Public health risks of ostrich and crocodile meat

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Summary
This paper discusses the infectious agents and chemical substances potentially capable of contaminating the meat of ostriches and crocodiles and which thus pose a danger to human handlers and consumers.
For ostrich meat, there is no danger from Crimean-Congo haemorrhagic fever or spongiform encephalopathy. Contamination of ostrich meat with salmonellae, chlamydia, pasteurellae, mycobacteria and erysipelas might be possible, but has never been reported. No parasites are known which could be transmitted through ostrich meat to human consumers. Residues from growth hormones, antibiotics and acaricides are potential public health hazards.
For crocodile meat, there is a distinct possibility of contamination with salmonellae, depending on housing, feed, slaughter technique and hygiene practices under which the animal is reared. Chlamydial infections are common on some crocodile farms in southern Africa. Mycobacteriosis is extremely rare. Tapeworm cysts have been found in crocodile meat in two cases only. Trichinellosis has been reported on several crocodile farms in Zimbabwe. A generalised coccidiosis with invasion of organs and tissues has been seen in several species of crocodiles, but should present no danger to consumers.

Keywords
Alligators – Caimans – Chlamydia – Coccidia – Crimean-Congo haemorrhagic fever – Crocodiles – Mycobacteria – Ostriches – Pasteurellosis – Public health – Salmonellae – Spongiform encephalopathy – Tapeworm cysts – Trichinella.

Introduction

Throughout the world, there has recently been a shift in emphasis from the production of leather to the production of meat as the primary product of ostriches. Low in fat and cholesterol as well as tender and tasty, ostrich meat is seen by many as a desirable red meat alternative to beef and not just another 'exotic' speciality. The heart, liver (without equal) and gizzard (similar to ox tongue) of ostriches are also regarded as delicacies, although these organs are not yet traded to any extent internationally. The recent outbreak of Crimean-Congo haemorrhagic fever amongst personnel at the ostrich abattoir in Oudtshoorn, South Africa, has highlighted the issue of public health hazards inherent in this meat.

Under the protection of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), crocodile ranching and farming has increased, and farm-produced crocodile skins are replacing those taken from the wild. However, under pressure from lower skin prices, crocodile meat (somewhat similar to white veal) is increasingly seen as an additional source of income and consequently is also marketed world-wide. In some countries, e.g. the Congo, the Democratic Republic of the Congo and Colombia, meat from legally captured wild crocodilians is also marketed and consumed locally. In the Congo at least, crocodile viscera are consumed as well. In this paper, the term 'crocodile' is used loosely, embracing all crocodilian species, including alligators and caimans.

Substances used for prophylaxis and therapy in ostriches and crocodiles could lead to residue problems, as could those used for growth promotion.

This paper examines the hazards to handlers and consumers emanating from these meats due to infections with viral, bacterial and parasitic agents, as well as the risks due to chemical residues.

Ostrich meat

Ostriches have no infectious or contagious species-specific diseases, but are susceptible to a number of infectious agents acquired from and common to other avian species. Some of these agents may pose a threat to public health as well.

Viral agents

Crimean-Congo haemorrhagic fever

Crimean-Congo haemorrhagic fever is not a disease of ostriches, but of humans. The virus occurs over the same area as the principal vectors (ticks of the genus *Hyalomma*) from south-eastern Europe to South Africa. When multiplying in sheep and cattle, the virus causes a mild and transient febrile reaction. Human infections result either directly from a tick bite or from contact with infected blood: 30% of these infections are fatal (28). A labourer on a South African ostrich farm contracted the infection when handling tick-infested slaughtered ostriches and ostrich tissues, and subsequent serological testing of ostriches in the area revealed birds which gave positive results (27).

