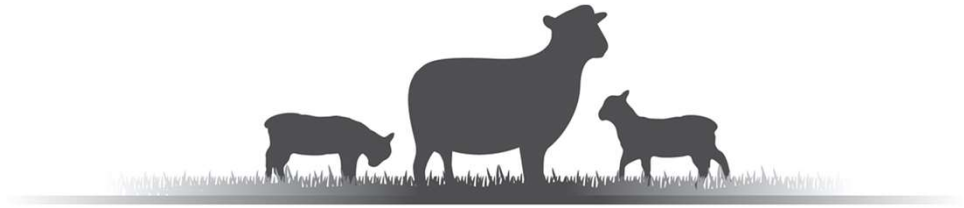
Slaughter age of 5, 8 & 14 months on collagen content, intramuscular fat and tenderness of lamb

Nicola Schreurs



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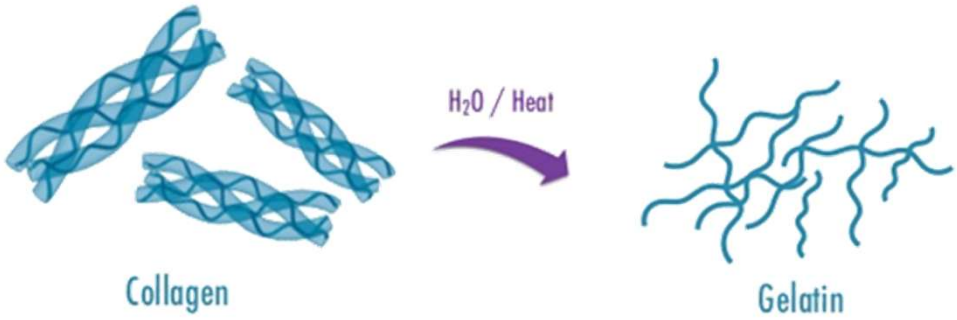
Why do we worry about meat quality?

- Food consumption has gone beyond just considering food for sustenance.
- Increasing food choices.
- Producers, more than ever, need to understand what consumers seek and tailor food to meet consumer specifications.
- Lack of knowledge as to how on-farm treatments influence meat eating quality.

What is intramuscular fat & collagen?

Intramuscular fat

- Fat located within the muscle (between the muscle bundles).
- Known as marbling
- Measured chemically (ether extraction)
- 0-30% of muscle.



Collagen

- Protein – 3 chains
- Important role in muscle structure
- Is soluble with heat (cooking)
- Increased crosslinking with age reduces the solubility
- 1-6% of muscle

