Emu and ostrich production and its consequences for human nutrition

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Summary

Emu and ostrich farming have expanded around the world since the 1970s. The main edible product is meat but some fat from both sources may also be consumed. Demand for both meats is slowly expanding as they are considered to be 'healthy red meat alternatives' due to their low contents of intramuscular fat and cholesterol.

Although ostriches are 2-times the size of emus, their slaughter ages and proportions of carcase meat are similar. Emus have a greater yield of fat. Objective tests of emu and ostrich meat eating quality have shown that although there are differences between individual muscles, average quality is similar and would be classed as tender in comparison with beef. However the average muscle pH of 6.0 indicates that the birds may be stressed to some extent immediately prior to slaughter. The meat of both birds is a deep red colour and has a relatively high iron content. One third to one half of the fat is oleic acid, a desirable monounsaturated fatty acid. The ratio of saturated to monounsaturated to polyunsaturated fatty acids in ostrich fat is close to 1:1:1, also considered nutritionally desirable.

Introduction

Emu farming and ostrich farming are classified as 'prospective new industries' by the Australian Rural Industries Research and Development Corporation (1). Both industries have passed through the establishment and breeding phases and are now in the processing and product development phases. Certain products of emu and ostrich farming have potential uses as beneficial nutritional components of human diets.

Ostrich farming began in South Africa in the 1860s and in Australia in the 1870s. The industry declined after 1914 but in the last 20 years it has expanded around the world (Table 1). Emu farming began in Western Australia in the 1970s and it has also spread to all other Australian States (Table 2) and around the world since then.

Table 1: Size of ostrich industry in world (1995 /1996)

Country	Number of farms	Number of breeding females	Number of birds (total)	Number of birds slaughtered 1995 (or 1996)
South Africa	400 - 450	32 000 +	300 000	170 000
USA	7 000 - 10 000	?	250 000	Small number
Australia	?	8 000	50 000	(2 000 - 3 000)
Namibia	120	5 000	20 000	43 000
Israel	30	4 000	25 000	9 000
Canada	?	3 500	?	nil
Europe	600 +	?	10 000	few
Zimbabwe	230 - 250	3 000	33 000	10 000
China	200	?	8 000 - 20 000	Small number
Botswana	10	500	5 000	few
Kenya	30	250	2 500	100
Ethiopia	1	35	45	0
Total	8 000	55 000	700 000	230 000

(2 and other sources)

Table 2: Size of the emu industry in Australia (1997)

State	Number of farms	Number of breeding females	Number of birds	Number of yearlings slaughtered	Number of slaughter houses	Location (and operator of slaughter house)
VIC	890	30 000	156 000	?	4	Pyramid Hill, Myrtleford St Arnaud (Golden Field Turkery) Whycheeproof
NSW	146	19 500	80 000	4 000 - 5 000	4	Narandera (Southern Emu Products)
WA	83 (50)*	22 000	35 000	7 000	2	Casuarina (Peter Purvie) Dardanup (Graham Golding)
QLD	45	4 400	20 000	3 000	4	Cherbourg (Council), Gin Gin, Crows Nest, Caboolture
TAS	70	3 500		1 500	3	(Tasman Quality Meats) (Island Emu) (Emu Tas)
SA	? 100	?1 000		?	1	Waikeric
Total	1 334	80 400	291 000	17 000	18	

* 83 registered, 50 operating (3 and other sources)

As a rough guide, emus and emu products are about half the size of ostriches and ostrich products, however the values of ostrich products are usually greater on a unit basis than those of emu products.

Up to 1996, both emu and ostrich farming received profits from the sale of live birds to new farmers. This demand has been satisfied for the present, and both industries are moving towards being fully commercial industries placing most reliance on product sales.

The non-living products of emus and ostriches are meat, leather, oil, eggs and feathers. The meat, oil and eggs are potential food sources, but the oil is mainly used for cosmetic and medical purposes and most eggs are incubated for chicken production. A few eggs are used for food but the main product consumed by humans is the meat.

Meat will be the main topic of this paper, but reference will be made to fat composition. This paper will compare the estimated production with the estimated demand for ostrich and emu meat, carcass yield, types of meat cuts produced, and nutrient composition.

