

AKC 2024

Gastrointestinal nematode infection as a model for the impact of chronic stress on meat quality

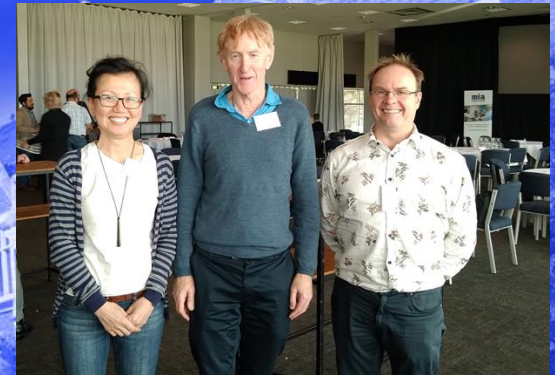
Hannah Y-Y. Lee¹, Alastair B. Ross², Andy Greer¹, Sandy Slow¹,
James D. Morton^{1*}

¹Lincoln University

²AgResearch Lincoln



LINCOLN
UNIVERSITY
TE WHARE WĀNAKA O AORAKI



agresearch
āta mātai, mātai whetū



Living in Lincoln

Our campus is in the Lincoln township, a thriving semi-rural community of around 8000 people.



LINCOLN
UNIVERSITY
TE WHARE WĀNAKA O AORAKI

This study has been brought to you by...

Lincoln University

Dr. Andy Greer (Parasitology)

Dr. Sandy Slow (Animal Science)

Prof. Jim Morton (Meat Science)

Martin Wellby (Animal Science)

Denise Coppens (Parasitology lab, JML)

Robin McAnulty (Parasitology lab, JML)

Rebecca McCracken (Animal Care, JML)

James Meyer (Ashley Dean Sheep farm)

Kelly-Anne Bentley (M.Sc) MIA PG Scholarship 2024

Ben Gibbs (M.Sc Dissertation project)

Katelyn Garbes (B.Sc research project)

Zhuoyi Fei (B.Sc research project)

AgResearch Ltd

Dandan Mou

Vanessa Ruppert

Erin Lee

Dr. Olle Hartvigsson

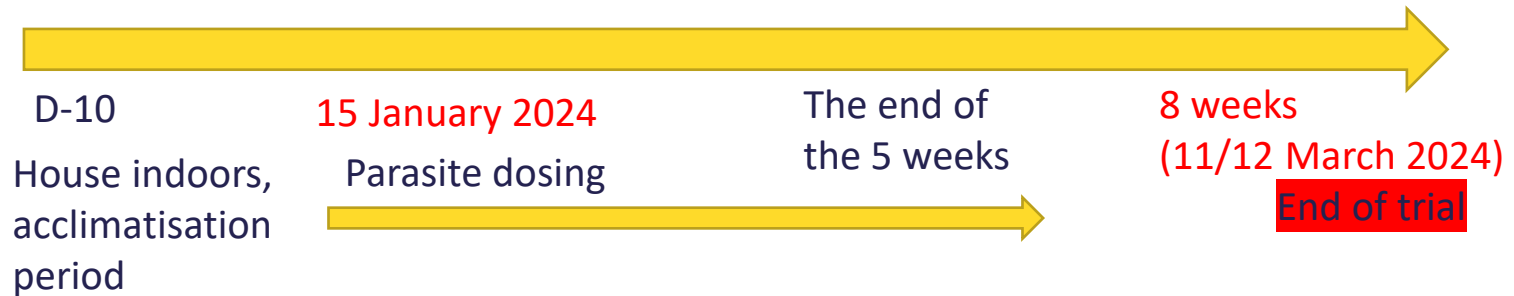
Background

- Livestock stressors impact animal welfare and meat quality.
- As a model of acute stress, pre-slaughter simulated mustering affected several important meat quality markers in lamb, including high pH (2021-2022 trials).
- Here we developed an infection model in sheep to examine a chronic stressor.
- Chronic stress induced with sub-clinical infection of gastrointestinal nematodes (GIN), *Trichostrongylus colubriformis* (T. col.) and *Teladorsagia circumcincta* (T. circ.) common GIN parasites frequently encountered in pasture.

GOALS:

- To determine if a chronic subclinical parasite infection and the associated inflammatory response has an impact on meat quality markers.
- A *proof of principle study* for detection of GIN parasite infection in sheep using rapid evaporative ionisation mass spectrometry (REIMS) in faeces and offal.