Collagen

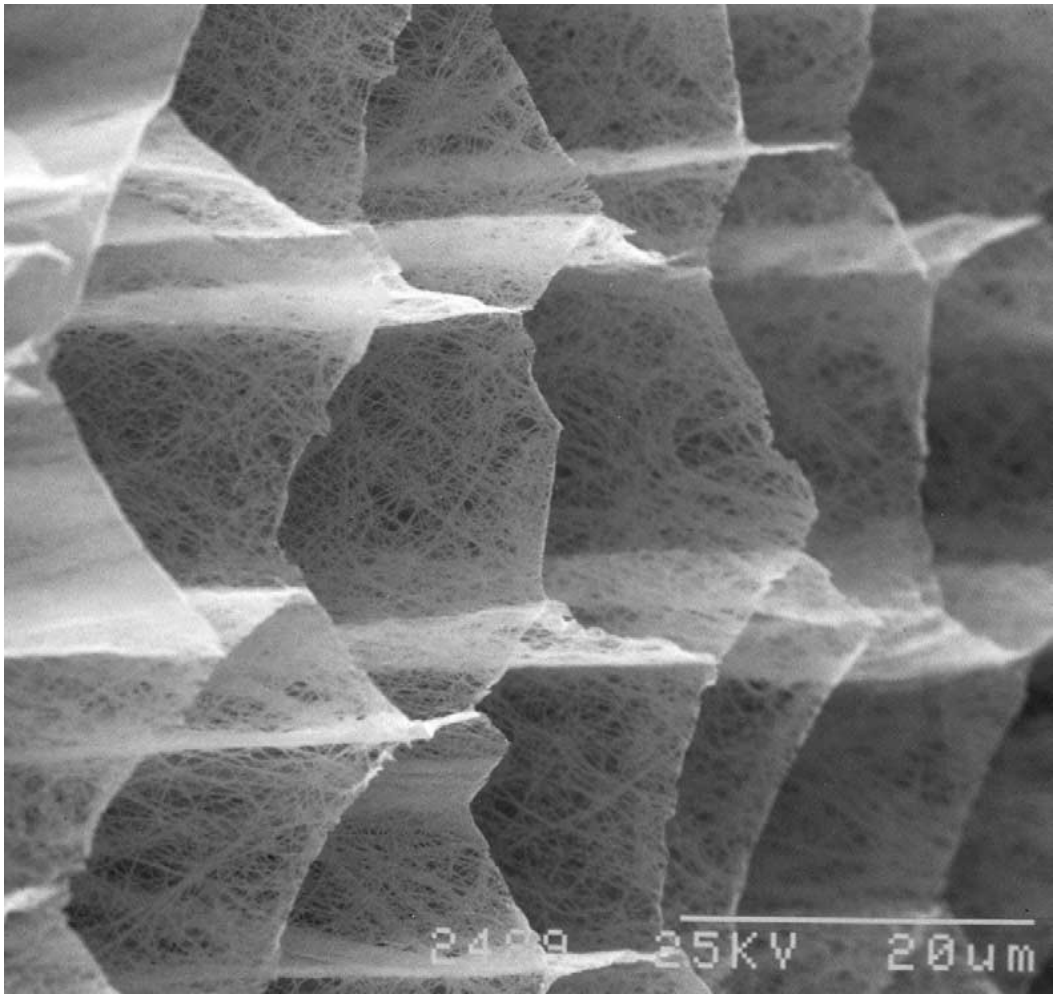
The muscle is a very organised structure:

- It needs to be for muscle contraction
- Collagen helps to maintain the structure

Surrounds:

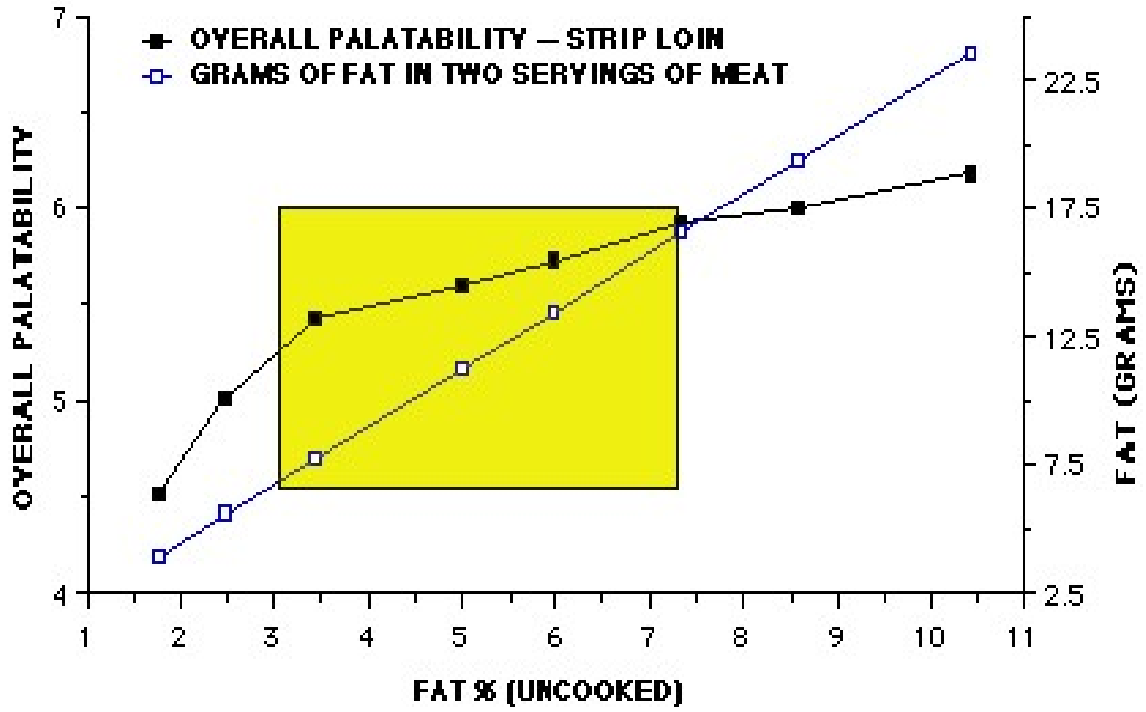
- Muscles
- Bundles of muscle fibres
- Individual muscle fibres

