Phenotyping the trans-10 shift in the rumen of finishing lambs

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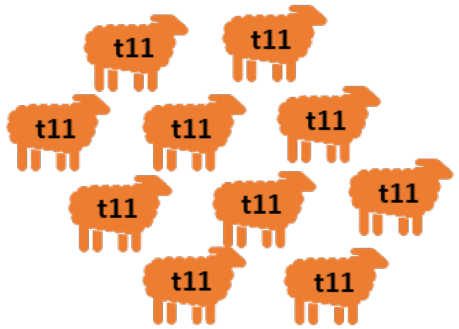
Introduction

- The rumen ecosystem mainly influences the fatty acid composition in ruminant products.
- In the rumen, dietary lipids undergo hydrolysis, isomerization, and hydrogenation of unsaturated fatty acids (UFAs) in a series of transformations known as rumen biohydrogenation (RBH).
- This process, driven by rumen microbiota, produces trans fatty acids and, ultimately, saturated fatty acids.

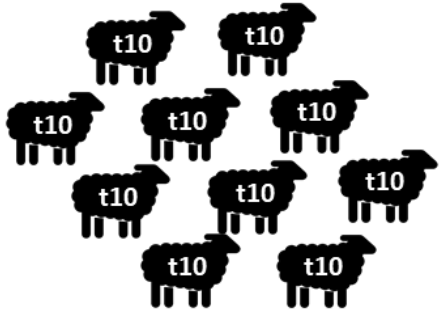
Introduction

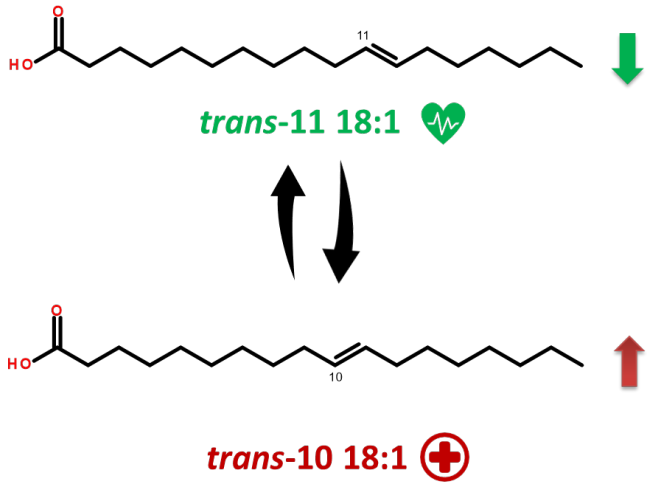


The type of diet (forage vs. concentrates) and UFA supplementation affect the trans-18:1 isomer produced during rumen biohydrogenation of linoleic and linolenic acids.

Forage-based diets with added oil increase the t11-18:1 isomer in milk, which has health benefits and is a precursor to the anticarcinogenic CLA.

On the other hand, concentrate-based diets promote the t10-18:1 isomer, which is associated with milk fat depression and possible negative health effects in consumers.





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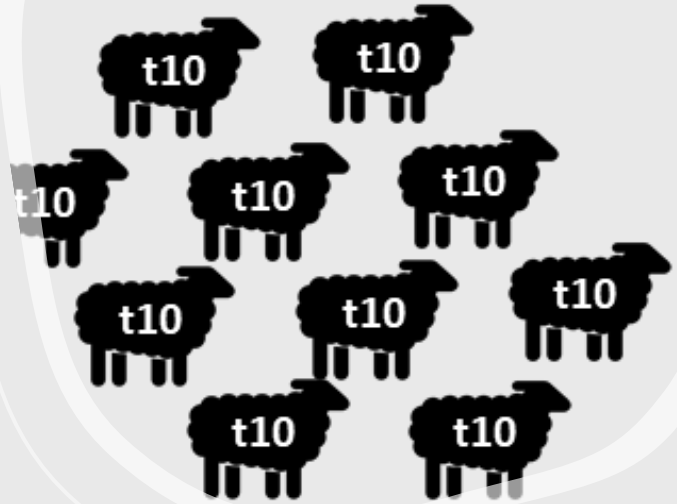


- The pathways for producing these isomers are known, but the microbial causes of shifts, especially the "t10-shift," and the mechanisms of trans-18:1 integration into bacterial membranes are not fully understood.“

- Ongoing research reveals contradictions, emphasizing the complexity of rumen fatty acid metabolism.