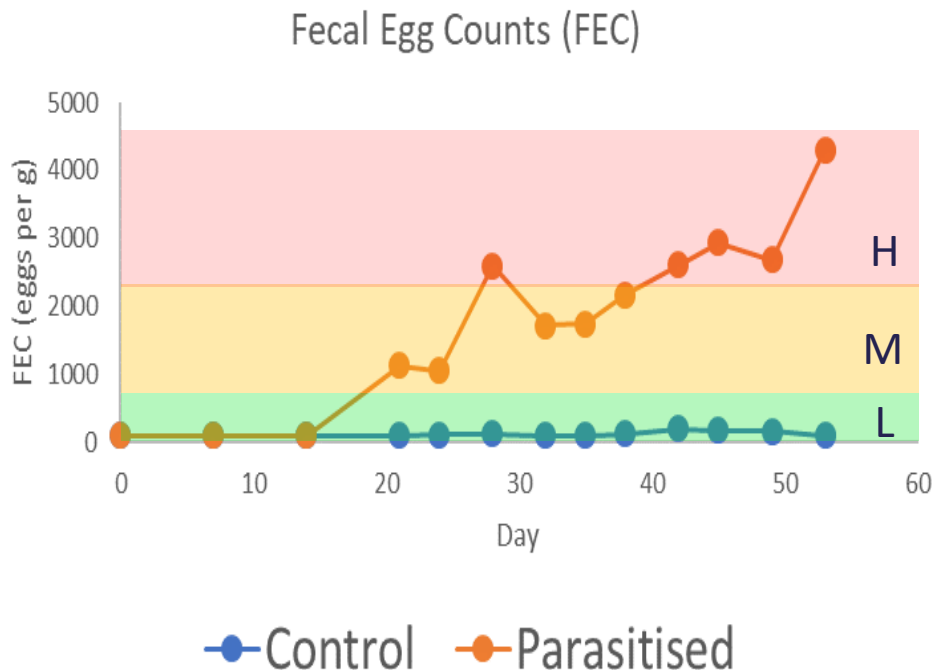
Design: GIN Parasite infection in sheep



Dosed with 4000 *T. circumcincta* and 2500 *T. colubriformis* L3 larvae/day
Restricted ration 1.4 kg DM/day (allow 150 -200 g/day LWG, industry norm)

RESULT: GI Parasite model: Mild chronic stressor.

	Control	Parasitised	
Initial LW (kg)	32.4	32] No difference
LWG (g/d)	174	179	
Carcass wt (kg)	22.3	22.3	
T circ worm burden	8	1,935	
T col worm burden	220	14,837	



- Mod/high parasite infection levels
- No sign of sickness
- No impact on performance
- No impact in Serum biochemistry & Haematology reports

→ Physical damage caused by infection

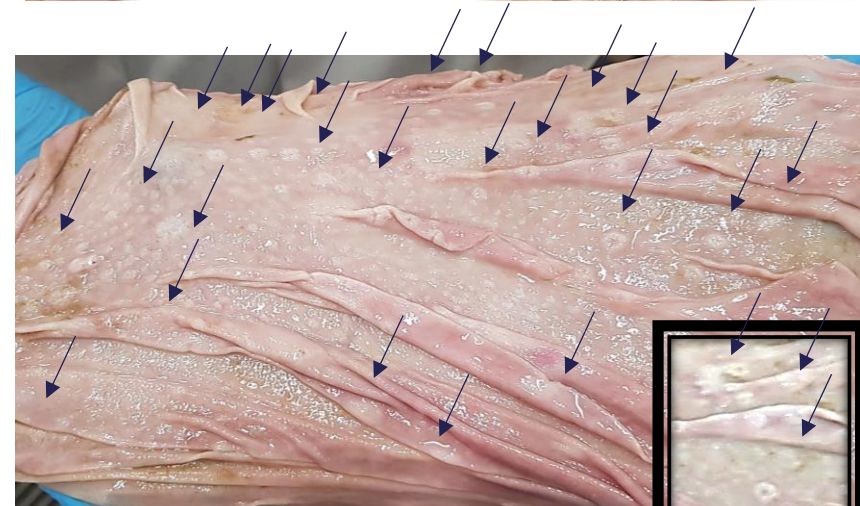
Region due to parasite invaded tissue, developing huge local tissue response