Also collagen molecules run along and across the muscle fibres



Purslow 2005; Meat Science

Intramuscular fat & meat quality.



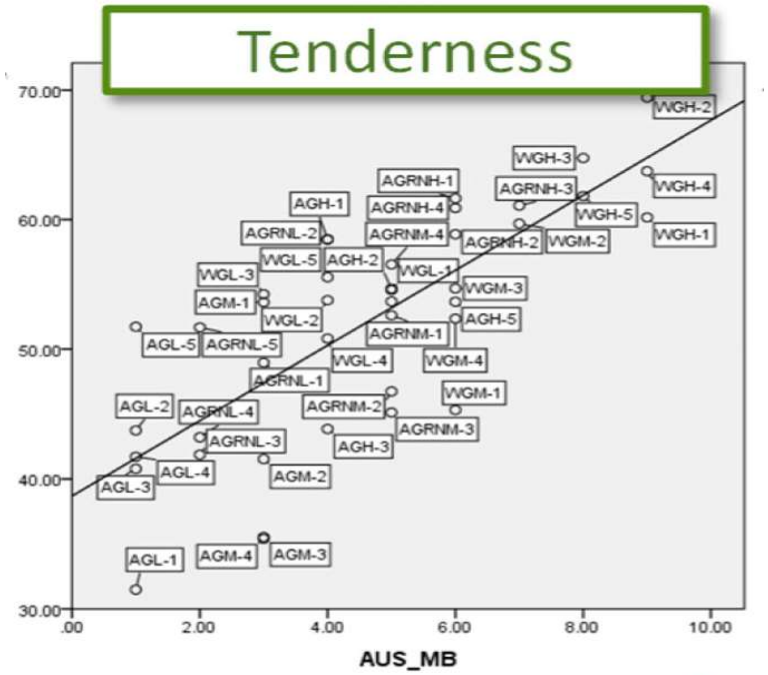
Savell & Cross (1988)
In: Designing Foods, National Academy Press.

Studies with lamb in Australia indicated:

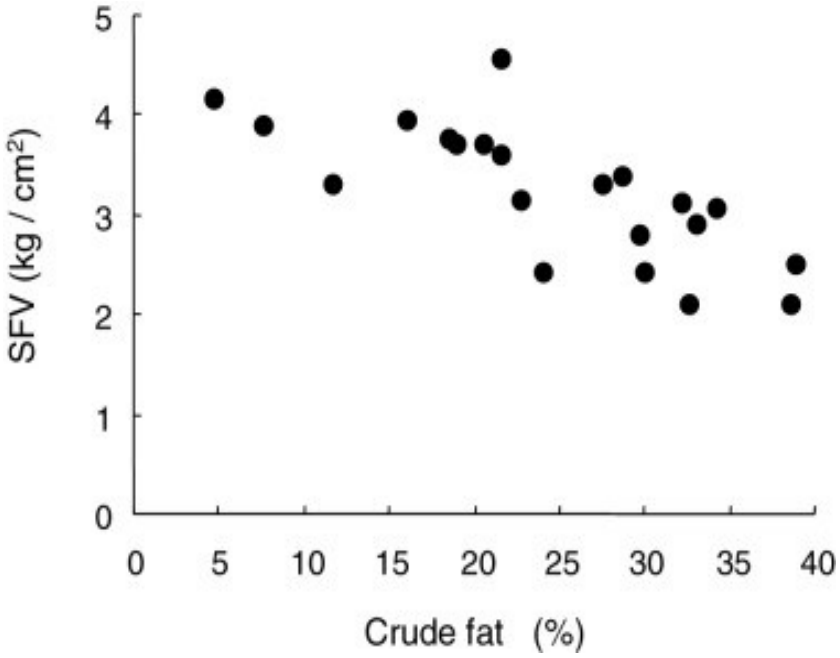
- IMF of 5% or more required to get high palatability score
- Intramuscular fat explained only 3% of variation in palatability.

Hopkins et al (2006);
Aust J Exp Agric

Intramuscular fat & meat quality.



Frank et al (2016);
Korean J Food Sci An



Ueda et al (2007);
Animal Science Journal.

