32. Game Meats II

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Learning objectives

On completion of this topic you should have an understanding of:

- The commercial potential for species other than kangaroo and deer to contribute to the supply of animal protein for human food
- Methods of farming and harvesting that are unique to each species.
- Quality control and potential risks to human health associated with different species
- The sources of information available on game meat production and factors influencing its quality.

Key terms and concepts:

- 1 Carcase composition and leanness
- 2 Utilisation of exotic meat species
- 3 Maintaining food hygiene standards
- 4 Exploiting these resources to meet world demand for dietary protein.
- 5 Animal health and the disease risk to humans

32.1 Introduction

Alternative meat producing species

Alternative meat producing species can often provide the required dietary nutrients for humans with the added benefit of offering some meat quality characteristics that are unique to that species: taste, flavour, colour, texture and favourable nutritional factors can all be important to the consumer. A selection of non-conventional and bush meat species, all of which have something different to offer, are detailed in this lecture. There are many more species utilised for their meat that will not be covered in these notes, such as:

- In Australia: Brushtail possum, rabbits & hares, and wild horses & donkeys
- Outside Australia: Grouse, partridges, pheasants, snipes, woodcock and wild ducks

Just as the quality attributes of the meat these alternative species offer is important, so too is the health and disease risk and status of these species. Potential disease risks should always be taken into account when developing new and exotic meats for human consumption; this will become apparent in the following lecture material.

32.2 Emu, ostrich and rhea

Emus, ostriches and the rhea are flightless birds belonging to the family ratites. Traditionally, emus and ostriches were farmed in Australia and Africa for the production of feathers, high quality leather and fat (Berge *et al.,* 1997). However, emu and ostrich production has increased in many regions of the world and now includes the production and processing of meat from these birds, which is no longer just a by-product. It is now marketed in small but increasing quantities. The popularity of these species for farming, however, has fluctuated greatly along with the value and supply of products. In Australia in 1996, 1,300 farms contained 104,000 emus; however this number had fallen to 150 farms holding 46,000 birds by 2001. A similar picture existed for ostriches with only
75 producers remaining in 2005 holding 80-100,000 birds. This is a sharp fall from the boom period prior to 1990 when there was an under-supply of products. Around 2,000 birds were slaughtered in 2001 yielding 20 tonnes of meat, 90% of which was consumed locally.

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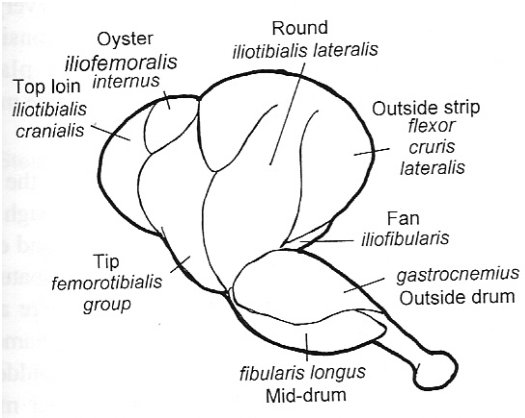
Emu:
The emu (*Dromaius novaehollandiae*) originates from the Australian desert and is now ranched in several countries. For a typical emu farmed for market, it will weigh just less than 40 kg at 15-18 months, and yield around 12 kg of boneless red meat, ~8 kg of fat and ~0.6 m^2 of hide. It produces a dark meat that is lean and has a mean muscle pH_u value of 5.5 (Berge *et al.,* 1997). The colour stability of fresh emu meat is generally very poor: Berge *et al*. (1997) noted that the intense red colour was very sensitive to oxidation, just as the intramuscular lipids were, thus limiting the storage of fresh meat under aerobic conditions to short periods of time only (under 3 days).

The distribution of muscles and primal cuts is similar to that of the ostrich. Lateral limb muscles and their North American names are shown below in Figure 32.1.

