Review of the Nutrient Composition of Australian Red Meat

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Overview

To maintain robust data on the nutrient content of Australian red meat, it is important to ensure data is available for nutrients of interest, and that it is representative of the type of meat available for purchase and how it is consumed.

Meat & Livestock Australia (MLA) has invested extensively in studies that describe the nutrient content of Australian red meat available for purchase. Conducting retail studies is expensive and involves the collection and analysis of samples in an accredited laboratory with demonstrated expertise in the specific analysis being undertaken.

The findings of the retail studies have contributed to data published in the *Australian Food Composition Database*, an important resource for nutrition policymakers, practitioners, marketers, and the general public. The database describes the nutritional value of raw and cooked Australian beef, lamb, veal, mutton and goat meat, and the different types of cuts and levels of trim.

Since the type and amount of meat consumed influences its nutritional value, MLA has also invested in studies to better understand the serving size and level of trim of consumed meat. This type of data provides information about how red meat is consumed and helps avoid over- or underestimation of the actual nutritional value of Australian red meat.

To determine the research required to maintain a cost efficient and robust database representative of Australian red meat, this report summarises key findings from:

- a review of the available data on the nutrient content of Australian red meat available for purchase generated from retail studies; and
- research that describes typical serving sizes and level of trim of consumed Australian red meat.

Objectives

1. To summarise data from studies conducted since 1982 to determine key factors that influence the nutrient content of Australian red meat available for purchase.
2. To describe key findings from MLA's Typical Recipes study and implications for measuring the serving size and level of trim of consumed meat.
3. To recommend directions for research to maintain representative data that describes the nutrient content of Australian red meat.

Background and methodology

1. Review of retail studies

Meat & Livestock Australia (MLA) commissioned Judy Cunningham, PhD, to review the nutrient data of Australian red meat available for purchase, and to recommend future directions for maintaining representative data. Analysis of the data was restricted to beef and lamb, the most popular meats with the greatest amount of data available. Data from original published and unpublished laboratory reports across several retail studies were extracted, compiled and analysed (AGAL, 1988; Greenfield at al 1987a; Hutchison et al 1982; MLA, 2016; Sadler et al., 1993; Williams et al., 2006).

Analytical nutrient data of popular Australian foods, including beef, veal and lamb, was initiated by the University of Sydney in 1982 (Hutchison et al., 1987) and continued by the University of NSW and the Australian Government in the 1990s. Most of the studies were conducted by National Measurement Institute (NMI), previously called Australian Government Analytical Laboratories (AGAL), while MLA's studies were designed in consultation with Food Standards Australia New Zealand (FSANZ), previously called Australia New Zealand Food Authority (ANZFA) and National Food Authority (NFA).

The nutrient data was aggregated by cut and year of sample to identify trends in the composition of lean and separable fat between cuts, and influence of different cooking methods on nutrient content. The methodology involved in the retail studies included:

1. Random selection of up to 13 samples per cut or type of mince purchased from supermarkets and butchers in different states, regions and SES areas.
2. Gross composition and reporting of relative proportion of separable lean meat and separable fat for raw and cooked samples, calculated after removal of inedible components such as bone, gristle and silver skin. Subsequent studies described the relative proportion of separable fat according to its location i.e., as selvedge and intermuscular.
3. Nutrient analysis of a composite sample of separable fat (an aggregate of all cuts) and a sample of separable lean for each cut (an aggregate of 8 to 10 sub-samples for each cut) for raw and cooked meat.
4. Calculation of the nutritional value of cuts from the relative proportion of separable fat and lean meat representing the different levels of trim, including lean, semi-trimmed and untrimmed. 'Lean' was defined as meat without selvedge or intermuscular fat; 'semi-trimmed' included meat with intermuscular fat but no selvedge fat; and 'untrimmed' meat had both selvedge and intermuscular fat.

Due to the relatively small number of data points available, particularly at the level of individual cuts, statistical analysis was not carried out, other than estimation of arithmetic mean, standard deviation and relative standard deviation using Microsoft Excel. Data were also reviewed qualitatively for overall quality (including number of data points and appropriateness of analytical methods) to identify any gaps in analytical data.

A summary of retail studies that analysed the nutrient content of Australian red meat available for purchase is presented in table 1.

Table 1. Summary of data available from retail studies representative of Australian red meat available for purchase since the 1980s

Study	Samples (type of cut)	Raw or cooked (cooking method)	Gross composition	Portion size	Analysed nutrients			
Beef (n=10)					Moisture, protein, fat, ash	Fatty acids, cholesterol	Minerals	Vitamins
Hutchinson et al. (1987)	4 cuts lean & fat (sirloin, blade, round, topside roast	✓ Raw ✓ Cooked (grill, roast)	✓	✗	✓ Amino acids (round steak)	✓ Cholesterol Fatty acids (round steak)	✓ Na, K, Ca, Fe, Mg, Zn, Cu, Cl	✓ B1, B2, B3 (lean only) Retinol (lean and fat)
Greenfield et al. (1987a)	8 cuts: lean 1 composite: separable fat	✓ Raw ✓ Cooked (stew, grill, roast)	✓	✓	✓	✓ No long chain PUFAs or isomer separation	✓ Na, K, Ca, Fe, Mg, Zn	✓ B1, B2, B3, carotenes, retinol
Fox et al. (1988)	1 sample (mixture of blade steak, ribs, rump steak, topside roast), untrimmed	✓ Raw	✗	✗	✓ Moisture and protein only Amino acids expressed as mg acid per gram nitrogen	✗	✗	✗