At the beginning of November 1996, 17 workers at the ostrich abattoir in Oudtshoorn contracted the infection, presumably from a single ostrich in the viraemic stage. As a consequence of this outbreak in humans, the European Union banned all imports of ostrich meat from South Africa until further notice. Subsequent research showed that the viraemia following infection remains clinically inapparent and persists only a few days (D.J. Verwoerd, personal communication). As a result, the ban was lifted on condition that all ratites were kept under tick-free conditions for at least 14 days prior to slaughter.

Although large numbers of cattle and sheep are slaughtered and consumed throughout the entire endemic area, no single human case of this disease has ever been traced to the consumption of meat from these animals. In southern Africa, raw dried meat (biltong) from cattle, ostriches and wild game is consumed customarily.

Spongiform encephalopathy

Although histopathological lesions of spongiform encephalopathy have been reported in ostriches from a zoo in Germany (25, 26), these cases have never been confirmed by other means. The claim that the ostriches had been fed with meat from emergency slaughter (25) is unlikely, as ostriches are very strict vegetarians, which further reduces the credibility of these reports.

Bacterial agents

Salmonellae

Intensively reared ostrich chicks which have failed to establish a normal intestinal flora are susceptible to infections with salmonellae and other enterobacteria. Older birds appear to be relatively resistant to these infections, although salmonellae have been isolated from faecal swabs of ostriches in quarantine. This may be due to stress. Although no salmonellae have been reported from the meat of slaughtered ostriches, faecal contamination of carcasses during slaughter remains a possibility.

Pasteurellosis

Pasteurella multocida is one of several agents which may be involved in air sac infections in ostriches. Haemorrhagic septicaemia has been reported in zoo ostriches (17). Chronic lesions of air sac infections are frequently encountered at slaughter. As birds do not have lymph nodes which could prevent the spread of pathogens from such lesions, removal of the lesions is not sufficient to guarantee that the pathogens have not spread further.

Chlamydia

Chlamydia have been isolated from ostrich chicks in Namibia (13) and in North America (12), as well as from young ostriches in a safari park in France, which resulted in infection in human contacts (23). Chlamydia were also isolated from a cloacal swab taken from a seropositive adult female ostrich (8). Cases of chlamydial infection have also been reported in rheas, another farmed ratite species (1, 8). These cases are so rare that each of the above authors believed his own case to be the first ever reported. However, contact with infected meat and organs of such birds could result in human infections. Serological monitoring of ostriches intended for slaughter might be useful for assessing the situation in different countries.

Mycobacteria

Mycobacterium avium infections are very rare in ostriches and generally appear to be limited to birds kept in zoological collections where there is contact with other avian species. The typical nodular lesions in the liver, spleen and other organs can be detected easily on inspection in the abattoir. No cases of human infection have been reported in connection with slaughtered ostriches.

Erysipelas

Deaths from infections with *Erysipelothrix rhusiopathiae* have been reported from ostriches and rheas in zoos (24, 29) as well as from emus kept in semi-intensive conditions (7, 19). The likelihood of infected birds coming to slaughter is extremely slim, but cannot be excluded.

Parasitic agents

No parasitic agents transmissible to humans have been found in ostriches.

Residues

No anticoccidials are used in the rearing of ostriches. Most of the infectious diseases occur in young birds, and treatment is discontinued long before the birds reach slaughter age.

Zeranol implants are registered for use as a growth stimulant in ostriches in South Africa. Deltamethrin and ivermectin are used against ectoparasites.

Crocodiles

Crocodiles do have crocodile-specific diseases, and these vary from species to species. Crocodiles also can carry and transmit certain non-specific pathogens.

Viral agents

No viral agents are known to be transmissible from crocodiles to human consumers.

