Animal health risks associated with the transportation and utilisation of wildlife products

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Summary
The animal health risks associated with the movement of wildlife products are infinitely less than those associated with the movement of live animals. Very few pathogens are sufficiently robust to survive the significant changes in temperature, pH, moisture content and osmolality which occur post mortem, or which are associated with preservation processes such as pickling, smoking or drying. Certain pathogens, however, (e.g. foot and mouth disease, classical swine fever [hog cholera] and African swine fever viruses and the anthrax bacillus) are hardy and resistant to these environmental changes and therefore constitute a finite animal health risk if raw, undercooked or under-preserved products from infected wild animals are imported.

Other less robust pathogens, such as rinderpest virus, may remain infectious in animal products if these are obtained from acutely infected animals and frozen immediately. Macroparasitic diseases such as trichinellosis and echinococcosis-hydatidosis, if present in the unprocessed tissues of infected wildlife, are potentially infectious to carnivorous or omnivorous companion animals. The importation of untreated wet hides may result in the introduction of alien ectoparasites and/or the infectious diseases for which they are vectors.

The author discusses the more significant pathogens found in free-ranging wildlife which should be taken into consideration when importing wildlife products from endemic or epidemically infected countries.

Keywords

Introduction
The animal health risk associated with moving infected wild animals is generally far greater than that associated with moving wildlife products. Thus, with international movement of wildlife products there are only a few 'foreign animal diseases' for which a definite risk exists and for which prevention strategies are important, if these wildlife products are imported from a disease-endemic region of the exporting country. The pathogens involved are usually fairly hardy and are resistant to environmental extremes of temperature, pH, moisture content, ultra-violet irradiation and osmolality.

Viral diseases

Foot and mouth disease
Foot and mouth disease (FMD) can potentially infect all cloven-hoofed wild ungulates. In most countries, infected cattle are the major source of FMD outbreaks in wildlife. On the African continent, however, African buffalo (Syncerus caffer) have been shown to develop long-term persistent infection, (7, 15) making them an ideal maintenance host and reservoir for these aphoviruses. In free-ranging African ecosystems, the endemic FMD infection in buffalo herds may,
from time to time, 'spill over' into other associated cloven-hoofed species and may result in short-term epizootic cycles (3). Such epizootics, because of the difficulty in determining their spatial and temporal scale, represent the periods of greatest animal health risk for the movement of wildlife products.

The decrease in pH which occurs during the glycolytic ripening process inactivates most FMD viruses present in skeletal muscle within 48 hours (9). However, when impala (Aepyceros melampus) were experimentally infected with a Southern African Territories (SAT) type 1 virus strain (SAR 9/81), this specific virus was found to be highly myotropic in the species (virus titres \( \geq 5 \) TCID\(_{50} \) were isolated from some muscles). Significant titres of virus were still present in certain muscle samples after 72 hours, by which time the pH had decreased to (and eventually stabilised at) 5.6 (Van der Walt and Bengis, personal communication). These findings demonstrate the risks of extrapolating from one species to another. Furthermore, the survival of FMD viruses at 4°C in tissues other than skeletal muscles, in which little or no post-mortem acidification occurs, is highly significant. Henderson and Brooksbys reported virus survival in excess of 5 months in bovine liver, rumen and lymph node stored at 4°C (16). Cottral reported virus survival for 120 days in chilled lymph nodes (8).

Heat also inactivates the FMD virus, and 69°C appears to be the critical temperature, although higher temperatures may be required if the virus is protected by lipid structures, as found in tissue cells and milk (18). Freezing preserves the virus, thus rapidly frozen or chilled products from infected animals are most likely to remain infectious. Pickling in brine or boiling does not destroy the virus unless vinegar or some other organic acid is also used in the process.

The raw or partially processed organs of infected wild ungulates are therefore potentially infectious, and appropriate animal health preventive measures should be taken to avoid importation or spread of the disease.

These measures should include the following:

a) Prohibit the importation of raw or unprocessed wildlife products from any region in which FMD is endemic in the buffalo population, or in which there is an active (buffalo- or cattle-associated) FMD epidemic.

b) Avoid including wildlife-derived trimmings and off-cuts in swill fed to pigs.

c) Ensure the processing of carcasses of ungulates from zones in which FMD is endemic among wildlife by 'hot' canning (retort cooking), hot smoking for at least 36 hours or pickling of thin strips in brine containing an organic acid which reduces the pH of the solution to below 4.0, for 24 hours, followed by drying to less than 40% moisture content.

d) Transport the carcasses of wild ungulates from adjoining, non-endemic surveillance zones without hides, heads, hooves and viscera; such carcasses should be ripened for 48 hours in a chilled hanging position, before transport.

e) Process hides of potentially infected wild ungulates using salt plus an organic acid (e.g. citric or formic acid) or alkali (sodium carbonate).

f) Clean skulls of potentially infected wild ungulates of all soft tissues, and then either boil in water for 45 minutes or immerse in 5% formaldehyde for 24 hours.