Study	**Samples (type of cut)**	**Raw or cooked (cooking method)**	**Gross composition**	**Portion size**	**Analysed nutrients**			
Beef (n=10)					Moisture, protein, fat, ash	Fatty acids, cholesterol	Minerals	Vitamins
AGAL (1988)	4 cuts (lean & fat)	✓ Raw ✓ Cooked (grill, roast)	✓	✓	✓ Moisture, ash, fat only	✓ Fatty acids not separated by isomers	✓ Na, K, Ca, Fe, Mg, Zn, Mn, P, Cu	Vitamin C only
Droulez et al. (2006); Williams et al. (2006); Williams et al. (2007)	9 cuts: lean 1 composite: separable fat	✓ Raw ✓ Cooked (grill, roast, dry fry)	✓	×	✓ Moisture, protein, fat only	✓ Fatty acids separated by isomers	✓ Na, K, Ca, Fe, Mg, Zn, Mn, P, Cu, Se	✓ A, B1, B2, B3, B5, B6, B12, folate, D, E
FSANZ (2006)	2 cuts (rump steak, regular mince)	✓Cooked (dry fry)	×	×	✓ Tryptophan also analysed	✓ Fatty acids separated by isomers	✓ Na, K, Ca, Fe, Mg, Zn, Mn, P, Cu, Se, I Mo	✓ A, B1, B2, B3, B5, B6, B12, folate, D, E
FSANZ (2008)	Lean mince	✓ Cooked (dry fry)	×	×	✓	✓ Fatty acids separated by isomers	✓ Na, K, Ca, Fe, Mg, Zn, Mn, P, Cu, Se, I, Mo	✓ A, B1, B2, B3, B5, B6, B12, folate, D, E

Study	**Samples (type of cut)**	**Raw or cooked (cooking method)**	**Gross composition**	**Portion size**	**Analysed nutrients**			
Beef (n=10)					Moisture, protein, fat, ash	Fatty acids, cholesterol	Minerals	Vitamins
MLA (2010)	n=26 samples; range of cuts	✓ Raw ✓ Cooked (dry fry, grill, roast, rare, medium and well done)	Cooking loss, trimming loss	✓	×	×	×	×
Fayet-Moore et al. (2014)	n=51 samples; 3 types of mince	✓ Raw ✓ Cooked (dry fry)	N/A	×	✓	✓ Limited fatty acid data	✓ Individual samples (Fe, Zn)	×
MLA (2016)	Gravy beef (*aka* osso buco/shin)	✓ Raw ✓ Cooked (stew)	✓	✓	✓	✓ Fatty acids separated by isomers	✓	✓ Includes vitamin D with improved detection limits

Lamb (n=7)								
Greenfield et al. (1987b)	8 cuts: lean 1 composite: separable fat	✓ Raw ✓ Cooked (stew, grill, roast)	✓	✓	✓	✓ No long-chain PUFAs or isomer separation	✓ Na, K, Ca, Fe, Mg, Zn	✓ B1, B2, B3, carotenes, retinol
Fox et al. (1988)	One sample (mixture chump chop, forequarter, loin chop), untrimmed	✓ Raw	×	×	× Amino acids expressed as mg acid per gram nitrogen	×	×	×
Sadler et al. (1993)	19 cuts: lean 1 composite, separable fat	✓ Raw ✓ Cooked (grill, roast, dry fry, microwave)	✓	✓	✓	✓ No long chain PUFAs or isomer separation	✓ Na, K, Ca, Fe, Mg, Zn, Mn, P, Cu, Se	✓ A, B1, B2, B3, B5, B6, E, biotin
Droulez et al. (2006); Williams et al. (2006); Williams et al. (2007)	6 cuts	✓ Raw ✓ Cooked (stew, grill, roast)	✓	×	✓ Moisture, protein, fat only	✓ Fatty acids separated by isomers	✓ Na, K, Ca, Fe, Mg, Zn, Mn, P, Cu, Se	✓ A, B1, B2, B3, B5, B6, B12, folate, D, E
MLA (2004)	11 cuts	✓ Raw	×	×	✓ Protein, fat only	Fatty acid totals only	Fe, Zn only	B1, B2, B3, B5, B6, B12 only
FSANZ (2008)	1 cut (loin chops), semi-trimmed	✓ Cooked (dry fry)	×	×	✓	✓ Fatty acids separated by isomers	✓	✓
MLA (2010)	n=30 samples	✓ Raw ✓ Cooked (dry fry, grill, roast), rare, medium, well done)	Cooking loss, trimming loss	✓	×	×	×	×