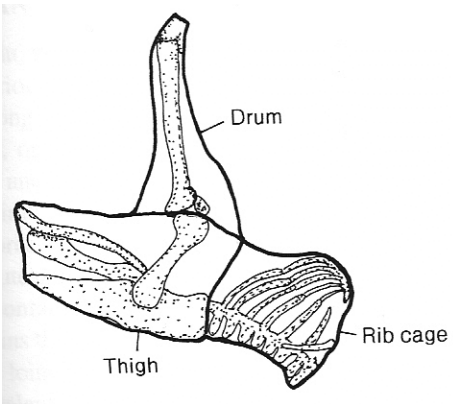
Figure 32.1. Leg muscles of the emu. Source: Swatland, (2004).



Why choose emu?
Emu meat ranks highly as a healthy alternative, as it has low cholesterol levels and a favourable fatty acid profile. Sales and Horbanczuk (1998), as quoted in Pegg *et al*. (2006), reported emu meat to contain higher levels of linoleic (C18:2 ω6), arachidonic (C20:4 ω6), □-linolenic (C18:3 ω3) and docosahexaenoic (C22:6 ω3) acids when compared to chicken drumstick and beef steak. The ratio of polyunsaturated: saturated fatty acids is more desirable in emu meat (0.72) than chicken (0.57) and beef (0.3) (Wang *et al*., 2000).

Ostrich:
The ostrich (*Struthio camelus*) is gaining in popularity as a source of red meat. This trend has started in South Africa and is now moving to Israel and Australia as well as North America and Europe. The main advantage that ostrich has to offer is that it seems to be a tender meat that has a low level of intramuscular fat (0.5%). However, its intrinsic higher ultimate pH of >5.9 (range 5.9-6.3; Heinze *et al.,* 1986; Morris *et al*., 1995; Sales, 1996) downgrades its quality not only in terms of shelf life, but also limits its use for further processing. Suspension of the carcase from the leg produces a shape shown in Figure 32.2. below. Typical primal cuts are the thigh, rib cage and drum (drumstick or leg).

Figure 32.2. Primal cuts of the ostrich carcase. Source: Swatland, (2004).



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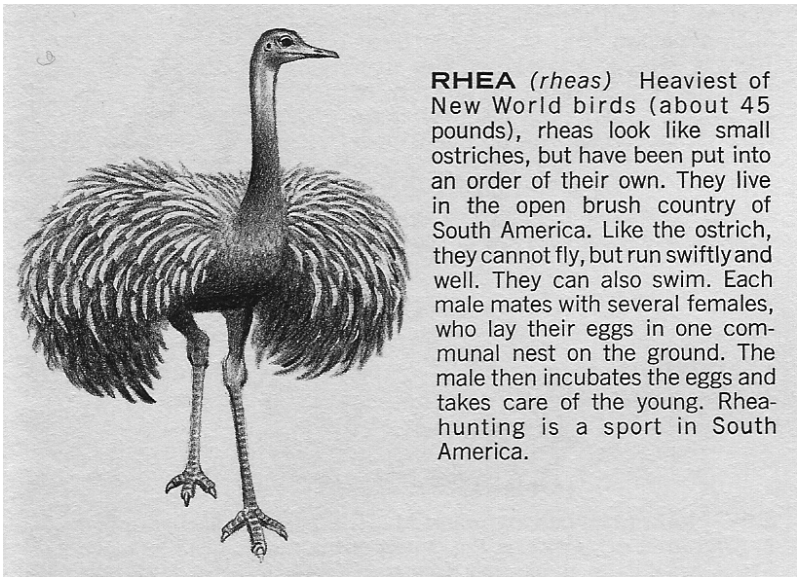
Although the meat is retailed similarly to emu by its major muscle groups, the terminology used for ostrich muscles is not universal. Currently, ostrich associations in various countries are attempting to standardize terminology by numbering muscles (Swatland, 2004). In South Africa, most muscles are simply named as steaks, as opposed to Australia where the long muscles tend to be called fillets while the 'chunky' muscles are rumps.

Why choose ostrich?
Lombardi-Boccia *et al*. (2005) have shown that ostrich meat contains the highest total iron content when compared to a range of game and domestic commercial meats species. The iron measured in ostrich sirloin was 2.57 mg/100 g compared with 2.37 mg/100 g in beef fillet, 1.98 mg/100 g in lamb chop, 2.27 mg/100 g in horse fillet, 0.70 mg/100 g in pork chump chop and chicken thigh, and 0.99mg /100 g in turkey thigh. It is also very high in vitamin B1 (thiamine), having higher levels than beef, lamb, chicken, turkey and rabbit, and levels similar to horse but not as high as that found in pork.