Bacterial agents

Salmonellae

Numerous salmonellae have been isolated from crocodiles (3). Most of these are believed to be harmless gut inhabitants. Eight out of fifty healthy farmed Nile crocodiles (*Crocodylus niloticus*) in Zimbabwe harboured salmonellae in their intestines (21). Under stressful conditions, however, the salmonellae can invade the visceral organs and, from there, other tissues. In young crocodiles, this may cause mortality (11, 22). Similarly, and particularly under handling stress, the pathogens can invade the meat of crocodiles before slaughter and faecal contamination can occur post slaughter. In Zimbabwe and Australia, salmonellae were isolated from 16% of meat samples from slaughtered crocodiles (2, 16). The fact that no salmonellae were isolated from alligator meat samples in one reported trial in the United States of America (20) is probably due to the very small sample size (four alligators only).

Most salmonella infections are acquired from feed, thus a significant reduction in the infection rate is expected from feeding compounded pellets, as is currently the case on many crocodile farms. Another mitigating influence can be attributed to keeping the crocodiles in closed, temperature-controlled conditions, out of reach of salmonella-carriers such as flies, lizards and small rodents. The strict avoidance of pre-slaughter handling stress, e.g. by shooting the crocodiles in the pen, is another extremely important factor which reduces the rate of salmonella contamination of the meat. This is also the only humane slaughter method for crocodiles presently practised. Kanamycin, oxytetracycline, enrofloxacin and sulfonamides are used in the treatment of outbreaks of salmonellosis in crocodiles.

Chlamydia

Chlamydia frequently cause outbreaks of hepatitis and conjunctivitis in Nile crocodiles (3, 10). This is believed to be a crocodile-specific strain of *Chlamydia psittaci*. The pathogenic potential of this strain with regard to humans is not yet known. No infections of people in contact with Nile

crocodiles have been reported. However, infected animals can remain carriers for life. Tetracyclines are used for the treatment of chlamydiosis in crocodiles.

Mycobacteria

Generalised infections with *M. avium* have been found in Nile crocodiles which had been fed carcasses from infected pigs. The incidence was extremely low (F.W. Huchzermeyer, unpublished findings).

Parasitic agents

Tapeworm cysts have been found in the meat of two freshwater crocodiles (*C. johnstoni*) in Australia and were provisionally identified as plerocercoids of *Spirometra erinacei* (18). The cysts have also been discovered in the meat of dwarf crocodiles (*Osteolaemus tetraspis*) at markets in the Democratic Republic of the Congo (F.W. Huchzermeyer, unpublished finding). In the latter case, the parasites have not been identified. Intensively reared crocodiles fed on farm mortalities or on compounded rations should be free from cestode cysts, particularly if kept indoors and out of contact with wild birds or rodents. Freezing and/or thorough cooking of the crocodile meat should kill the parasites.

Trichinella spiralis nelsoni was found in the meat of slaughtered Nile crocodiles from eight crocodile farms in Zimbabwe (4). On most crocodile farms in Zimbabwe, the young crocodiles are raised in the open, where small rodents might well be attracted to left-over meat in the pens and may in turn become prey for the crocodiles.

Coccidia

Eimeria spp. (as yet unnamed) of several crocodilian species show a tendency to invade organs and tissues and thereby to cause generalised infections, sometimes with severe inflammatory reactions (5, 6, 9, 14, 15). The sporulated oocysts, or the sporocysts alone, remain alive, probably waiting to be transmitted to another host by cannibalism. However, these coccidia are unlikely to be able to infect human consumers of the meat. Sulphachloropyridazine is used for the treatment and prevention of coccidiosis in crocodiles.

Residues

No growth hormones are used in crocodiles. On some farms, zinc bacitracin is used as a growth promoter. The most commonly used antibiotic is oxytetracycline. No work on residue levels and withdrawal periods has been reported for these substances in crocodiles.

Conclusion

While there is very little danger to humans arising from the trade in and the consumption of ostrich meat, there is a

potential danger with regard to crocodile meat. More research needs to be conducted into:

– the invasion of crocodile meat by salmonellae under pre-slaughter handling stress

– certain aspects of gut colonisation

– many other aspects of crocodile diseases.