Control abomasum showing no damage

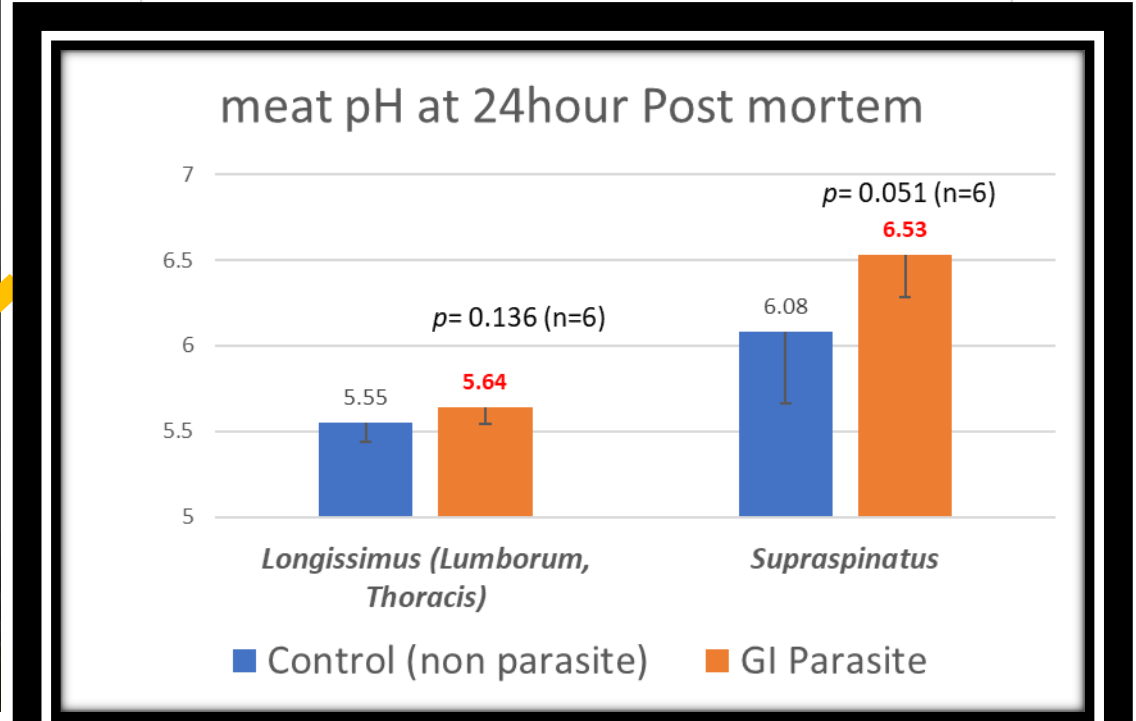
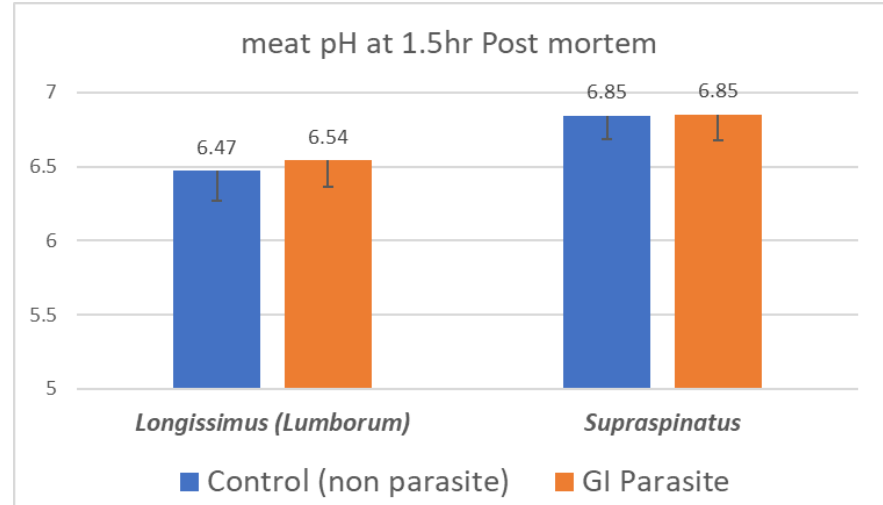
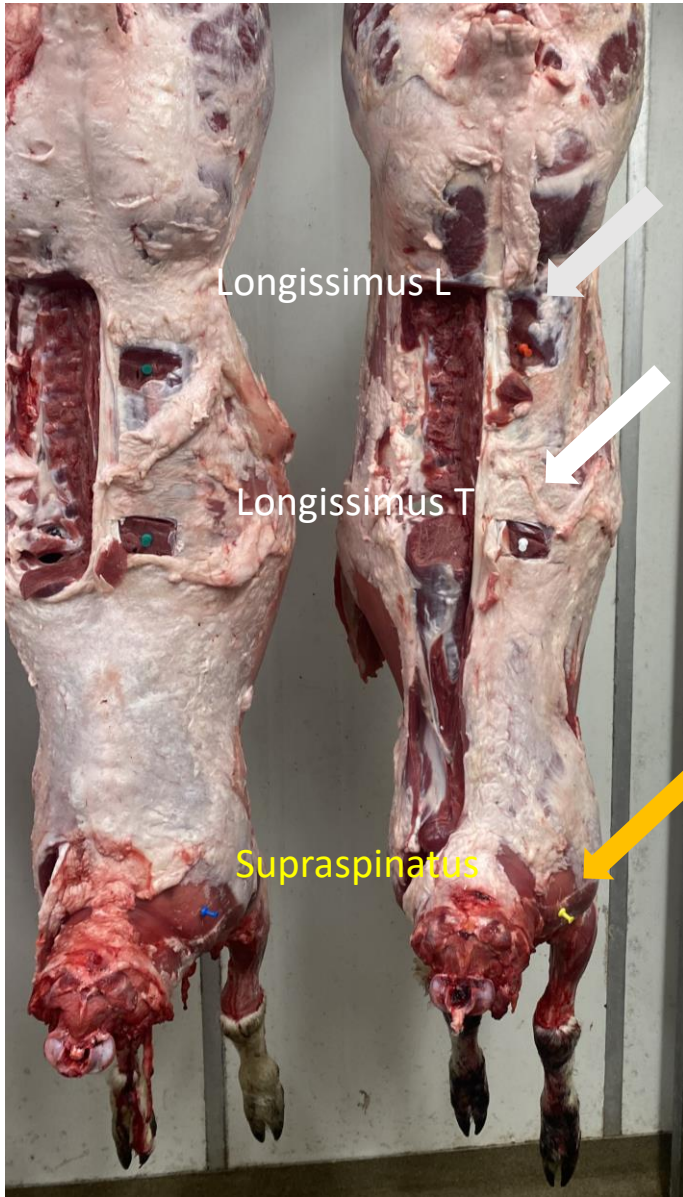


Abomasum fold of ID 247 (parasite)