Figure 32.3. Rhea. Source: George, (1964).



Includes two types: the greater rhea (*Rhea Americana*) and the lesser rhea (*Pterocnemia pennata*), both originating from South America and are the smallest of the ranched ratites. They reach live weights of about 35 and 20kg, respectively, and yield lean meat similar to that of ostriches, about 64% of the carcase. However, unlike the ostrich, rheas have a higher proportion of wings, feet and head. The greater rhea is ranched commercially in the USA for its meat, hide, oil and feathers (Sales *et al.,* 1997).

32.3 Crocodiles

Alligators, caimans and crocodiles are all in the Order Crocodylia. The hunting of them for their skins has pushed several species near to extinction, where illegal hunting remains a problem. However, meat from alligators, caimans and crocodiles is now produced as a by-product of ranching crocodilians for their skins and is commercially available as a gourmet item in the USA, Australia and elsewhere.

The crocodile industry is another small but growing industry. By law crocodiles can only be harvested from commercial farming operations in Australia and in 2002 there were 11 such enterprises holding 68,000 crocodiles. The saltwater variety produce higher quality skins, and thus would probably provide the greater proportion of meat for the industry due to their higher demand. In Australia over 15,000 were harvested in 2001 producing 90 tonnes of meat, most of which was exported.

The major constraint to world trade in crocodile meat is contamination with the parasitic worm Trichinella. Non-encapsulating forms of this parasite have been identified in up to 35% of crocodiles in Zimbabwe, while the practice of feeding infected pig carcases to crocodiles in Papua New Guinea has resulted in high infection rates in that country (Pozio, 2005). Clearly, there is a lesson to be learned here in developing feed resources for our burgeoning industry, although at present Australia remains free of this parasite.

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Figure 32.4. Crocodile Meat products.
Source: Kangaroo Industry Association of Australia (KIAA).

a) Live Animals. Source: http://www.rirdc.gov.au/champions/LagoonCrodolieFarm.html

b) Meat Product. With permission from Debra McKenzie OKRA Photography and Styling.

c) Further Products Source: Source: http://www.jerky.com.au/crocodilejerky.htm

Since we know so little about factors influencing meat quality in this species, the focus has been on food safety. Meat cuts are dipped in an antimicrobial solution prior to packing and freezing. Crocodile meat has a firm texture, is light in colour, and has a delicate fishy taste.

In captivity, crocodiles may be given diets of red meat or fish or chicken. Off odours that sometimes occur, which are associated with a grassy or fishy taste, are believed to originate from hexanal and heptenal (Swatland, 2004). Research has been carried out in the food industry using hexanal as a biomarker for lipid peroxidation, a process that produces a large number of compounds giving rise to off-flavours and off-odours in foods, (www.bioscienceworld.ca/HighThroughputMethodforMeat SpoilageAnalysisSPMEwithCombiPALAutomation). Volatile heptanal is known for its characteristic sweet odour that is given off during oxidative processes.

Crocodile can be purchased as body fillets, tail fillets, whole tails or as a whole body. Further processed products are available such as crocodile jerky as pictured above (Figure 32.4):

32.4 Buffalo

African buffalo (*Syncerus caffer*) come in several sizes, ranging from the dwarf forest buffalo of West and Central Africa to the heavy Cape buffalo of South Africa. For bulls and cows, carcase weights of 380 and 326 kg have been recorded, respectively, with dressing percentages of up to about 50%.

In 2003, the number of buffalo in Australia totalled 51,000, with over 16,000 located on farms and the remainder in the wild. These have emanated from the water buffalo from Indonesia. Some 2,500 were exported live and 1,200 were slaughtered for meat. Only 305 of these were classified under the Northern Territories Buffalo Council classification system as “Tenderbuff”. In 2003-4 this industry was worth $1.8 million.