Veal (n=2)								
Greenfield et al. (1987a)	4 cuts: lean 1 composite: separable fat	✓ Raw ✓ Cooked (stew, grill, roast, dry fry)	✓	✓	✓	✓ No long-chain PUFAs or isomer separation	✓ Na, K, Ca, Fe, Mg, Zn	✓ B1, B2, B3, carotenes, retinol
Droulez et al. (2006); Williams et al. (2006); Williams et al. (2007)	4 cuts: lean 1 composite: separable fat	✓ Raw ✓ Cooked (dry fry, grill, roast)	✓	×	✓ Moisture, protein, fat only	✓ Fatty acids separated by isomers	✓ Na, K, Ca, Fe, Mg, Zn, Mn, P, Cu, Se	✓ A, B1, B2, B3, B5, B6, B12, folate, D, E
Mutton (n=1)								
Droulez et al. (2006); Williams et al. (2006); Williams et al. (2007)	2 cuts: lean 1 composite: separable fat	✓ Raw ✓ Cooked (stew, roast)	✓	×	✓	✓ Fatty acids separated by isomers	✓ Na, K, Ca, Fe, Mg, Zn, Mn, P, Cu, Se	✓ A, B1, B2, B3, B5, B6, B12, folate, D, E
Goat (n=1)								
Jacobsen and Pethick (2013)	3 cuts: lean ` 1 composite: separable fat	✓ Raw ✓ Cooked (stew, roast)	✓	×	✓ Also analysed amino acids	✓ Fatty acids separated by isomers	✓ Na, K, Ca, Fe, Mg, Zn, Mn, P, Cu, Se	✓ A, B1, B2, B3, B5, B6, B12, folate, D, E

Na, sodium; K, potassium; Ca, calcium; Fe, iron; Mg, magnesium; Zn, zinc; Mn, manganese; P, phosphorus, Cu, copper; Se, selenium; I, iodine; Mo, Molybdenum; PUFAs, polyunsaturated fatty acids; AGAL, Australian Government Analytical Laboratories; FSANZ, Food Standards Australia New Zealand.

2. Typical Recipes Study

The study was commissioned by MLA using a representative sample of Australian main meal preparers to gain a better understanding of the typical serving sizes and level of trim of beef and lamb, as consumed. Twelve different types of meals were previously identified from research (*MLA Healthy Meals Report*) exploring popular main meals and representative of different socio-economic, cultural and age groups (MLA, 2020).

In this current study, Australian adults (19-65 years of age) intending to cook at least one of 12 different types of meals were asked to record the type of beef and lamb cuts used, amounts in raw weight, and the number of serves prepared. The online survey, conducted by Ipsos between the 28 June and the 14 July 2019, included a total of 541 participants who prepared meals with beef and 343 participants who prepared meals with lamb. Edible raw weight was calculated from the purchase weight by removing weight from bone, gristle and separable fat trimmed, according to reported level of trim. Median meal portion size was calculated from the number of serves prepared from the edible weight of meat purchased.

3. Key study findings

3.1 Nutrient data gaps

The range of beef and lamb cuts for which nutrient composition data already exists is extensive and covers both raw and cooked meats. A comparison of the available data against *Australian Nutrient Reference Values* (NHMRC, 2006) suggest there are few data gaps, except for vitamins D and K, and choline, and for biotin and amino acids in earlier studies.

A detailed examination of the available data suggests the nutrient content of Australian beef and lamb has remained stable over time. Levels of moisture, protein, iron and zinc have remained largely consistent between analyses on samples collected between 1982-1985 and 2002. There were some methodological differences between studies including sampling procedures, incomplete gross composition and homogenization of samples, and nutrient analytical techniques. However, differences in the levels of nutrients analysed were minimal.

Findings from agricultural studies suggest that within the context of Australian red meat production systems, the influence of breed and feeding regime on the nutrient content of red meat is small.

- Ruminants convert alpha-linolenic acid (ALA) in grasses into long-chain omega-3 fatty acids (Ponnampalam et al., 2006). The amounts produced vary according to the type of grass, climatic conditions and number of days feeding on grain (Sinclair and O'Dea, 1987; Mann et al., 2003).
- Within the context of the predominantly grass-fed Australian red meat production system, differences in the omega-3 content of meat according to the number of days of grain-feeding are small. Ponnampalam and colleagues (2014a, 2014b) found only minor effects of breed on levels of long chain omega-3 polyunsaturated fatty acids (LCPUFA) in Australian sheep, equivalent to around 2 mg per 100 g (EPA+DHA).