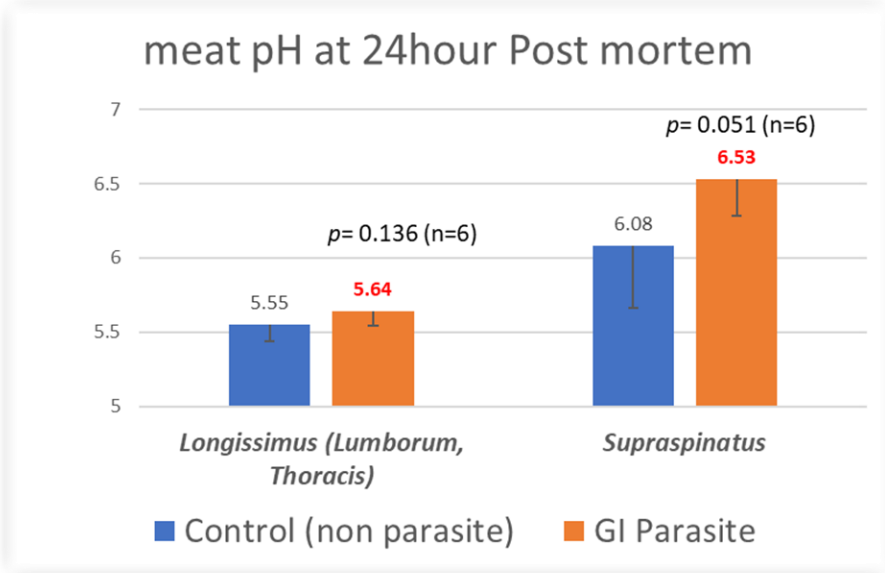
Abomasum fold ID 248 (parasite)

RESULT: Mild chronic stressor- meat pH

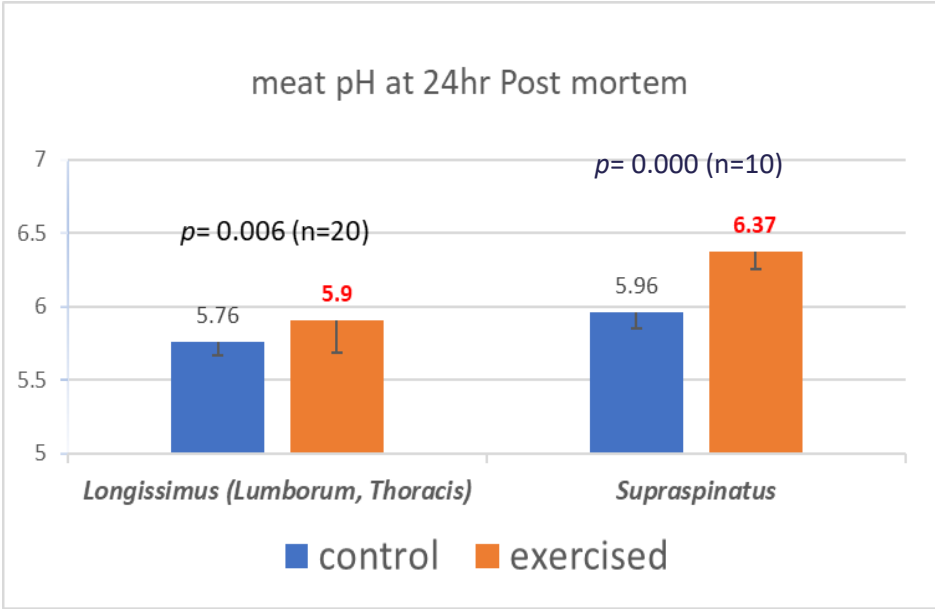


→ Meat quality trait : Chronic vs Acute stressors

Chronic stressor: GI Parasite
(ram, 6-month old, 2024)



Acute stressor: Pre-slaughter farmyard mastering stress (2021)
(ram, 5-month old)

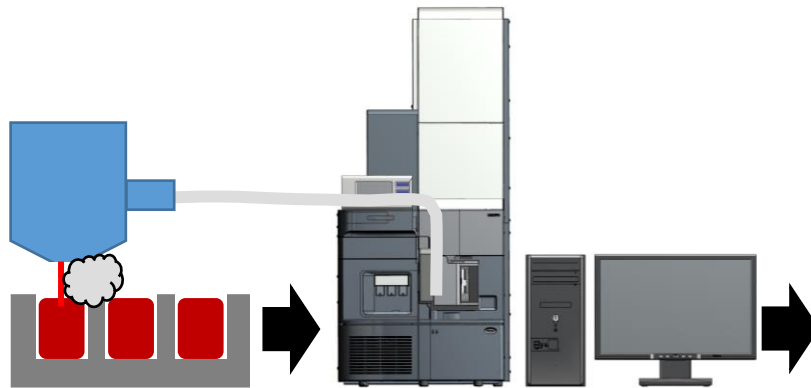


- ❌ **Cooking Loss:** no impact
- ❌ **Shear Force** measurement: no impact
- ❌ **Colour measurement:** no impact

- ✅ **Cooking Loss:** Stress lowered the cooking loss.
- ✅ **Shear Force** measurement: Stress lowered the shear force of LT, LL, IS & SS at 7 days pm
- ✅ **Colour** measurement: Stress made LL, IS, SS, GM and SM darker (lower L value)