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32.5 Camels

Camels are important meat producing animals. They are also unique species as they are capable of adapting to the most rigorous of environmental conditions. *Camelus dromedarius* is the Arabian camel or known simply as dromedary; has one hump, slender limbs and runs swiftly. *Camelus bactrianus* is referred to as the Bactrian camel and it comes from the cold deserts of Asia; it has two humps and thick limbs. The predominant species in Australia is the dromedary. Of the world population of 20 million, 0.5 million are found in Australia. Initially imported into Australia in 1840 as a means of transport in Australia's vast outback, the number imported to 1907 was around 12,000. Our native population has grown from there. Their ability to survive and grow on poor quality rangelands foliage under conditions of extreme heat and water deprivation has been most important for their reproductive capabilities in central and Northern Australia.

Camel meat is similar to beef and has a similar nutritive value (Swatland, 2004). In terms of best cooking practices, prime meat from younger animals can be cooked quickly with dry heat (dry cooking), while wet cooking is more suitable for meat from the extremities of younger animals and all the meat from the older animals. Animals are typically harvested between 3 and 10 years of age at liveweights 400-600kg: abattoirs cannot handle larger animals. Care must be taken to avoid harvesting rutting (sexually active) bulls since these animals do not eat when in season and therefore meat can be of inferior quality.

The management of wild herds requires some skill to ensure they remain as a large group. As with cattle, animals are herded into portable or fixed yards and those meeting specification for slaughter are drafted from the main herd, and then transported to the abattoirs in road trains. Animals are selected on frame or hump score with an emphasis on heavier framed animals. A system for scoring animals used in the industry is based on hump size, with a score 5 denoting the heaviest framed animals. These animals tend to be in positive energy balance with reserves of sub-cutaneous fat present on carcases. Not surprisingly, these animals yield higher quality meat.

Carcases have standard specifications and are slaughtered to strict AQIS procedures. Standard hind quarter joints are marketed including the topside, eye round, knuckle, striploin and tenderloin. Similarly the blade, cube roll, chuck eye roll, chuck, brisket, shin and flank and skirt steak are on offer from the forequarter.

This is another multipurpose species with camel oil, leather and wool all being sought after. Camel milk is now recognised as having unique properties and may be the source of commercially important pharmaceutical products of the future. Little is known of factors that influence the quality of meat from this species. There is little doubt that this deserves our attention if we are going to exploit this species commercially for meat within Australia.

The information for this segment on camels has, unless otherwise stated, been derived from www.camelsaust.com.au and from Dr Arshad Iqbal, University of Agriculture, Faisalabad, Pakistan (pers. comm.).

32.6 Horses

Although not traditionally or correctly termed as a game meat species, this section has been included for three reasons. Firstly ancestral horses were hunted to provide meat for humans in pre-historic times (Clutton-Brock, 1981) and so have been a major source of animal protein ever since. They were particularly important to meat supplies during the industrial revolution in the 19th century in Great Britain. Secondly, there is a potential source of game meat available from existing wild 'brumby' species found more in the rugged eastern ranges of Australia, and thirdly because they too are an important host for the parasitic zoonosis, trichinellosis like the wild pig (see below) and the crocodile.

The term horse meat does not just refer to meat from horses but also includes meat from various species of donkey (or ass), hybrids like mules (offspring of a male donkey and a female horse) and hinnies (offspring of a female donkey and a male horse). Compared to beef, pork and lamb, the total world consumption of horse meat is low, but a high proportion is traded internationally (Swatland 2004). In the USA and Canada, a surplus of horse meat is available since domestic demand is so low.

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This meat is supplied to overseas markets in France, Japan and Italy where it is often eaten raw, and local supplies are limited.

Horses continue to remain as a popular and well-loved companion and working animal that is enjoyed by many people all over the world. Thus, the slaughter of horses for human consumption has not been taken lightly, particularly in the USA, and many feel that it is unacceptable. Regardless of this, there are countries where horse meat for human consumption is acceptable, such as France, Italy and Mexico, and where it has traditionally been retailed by butchers dealing solely in horse meat (Chemorin, 2002; Pennazio *et* al., 1988; Perez Chabela *et* al., 1999). Iceland, for instance has bone-in primal cuts for horse meat such as T-bone (T-beinsteikur) and blade steak (folaldabógsneiðar), (Swatland, 2004). Horse meat is also believed to have a taste that is intermediate between beef and venison (Swatland, 2004).