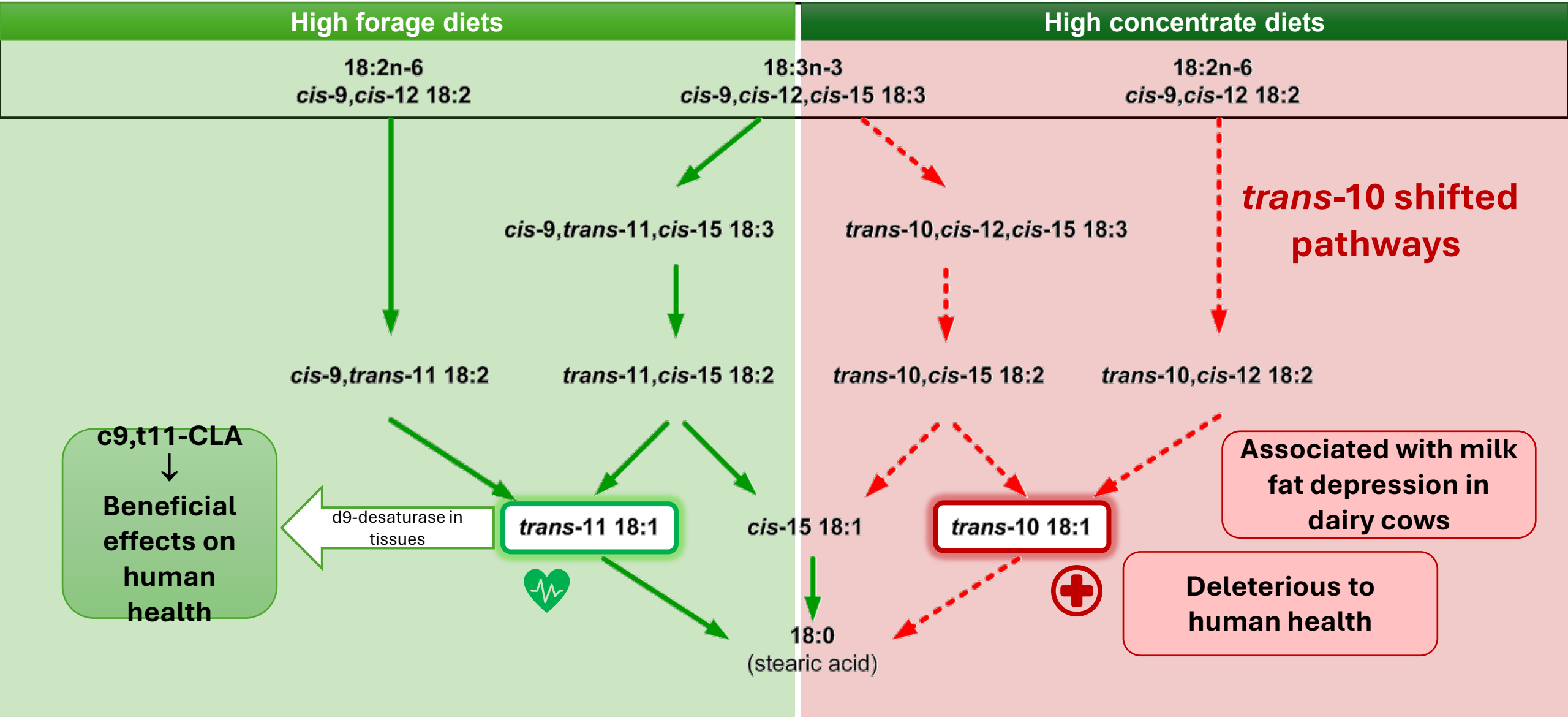
Specific objectives of this work

This study aimed first to phenotype the variability of t10-shift expression in a large number of finishing lambs

Hypothesis

The individual resistance to t10-shift is in part related to host genetics and it will be possible to identify genetic markers to be used in future marker-assisted selection programs.