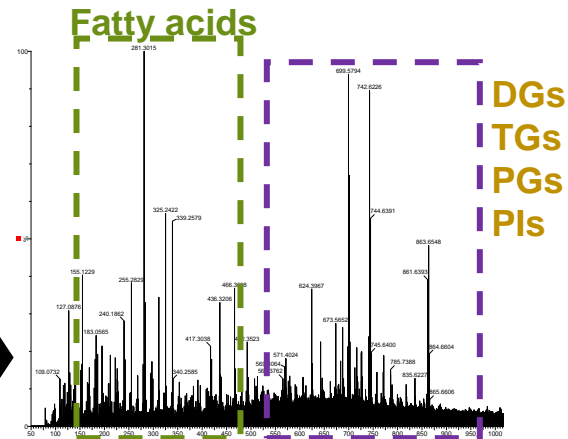


Ambient pressure mass spectral fingerprinting: Rapid screening of samples for metabolite differences



A laser 'burns' a sample, volatilising metabolites from the sample

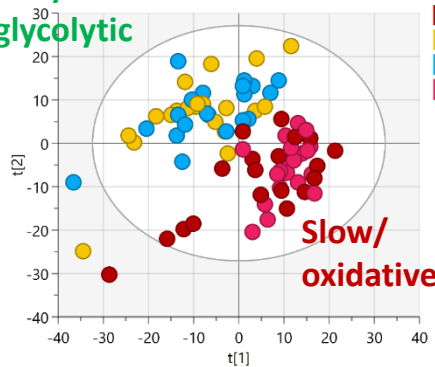
Sample metabolites are drawn into a high-resolution mass spectrometer within a few seconds of the laser 'burn'



Each spectrum or 'fingerprint' is made up of the detectable metabolites present in the sample aerosol, ranging from 500-3000 features depending on the sample

REIMS is a useful tool to investigate meat

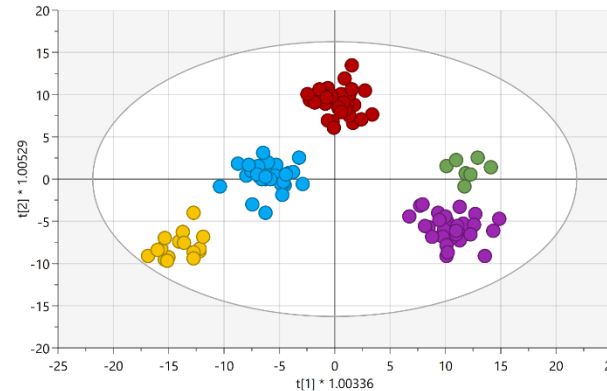
Fast/
glycolytic



- Infra-Spinatus (IS)
- Longissimus Lumborum (LL)
- Longissimus Thoracis (LT)
- Supra-Spinatus (SS)

Differentiate
different lamb
muscles

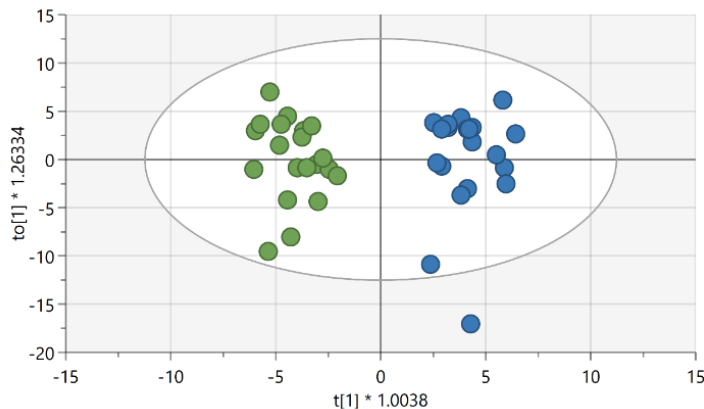
= 0.189, R2X[2] = 0.132, Ellipse: Hotelling's T2 (95%)



- Milk
- Red Clover
- PermPasture
- Grass
- Chicory

Differentiate
lambs finished
on different
feeds

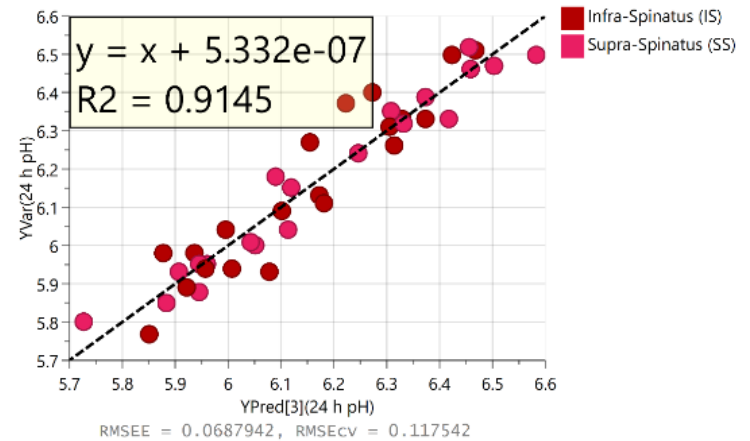
Scaled proportionally to R2X, R2X[1] = 0.0507, R2X[2] = 0.0281,
Ellipse: Hotelling's T2 (95%)



- 2
- 1

Scaled proportionally to R2X, R2X[1] = 0.144, R2Xo[1] = 0.179,
Ellipse: Hotelling's T2 (95%)