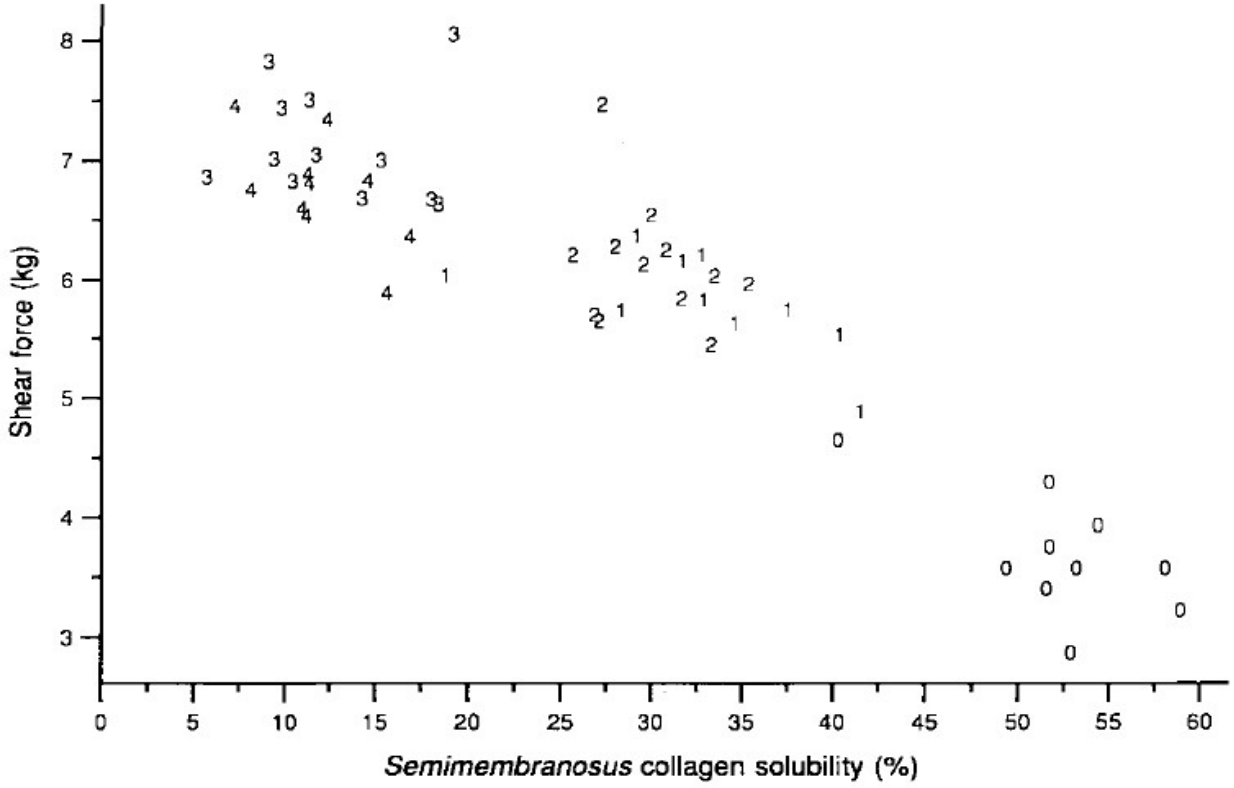
Collagen and meat quality

Correlations - beef quality.
Jeremiah et al (2003); Meat Science

	Tenderness	Palatability
IMF	0.21	0.002
Total collagen	-0.38*	-0.48*
Insoluble collagen	-0.51**	-0.59***

Influence of collagen solubility in lamb
Young et al 1993; NZJAR

0 = birth
1 = 42 days (1.4 mth)
2 = 70 days (2.3 mth)
3 = 274 days (9 mth)
4 = 365 days (12 mths)



What we wanted to achieve from this research

- Consider the effect **slaughter age** has on meat quality
  - when are meat quality issues likely to occur?
- Look at the **interaction** of collagen and intramuscular fat on meat quality.
- Low animal numbers but:
  - provided a mechanism to develop collagen methods.
  - a start for considering multifactorial aspects of lamb meat quality

The research

60 spring-born lambs, slaughtered at:

- 5 months
- 8 months
- 14 months

Loins collected – objective meat quality tests:

- 10 samples each slaughter age for IMF
- 14 samples each slaughter age for collagen

Correlations and regressions

Results – Live weight and carcass

	Slaughter age (months)			P-value
	5	8	14	
Final live weight (kg)	42.1 ^{c}	45.0 ^{b}	61.6 ^{a}	**<0.001**
Carcass weight (kg)	16.8 ^{b}	18.2 ^{b}	28.3 ^{a}	**<0.001**
Dressing out (%)	40.0 ^{b}	40.7 ^{b}	46.2 ^{a}	**0.002**
GR (mm)	4.01^{b}	5.64 ^{b}	11.27 ^{a}	**<0.001**
Lean meat yield (%)	54.3 ^{a}	54.4 ^{a}	51.6 ^{b}	**0.018**
Intramuscular fat (%)	2.5 ^{b}	3.0 ^{b}	3.8 ^{a}	**0.003**
Number with 2 incisors	0	0	7	

Results – Meat Quality

	Slaughter age (months)			P-value
	5	8	14	
Intramuscular fat (%)	2.5 ^{b}	3.0 ^{b}	3.8 ^{a}	**0.003**
pH	5.54 ^{a}	5.42 ^{b}	5.45 ^{b}	**<0.001**
*L** (Lightness)	37.8 ^{b}	39.1 ^{a}	39.2 ^{a}	**0.045**
*a** (Redness)	13.2 ^{b}	13.3 ^{b}	15.1 ^{a}	**<0.001**
*b** (Yellowness)	3.59 ^{b}	3.33 ^{b}	4.53 ^{a}	**<0.001**
Shear force (kgF)	6.87 ^{b}	7.98 ^{a}	5.72 ^{c}	**<0.001**
Total collagen (% of lean muscle)	0.96 ^{a}	0.87 ^{a}	0.62 ^{b}	**0.020**
Soluble collagen (% of total col)	43.1 ^{a}	32.2 ^{ab}	22.4 ^{b}	**0.007**

Correlations

	IMF	Soluble collagen	Total collagen
Shear Force	-0.08	0.05	0.04
Significance	NS	NS	NS

No correlation:

- Not surprising given small number of samples
- Quite substantial variation between animals
- Likely to be many factors which influence shear force values

How much variation in shear force is explained by intrinsic determinants?