World production of ostriches and emus

South Africa is by far the largest producer of ostriches (Table 1) accounting for about 90% of the commercial production.

The picture is less clear with regard to emu production. In 1995 there were more emus on farms in the USA than in Australia. In 1995 there were said to be over 1 million emus on farms in the USA. The largest number of farmed emus officially recorded in Australia was 70,000 in 1995. Since then there have not been any national counts, but recent estimates have placed the number in the vicinity of 300,000. Numbers of both emus and ostriches on farms in USA have also declined recently due to the exit of farmers who are not willing to wait until product markets are established.

World demand for ostrich meat

A 1996 survey by the British Ministry of Agriculture Fisheries and Food (4) estimated that the USA would have the largest demand for ostrich meat (about 60%) followed by the European

Union countries (about 30%) with some demand from the Far East (Japan, Hong Kong, Singapore), non-EU European countries and the Middle East (Table 3).

Table 3. Ostrich meat markets

Country	Quantity (mt/year)
USA	15 000
EU	8 881
Far East (Japan, Hong Kong, Singapore)	1 661
Other European	828
Middle East	285
Total	26 665

(4)

These figures are based on calculating a substitution of 0.1% of the beef market in these countries. A similar figure has been used to calculate the potential demand for emu meat. The figures in Table 3 may be regarded as combined emu and ostrich meat demand, because features such as low fat, low cholesterol, 'healthy red meat', the 'red meat alternative' and 'Heart Foundation approved' will be used to market both meats. Ostrich meat has an advantage over emu meat in that it is a recognised product in the market place, where emu meat is virtually unknown at present.

Carcase composition

The average carcass compositions for the ostrich and emu are similar, except for the extra fat in emus (Table 4). These are rounded figures from several sources and represent typical compositions of carcasses at recommended slaughter ages of 14-15 months for both ostrich and emu. There is only one species of emu recognised and no sub-species. Even so, there has been a wide range of weights reported at slaughter depending mainly on the nutritional conditions of the birds. Thus, carcass weights of emus are fairly consistent, but fat weights vary widely in response to the nutritional regime.

Table 4. Carcass composition and yield

	Ostrich		Emu	
	Kg	(% LW)	(kg)	(% LW)
Liveweight at slaughter	100	100	40	100
Carcase weight	55	55	22	55
Feather, viscera, skin and fat	45	45	18	45
Meat	33	33	12	30
Bones	22	22	10	25
Fat	0	0	7	17.5

Because the estimated return for emu fat is greater per unit weight than that of the other products, emus are kept until they reach maximum fat yield which occurs around December (after an average hatch date of September the previous year). Emus seasonally decrease their food consumption and mobilise their fat reserve so that slaughter fat yield varies throughout the year.

In contrast, ostriches have four native sub-species all larger than the cross-bred domestic strain, so live weight and carcass weight vary for the same age birds depending on strain. Ostriches can reach market weight when they are seven months old and may lay down fat if held on high nutrient dense diets. However fat is not such a marketable product from ostriches. It is more common to hold birds on low maintenance diets up to 14 months because the older birds have more mature skin characteristics that increase the value of the leather but the amount of fat they lay down is thereby restricted. This has to be balanced against the greater risk of skin damage the longer the birds are held on farm. In the main ostrich-producing area in South Africa, Oudtshoorn, birds are placed out on range so they have a larger area per bird than hand fed penned birds and therefore less frequent damaging interactions between birds, and between birds and objects such as fences.

Meat cuts and meat quality

In both emus and ostriches, individual muscles are cut from the carcass and given separate identifying names and numbers (5, 7). There is no breast meat and the majority of the meat comes from the legs and rump, with smaller amounts from the back, ribs and the neck.

At present, there is no official distinction between the qualities of emu muscles. However for the ostrich, South Africa, Australia and the USA distinguish various and sometimes different muscles as suitable for fillet, steak or processing meat. In South Africa only three muscles of the ostrich are designated as fillet, one as small leg which is equivalent to tenderloin, seven muscles are designated as steak and the other 11 muscles are sent for processing into byproducts, mainly a wurst-type sausages. In Australia five muscles of the ostrich are designated as fillet, one as tenderloin, nine as rump steak, the gastroconemius group as leg muscle and the other six muscles are processed into byproducts. Thus in Australia a greater proportion of the ostrich carcass is used as whole meat cuts. In contrast all of the emu carcass is used as whole meat cuts, however some preferences are becoming evident for certain emu cuts.