What is of concern however, is that horse meat is consumed raw by some people (in Japan, Italy and France, for instance) and this product is also known to harbour parasitic *Trichinella*, which causes zoonotic disease: trichinellosis (refer below) which has been prevalent in Western Europe. The occurrence of this parasitic infection in horses is believed to be the result of feeding horses with by-products prepared from infected waste meats, food scrapes and carcases, such as pig meal, in an attempt to improve the condition and therefore value of horses to be sold for slaughter. Another potential source is the carcases of infected rodents found in feeds or on pastures.

Horses are also susceptible to highly toxic cadmium accumulation in their tissues. Such an accumulation is greatest in the kidney and liver, thus potentially rendering horse offal as unsuitable and unsafe for human consumption. It is worth noting that horse liver is consumed in Japan and so this may be a potential problem for this population.

32.7 Wild (feral) pigs (*Sus scrofa*)

It is thought that Australia's wild pig populations has resulted from escapee domesticated pig stocks, many of whom have wandered off from farms or settlements through lack of proper housing and confinement of animals (Puller 1950). His studies highlight the fact that here has been no account of the deliberate release of the European wild pig/boar into Australia.

Puller attempted to trace the origins of feral pigs in Australia, where he studied journals written by explorers and navigators for clues. His efforts revealed only one reference to pigs being released deliberately, and this was on the Bass Strait islands by sealers and whalers. Prior to 1870, there were already established populations of feral pigs in Queensland, Northern Territory and along the junctions of the Darling and Lachlan-Murrumbidgee river systems. Today, the distribution of feral pigs in Australia is still studied. Feral pigs are found in diverse environments: mountains, coastal dunes, marsh areas, mangrove swamps, forests and inland river courses. All these environments have one thing in common, an assured food supply and a permanent source of water. The major populations are found in localised areas of New South Wales and more extensively through Queensland. Small colonies are also found on Kangaroo and Flinders Islands, as well as in the Darling Range and south-west of Western Australia. However, populations no longer exist in Victoria and Tasmania.

Figure 32.5. A photograph of the typical wild (feral) pig found in Australia.
Source: Parsonson, (2000)

Feral pig (*Sus scrofa*), northern Australia.

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Feral pigs are of particular concern for animal and human health since they have the potential to amplify a number of exotic viruses and other diseases of animals and humans. Examples of these include foot-and-mouth disease, Japanese encephalitis, and exotic disease of pigs such as trichinosis (refer below).

32.8 Feral goats (*Capra hircus*)

The feral goat has established populations in a variety of habitats across Australia. It competes with native fauna for feed resources threatening plant and animal species and ecological communities alike. Despite these issues it also has commercial value for meat production. Feral goats are harvested for both their hides and their meat for which there are established export markets in Asia and the Middle East. As with kangaroos, they are harvested and stored in chiller boxes in field prior to the transport to processing plants.

Apart from their destructive effect on the environment, these animals provide a potential reservoir for devastating exotic diseases including foot and mouth disease, scrapie, rinderpest, rift valley fever, rabies and blue tongue. They are also prone to endemic diseases such as Q fever, tetanus, leptospirosis, brucella melitensis, pulpy kidney blackleg and various gastrointestinal worms.

Despite this, there are some positive aspects associated with this wild population.

Production of goat meat in Australia is valued at approximately $20 million per annum. Australia is the world's leading goat-meat exporter, with the majority of meat originating from captured feral goats. Orders for goat meat usually exceed our capacity to supply. Unfortunately, these markets depend on the low cost and erratic sources of feral goats from semi-arid rangelands. Expanding potential markets in south-east Asia cannot be supplied as production of farm-reared goats is low. Unsupplied markets exist in all capital cities in Australia. The goat-meat industry needs greater supply of quality, market-specific goat meat, which means more goats on well managed farms in reliable grazing districts (McGregor, 1997). Prime goat meat is traditionally regarded as lean, tender and juicy. It is sold under many names but `capretto', the Italian name for tender, milk-fed kid, is the best known in Australia. More recently, the potential for the production of high quality product from farmed species has been realised and this is more likely to be the source for this product in the future as more export markets become apparent. The unique flavour of goat meat has prevented it from becoming a popular domestic product, although it is popular among ethnic minorities.

