encountered. Thus, whenever such animals or carcasses are handled, there is a risk of zoonotic transmission to operators involved in culling operations or processing carcasses at the abattoir. In southern Africa, where meat is traditionally eaten
'undercooked' or dried and salted, a zoonotic risk also exists for the consumer. This risk is probably being compounded by the human immunodeficiency virus (HIV) panzootic sweeping the region and an increased immuno-compromised human population. Some buffalo herds in the KNP and the Hluhluwe/Umfolosi game reserves have demonstrated infection rates exceeding 50%.

**Erysipelothrix infections**

Erysipelothrix infections in wildlife are considered to be rare and the public health significance is difficult to determine (6). However, springbok (Antidorcas marsupialis) have been linked with workers infected during carcass handling and dressing (C.M. Veary, unpublished findings).

**Nocardiosis**

Nocardiosis has been diagnosed as a cause of pyogranulomatous pneumonia, pyothorax, peritonitis, lymphadenitis and abscesses in several non-domesticated species. The risk of zoonotic transfer is relevant for veterinarians, abattoir workers and hunters.

**Salmonella**

Salmonella infection is common in crocodiles (Crocodilidae spp.) although most of the involved species are believed to be of little public health importance (9, 16).

**Rickettsial and chlamydial diseases**

**Chlamydiosis**

Chlamydiosis is widespread in Nile crocodiles (Crocodylus niloticus) on farms in Zimbabwe (9, 16). However, the dangers of zoonotic transfer are unknown, since there have been no recorded cases of crocodile-derived chlamydia resulting in human infection to date.

**Q fever**

Q fever (Coxiella burnetii) is ubiquitous in the free-ranging environment where the organism cycles between ticks and various small and large mammals. Once again, personnel involved in the processing of carcasses are at risk of contracting infection.

**Parasitic diseases**

**Cysticercosis**

The cysticerci recorded in impala, buffalo and blue wildebeest are predominantly the intermediate stage of *Taenia regis* or *Taenia hyaena*, and the definitive hosts for these two tapeworms are the spotted hyaena (*Crocuta crocuta*), lion, leopard (*Panthera pardus*) and jackal (*Canis spp.*). In surveys conducted in the late 1960s, approximately 30% of all impala and buffalo carcasses screened and over 70% of blue wildebeest carcasses screened were infected with cysticercosis (34, 35, 36). Experimental work has demonstrated that humans are refractory to infection with these two cestodes (A. Verster, personal communication). More recently, however, 39 out of 260 buffalo carcasses from the Hluhluwe/Umfolosi game reserve in South Africa were found to be infected with *Cysticercus bovis*, the intermediate stage of *Taenia saginata*, which has serious public health implications. This new development has probably resulted from environmental contamination with gravid proglottids by people from neighbouring tribal communities who enter the reserve to collect firewood, thatching grass and reeds.

**Echinococcosis/hydatidosis**

*Echinococcus granulosus* adult worms occur in large numbers in the small intestine of many hyaena, lion, wild dog (*Lycaon pictus*) and leopard. The possibility of exposure to the ova shed by these dwarf tapeworms, and the subsequent risk of hydatid disease during handling of these species or their faeces should always be kept in mind. Saturated salt (NaCl) solution is the most effective disinfectant to destroy these ova. Hydatidosis is commonly encountered in free-ranging Burchell's zebra in the KNP and sporadically in buffalo and greater kudu (32). Hippopotamus and impala may also serve as wild intermediate hosts. The jackal has not been extensively surveyed as a sylvatic reservoir of echinococcosis in South Africa.

With the increased movement by people from the neighbouring tribal communities, accompanied by domestic animals, into these game parks, the potential for interlinking sylvatic and synanthropic cycles of this disease with its attendant zoonotic implications should not be overlooked.

**Pentastomiasis (linguatuliasis)**

In 1995, Young claimed 100% infestation with *Linguatula serrata* in older lions in the KNP (33). The incidence of larval infestation is very high in buffalo (60%-70%) and blue wildebeest (70%-80%). Humans can become infested through the preparation of meat and edible organs from infested wild herbivores (37).

**Trichinellosis**

Exhaustive analyses of numerous muscle samples of various herbivorous species for the presence of *Trichinella spiralis* have all given negative results. This parasite is, however, very common in the muscle tissue of various large carnivores, especially spotted hyaena and leopard. The jackal, and in particular the black backed jackal (*Canis mesomelas*), has not been as extensively surveyed as a sylvatic reservoir of trichinellosis in South Africa, though such surveys have been performed in countries of central and East Africa. Of potential public health significance is the possibility of partly cooked,
infested warthog meat as a source of human infestation. In South Africa, however, only a single case of trichinellosis has been diagnosed in an old adult warthog boar in the KNP (20).