The basis of distinction between fillet, steak and processing categories is tenderness. Tenderness has several components. The actin and myosin protein strands form the bulk of the muscle mass. If the muscle is relaxed when it enters rigor mortis (that is, the sarcomere unit is long, over 2 um say), the meat is the most tender it could be. The actin and myosin content is constant for all muscles. However, the larger the amount of connective tissue between the muscles and the greater the number of crosslinks between the collagen fibres (that is, the older the animal) the tougher that piece of meat is. This varies for different muscles and appears to be the factor responsible for tenderness differences between muscles. In general it appears that the more work a muscle does the greater the amount of connective tissues deposited between the muscles. The rate of ageing of the collagen may differ between animals, but is thought to be constant within an animal, so for birds of the same age the main difference in tenderness between muscles is the amount of connective tissues in each muscle.

The muscles in the front of the thigh (the quadriceps group) and the back of the lower leg (the gastrocnemius group) appear to be used more in locomotion as they are usually tougher and have more connective tissue than rump muscles and inside loin muscles.

There are interactions between these factors. For example, a stressed animal with low glycogen levels in the muscles at slaughter will enter rigor mortis early at a high pH and when the body temperature is high. Under those conditions actomyosin fibres contract so strongly that they break and hence result in a more tender meat than that obtained from a less stressed animal. It has been found that the toughest meat for the same muscle from animals of the same age occurs at around pH6 and that the meat is more tender as pH falls to pH 5.5 or rises to pH 6.5. The muscles that are used more for locomotion, as well as having a greater content of connective tissue, also have a greater amount of their glycogen stores depleted at slaughter if there has been much activity immediately prior to slaughter.

The juiciness or moisture-holding capacity of the muscle is also greater at pH extremes than at pH 6. There is a wide range in these values for different muscles and for different pHs of the same muscle of the emu (Table 5).

Table 5. Objective tests of emu and ostrich meat quality

	Emu meat	Ostrich meat
pHf	5.7 - 5.4	6.0
Shear strength (kg)	3.0 - 6.9	3.3
Compression strength (kg)	0.8 - 2.0	-
Sarcomere length (um)	1.4 - 3.6	1.5 - 2.2
Moisture loss on cooking (%)	17 - 34	-
	(6)	(7)

Nutrient composition and appearance

Typical nutrient analysis of emu and ostrich meat in comparison with the meat of other game and domestic animals is shown in Table 6. The moisture and protein contents are similar, the greatest difference being in fat content. Game meat has very little intramuscular fat but beef and pork in particular have 10 to 20 times as much. As a consequence of low fat content, the cholesterol content is also lower in emu and ostrich meat than in the meat of other domestic animals. These are both positive health factors and both emu and ostrich meat have received the Australian National Heart Foundation's tick of approval which has enabled the use of the slogan 'healthy red meat' as part of the advertising campaign for both meats.

Table 6. Nutritional comparison of meats

Analysis	Ostrich	Emu	Deer	Pork	Beef	Poultry	Fish
Water (%)	75.4	73.6	74.5-75.1	70	75	73-75	82
Fat (%)	1-2	1.7-4.5	3.3	25	2-16.3	1-3.6	1
Protein (%)	22	21	20.6	18-28	18-22	21-24	16
Collagen (%)	0.37	1.1-2.0	1.24	0.5			
Iron (mg/100g)	3.5	?	4.5	1.1	3.0	1.2	
Magnesium (mg/100g)		28.7-30.9	29	17-25	20	20-27	25-50
Phosphorus (mg/100g)		480-490	249				240-500
Potassium (mg/100g)		313.5-3.17	330				250-400
Cholesterol (mg/100g)	38-60	39-48	112	62-105	63-86	64-98	57
Calcium (mg/100g)	5.2	4.5-7.7	7	10	9-10	8.17	20-40
Energy (KJ/100g)	438	471-531	494	1335.8	657.6	478.6	397.4
Calories (Kcal/100g)	100-115	113-127	108	319.3	160-256	110-185	70-120