**African swine fever**

The natural sylvatic hosts of African swine fever (ASF) viruses are certain argasid ticks of the genus Ornithodoros. The ticks are true maintenance hosts in which these viruses can cycle independently - requiring no additional vertebrate or invertebrate host - and both horizontal (sexual) and vertical (transovarial) transmission have been documented (21, 22). ASF can also infect wild and domestic swine, hence its veterinary importance. ASF virus has been isolated from warthogs (Phacochoerus aethiopicus), bush pigs (Potamochoerus porcus) and the giant forest hog (Hylochoerus meinertzhageni). These infections are generally subclinical, but virus might be present in normal physiological secretions and excretions, and has been shown to be transmitted under experimental conditions (E.C. Anderson, personal communication). No horizontal transmission has been demonstrated in these wild porcine species, which appear to be 'dead end' hosts in the absence of the argasid tick (tampan) vectors. In contrast, ASF in domestic pigs is usually a clinical entity with high morbidity and variable mortality. Acute disease with high mortality is usually seen in commercial breeds raised in intensive farming conditions, whereas subacute and chronic disease, which may become endemic, is more common in free-ranging rustic pigs. Horizontal transmission readily occurs amongst domestic pigs since virus is present in most physiological secretions and excretions and, in the endemic free-ranging situation, these pigs may become maintenance hosts.

The environmental stability of the ASF virus is a notable feature. The virus has been found to survive in serum at room temperature for 18 months (19), and in refrigerated blood for at least six years (11). The virus is still infectious after 15 weeks in chilled meat, and for three to six months in processed hams, salamis and smoked sausages (17). Heating at 56°C for 30 minutes does not kill the virus, which remains stable at pH 4-10. Putrefaction does not destroy the virus quickly, which is resistant to proteases.

In wild swine, viraemia develops following exposure to an infected tampan, and this may last three weeks. Thereafter the virus persists in the peripheral and visceral lymph nodes for many months (23). In turn, non-infected tampans feeding on viraemic pigs also become infected with ASF virus.

In the past, ASF was limited to those parts of the African continent corresponding to the geographic distribution of the...
argasid tick maintenance host. During the past forty years, however, ASF outbreaks have occurred for the first time outside Africa: initially in Portugal, from where the disease spread to Spain, France, Italy, Belgium, Malta, Sardinia and Madeira. From Europe, ASF also spread to the Caribbean and to Brazil. The spread of ASF outside Africa appears to have been related to the movement of contaminated, underprocessed pork products, and wildlife per se could not be directly incriminated. Nevertheless, it is important to prevent the introduction of this economically devastating porcine disease from a wildlife source, and this may be accomplished by the following precautions:

1. The movement or importation of all wild porcine meat products from ASF-endemic countries/regions/zones should ideally be prevented; alternatively, such products must be adequately processed using an approved technique to ensure biosafety.

2. All hides from wild porcines should be dipped in an approved acaricide to prevent the passive transportation of viable (potentially ASF-infected) argasid ticks.

3. Skulls and tusks must be cleaned of all soft tissues, and then boiled for 45 minutes, or immersed in 5% formaldehyde for 24 hours. Lipid solvents, detergents, oxidising agents and substituted phenols are also effective.

**Rinderpest**

Rinderpest is primarily a disease of domestic cattle which is capable of "spilling over" into non-domestic ungulates during cyclical epizootics. Previous records indicated that once the disease had been controlled in cattle, it disappeared from surrounding wildlife populations (27). More recently, however, events in East Africa have indicated that the role of wildlife may not be as straightforward. Serological surveys in the 1970s and 1980s suggest that certain strains of rinderpest may cycle in certain wildlife populations and may be maintained independently of cattle for variable periods of time (24). Moreover, isolates from the most recent outbreaks in wildlife in East Africa (1995 to 1997) have been genetically fingerprinted and have proved to be identical to the strain isolated during the last outbreak in the 1980s, despite the absence of any identifiable disease in cattle in the intervening period. A more cautious reappraisal of the role of wildlife in the epidemiology of rinderpest is thus required.

The rinderpest virus is, however, relatively fragile and at tropical ambient temperatures survives for only a few hours outside the host (26). Carcass decomposition inactivates the virus in one to three days (10). Being enveloped, the virus is readily inactivated by lipid solvents, and is sensitive to light, ultraviolet radiation, heat and extremes in pH. Infectivity is also destroyed by most disinfectants.