Distinguish between rested
and exercised lambs

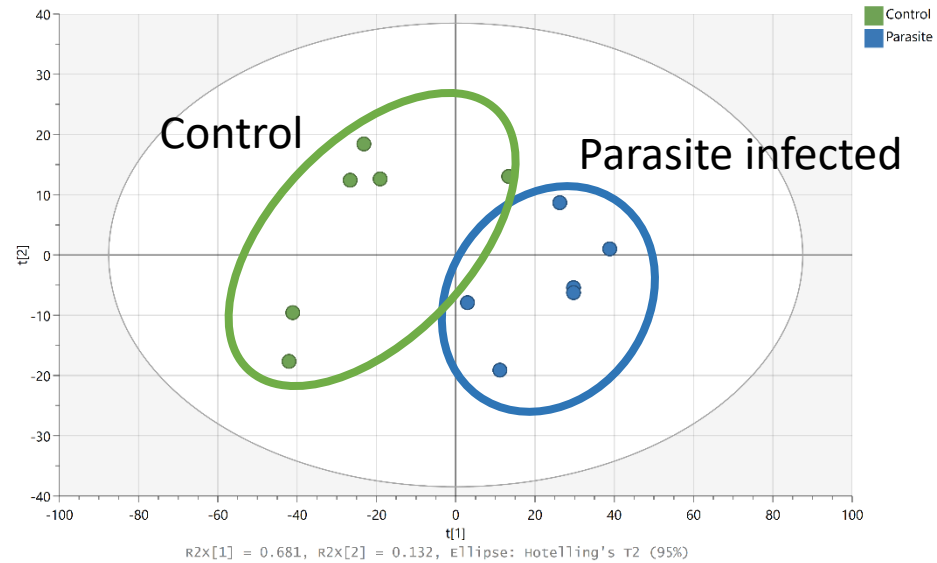
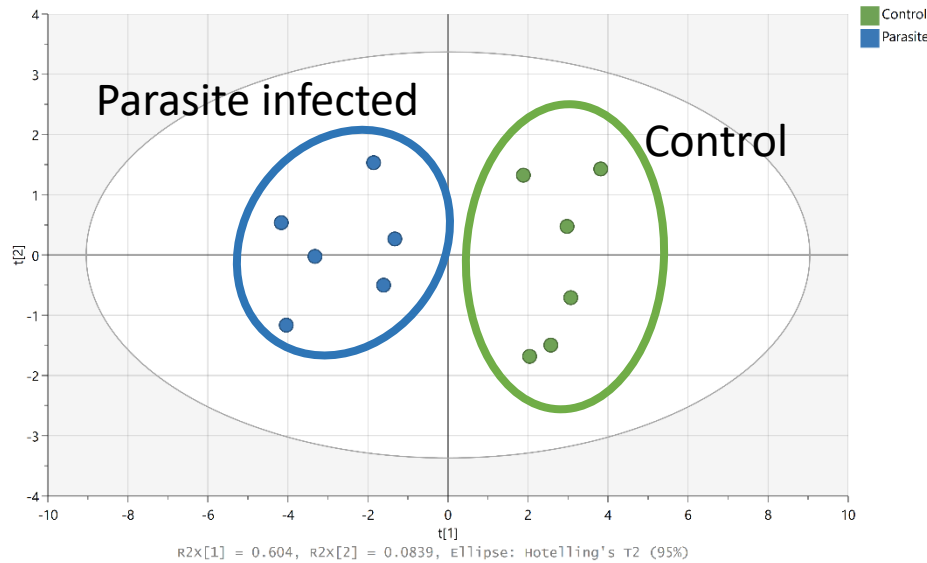


- Infra-Spinatus (IS)
- Supra-Spinatus (SS)