- Iron and zinc levels of lamb produced in three different locations in Australia and breeding practices aimed at increasing meat yield did not influence iron and zinc levels (Pannier et al., 2010; Pannier et al., 2014). Similarly, there was no difference in the vitamin D content of beef produced in tropical regions compared to Tasmania (Liu et al., 2013).
- Marbling refers to intramuscular fat, which unlike separable fat, can't be removed with a sharp knife. Whilst some breeds, such as Wagyu, accumulate more fat intramuscularly compared to other breeds (Lawrie, 1991; Schenkel et al., 2004), the level of marbling is largely determined by the type of feeding regime.
- The influence of feeding regime on the amount of intramuscular fat (marbling) and separable fat of meat is mainly a function of its influence on rate of growth. Hence, heavier, 'well fed' animals tend to have more marbling and separable fat (Warren et al., 2008).
- There is also a slight increase in the proportion of monounsaturated fatty acids and a decrease in polyunsaturated fatty acids in beef as duration of grain feeding increases, however in absolute amounts this difference in overall fatty acid composition is negligible (Duckett et al., 1993).
- Marbling tends to become apparent in meat after 150 to 200 days on grain. However, marbling tends to be low in Australian red meat where grain-feeding is on average between 80 to 100 days. Grain feeding which involves 300 days or longer on grain-based diets represents a small percentage of overall production and is used to produce meat for niche markets only.

3.2 Nutrient content by type of lean meat

Taking into consideration methodological differences between studies, findings suggest that the nutrient content of meat produced from cattle, sheep and goats are similar. Differences in the nutrient content of meat from cattle, sheep and goat meat is within the expected range of natural variability, except for iron content, which increases with age of the animal. Hence, iron content is higher in beef and mutton compared to veal and lamb, respectively. Table 2 compares the nutrient content of separable lean and fat components for beef, veal, lamb, mutton and goat meat.

3.3 Type of cut

A comparison of the nutrient profile of different cuts of lean beef and lamb is presented in table 3. Across all cuts and analytical programs, protein and fat content averaged 22.6 ± 2.0 and 3.3 ± 1.4 g per 100 g for beef (mean ± SD), and 21.1 ± 1.8 and 4.4 ± 1.5 g per 100 g for lamb, respectively. For those cuts where there was more than one analysis of the separable lean, the variation in fat and protein contents within the cut was often comparable to or greater than the variation across all cuts (assessed as mean ± SD). For example, the protein and fat content of the separable lean of beef sirloin steak varied from 21.4 to 24.1 g per 100 g protein and from 1.9 to 6.9 g per 100 g fat, respectively. While lamb loin chops ranged from 20.6 to 28.6 g per 100 g protein, and 3.9 to 6.5 g per 100 g fat.

There was a similar trend of variability within cuts for iron and zinc levels. For iron, levels in beef fillet and lamb shoulder ranged from 2.2 to 3.5 mg per 100 g in beef and 1.4 to 2.2 mg per 100 g in lamb, compared to overall mean values of 2.0 ± 0.5 and 2.1 ± 0.4 mg per 100 g for beef and lamb, respectively. For zinc, beef blade ranged from 3.7 to 4.8 mg per 100 g and lamb shoulder from 4.0 to 5.5 mg per 100 g compared to overall mean values of 4.2 ± 1.0 and 3.7 ± 1.0 mg per 100 g for beef and lamb, respectively.

Table 2. Summary of nutrient data for separable lean and fat of raw red meat, including beef, veal, mutton, lamb, and goat

Meat type and part	Proximates			Minerals				Vitamins		Fatty acids[2]	
	Moisture g	Protein g	Fat g	Iron mg	Zinc mg	Phosphorus mg	Selenium µg	Vitamin B3[2] mg	Vitamin B12 µg	Saturates %	LCPUFA %
Separable lean											
Beef	73.6	22.9	3.0	1.9[1]	4.2	217	9	5.0	1.1	41.8	2.8
Veal	76.1	22.8	1.4	1.4	3.5	260	0	16.0	1.6	38.5	6.0[2]
Mutton	73.2	21.5	4.0	6.6	3.9	290	0	8.0	2.8	41.3	3.3
Lamb	73.4	21.1	4.3	2.2	3.7	232	22	5.4	0.9	38.7	1.9
Goat	74.9	22.0	1.8	2.6	4.2	185	12	3.6	1.0	47.8	2.0
Separable fat											
Beef	25.4[1]	12.1[1]	61.4[1]	1.3	0.9	87	0	2.0	2.9	44.8	0.04
Veal	51.1	19.4	30.2	1.1	1.6	110	0	3.0	3.0	51.4	0.2
Mutton	28.8	8.2	64.4	0.8	1.0	88	0	5.0	2.9	47.4	0.3
Lamb	32.9[1]	11.2[1]	55.7[1]	0.4	0.5	56	0	2.0	2.9	48.4	0.3
Goat	45.4	12.2	44.6	2.0	1.2	78	6	1.5	1.5	57.5	0.2

LCPUFA, long chain polyunsaturated fatty acids

Values are per 100 g edible portion and, for separable lean, are averaged over different analytical programs since the mid-1980s, where comparable samples and methods of analysis were used.

[1] For beef and lamb separable fat, where production or processing conditions are known to have changed substantially since a dataset was generated, only more recent and comprehensive data (2002) was used.

[2] Where methods of analysis are known to have changed substantially since a dataset was generated, only newer data (2002) was used. Selenium and B12 values are based on small datasets with a proportion on non-detections (reported as <Limit of Reporting); non-detections treated as zero for calculation and reporting purposes.