Ruminal metabolism: What do we know about metabolic pathways?



The *trans*-10 shift

WHAT WE KNOW

- This alteration is associated with the production of deleterious *trans*-FA
- Association with low-fiber high-starch diets

High variability among animals feeding the same diet

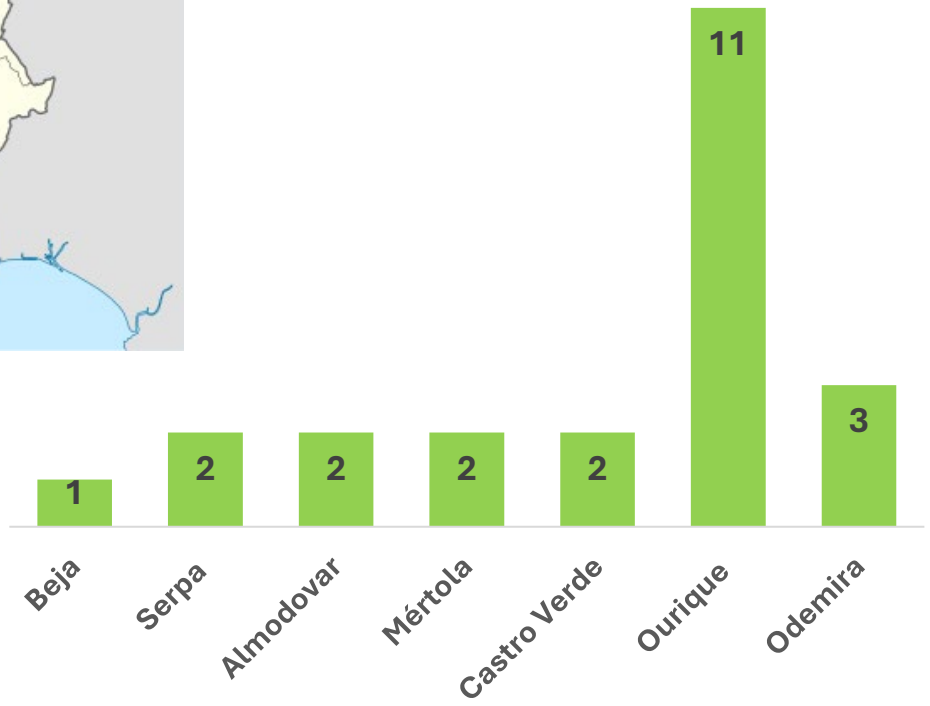
WHAT WE DO NOT KNOW

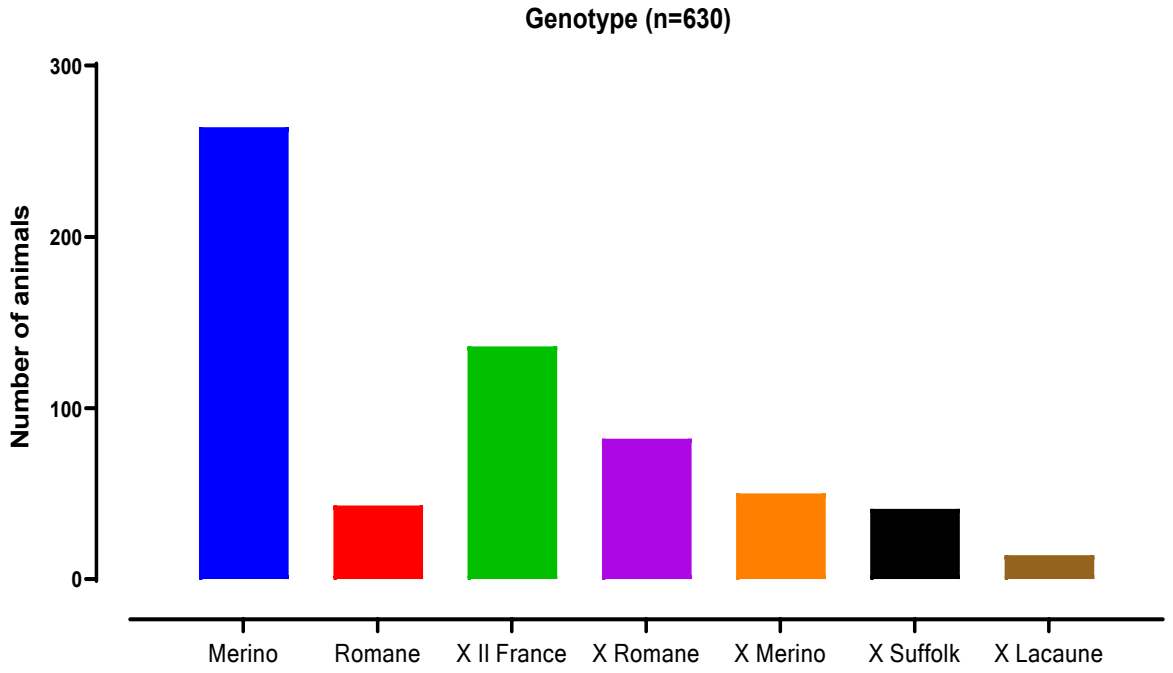
- Why does ruminal biohydrogenation change?
- Which bacteria and enzymes are involved?
- What are the reasons for the variability among animals feeding the same diet?

Material and methods

Sample Collection Plan for Lambs in Baixo Alentejo (2022-2024)

- June 27, 2022 – July 8, 2024
- 630 lambs, all females.
- 23 producers in Baixo Alentejo.





Material and methods

Sample Collection Plan for Lambs in Baixo Alentejo (2022-2024)

Sheep in the field

Production Systems

Feed management

- Pasture/forage

- Supplementation with concentrates when pasture/forage are not available;