Illegal poaching and killing of warthog and wild carnivores occur at a low level, but a real threat of transmission of the disease exists with the prescription of uncooked predator organs and products by traditional healers to patients in infested areas. In general, however, trichinellosis appears to have a predominantly predator-to-predator cycle in this ecosystem. The infectious potential of this specific Trichinella to humans is unknown.

Trichinella has been diagnosed in cull crocodiles from 11 out of 17 crocodile farms in Zimbabwe (10, 26). The organism also infects baboons and rats (10, 26). Other farms have not been tested. The situation in the wild is unknown.

Toxoplasmosis

Toxoplasmosis has been described in a wide range of non-domesticated species both in the tissue cyst (bradyzoites) stage and the intestinal coccidian parasite stage. Data on the prevalence of the disease in wild animals in southern Africa is scarce and, as in synanthropic animals, carriers are asymptomatic. Handling or consumption of raw or undercooked wildlife products or exposure to oocysts may constitute a risk of zoonotic transfer.

Other diseases

There are several other diseases which pose a zoonotic threat, though mainly not through consumption of wildlife products, but rather through contact with raw hides infected with the pathogens (e.g., dermatomycoses) or infested with certain ectoparasites. The ectoparasites may either infect the human directly (e.g., sarcoptic mange or scabies) or may transmit diseases such as tick bite fever (rickettsiosis) or Lyme disease (borreliosis) to the human victim. Once again, veterinarians, abattoir workers and hunters are most at risk.

Conclusion

As is the case with domestic livestock, the presence of certain anthropo-zoonotic pathogens in the tissues of wild animals may constitute a finite risk of infection to humans. With the exception of farmed deer, most wild animal carcasses are never subjected to formal meat inspection as they are usually sourced from kills (by hunters) or informal population reduction culls. This may result in an increased risk to consumers, as macroscopically identifiable lesions (e.g., parasitic cysts, tubercles and abscesses) which would normally have been removed by trimming and partial or total condemnation of the carcass, may then enter the human food chain. Furthermore, the potentially more dangerous, yet sporadic and rare infestations of wildlife are often macroscopically inapparent (e.g., Crimean-Congo haemorrhagic fever, Rift Valley fever, brucellosis, anthrax, Salmonella and others) and the presence of such pathogens may frequently not even be suspected.

Certain basic practices, such as refraining from utilising any organ which appears abnormal, wearing disposable rubber gloves when dressing carcasses (sports hunters), trimming and washing potentially contaminated bullet-wound channels, and thorough cooking of meat and edible offal, should substantially reduce the risk of zoonotic transfer of significant pathogens.

Risques pour la santé publique de l'utilisation de produits dérivés d'animaux sauvages dans certaines régions d'Afrique

R.G. Bengis & C.M. Veary

Résumé

Les auteurs exposent les risques de santé publique liés aux produits dérivés d'animaux sauvages dans certaines régions d'Afrique. Les informations qu'ils présentent ont été, pour la plupart, fournies par la République d'Afrique du Sud et notamment par le Kruger National Park.

Il n'existe pas, en Afrique du Sud, de texte de loi régissant l'inspection générale du gibier avant la vente; les auteurs présentent, néanmoins, les critères...
actuellement appliqués lors des inspections. L'élevage du gibier en Afrique australe est généralement de type extensif puisque les herbivores pâturent dans des conditions quasiment naturelles (élevage en semi-liberté). Plusieurs affections et maladies ont été identifiées lors de l'examen des carcasses d'animaux sauvages ; les auteurs énumèrent les problèmes rencontrés ainsi que leurs conséquences pour la santé humaine.

Mots-clés

Riesgos de salud pública asociados al uso de derivados de la fauna salvaje en algunas regiones de África

R.G. Bengis & C.M. Veary

Resumen
Los autores describen los riesgos de salud pública que entrañan los productos derivados de la fauna salvaje en algunas regiones de África. Gran parte de esta información se obtuvo en la República de Sudáfrica, especialmente en el Parque Nacional Kruger.

En Sudáfrica no existen requisitos legales para la inspección general de canales de animales cinegéticos antes de su venta. Los autores exponen, sin embargo, los actuales requisitos reglamentarios de inspección. Los sistemas de cría de animales cinegéticos en África austral suelen ser sistemas extensivos, que permiten a los herbívoros salvajes vivir en estado natural, cercano al estado de libertad. Se han detectado y confirmado varios procesos patológicos o enfermedades de cierta gravedad en canales de animales salvajes. Los autores exponen las consecuencias zoonóticas de estas enfermedades.

Palabras clave

References