RMSEE = 0.0687942, RMSEcv = 0.117542

Models with good pH
prediction

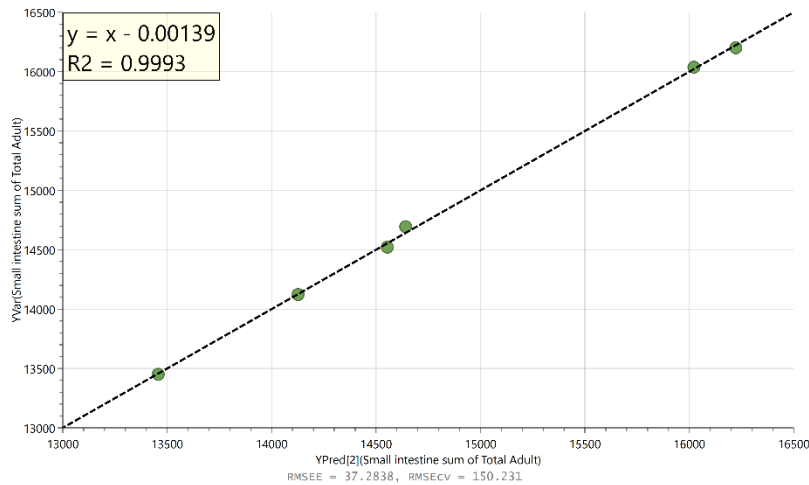
Parasite effects: muscles



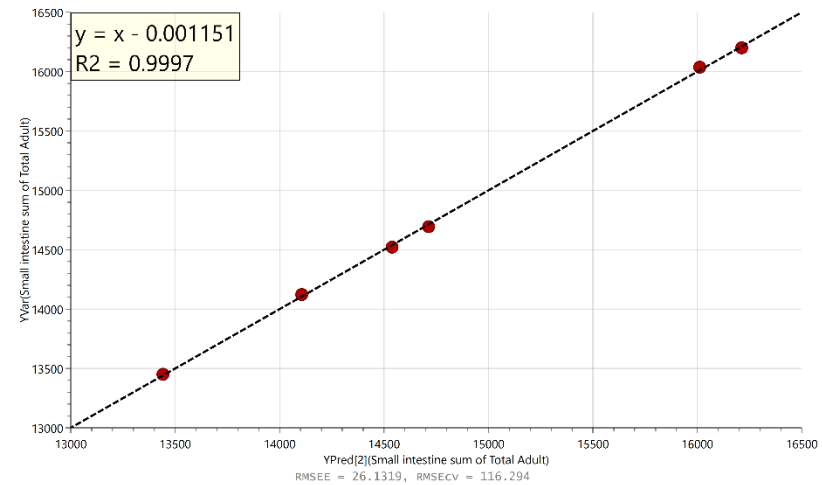
PCA plots of selected REIMS features. NB – low model confidence due to low sample numbers

Parasite effects – correlations between worm counts and meat features

Longissimus lumborum



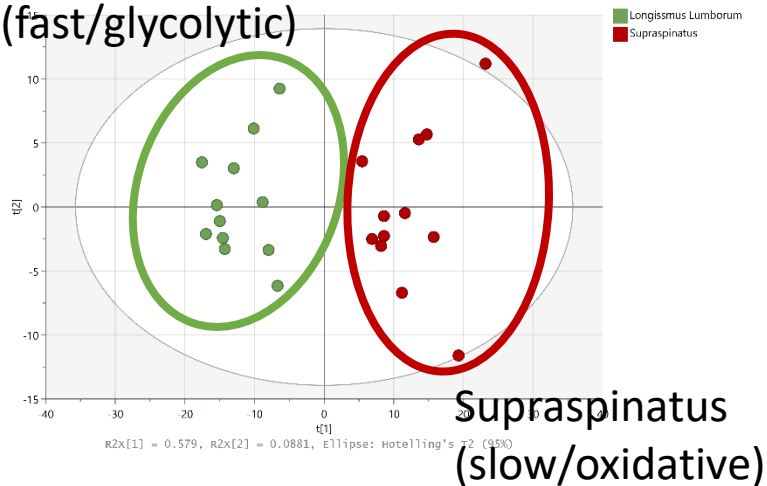
Supraspinatus



Measured total parasites in the small intestine vs predicted values from REIMS analysis of muscles (feature selected)
NB – very low number of samples

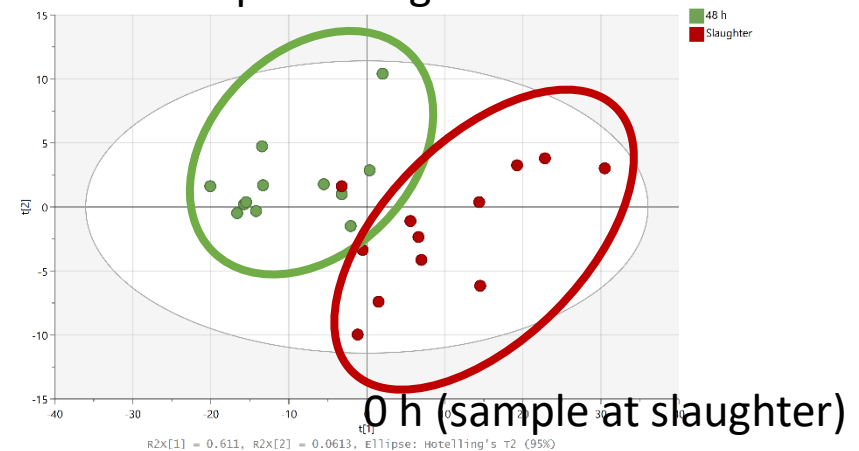
Other comparisons

Longissimus lumborum
(fast/glycolytic)



Slow/oxidative muscle (Supraspinatus, shoulder) is clearly differentiated from fast/glycolytic muscle (Longissimus lumborum)