- **Lambs:** Most producers provide concentrated feed to lambs before weaning.

Production Systems

Weaning → Fattening

45 – 60 days

- **Lamb finishing company**: Carlos & Helder Alves – Sociedade Agro-Pecuária, LDA Ourique.
- Lambs housed indoors;
- Pens with a capacity of about 100 animals and separated by sex and weight;
- Lambs are subjected to the same sanitary and food; management.

Material and methods

Fattening 40 – 50 days

Adaptation: During the lockdown, the lambs were first given a high-fiber adaptation concentrate for a week, which was then gradually replaced with a commercial concentrate for lamb fattening.

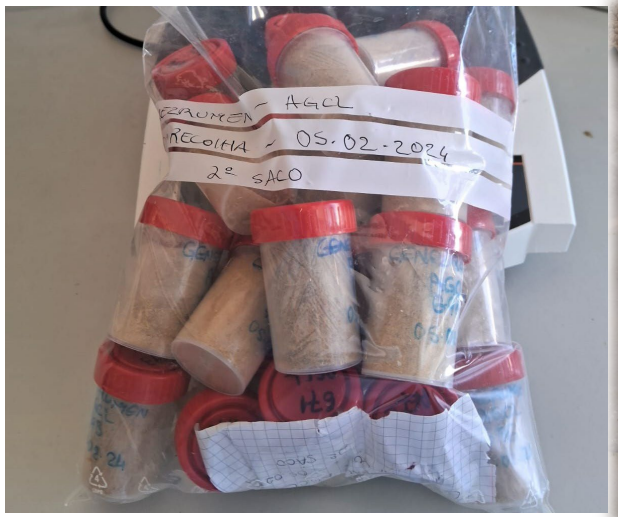
After the transition period, and until slaughter, lambs were fed with the commercial concentrate and straw at a ratio of 90:10. Feed was offered *ad libitum*

Lambs were identified with ear tags to facilitate their tracking into the commercial slaughterhouse.