As with other game meat species the meat is high in iron content and low in fat compared with meat from domestic species. These characteristics are also found in farmed goat meat.

32.9 Diseases transmitted through game meats to consumers: The Zoonoses

One of the major concerns for consumers of game meats and in particular bush meats are the bacteria, viruses, parasites and unconventional agents that reside within the product and are therefore transmitted to them. The first 3 classes are self-explanatory, however an example of an unconventional agent is the infective altered protein or prion that causes Bovine Spongiform Encephalopathy (BSE).

Examples of zoonoses coming from different species are listed below

Birds

- Psittacosis/ornithosis (Chlamydia)
- Salmonella/*Campylobacter*: refer below.
- Mycobacterium

Terrestrial mammals

- Salmonella/*Campylobacter*: the mode of infection to humans is through contact with faeces such as rat droppings; however, foods of animal origin are the major causes of campylobacteriosis in humans, where various species such as chickens and pigs harbour *Campylobacter* species.

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- Thakur and Gebreyes (2005) have reported *Campylobacter* to be the leading cause of food-borne bacterial infection, being responsible for an estimated 2.4 million cases. *Campylobacter jejuni* in humans has generally been considered to be the most important species of *Campylobacter* causing infection, however, research carried out in Spain and the United Kingdom (Saenz, *et al.,* 2000; Tam, *et al.,* 2003) has suggested that another species: *Campylobacter coli* is just as important as a human pathogen. These studies have highlighted the importance of *C. coli* based on its resistance to various classes of antimicrobials and its prevalence in the indigenous population of Australians as an agent for food borne disease.
- Ringworm
- Sarcoptic mange
- Lyssa/Hendra and Menangle virus
- Toxoplasmosis is the causal agent in the cat and animals transmitting the infection to humans include cats, sheep, rodents, dogs, cattle pigs, goats and horses. This disease is of great importance in early pregnant susceptible women and it can cause blindness and abortion.
- Psittacosis/ornithosis (Chlamydia)
- Salmonella/*Campylobacter*: refer below.
- Mycobacterium
- Salmonella/*Campylobacter*: the mode of infection to humans is through contact with faeces such as rat droppings; however, foods of animal origin are the major causes of campylobacteriosis in humans, where various species such as chickens and pigs harbour *Campylobacter* species.
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- Ringworm
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- Toxoplasmosis is the causal agent in the cat and animals transmitting the infection to humans include cats, sheep, rodents, dogs, cattle pigs, goats and horses. This disease is of great
- Trichinellosis: see below.

Trichinellosis: an emerging and re-emerging zoonotic disease

Disease summary:

Caused by parasitic nematodes of the *Trichinella* genre, trichinellosis is a world wide, helminth zoonotic disease of humans and animals. It has a sylvatic cycle associated with the consumption of raw or improperly cooked infested meat in humans, and through the predatory consumption of infected carcases or feeding of swill and carcases in wild and farmed animals, respectively. Trichinellosis should be regarded as both an emerging and re-emerging disease. For an excellent review on this topic refer to the paper *New patterns of Trichinella infection* (Pozio, 2001). As outlined in this paper, the re-emergence of trichinellosis caused by *Trichinella spiralis* (a non-encapsulated type) has primarily been related to the following reasons:

- A breakdown of government veterinary services and state farms, such as in countries of the former USSR, Bulgaria and Romania
- Economic problems and war, such as in the former Yugoslavia, where the 1990's saw a large increase in the occurrence of this infection in swine herds
- An increase in the number of small farms, particularly in Argentina, China and Mexico

New species of *Trichinella* (*T. native, T. britovi, T. murrelli, T. nelsoni*) have also been identified, both non-encapsulated and encapsulated types, and not just infecting mammals but birds and reptiles too. Examples of new non-encapsulating species of *Trichinella* include: *T. pseudospiralis* and *T. papuae,*and will infect a wide spectrum of hosts such as humans, mammals including marsupials, birds and crocodiles. Examples of encapsulating species include: *T. spiralis, T. britovi,* and *T. murrelli*, of which will infect herbivores, mainly horses. For the latter, the occurrence of trichinellosis in horse

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meat is localised to France and Italy, where the consumption of raw horse meat is enjoyed by the locals. Furthermore, the occurrence of this disease in mutton and beef is rare and has only been known to occur in China (Pozio, 2001).

