Public health risks of the flesh of farmed crocodiles

J.M. Millan, J.L. Purdie & L.F. Melville
Department of Primary Industry and Fisheries, GPO Box 990, Darwin, Northern Territory 0801, Australia

Summary
The farming of crocodiles in the Northern Territory of Australia is a rapidly growing industry. The saltwater crocodile produces a premium quality skin which is sought world-wide for the lucrative leather trade and manufacture of finished articles. Flesh is considered to be a by-product of skin production. Several procedures are used in abattoirs to prevent the risk of cross contamination of flesh. The public health risks linked to the production of crocodile flesh are described for the two main diseases of concern, namely: sparganosis and salmonellosis. The slaughter and hygienic processing procedures and local laboratory evidence indicate that the consumption of crocodile flesh produced in the Northern Territory carries a negligible public health risk.

Keywords

Introduction
The farming of crocodiles presents a number of unique challenges. This is due to the skill and care required in handling the animals, the fact that many species of crocodilians are endangered, and the secondary role of the production of flesh for human consumption compared to the high value placed on crocodile skin.

In many countries, intense hunting pressure has seriously depleted wild populations of crocodilians. In 1971, the Northern Territory (NT) of Australia provided legal protection for the saltwater crocodile (Crocodylus porosus) to counter the threat of extinction resulting from hunting for the skins. The wild crocodile population subsequently recovered in numbers, but the loss of natural habitat to expanding human development on the wetlands was becoming a serious concern. Conservationists understood that if the wetlands represented an economic value then preservation of the area would be soundly supported; thus the development of the crocodile farming industry was encouraged.

Trade in crocodile products is permitted under strict international supervision in accordance with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) regulations. Since trade in saltwater crocodiles was given legal status in 1985, the wild population of crocodiles in the NT has increased by 50% and continues to increase by about 5% annually. The NT crocodile farming industry emerged from the sustainable use of crocodiles, including the harvest of eggs from the wild population.

The Northern Territory crocodile farming industry
Crocodile farms and ranches have been in operation in the NT since the early 1980s. Improvements in husbandry techniques have seen the industry develop into a commercially viable enterprise in recent years. These farms operate under a management programme which ensures the conservation of the wild crocodile population through regulated sustainable harvesting of eggs (ranching) from the wild. The management plan and the export of crocodile products comply with CITES regulations.

The industry used to farm both freshwater (Crocodylus johnstoni) and saltwater crocodiles, but is now solely based on the saltwater crocodile. This is due to the premium quality of the C. porosus skins, which have small belly scales and no osteoderms (bony plates under the skin), characteristics which are highly sought after by international markets.
There are eight crocodile farms of varying size in the NT, raising a total of 40,000 saltwater crocodiles. Two of these farms have associated tourist enterprises: the remaining six farms are based entirely on the commercial production of crocodile skin and flesh. Currently, there are two crocodile farms are based entirely on the commercial production of flesh were produced, mostly for the domestic market. In 1996, 6,400 skins were exported and 35,400 kg of flesh produced.

Animals are usually slaughtered at two to three years of age, depending on size. The processing age is determined by the size of the animals in relation to the width of the bellyskin. The bellyskin is the most valuable product from the animal and is currently valued at approximately US$8.50 per cm width, with skins averaging 37-38 cm. Other by-products for further manufacture in the tourist industry such as teeth, feet and backstraps (the less valuable skin along the back) are sold domestically.

Production of crocodile flesh

Crocodile flesh is a by-product of skin production. Due to the high value of the skin and the fact that skin does not 'peel' off easily, the crocodiles must be skinned on a flat surface, which is very labour-intensive and provides opportunity for contamination of the flesh. Therefore, cross-contamination of the flesh is of greater concern in the processing of crocodiles than in meat production from conventional species.

Fasted crocodiles are slaughtered with a 0.22 calibre round positioned just behind the bony plate of the head and directed forwards. The animals are then bled by severing the back of the neck behind the cranial platform and the carcass is then hung from the tail. The entire outer surfaces are then washed in chlorine solution spray (at least 30 ppm) prior to the carcasses being placed in a chiller overnight or for at least several hours. This chlorine wash has been shown to be very effective: no Salmonella has been detected from swabs taken from the skin surfaces of carcasses hung in chillers at NT abattoirs prior to skinning. The carcasses must be hung for a considerable time to reduce the muscle contractions, which would severely hamper the skinning process.

The animals are then skinned in the abattoir and the flesh is prepared for packaging. The carcasses are rarely eviscerated (due to the cuts of flesh required by markets); thus, contamination due to accidental leakage of ingesta is prevented. Prior to packaging, the flesh is dipped in acetic acid (0.25% at 40°C for 10 minutes) or chlorine (60 ppm at 5°C-6°C for 20-30 minutes) to destroy any possible contamination which may have occurred.

There are several measures in place to minimise the risk of cross-contamination of the flesh. These are as follows:

(a) crocodiles are fasted for three days prior to slaughter to prevent contamination by leakage of gastrointestinal contents

(b) two decontamination steps are taken:
   - carcasses are washed in chlorine after slaughter and prior to being hung in the chiller
   - the flesh is dipped in either chlorine or acetic acid prior to packaging

(c) processing tables and equipment are sanitised between carcasses

(d) extra care is taken during skinning to prevent the outer surface of the skin from coming into contact with the flesh

(e) carcasses are not eviscerated.