Variable	Partial R^2 (%)	Additive R^2 (%)
Soluble collagen	5.1	5.1
IMF	2.2	7.3
Expressed Juice	2.8	10.1
Total collagen	9.0	19.1
Sarcomere Length	0.1	19.2

Hopkins et al (2006); APS

- Sensory analysis of lamb from four experiments.
- 471 lambs

	Tenderness
Multivariate model	
Intercept	75.5 ± 2.74
Shear force (N)	−0.62 ± 0.08
Intramuscular fat (%)	1.68 ± 0.29
Cooking loss (%)	—
Age (months)	−0.25 ± 0.04
R^2	23.7
r.s.d.	9.1

Conclusions

- Meat from the 14-month old sheep not the toughest (not expected)
  - Appears to be interacting role of collagen solubility and IMF content
  - Hogget downgrade justified?
  - Other factors to consider.

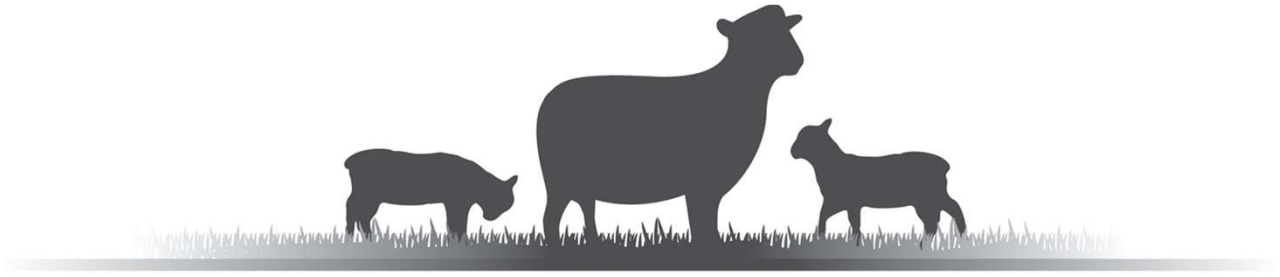
- Correlations poor, little variation in shear force between animals explained by collagen & IMF
  - Multiple factors likely to be involved

Other studies happening

- Carcass characteristics and meat quality of early weaned lambs (n = 300)
- Carcass characteristics and meat quality measurements correlated to genotype (n = 700)
- Development of a database combining on-farm treatments, carcass characteristics and meat quality

Comparison of castrate and entire ram-lambs for meat quality and skatole in the fat.

Nicola Schreurs



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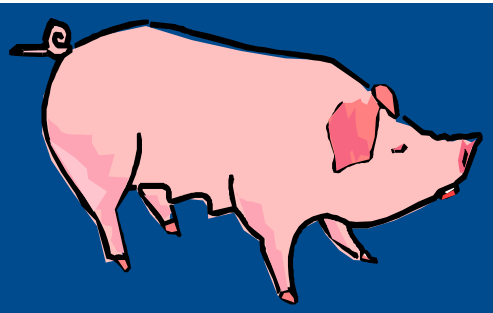

Lessons from pigs

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Boar taint: undesirable flavour in pork.

- Androstenone: sex steroid.
- Skatole: (3-methylindole): produced in hind-gut from tryptophan.

Threshold concentration for skatole detection: 0.25 µg/g

- Norwegian taste panel: 0.1 µg/g (Lunde *et al*., 2010).
- Singaporean taste panel: 0.03 µg/g (Leong *et al*., 2011).

Sheep also produce skatole

- In rumen from tryptophan.
- Pasture diet = high soluble protein.
- No scientific evidence of “ram taint”.