Sadly, however, dedicated funding for research on crocodile diseases is lacking world-wide, and present knowledge is derived from diagnostic work alone.

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Risques pour la santé publique liés à la viande d'autruche et de crocodile

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Résumé

L'auteur étudie les agents infectieux et substances chimiques pouvant contaminer la viande d'autruche et de crocodile et qui présentent un danger pour les personnes qui manipulent ces produits ou pour le consommateur.

La viande d'autruche ne présente aucun danger pour ce qui concerne la fièvre hémorragique de Crimée-Congo ou l'encéphalopathie spongiforme. Elle peut, en revanche, être contaminée par *Salmonella, Chlamydia, Pasteurella,* des mycobactéries et *Erysipelothrix,* mais aucun cas n'a été signalé. On ne connaît aucun parasite pouvant être transmis par la viande d'autruche au consommateur. Des résidus d'hormones de croissance, antibiotiques et acaricides constituent des risques potentiels.

S'agissant de la chair de crocodile, il existe différentes possibilités de contamination par *Salmonella,* qui dépendent des installations d'élevage, du type d'alimentation, des techniques d'abattage et des conditions d'hygiène dans lesquelles l'animal est élevé. Les infections à *Chlamydia* sont fréquentes dans certains élevages de crocodiles d'Afrique australe.

Les contaminations par des mycobactéries sont extrêmement rares. Des kystes de ténia n'ont été découverts dans de la chair de crocodile qu'à deux occasions. Des cas de trichinellose ont été signalés dans plusieurs élevages du Zimbabwe. Une coccidiose généralisée avec invasion des organes et tissus a été observée chez plusieurs espèces de crocodiles, mais elle ne devrait présenter aucun danger pour le consommateur.

Mots-clés

Alligator – Autruche – Caïman – Chlamydia – Coccidie – Crocodile – Encéphalopathie spongiforme – Fièvre hémorragique de Crimée-Congo – Kystes de ténia – Mycobactérie – Pasteurellose – Salmonella – Santé publique – Trichinella.

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Riesgos de salud pública ligados a la carne de avestruz y de cocodrilo

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Resumen

El autor examina los agentes infecciosos y las sustancias químicas eventualmente capaces de contaminar la carne de avestruz y de cocodrilo y que resultan, por este motivo, peligrosos para las personas que manipulen o consuman dicha carne.

La carne de avestruz no conlleva peligro de fiebre hemorrágica de Crimea-Congo ni de encefalopatía espongiforme. Sería posible, aunque nunca se ha descrito, su contaminación por *Salmonella, Chlamydia, Pasteurella,* micobacterias o erisipelas. No se conoce ningún parásito que pueda transmitirse al ser humano por ingestión de carne de avestruz. Los residuos de hormonas de crecimiento, antibióticos o acaricidas, en cambio, constituyen peligros potenciales.

En cuanto a la carne de cocodrilo, existe una clara posibilidad de contaminación por *Salmonella,* eventualidad que depende de la técnica de sacrificio y de las condiciones de hospedaje, alimentación e higiene en que se haya criado el animal. En algunas granjas de cocodrilos del África austral son corrientes las infecciones por *Chlamydia.*

Las micobacteriosis son extremadamente raras. Sólo en dos ocasiones se han hallado quistes de tenia en carne de cocodrilo. Se han descrito casos de triquinelosis en varias granjas de cocodrilos de Zimbabue. Por último, también se ha observado en varias especies de cocodrilos una coccidiosis generalizada con invasión de órganos y tejidos, aunque ello no debería suponer peligro alguno para el consumidor.

Palabras clave

Aligator – Avestruz – Caimán – Chlamydia – Coccidia – Cocodrilo – Encefalopatía espongiforme – Fiebre hemorrágica de Crimea-Congo – Micobacterias – Pasteurelosis – Quistes de tenia – Salmonella – Salud pública – Trichinella.

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