Sampling

Slaughterhouse

✓ **Rumen content**

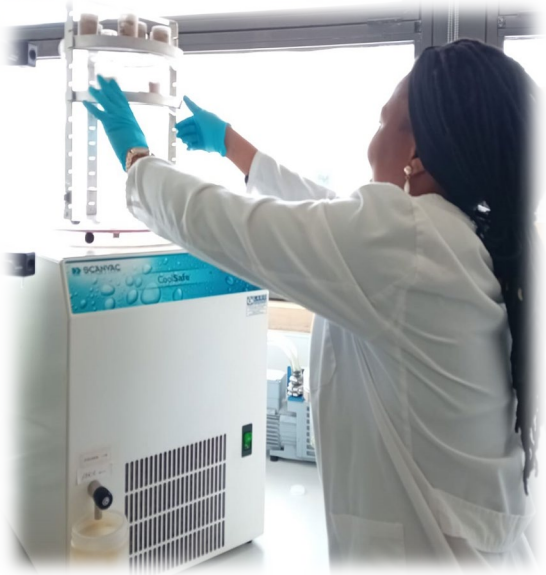


Materials and Methods

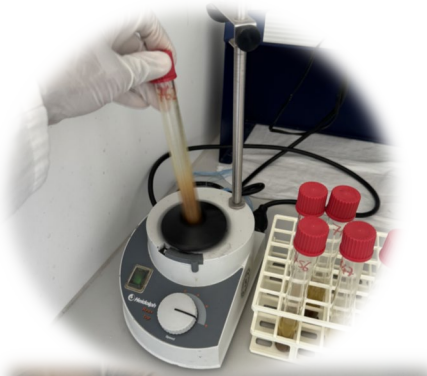
Analyses of the samples

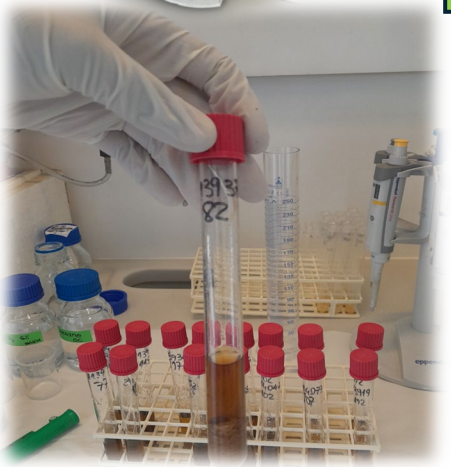
Slaughterhouse

✓ **Rumen content**