(5, 8 and other sources)

Another health factor used in advertising campaigns is the amount of iron in the meat. The iron content in emu and ostrich meat is higher than in the meat of other domestic animals (Table 6). The major reason for this would probably be the absence of the diluting factor of fat. However within the muscles themselves, the amount of iron depends on the relative amount of red fibrils which contain myoglobin compared with the amount of white myofibrils (which do not contain myoglobin). The ratio of red to white myofibrils is greater in leg muscle and is less in the breast muscle of domestic chickens. However the relative proportions of these two myofibrils have not been studied in emu and ostrich leg muscles. Some indication of these relative proportions may be obtained by studying the intensity of the red colour of different muscles (because the iron containing globin molecule provides the red colour of erythrocytes and muscle). In the studies reported by Dingle et al (6) there were no, or few, significant differences in the objective evaluation of different emu muscles. In the studies reported by Mann et al (9), there were small, but significant, differences in the subjective evaluation of muscle colour, the brightest red colour (5, 6) being the *M. Iliotibialis cranialis* and the darkest (4.4) being the *M. Iliofemoralis*, on a 1 to 8 scale of bright cherry red to very dark colour. Such comparisons can be made between muscles within a trial but can not be made between trials without a consideration of muscle pH (because low pH produces a lighter coloured muscle and high pH produces a darker coloured muscle). To a smaller extent, it depends on oxygenation because the surface of all muscles exposed in the air blooms to its brightest cherry red colour, whereas the surface of muscles in vacuum packs, where all the oxygen has been depleted, become very dark due to the formation of metmyoglobin.

Under similar conditions however, both emu meat and ostrich meat are generally darker than beef. Darker meat is a characteristic of game animals and is favoured by game-consuming societies such as in Germany, Belgium, Switzerland and the Netherlands. This feature is a positive character for sales into these markets. In societies not accustomed to eating game meat however, such as the majority of Australians, lighter coloured meat is favoured. Younger emus and ostriches have lighter coloured meat than older animals and therefore it would be preferable to market younger birds locally and export older birds to the European Union.

Fat

The fatty acid compositions of emu and ostrich fat are compared in Table 7. Although oleic acid (monounsaturated fatty acid favoured in human diets for health reasons) has the highest concentration (29%) of ostrich fatty acids, proportionally it is not as high as in the fat of emus (50%). The proportion of saturated fatty acids (SFA) in ostrich fat is 38% of monounsaturated fatty acids (MUFA) is 33% and of polyunsaturated fatty acids (PUFA) is 30% (Table 7). This approximate 1:1:1 ratio is promoted as the most beneficial ratio for human diets.

No analysis has yet been made of the differences between subcutaneous, abdominal and intramuscular fat. It has been observed however that subantaneous fat appears firmer than abdominal fat and therefore it may possibly contain a higher proportion of saturated fatty acids. In addition the subcutananeous fat of emus is usually substantial and more permanent and the layer closer to the muscles possibly being more labile. Attempts are being made to identify the fatty acid component of emu fat that contains anti-rheumatic and anti-inflammatory properties. Although some emu fats are high in these properties and some emu fats do not contain them, there is evidence that the activity of such anti-rheumatic agents is related to a particular fatty acid profile (10).

Table 7. Fatty acid composition of ostrich and emu fat

Fatty acid profile	C:bond	Ostrich Intramuscular fat (%)	Fatty acid groups (%)	Emu Composite fat (%)	Fatty acid groups (%)
Palmitic	16:0	22.2		23.9	
Stearic	18:0	15.4	SFA	9.7	SFA
			37.6		33.6
Palmitoleic	16:1	3.9		3.4	
Oleic	18:1	28.7	MUFA	50.0	MUFA
			32.6		53.4
Linoleic	18:2	16.5		10.3	
Linolenic	18:3	2.5		0.6	
Homo-linolenic	20:3	0.6			
Arachidonic	20:4	7.9			
EPA	20:5	1.6	PUFA		PUFA
DPA	22:5	1.1	29.8		11.0
DHA	22:6	1.4			
			(11, 12, 13)		(14, 15, 16)

Emu and ostrich farming thus provides meat and fat with desirable qualities as ingredients of human diets.

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