Table 3. Mean nutrient composition of the raw, separable lean of Australian beef and lamb, per 100 g edible portion, by cut and overall mean

Cut	Samples[2] (*n*)	Moisture (g/100g)	Protein (g/100g)	Fat (g/100g)	Iron (mg/100g)	Zinc (mg/100g)
Beef separable lean						
Shin	1	76.1	21.9	0.6	1.9	4.9
T-bone	1	72.9	24.4	2.0	2.2	3.8
Silverside	2	75.1	23.2	2.3	1.9	3.2
Skirt	1	74.7	22.5	2.4	1.9	5.5
Diced or strips	2	71.7	27.6	2.4	1.7	5.7
Rump	2	73.7	21.9	2.7	2.5	4.1
Round	3	74.0	21.0	3.0	1.7	4.1
Chuck	2	74.5	21.8	3.2	2.0	6.5
Topside	3	73.5	20.5	3.7	1.7	3.0
Rib or rib eye	2	72.8	22.4	4.1	2.4	4.3
Blade	3	73.4	21.2	4.2	2.0	4.4
Sirloin	3	72.0	22.8	4.5	1.9	3.5
Fillet	2	74.1	21.9	4.7	2.9	3.6
Mean	n=28	73.5	22.6	3.3	2.0	4.2
SD		1.4	2.0	1.4	0.5	1.0
RSD[1] (%)		2	9	42	24	24
Lamb separable lean						
Shin	1	73.0	23.9	1.9	1.9	5.7
Topside steak or roast	3	74.4	21.0	2.9	2.5	3.0
Leg	3	73.5	21.5	3.3	2.2	3.4
Round	2	75.0	19.9	3.5	2.2	4.8
Diced or strips	3	74.0	21.1	3.6	2.6	3.5
Shoulder	2	75.2	19.4	3.9	1.8	4.8
Fillet	1	73.9	19.8	4.0	2.1	2.9
Loin chop or steak	6	71.5	22.5	4.9	1.8	2.5
Butterfly steak	1	73.1	20.6	4.7	2.5	2.6
Trim lamb mini roast	1	73.9	21.9	4.7	2.6	4.0
Chump	3	73.2	21.1	5.0	2.3	3.5
Cutlets	1	74.0	21.9	6.7	2.1	2.9
Neck	2	71.9	19.7	7.1	1.7	4.8
Mean	n=29	73.4	21.1	4.4	2.1	3.7
SD		1.9	1.8	1.5	0.4	1.0
RSD[1] (%)		3	8	33	19	29

SD, standard deviation; RSD, relative standard deviation

[1] RSD = (SD/mean)*100 [2] For protein, n=24 in total

These differences are within the expected range of natural variability and suggests type of cut is not a major determinant of the nutrient content of lean Australian red meat.

3.4 Cooking method

Except for moisture content, differences between raw and cooked meat for other nutrients are small and most likely explained by concentration due to moisture loss and natural variability between samples.

A study reporting the nutrient content of raw, pan-fried and barbequed sausages also found small differences between raw and cooked samples, including fat content (Cunningham et al., 2015). The fat content of raw, medium fat sausages was 13.8 g per 100 g, 14.5 g per 100 g pan-fried sausage, and 15.4 g per 100 g barbecued sausage.

Moisture loss from cooking varies from 15 to 30 per cent according to 'dry' or 'wet' cooking method, the size and surface area of the meat cooked and the level of doneness. Moisture loss is similar for dry heat cooking (i.e. roasting and grilling or pan-frying without oil) and slightly lower for moist heat cooking (i.e. boiling, poaching, stewing). The surface area to volume ratio influences moisture loss with moisture levels slightly higher in roasting pieces of meat than steaks or chops.

Since many variables determine the amount of moisture loss, it is difficult to accurately predict the weight conversion from raw to cooked meat. However, these findings suggest that other than moisture loss, the impact of cooking on the nutrient content of Australian beef and lamb is small. A summary of aggregated data for raw and cooked beef and lamb by cooking method is presented in table 4.

3.5 Level of trim of meat available for purchase

As the amount of separable fat increases, the energy and fat/fatty acid content increases while the moisture, protein, iron and zinc content remain largely unchanged. The location and amount of separable fat is determined by butchering practices. Specific cuts, such as fillet, have no selvedge or intermuscular fat, whereas sirloin steak has only selvedge fat and rump steak both intermuscular and selvedge fat.

There is a wide within-cut variation in the proportion of separable fat of retail cuts. For example, among the samples reported by Williams and colleagues (2006), the proportion of separable fat ranged from 3-21% in blade steak, and from 2-26% in lamb mini roasts. Similarly, a study of fifteen representative beef and lamb cuts found wide variability in the external fat width of cuts (Cobiac et al., 2003). The amount of selvedge fat of the same retail cut can vary from 0 to 5 mm due to the natural variability that occurs between animals.

A study involving the sampling of key foods, including rump steak and beef mince, did not identify any trends in composition related to location of purchase (FSANZ, 2006). Retail studies have consistently reported little differences in the type of meat available for purchase according to state, region or suburbs based on socio-economic status (Cobiac et al., 2003; Fayet-Moore et al., 2014).