Importation of fresh carcasses and meat products from an infected zone/country does constitute a finite threat, and at least one epidemic has been attributed to this source (1). In frozen meat, the virus persists for much longer than in fresh meat and is therefore a risk to swill-fed pigs (25). Infectivity disappears rapidly from adequately dried infected hides (2). As a result of the environmental lability of rinderpest virus, the risk of importing the virus with meat and products of wild game animals is minimal, and then only when meat from acutely infected animals is rapidly frozen prior to transportation.

A related virus which causes peste des petits ruminants (PPR) infection has only once been reported in wildlife. An outbreak occurred in a zoo in the United Arab Emirates, and mortalities were recorded in wild sheep (Ovis orientalis laristantica), gazelles (Gazella dorcas), gemsbok (Oryx gazella) and a Nubian ibex (Capra nubiana) (14).

**Classical swine fever (hog cholera)**

Classical swine fever (hog cholera) is known to circulate in wild boar populations, and such an endemically-infected population is a potential risk to domestic pigs, either through the food chain or by direct contact. The virus is relatively robust and can survive in pork and processed pork products. Survival can be prolonged for months when meat is stored cool, or even for years when stored frozen (28).

Preventive measures include prohibiting the importation of insufficiently cooked pork and pork products from infected countries.

**Common arbovirus diseases of ungulates**

In Africa, the common arbovirus diseases of ungulates include Rift Valley fever, bluetongue and African horse sickness. These endemic diseases which are indigenous to Africa have all been shown to cycle in wild ungulate populations, which were probably the natural hosts for the viruses before the arrival of pastoral man with his domesticated livestock. Infections with these viruses in African wildlife are generally subclinical, and because of the non-contagious nature of the infections in animals, as well as the pH sensitivity of the viruses, wild animal tissues and products, even from infected animals, are unlikely sources of infection.

**Transmissible spongiform encephalopathies**

Spongiform encephalopathies have been documented in farmed and free-ranging white tailed deer (Odocoileus virginianus), mule deer (Odocoileus hemionus) and wapiti (Cervus canadensis) in North America since the late 1960s. Chronic wasting disease has been reported from the states of Colorado and Wyoming, and more recently in a Rocky Mountain elk (Cervus elaphus nelsoni) in Saskatchewan, Canada (this animal originated from South Dakota) (20). As an animal health protection measure, carcasses from victims of this disease should be prevented from entering the commercial farm-animal feed production chain.
Bacterial diseases

Anthrax

Anthrax has been documented in many species of wild animals from various taxa, including: artiodactyls, perissodactyls, proboscids, carnivores and primates (13). Anthrax also has an almost world-wide distribution and has been described in wildlife in various parts of Africa, Eastern and Western Europe, Asia, the Pacific Rim and North and South America (4, 6). Vaccination and other animal health measures have resulted in a lower incidence of anthrax in domestic livestock in many countries, but an endemic situation with interspersed cyclical epidemics still exists among free-ranging wildlife in the so-called ‘anthrax belts’.

The anthrax bacillus is notoriously resistant to environmental extremes and may survive for decades in organic materials. The vegetative bacillary form is killed by heating to temperatures of 60°C for 30 minutes (5). By contrast, the spores are highly resistant to heat treatment (without pressure), as well as to exposure to alcohols, phenols, quaternary ammonium compounds, acids and alkalis.

The terminal septicaemic nature of anthrax ensures that most organs of the victim are infected, and therefore all parts of the carcass (including hides, bones, horns and hooves) are potentially infectious. Preventing importation of wildlife products from endemic areas (especially during epidemic cycles) is therefore important. Such products should never be allowed to enter the domestic animal food chain. It must be remembered that anthrax-contaminated bone meal has been shown to still be infective after being steam-treated for 15 minutes at 115°C or treated with dry heat (140°C) for 3 hours (12).

Bovine tuberculosis and bovine brucellosis

Both of these significant bacterial diseases have been reported in free-ranging and farmed wildlife, on several continents. The heat-labile nature of the causative organisms, combined with their predilection for visceral organs and lymph nodes makes them unlikely animal health risk candidates when importing wildlife products.

Macroparasitic diseases

Echinococcosis/hydatidosis

This parasitic infection is frequently reported in natural ecosystems in which the definitive hosts are indigenous carnivores with adult tapeworms present in the small intestine. In these ecosystems, herbivorous prey animals perform the role of the intermediate hosts in which hydatid cysts develop following ingestion of vegetation contaminated with infected predator faeces. The movement of raw predator hides contaminated by faecally-borne gravid proglottids, or the movement of raw cyst-containing organs, may result in directly or indirectly linking the sylvatic and synanthropic cycles through the infection of domestic livestock or carnivorous companion animals.

Trichinellosis

Infection with Trichinella spp. has been diagnosed in the flesh of many wild carnivores and some wild swine. The raw, undercooked, dried or cold-smoked meat of these infected animals are potentially infectious to carnivorous or omnivorous companion animals.