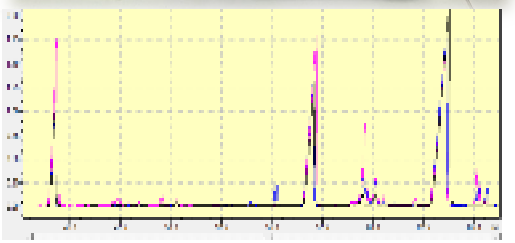
Lyophilization of the samples



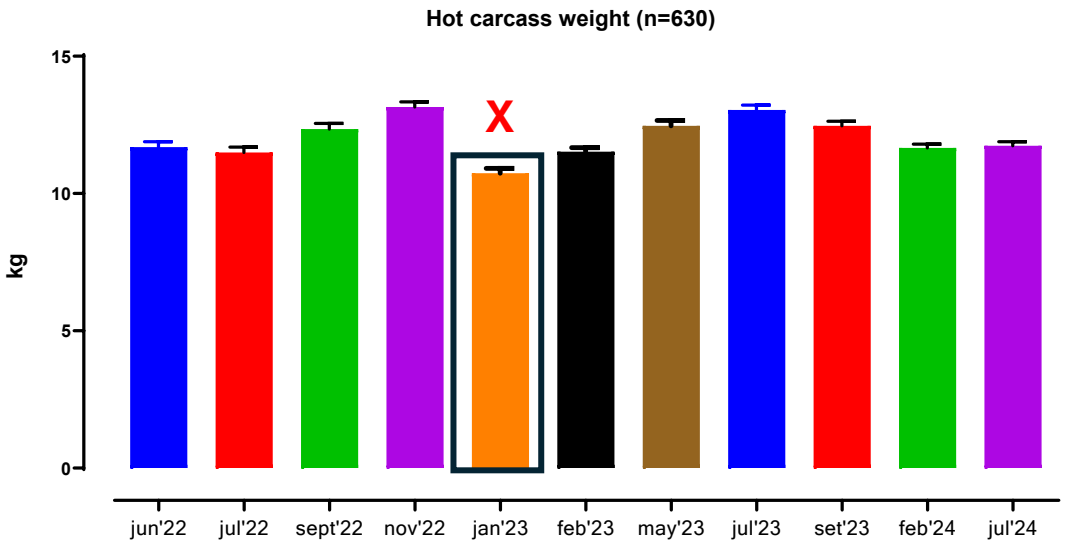


Preparation of methyl esters by transesterification

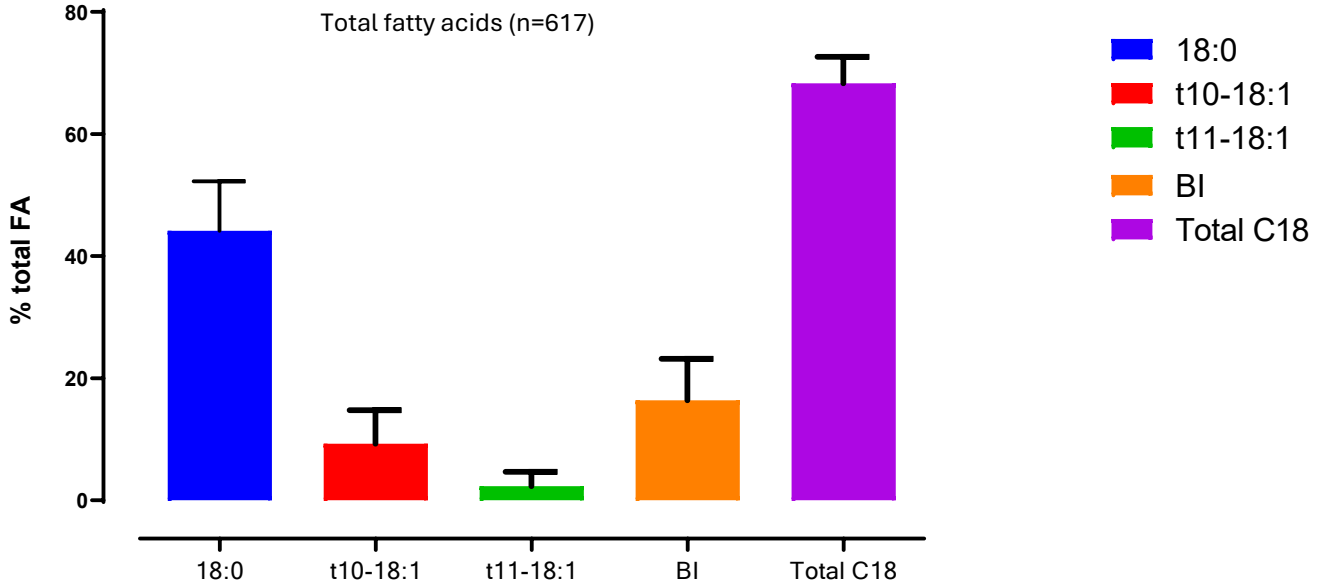
Quantified by gas chromatography with flame ionization detection (GC-FID)