Table 4. Summary of nutrient data for raw and cooked separable lean and fat of beef and lamb[3]

Meat type	Proximates			Minerals				Vitamins	
	Moisture g	Protein g	Fat g	Iron mg	Zinc mg	Phosphorus mg	Selenium µg	Vitamin B3[2] mg	Vitamin B12 µg
Separable lean									
Beef, raw	73.7	23.0	2.6	1.9	4.2	214	9	4.7	1.16
Beef, roasted	63.5	31.1	4.3	2.7	4.7	225	8	3.4	1.50
Beef, grilled or pan fried	63.0	31.4	5.0	2.9	6.5	263	10	3.2	1.80
Beef, stewed	60.1	34.6	5.4	2.8	10.0	217	8	4.2	2.12
Lamb, raw	73.4	21.1	4.3	2.2	3.7	232	22	5.4	0.95
Lamb, roasted	62.4	29.1	7.6	2.3	5.3	264	17	5.1	1.93
Lamb, grilled or pan fried	62.0	29.5	7.3	3.0	4.4	277	28	6.4	1.69
Lamb, stewed	56.4	33.5	9.1	3.2	9.8	-	-	3.2	-
Separable fat									
Beef, raw	18.7	7.6	75.0	1.0	0.6	52	0	2.0	2.9
Beef, cooked	21.4	11.0	70.9	1.3	1.0	109	0	1.4	2.10
Lamb, raw[3]	30.4	16.2	53.4	0.7	1.0	82	0	7.0	3.00
Lamb, cooked	21.5	9.7	67.1	1.1	1.3	99	3	4.0	1.11

Values are per 100g edible portion and averaged over different analytical programs since the mid-1980s, where comparable samples and methods of analysis[1] were used

[1] Where production or processing conditions are known to have changed substantially since a dataset was generated, only more recent data (2002) was used.

[2] Where methods of analysis are known to have changed substantially since a dataset was generated, only more recent data (2002) was used. Selenium and vitamin B12 values are based on small datasets with a proportion on non-detections (reported as < limit of reporting).

[3] Includes older values with lower moisture content to build a larger dataset for comparison of cooking effects, therefore some values may be different to those listed in table 3.

There has been a trend towards greater availability of lean retail meat over time. Williams and Droulez (2010) compared the proportion of separable fat in common beef, lamb and veal cuts and found reductions in separable fat between 19 and 60% between 1983 and 2002. For example, the proportion of separable fat in samples of beef rump steak decreased from 18 to 12 per cent, respectively and lamb shoulder from 17 to 13.8%, respectively. This trend towards greater availability of lean meat was also observed in a study of beef mince (61 samples) with an average of 4.1 g fat per 100 g (raw weight) reported in 48 per cent of samples (Fayet-Moore et al., 2014). Similarly, a study of beef sausages found the average fat content was 30 per cent lower than previously reported and varied from 7.3 g to 22.6 g per 100 g, raw weight (Cunningham et al., 2015).

The findings highlight the importance of monitoring the proportion and location of separable fat of retail cuts. The nutrient profile of raw beef and lamb with different levels of trim, using the average and maximum proportion of separable fat is presented in table 5.

Table 5. Nutrient profile of raw beef and lamb estimated based on hypothetical proportions[1] of separable lean and separable fat

	Separable lean (%)	Separable fat (%)	Moisture (g/100 g)	Protein (g/100 g)	Fat (g/100 g)	Iron (mg/100 g)	Zinc (mg/100 g)
Beef							
Separable lean	100	0	73.5	22.6	3.3	2.0	4.2
Semi-trimmed average	96	4	71.4	22.0	6.0	2.0	4.1
Untrimmed average	92	8	69.4	21.4	8.7	2.0	3.9
Untrimmed maximum	88	12	67.3	20.9	11.3	2.0	3.8
Lamb							
Separable lean	100	0	73.4	21.1	4.4	2.1	3.7
Semi-trimmed average	91	9	68.8	19.9	10.3	2.0	3.4
Untrimmed average	86	14	66.2	19.2	13.6	2.0	3.3
Untrimmed maximum	75	25	60.5	17.7	20.8	1.8	3.0

[1] Proportions of separable fat and lean are derived from Williams et al. (2006). Semi-trimmed contain only internal separable fat (inter-muscular fat only); whereas untrimmed contain either the average proportion of internal and external (selvedge fat, on the outside of cuts) (untrimmed average) or the maximum proportion reported for that species (untrimmed maximum).

3.5 Level of trim of meat as consumed

A review of data from the *Typical Recipes study* (2020) revealed a discrepancy between the type of cut used to prepare the meal and participant's reported trimming practices. For example, participants described trimming practices for meat purchased lean as 'untrimmed' instead of 'lean'. Similarly, the level of trim for sirloin steak after removal of selvedge fat during meal preparation was described as 'semi-trimmed', instead of 'lean' (MLA Typical Recipes study, 2020).