48 h post slaughter

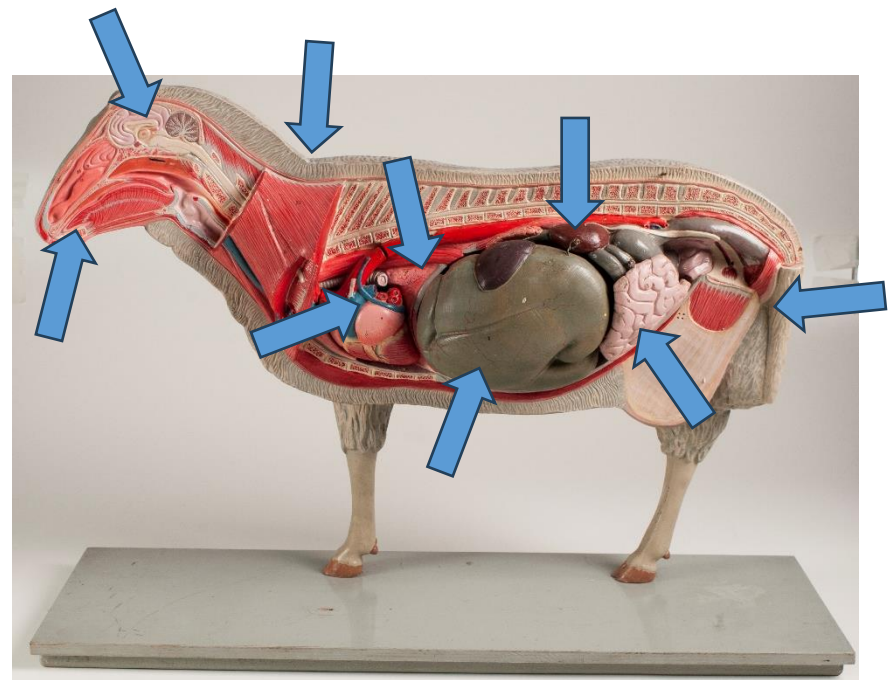


The transition from muscle to meat can be detected based on samples collected at slaughter and at 48 h

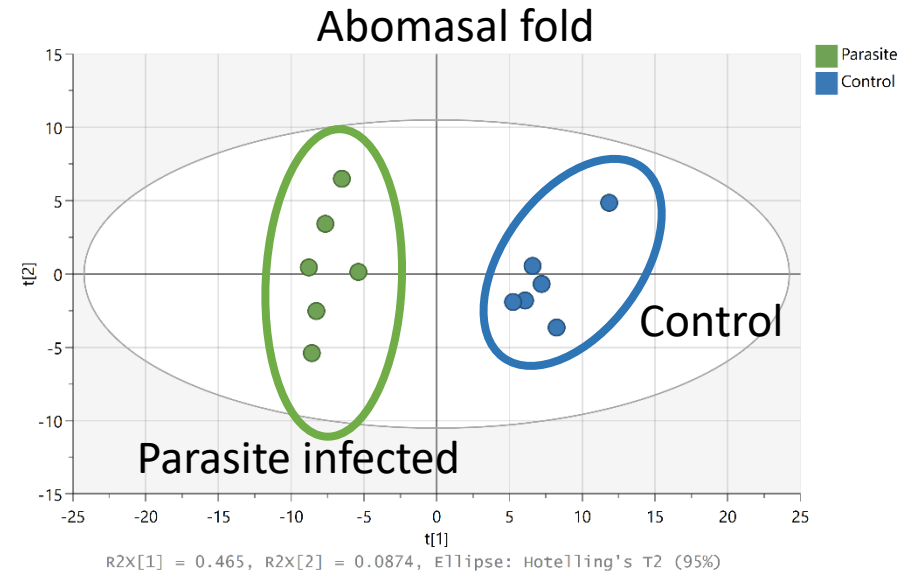
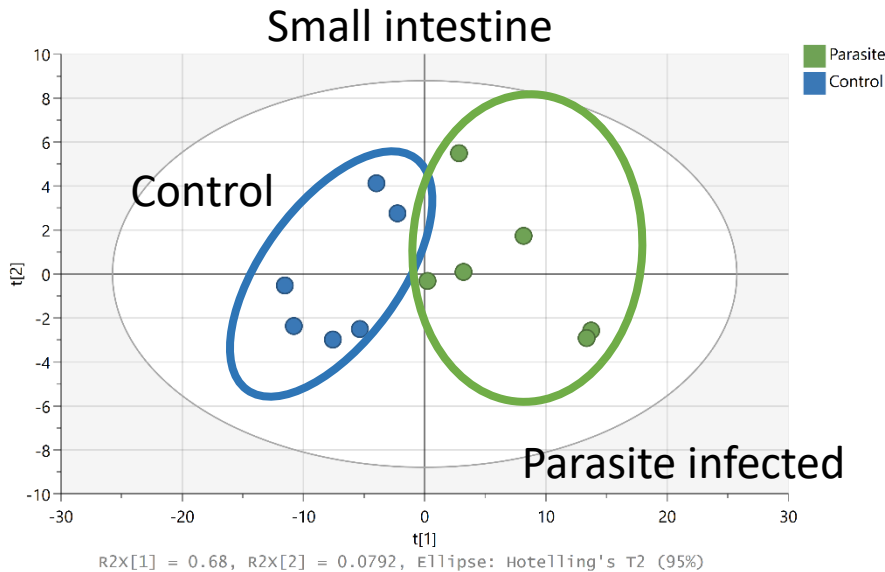
Plots are PCA scores plots based on feature reduced data

What's next?

- Many samples have been collected to further assess the difference between parasite infected and non-infected lambs
 - Time-course
 - Plasma & Saliva
 - Faeces
 - Wool
 - At slaughter
 - Brains
 - Guts (small intestine and abomasum)
 - Liver
 - Heart
 - Kidney
 - Adipose



Parasite effects – gastrointestinal samples



Plots are PCA scores plots based on feature reduced data

Conclusions

- The GI parasite induced-chronic stress led to the systematic impact, resulting in the high pH of slow twitch/oxidative muscle fibre type
- The mild GI parasite infection was not clearly detected in muscle using REIMS, though there was correlation between muscle features with gastrointestinal egg counts
- This pilot study suggests that gastrointestinal parasites can impact on several markers of meat quality, and that future work would need more animals to see clearer effects
- In future, biomarkers of systematic stress could be used for enhancing animal welfare and confirm the relationship between minimising pre-slaughter stress and improving the consistency



Sheep research Farm & indoor facilities (1.5km from the LU campus):