To add to the problems of both emerging and re-emerging parasites, the role of game animals as a source of infection for humans has greatly increased both in developed and developing countries, such as Bulgaria, Canada, Lithuania, some EU countries, Russia and USA.

Australian Situation:
Trichinella spiralis is not present in Australia (www.aqis.gov.au).
A different, distinct species, *Trichinella pseudospiralis*, has only been detected in certain wildlife species in Tasmania.

Abattoir monitoring and surveys on mainland Australia have remained negative for *Trichinella* spp. Extensive monitoring at abattoirs of meat from pigs and horses for *Trichinella* sp. continues to show negative results. Australia's domestic pig population is also recognised as free from *T. pseudospiralis* and other *Trichinella* sp. Different markets have different requests for *Trichinella* status of product they purchase. For instance, Russia requests a *Trichinella* free status for Australian pork to be ascertained each time they purchase meat from our export pork processing plants and boning rooms operating under AQIS Approved Arrangements. To meet this request samples from the diaphragm of each carcase, must be sent away to approved AQIS labs for testing (pers. comm. 2006).

Animal health and disease risks relating to the consumption of kangaroo meat

When considering the consumption of meat from wild, field shot kangaroos, health concerns by the general public still to this day are directed towards 'worms'. Kangaroos exhibit diverse populations of intestinal worms that exist in the gastrointestinal tract namely because the kangaroo is a wild free ranging species that is therefore not drenched like sheep and cattle, so there is no intervention and worm control. For instance, of the strongyloid nematodes found in macropods, there are 40 genera and 171 species described (Hume, 1999), with many species still undescribed. With such a large array of Helminths in macropods, and still scope for more research, it hard to determine the real purpose of such a vast biomass, of nematodes in particular, in macropods, i.e. parasitic versus symbiotic. Saz (1981) and Köhler (1985) have reported Helminths to commonly ferment carbohydrates to short-chain fatty acids, and as Hume (1999) noted, this is an area of macropodid digestion that should attract further investigation.

A part from this, other health concerns are related more specifically towards: hydatids, salmonella and *Dirofilaria roemeri*, the latter colloquially referred to as joint worm.

- Hydatid disease (*Echinococcus*): there are two causal agents. One involves *Echinococcus granulosus*, where the mode of infection to humans is through contaminated food, water, hands; careless smoking; lamb marking; handling dogs, dogs' premises, sheep, among others. Animals known to transmit the infection include dogs, dingos to infect humans, and to reinfect dogs, sheep, cattle, kangaroos and pigs. The disease is often found in humans in which it can cause death, the need for surgery to remove cysts, and tapeworms leading to ill-health (Hungerford, 1990).

- *Dirofilaria roemeri*: this is probably the most common parasite of macropods. Others include Strongyles, Oxyurids, Cestodes, Trematodes, and Helminth parasites (refer above). *Dirofilaria roemeri* is a large filarid that occurs in fibrous capsules in the vicinityof the knee joint in Kangaroos. In heavily infected kangaroos this parasite is not just found isolated within the knee joint but can be found on the surface of the muscles of the upper hind limb, particularly on and around the rump muscles and deeper portion of the topside (pers comm. 2006). The intermediate host of *Dirofilaria roemeri* is one of several species of Tabanid flies, the most important being *Dasybasis hebes*. Transmission usually occurs from October to May with a maximum in April and there is a pre-patent period of about 9 months (Dunsmore, 1978).

So what is the potential risk when consuming kangaroo? Carcases are inspected at the plant, where the heart, liver, lungs, spleen and kidneys must remain intact with the carcase for inspection by a qualified AQIS meat inspector. However, health inspection of animals in the field by the shooter may

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assist with the identification of infected carcases, although there is scope for this problem to be ignored. Thus in order for the industry to maintain credibility, it is important that all products for human consumption undergoes a rigorous AQIS approved inspection procedure. The potential health concerns that kangaroo meat poses to humans was investigated by A. E. Andrew in 1988, but further work has been lacking.