Results: Phenotyping for the t10-shift occurrence

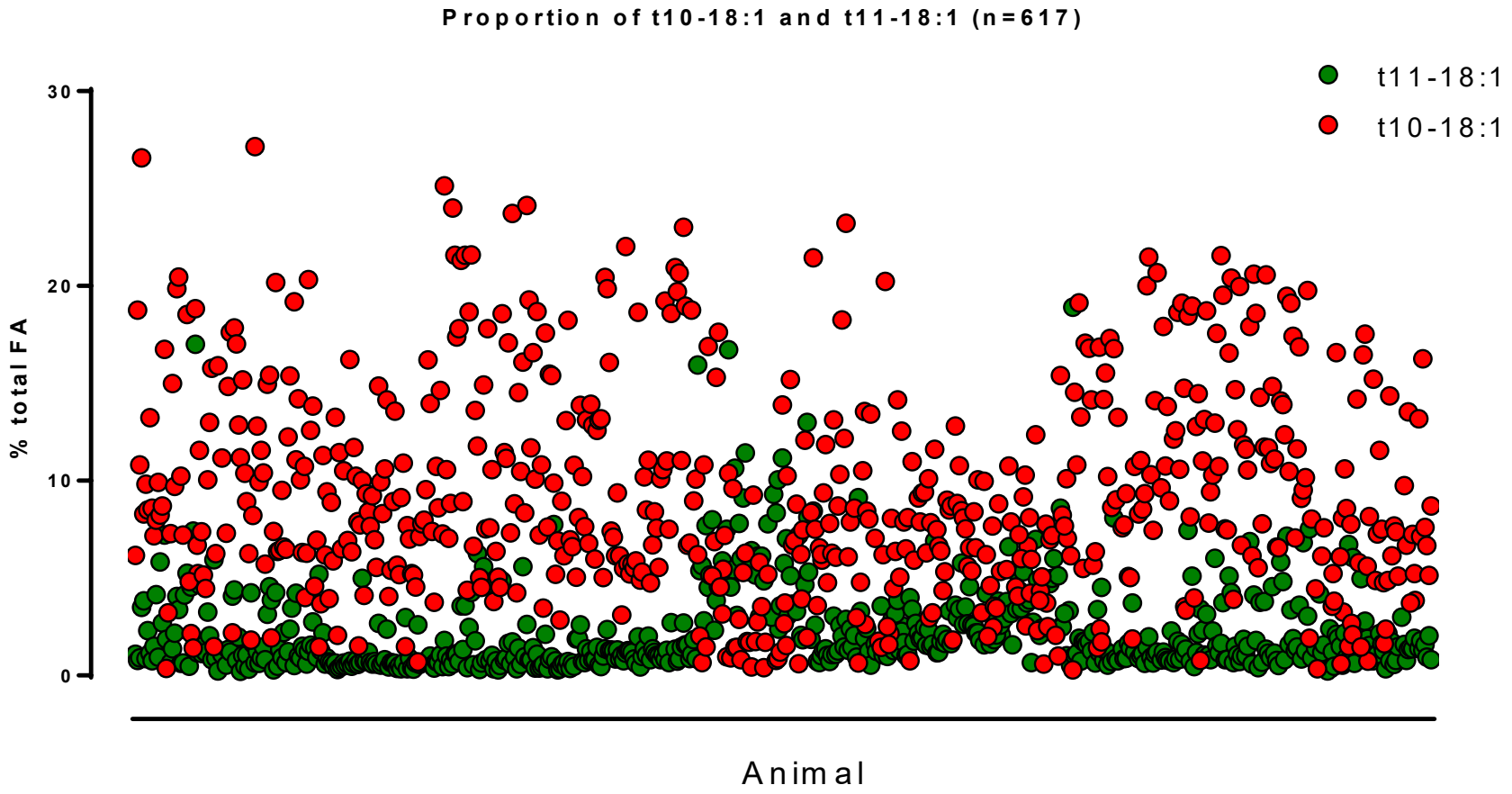


Variation in carcass weight throughout the year



Percentage of total fatty acids