All sterilisation and decontamination procedures use chemicals approved by the Australian Quarantine Inspection Service at the specified dilutions, temperatures and contact time (1).

Public health aspects

Monitoring of crocodiles and crocodile flesh in the NT has shown that the two main areas of concern to public health are sparganosis and salmonellosis.

Sparganosis

Sparganosis results from crocodiles becoming infected with the tapeworm *Spirometra erinacei* which produces an infective stage (spargana) in the muscle. People who consume infected flesh may develop sparganosis resulting in inflammation of the skin, swellings or muscle pain.

Sparganosis was diagnosed in freshwater crocodiles slaughtered in the NT in 1988. These animals had been housed in earthen pens. No further cases have been recorded. The current risk of infection is considered negligible as all crocodiles raised on commercial farms are now housed in concrete pens; thus, exposure to the intermediate host (freshwater crustaceans) is prevented.

Furthermore, spargana are readily destroyed by freezing the flesh at −10°C for a minimum of 24 hours (1). All crocodile flesh produced in the NT is frozen immediately after...
processing. Therefore the possibility of contracting sparganosis from eating NT crocodile flesh is considered extremely unlikely.

Salmonellosis

Salmonellosis is a bacterial disease contracted from eating food contaminated with faecal material. Many types of *Salmonella* have been identified in reptiles and some may produce more severe disease than others.

Results of swabs collected regularly from the flesh of farmed crocodiles at slaughter over recent years from both NT crocodile abattoirs suggest that the public health risk of consuming crocodile flesh is minimal. Although a number of *Salmonella* serovars have been detected in crocodile flesh, none of these have been reported as causing disease in humans (3). The serovars isolated from NT crocodile flesh since 1990 are: S. Anatum, S. Arizonae, S. Bahreifeld, S. Bovis-morbificans, S. Chester, S. Johannesburg, S. Onderstepoorte, S. Poona, S. Singapore, S. Typhimurium, S. Urbana, S. Virchow, S. subsp. 1 and S. subsp. 3b ser 50:k:z. (L.F. Melville, personal communication).

5. Arizonae has been the most frequently isolated salmonella serovar in NT crocodile flesh since 1994. This is in contrast to a 1989 investigation (4), which found a higher prevalence of salmonellas in crocodile flesh and included serovars potentially pathogenic to humans, such as S. Enteritidis and S. Saintpaul. It is likely that increased production and demand for quality produce has led to the development of better abattoir techniques and high standards of hygiene.

The recent (February 1997) detection of S. Typhimurium from crocodile flesh at an NT crocodile abattoir indicates the value of continual monitoring and the importance of ensuring that strict hygiene and disinfection procedures are maintained. Detection of serovars potentially pathogenic to humans results in an increased level of microbiological testing to determine the source and prevent further contamination.

The steps described above (fasting animals prior to slaughter, disinfection of skin, non-evisceration of carcasses, cleaning of surfaces and equipment between carcasses, dipping of flesh) minimise the possibility of contamination of crocodile flesh.

Australian standards

All Australian crocodile abattoirs are required to comply with the Australian code of practice for veterinary public health: the hygienic production of crocodile meat for human consumption, which was developed in 1993 (1). This is based on hazard analysis and critical control point (HACCP) principles and is currently being rewritten (2) as one of a series of mandatory Australian standards which will ultimately cover all types of meat production and processing. Microbiological testing to verify the effectiveness of HACCP programmes is an ongoing requirement.

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observées lors de la transformation et la surveillance effectuée par les laboratoires locaux indiquent que le risque pour la santé publique lié à la consommation de chair de crocodiles élevés dans le Territoire du Nord est négligeable.

Mots-clés
Aquatique - Australie - Crocodiles - Salmonelle - Santé publique - Spargano - Techniques d'abattage.

Riesgos de salud pública que plantea la carne de cocodrilos de cría

J.M. Millan, J.L. Purdie & L.F. Melville

Resumen
La cría de cocodrilos es un sector floreciente en el Territorio Norte de Australia. La especie de cocodrilos que vive en agua salada produce una piel de primera calidad, muy buscada en el mundo entero para el lucrativo comercio del cuero y la fabricación de artículos de marroquinería. Considerada un subproducto del proceso de fabricación de la piel, la carne es sometida en los mataderos a tratamientos diversos para eliminar cualquier posibilidad de contaminación cruzada. Los autores describen los riesgos de salud pública ligados a la producción de carne de cocodrilo en relación con las dos principales enfermedades que suscitan inquietud, a saber: la esparganosis y la salmonelosis. El elevado nivel de higiene propio de los sistemas de sacrificio y procesado, junto con los resultados obtenidos por los laboratorios locales, permite calificar de insignificante el riesgo de salud pública que entraña el consumo de carne de cocodrilo originaria del Territorio Norte.

Palabras clave
Acuicultura - Australia - Cocodrilos - Esparganosis - Salmonelosis - Salud pública - Técnicas de sacrificio.

References