In 1980 Commonwealth legislation was enacted, enabling kangaroo meat to be prepared and exported for human consumption. This occurred only after a thorough investigation of the procedures used in the kangaroo harvesting industry. Andrew (1988) reported that kangaroos suffer from few diseases normally associated with domestic animals and that they present little or no danger to human health. In field studies conducted in 1980 on Red, Eastern Grey and Western Grey kangaroos, a complete absence of the major diseases or conditions associated with domestic animals was noted. Mention was made of the nematode *Dirofilaria roemeri*, which does not affect humans and is mostly confined to the stifle joint. The tapeworm *Progamotaenia festiva* is a common inhabitant of the bile ducts in the liver, however, this parasite is of no public health significance (Andrew, 1988). In terms of hydatid disease, Andrew (1988) reported that there is no danger of humans contracting hydatid disease through the consumption of meat affected with the disease: the danger lies in fact with the consumption of eggs from the tapeworm through direct or indirect contact with infected dogs.

Control of exposure to zoonoses in the population of developed countries is well advanced, however at the other end of the spectrum, the exposure of native tribes to such horrific viruses as the ebola virus, through the consumption of primate bush meat (eg gorillas and monkeys) stands as a real potential threat. World health regulatory organisations have much ground to cover in some areas to minimise these threats.

32.10 Conclusion on game meat

The continued demand for meats that have a unique and often strong gamey flavour and which are low in fat content will ensure a marketplace for game meats in the future. In addition, the demand for alternative sources of meat is strengthened by any health concerns or incidents that occur relating to the consumption of the more traditional farmed species. For example, the occurrence of BSE in cattle helped increase the consumption and popularity of horse and ostrich meat in Italy.

The challenge remains to maintain the supply of high quality product that will enjoy the confidence of the consumer and at the same time ensure the sustainability of species involved and the environment within which they reside.

In contrast, where game or bush meats provide the sole source of human dietary protein, significant challenges await regulatory authorities since quality control over such product is either non-existent or at best rudimentary. As these procedures are implemented game meats will become more important in the world food equation. The mere fact that kangaroo and emu harvesting ranges and farms are spread as widely as China, Europe and North America bears testimony to this fact.

Readings

The following readings are available on CD:

1. Title: Australian standard for hygienic production of game meat for human consumption. Publisher: Collingwood, Vic.: CSIRO Publishing, 1997.
2. Bobbitt, J.(2002) Shelf life and microbiological safety of selected new and emerging meats RIRDC publication 02/038.
3. Bobbitt, J., Haines, H., Hodgeman, R. and Roache, T. (2006) Alternative Meats – Novel flavours, products and safe delivery. RIRDC Publication No 06/008 RIRDC Project No DAV-216A
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www.uwyo.edu/CES/PUBS/B920R

Activities	Available on WebCT
Multi-Choice Questions	Submit answers via WebCT
Useful Web Links	Available on WebCT
Assignment Questions	Choose ONE question from ONE of the topics as your assignment. Short answer questions appear on WebCT. Submit your answer via WebCt

Summary

Summary Slides are available on CD
Refer to 2.12 Conclusion above

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Glossary of terms

Ratities	flightless birds
Polyunsaturated fatty acids (PUFA's)	are lipids that contain more than one double carbon bonds (C=C)
Saturated fatty acids	are lipids that do not contain double carbon bonds (C=C)
Lipid oxidation	PUFA's present in meat can react with oxygen to form fatty acid hydroperoxides. These are unstable and break down into various compounds including aldehydes, ketones and carboxyl compounds, which can produce off-flavours. The process is relatively rapid, often occurring within 1-2 days in meat that has been cooked then kept refrigerated, and leads to the stale, rancid flavour known as 'warmed-over flavour'. These off-flavours caused by lipid oxidation can also occur in uncooked meat.
Zoonoses	Any disease and/or infection which is naturally "transmissible from vertebrate animals to man" is classified as a zoonosis. Over 200 zoonoses have been described (for examples refer to http://www.who.int/topics/zoonoses/en/). They involve all types of agents: bacteria, parasites, viruses and unconventional agents.
Trichinellosis	is a parasitic zoonosis with worldwide distribution and is caused by the tissue-dwelling nematode *Trichinella*.
Helminth	a parasitic worm; a fluke, tapeworm or nematode

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