Ectoparasitoses

Ectoparasitoses may constitute an animal health problem if untreated wet hides from wild animals are imported. This problem may be associated with importing an exotic ectoparasite per se (e.g. alien ixodid or argasid ticks, mites, lice or screw worms) or the problem could be associated with the importation of a disease vector which may or may not be infected with an alien pathogen, e.g. heartwater (cowdriosis), tularemia, babesiosis or ehrlichiosis. Untreated wet hides may also be a source of dermatomycoses or pox viruses.

Conclusion

In general, with the notable exceptions of the individual diseases listed, the animal health risks associated with the movement of wildlife products are infinitely less than those associated with the movement of live animals. It behoves the regulatory authority of the importing country to ascertain if any of these diseases are present in the country/region from which the products originate, and to take appropriate measures to prevent the importation of these disease agents. However, it should also be remembered that since disease surveillance in free-ranging wildlife populations is often difficult and frequently inadequate, the decision-maker should preferably err on the conservative side when considering the importation of products derived from known wildlife host species, when no reliable data is available.
Risques zoosanitaires liés au transport et à l’utilisation de produits dérivés d’animaux sauvages

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Résumé
Les risques zoosanitaires liés aux échanges de produits dérivés d’animaux sauvages sont infiniment moins importants que ceux liés aux déplacements d’animaux sur pied. Très peu d’agents pathogènes survivent, en effet, aux importantes variations de température, de pH, d’hygrométrie et d’osmolarité survenant après abattage ou liées aux procédés de conservation, tels que le marinage, le fumage ou le séchage. Cependant, certains agents pathogènes (par exemple les virus de la fièvre aphteuse, de la peste porcine classique et de la peste porcine africaine, ainsi que le bacille de la fièvre charbonneuse) résistent à ces modifications du milieu et constituent donc un risque zoosanitaire limité en cas d’importation de produits crus, mal cuits ou mal conservés et provenant d’animaux sauvages infectés.

Des agents pathogènes moins résistants, tels que le virus de la peste bovine, peuvent rester infectieux dans les produits d’origine animale lorsque ceux-ci proviennent d’animaux souffrant d’une infection aiguë et qu’ils ont été congelés immédiatement. Les agents de maladies macroparasitaires, telles que la trichinellose et l’échinococcose-hydatidose, présents dans les tissus non traités d’animaux sauvages atteints, présentent un risque d’infection pour les animaux de compagnie, carnivores ou omnivores. Des ectoparasites étrangers peuvent également être introduits dans un pays, avec les maladies infectieuses dont ils sont les vecteurs, à l’occasion de l’importation de peaux vertes non traitées.

L’auteur étudie le cas des principaux agents pathogènes rencontrés chez les animaux sauvages en liberté, qui doivent être pris en considération lors de l’importation de produits dérivés de la faune sauvage et provenant de zones d’endémie ou d’épidémie.

Mots-clés
Agents pathogènes — Commerce international — Faune sauvage — Produits d’origine animale — Risques — Santé animale.

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Riesgos zoosanitarios asociados al transporte y el uso de productos derivados de la fauna salvaje

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Resumen
Los riesgos zoosanitarios asociados a los intercambios de productos derivados de la fauna salvaje son infinitamente menores que los que entraña el movimiento de animales vivos. Son muy pocos los patógenos lo bastante resistentes como para sobrevivir a los notables cambios de pH, temperatura, humedad y osmolaridad que se siguen de la muerte del animal o que acompañan a procesos de conservación como el adobado, el ahumado o el secado. Ciertos patógenos, sin embargo (por ejemplo los virus de la fiebre aftosa, la peste porcina clásica o la peste porcina africana, así como el bacilo del carbunco bacteridiano), resisten a estos cambios ambientales y constituyen un riesgo zoosanitario finito en el caso de importación de productos crudos, semicrudos o en semiconserva procedentes de animales salvajes infectados.
Aunque menos resistentes, otros patógenos (como el virus de la peste bovina) pueden conservar su infecciosidad en el interior de derivados animales en el caso de que éstos procedan de individuos con infección aguda y sean congelados inmediatamente. Cuando están presentes en tejidos no procesados de animales salvajes enfermos, algunas enfermedades macroparasitarias como la triquinelosis o la equinococosis/hidatidosis resultan potencialmente infecciosas para los animales de compañía carnívoros u omnívoros. La importación de cueros no tratados, por su parte, puede acarrear la introducción de ectoparásitos extraños y/o la aparición de las enfermedades infecciosas de las que son vectores.

El autor examina una serie de importantes patógenos que afectan a la fauna salvaje en libertad y cuya eventual presencia convendría tener en cuenta a la hora de importar productos derivados de animales salvajes desde países infectados, ya sea de forma endémica o epidémica.

**Palabras clave**
Comercio internacional — Fauna salvaje — Patógenos — Productos de origen animal — Riesgo — Sanidad animal.

**References**