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Method

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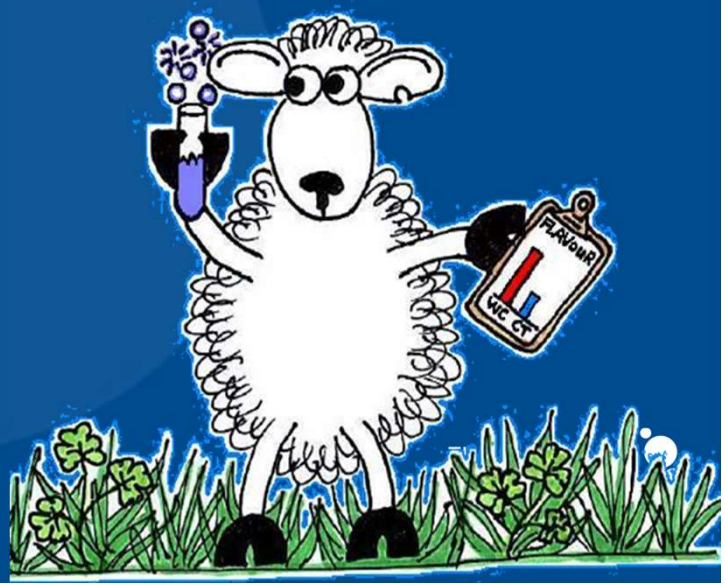
- 19 castrated males and 19 entire males
  - Weaned
  - 5-months old
- Grazed together on Autumn pasture for 70 days
- Live weight at start and end
- Slaughtered at commercial abattoir
- Loins (*Longissimus dorsi*), frozen after 48 hrs chilling
  - Warner Bratzler shear force
  - Colour (L* a* b*)
  - pH
- Intermuscular fat from hind legs
  - Skatole concentration by GCMS



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Growth performance

	Entire	Castrate	P-value (T-test)
Live weight at start (kg)	40.3 ± 0.7	37.7 ± 0.6	0.012
Live weight at end (kg)	51.5 ± 1.1	46.6 ± 0.5	<0.001
Liveweight gain (g/day)	160 ± 10	127 ± 5	0.006
Hot carcass weight (kg)	22.0 ± 0.3	20.5 ± 0.3	0.004
GR fat depth (mm)	10.4 ± 0.8	13.5 ± 0.8	0.009

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Meat quality

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	Entire	Castrate	P-value (T-test)
pH	5.68 ± 0.02	5.70 ± 0.02	NS
L*	39.5 ± 0.4	39.3 ± 0.4	NS
a*	13.0 ± 0.3	12.5 ± 0.3	NS
b*	4.0 ± 0.2	3.7 ± 0.2	NS
Warner Bratzler (log kgF)	1.97 ± 0.06	1.88 ± 0.06	NS
Warner Bratzler (kgF)	7.19	6.52	