Following consultation with key internal and external stakeholders, the following adjustments were made to better align products purchased with level of trim of meat as consumed:

- Cuts typically available for purchase with little to no separable fat (i.e. diced, strips and fillet) which were reported by participants as 'untrimmed', were subsequently categorised as 'lean' meat.
- The level of trim of cuts, reported as 'semi-trimmed', which do not have intermuscular separable fat (e.g. sirloin steak), were subsequently categorised as 'lean' meat.
- Cuts, such as gravy beef and lamb shank, with high levels of silver skin and little separable fat, were categorised as 'lean'.
- A survey previously reported 48% of mince samples available for purchase was lean (Fayet-Moore et al., 2014), therefore 'lean' mince was used in the study. Furthermore, the study found that descriptors at point-of-sale are not always indicative of the amount of fat content in mince available for purchase.
- Since scotch fillet is sold either with or without selvedge fat, depending on its position in the carcase, the percentage of 'untrimmed' was halved and attributed to percentage of 'semi-trimmed'. This is due to less selvedge fat on scotch fillets cut from the tenderloin end of the primal compared to chuck.
- The percentage of participants who consumed gravy beef and lamb shank as 'lean' and 'semi-trimmed' was adjusted according to trimming practices reported for cuts with similar amounts and location of separable fat.

Adjustments were then applied to the number of participants who reported consuming meat as 'lean' and 'semi-trimmed'.

Popular products as a percentage of total usage are presented in table 6. The findings are consistent with data and insights reported in studies about popular meals and practices (MLA, 2011; MLA, 2013).

Table 7 describes the location of separable fat for popular retail cuts as purchased and its level of trim as consumed. The findings suggest retail cuts purchased lean or cuts with only selvedge fat are more likely to be consumed lean compared to those with intermuscular fat. The findings suggest the most popular retail cuts are consumed lean.

An evaluation of data describing popular product usage (tables 6 and 7) to the corresponding level of trim, as consumed, suggests almost three quarters of Australians eat beef and lamb 'lean' and 'semi-trimmed', with most (65%) beef and lamb eaten lean.

Table 6. Popular retail cuts as a percentage of total usage

Retail cut	Type of meal	Beef (%)	Specific beef cuts		Lamb (%)	Specific lamb cuts	
Mince	Pasta, Mexican, Burger, rissoles, meatballs, pie/bake, sandwich/wrap	40%			12%		
Strips/Diced	Soup, salad, stir-fry	20%			18%		
Steaks/chops	'Meat and veg' style meal	24%	Rump Sirloin/T-bone Fillet/blade Scotch fillet	9% 6% 6% 3%	38%	Loin chops Leg steak Cutlets Forequarter chops Chump chops Backstrap	11% 9% 8% 5% 3% 2%
Roast	'Meat and veg' style meal	9%	Blade/rump Topside Corned beef	4% 3% 2%	18%	Leg Mini-roast Loin	11% 4% 3%
Slow Cooked	Curry, casseroles, stew, ragout	7%	Chuck Shin/gravy	4% 3%	14%	Shoulder Shanks	7% 7%

Table 7. Level of trim of retail cuts, as consumed (MLA Typical Recipes study, 2020)

Popular products	Level of trim	
	Location of separable fat	**As consumed**
Mince	48% lean; 21% medium fat; 31% higher fat	
Strips or diced	No selvedge fat No intermuscular fat	90% lean
Beef Fillet* Beef Oyster Blade* Lamb backstrap	No selvedge fat No intermuscular fat	90% lean
Beef Sirloin* or T-bone**	Selvedge fat No intermuscular fat	65% lean
Beef Rump*	Selvedge fat Intermuscular fat	60% lean; 20% semi-trimmed
Beef Scotch fillet*	Selvedge fat (variable) Intermuscular fat	30% lean; 40% semi-trimmed
Lamb leg steak Lamb rump steak Schnitzel Minute steak Medallions	No selvedge fat No intermuscular fat	90% lean
Lamb loin chop	Selvedge fat No intermuscular fat	60% lean
Lamb forequarter chop	Selvedge fat intermuscular fat	50% semi-trimmed
Lamb chump chop	Little Selvedge fat No intermuscular fat	80% lean
Lamb French cutlet	No selvedge or intermuscular fat	Lean
Lamb cutlet	Selvedge fat No intermuscular fat	60% lean
Beef blade	Selvedge fat intermuscular fat	65% lean; 20% semi-trimmed
Beef rump	Selvedge fat intermuscular fat	60% lean; 20% semi-trimmed
Beef topside, Silverside, corned beef^	Little selvedge fat No intermuscular fat	80% lean
Lamb leg	Selvedge fat intermuscular fat	35% lean; 25% semi-trimmed
Lamb mini-roast	No selvedge fat No intermuscular fat	Lean
Lamb loin	Selvedge fat No intermuscular fat	50% lean
Diced	As above	Lean
Beef chuck	Selvedge fat Intermuscular fat	35% lean; 30% semi-trimmed
Beef gravy Diced Lamb shank	Little selvedge fat No intermuscular fat	90% Lean
Lamb shoulder	Selvedge fat intermuscular fat	40% lean; 40% semi-trimmed

*Level of trim for roasts tend to be the same for equivalent steak cut (i.e. sirloin steak has same level of trim as sirloin roast)
**T-bone is a sirloin and fillet separated by bone with typical trimming similar to sirloin
^Corned beef is typically made from topside or silverside roast but the sodium content is higher

3.6 Serving size

The median serving size of Australian beef and lamb in each of the twelve different types of meals prepared by participants in the study are outlined in table 8. The median serving size represents the combined findings of beef and lamb since for each type of meal, there was no difference in reported serving sizes between beef and lamb.