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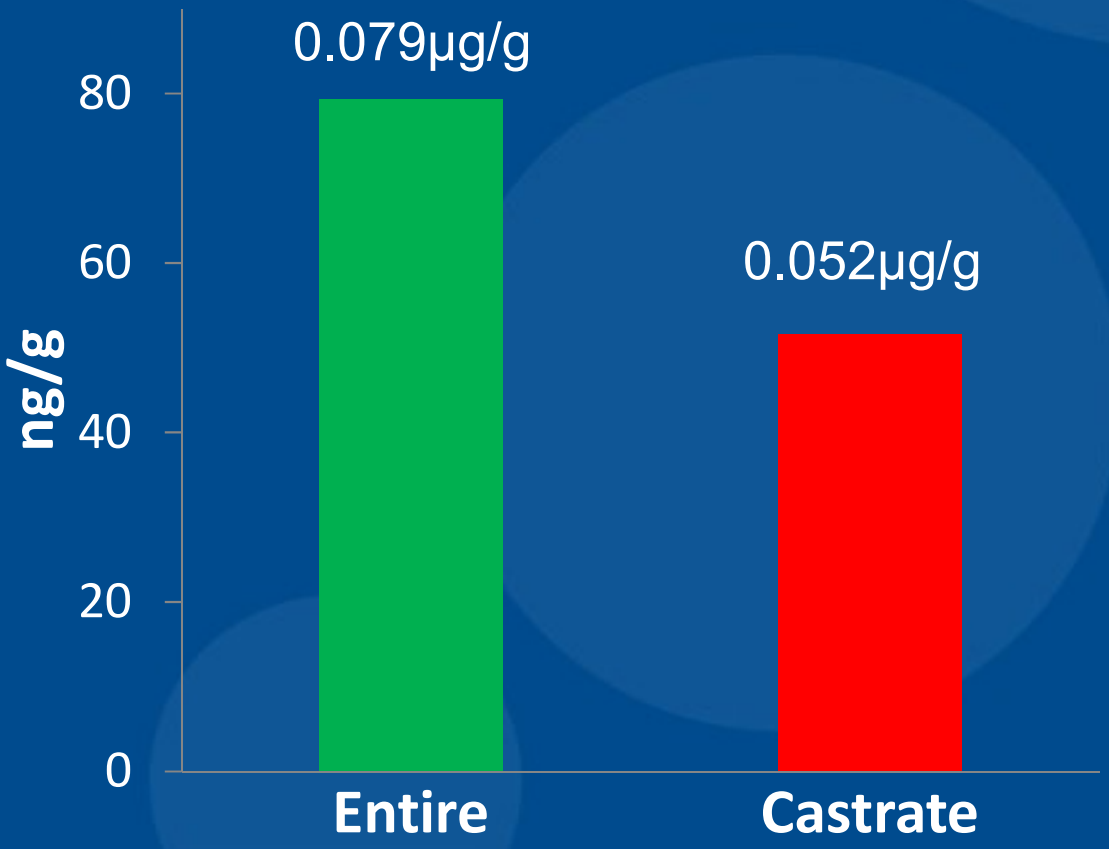
Skatole in the fat

	Entire	Castrate	P-value (T-test)
Skatole (log ng/g)	4.37 ± 0.14	3.94 ± 0.14	0.03



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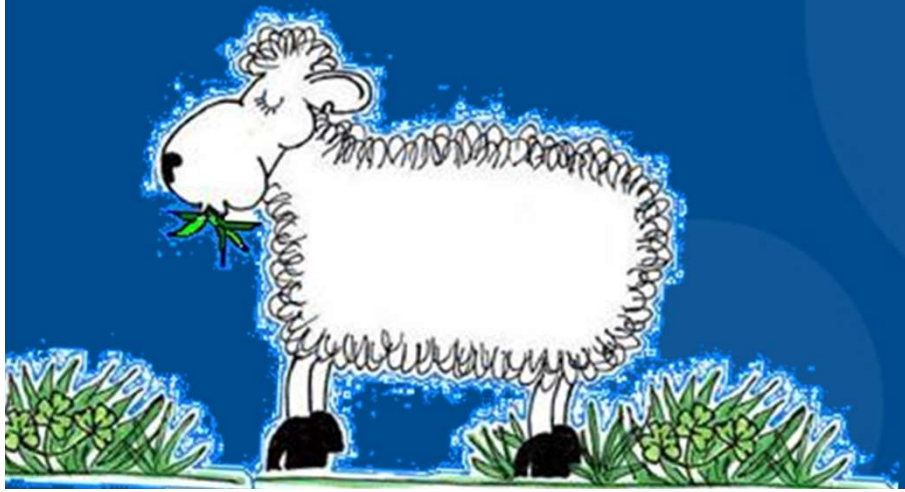
Conclusions and Implications

- Ram lamb better growth performance.
- Ram lamb not associated with poorer quality meat compared to castrate.
- Skatole higher in fat from ram lamb.
  - But concentration below detection threshold
  - Flavour issues likely to be dependent on the market



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