The median serving size across all meals was 130 g (raw weight) with an interquartile range of 97 to 209 g for beef, and 89 to 228 g for lamb. These findings are consistent with qualitative research where meal preparers reported typically purchasing meat to serve 100 to 200 g raw weight per person per meal (MLA, 2020; MLA Typical Recipes study, 2020).

Median portion sizes for meals prepared using mince and steaks were consistent with typical purchase weights. Mince is typically sold in 500 g packages and is generally used to serve four people. Similarly, the purchase weight of steaks and chops are generally around 100 g or 200 g (raw weight). Insights suggest shoppers purchase these cuts according to units, for example, half per person for large pieces such as rump steak, one per person for regular pieces such as sirloin steak, and two to three per person for small pieces such as chops or cutlet (MLA, 2020; MLA Typical Recipes study, 2020).

The findings confirm serving sizes are largely determined by the type of meal consumed. While participants used a variety of cuts to prepare meals, there were no differences in the median serving size of the meal. A secondary analysis of meal composition data reported in the *2011-2012 National Nutrition and Physical Activity Survey* showed similar serving sizes by type of meal consumed (Sui et al., 2017). A serving size of 150 g, raw weight, represents the approximate average of larger (200 g) and smaller (100-125 g) portion sizes of popular beef and lamb meals in the Australian diet (Table 8).

Table 8. Median serving size of beef and lamb* for popular meals

Type of meal	Serving size
Pasta	115 g
Mexican (i.e. tacos, burritos, nachos)	125 g
Burger, rissoles, meatballs	125 g
Pie or bake	125 g
Sandwich or wrap	115 g
Soup	115 g
Salad	125 g
Stir fry	140 g
Steak, regular	200 g
Steak, small	100 g
Chops, regular	150-200 g
Chop, small	80 g**
Roast	175 g
Curry	160 g
Casserole, stew, ragout	150 g

*Unless specified, product indicated refers to raw weight of beef and lamb

** Typical portion size ranges from 2 to 3 chops (160 to 240g raw weight)

Conclusion

Within the context of Australian red meat production system, the nutritional value of red meat is stable, with only minimal differences observed due to production practices, including breed and breeding practices, feeding regime and region of production. The findings suggest data available in the *Australian Food Composition Database* is extensive, representative of Australian red meat available for purchase, and features key nutrients required for marketing and advertising, nutrition communications, and public health policy purposes.

The available nutrient data set is sufficient for making nutrition claims for Australian red meat, including beef, veal, lamb, mutton and goat meat and represents key nutrients required to inform public health policy and food regulations. The findings suggest MLA should continue to monitor the scientific literature and only conduct further analytical studies of lean meat when evidence suggests analytical methods used to measure current nutrients are outdated, or when consumption of Australian red meat makes an important contribution to intake of a specific nutrient and where there is insufficient data currently available.

The energy and fatty acid content of Australian red meat is largely determined by the level of trim of meat as consumed. Differences in the location and amount of separable fat between retail cuts determines consumer trimming practices. For example, the most popular cuts are purchased and consumed lean, and cuts with selvedge fat only are more likely to be consumed lean than those with intermuscular fat.

The findings suggest combining data that describes the location and proportion of separable fat of retail cuts with popular usage data provides a better understanding of Australian red meat consumption and its contribution to energy, and fatty acid intake. Anecdotal evidence suggests poor product knowledge and confusion with terminology describing level of trim may contribute to the overestimation of the energy, total fat, and fatty acid content of Australian red meat.

The serving size is largely determined by the type of meal consumed and varies between 100 to 200 g, raw weight. Collecting consumption data from the main meal preparer within the context of popular meals and using photographs of the purchase weight, type of cut and number of serves prepared provides a better understanding of typical serving sizes of Australian red meat. Considering the wide variability in moisture loss as result of cooking, raw weight therefore provides a better indication of typical serving sizes than cooked weight. Anecdotal evidence suggests assumptions about serving sizes may contribute to an overestimation of total red meat consumption.

Level of trim and serving size are key determinants of the nutritional value of Australian red meat for both marketing and public health purposes. A food must meet specific conditions to make nutrient content claims (refer Food Standards Code, FSANZ). With public health priorities focused on addressing overweight and obesity and associated chronic diseases, it is important to maintain robust and up-to-date data on the energy, fat and fatty acid content of Australian red meat, as consumed.

The *Typical Recipes Study* provides a novel approach for maintaining up-to-date data on the average serving size of Australian red meat and typical trimming practices. Establishment of a *Typical Recipes Monitoring Study* is recommended to maintain up-to-date and robust data on product usage, including the location and amount of separable fat on popular retail cuts, typical consumer trimming practices, and common serving sizes.

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