Results: Phenotyping for the t10-shift occurrence



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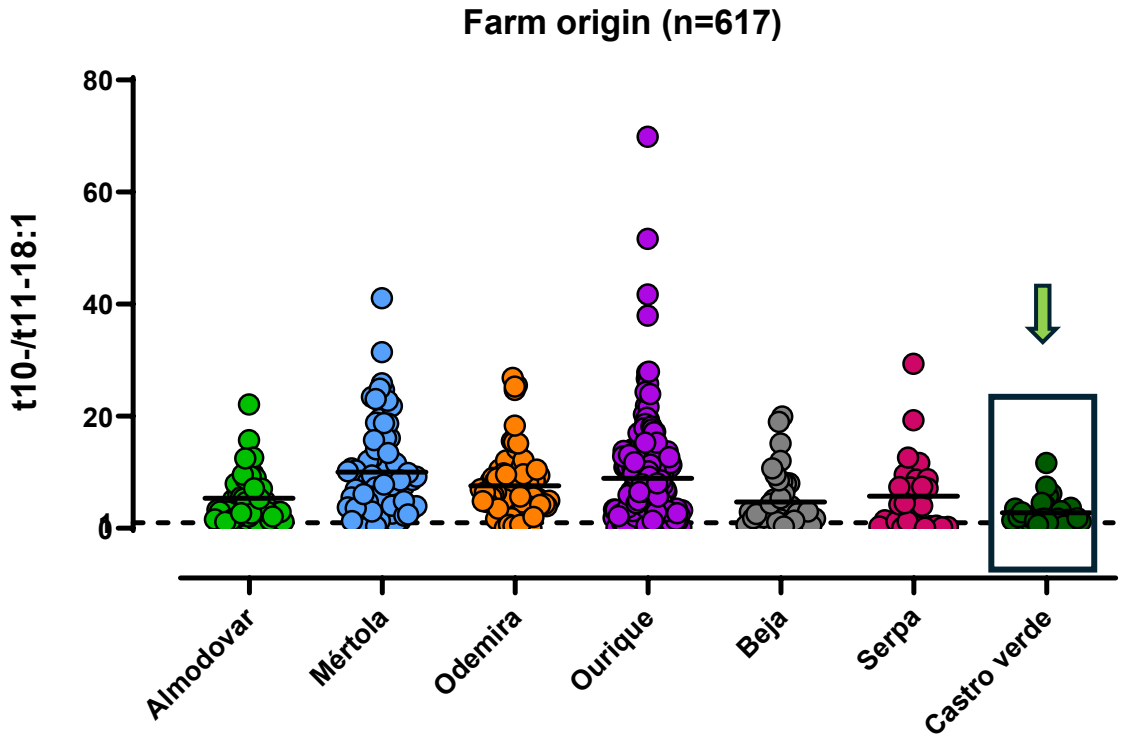
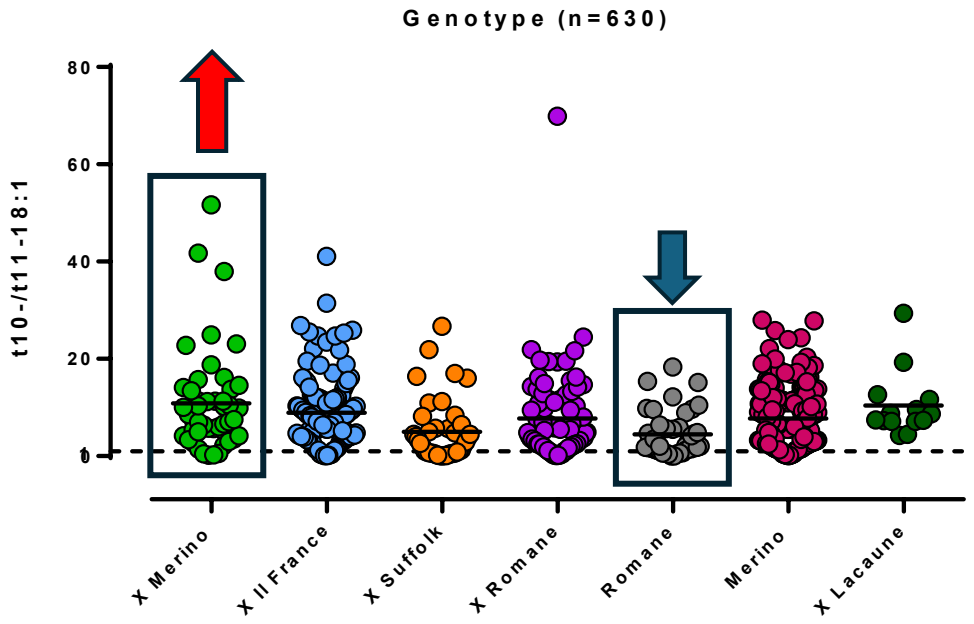
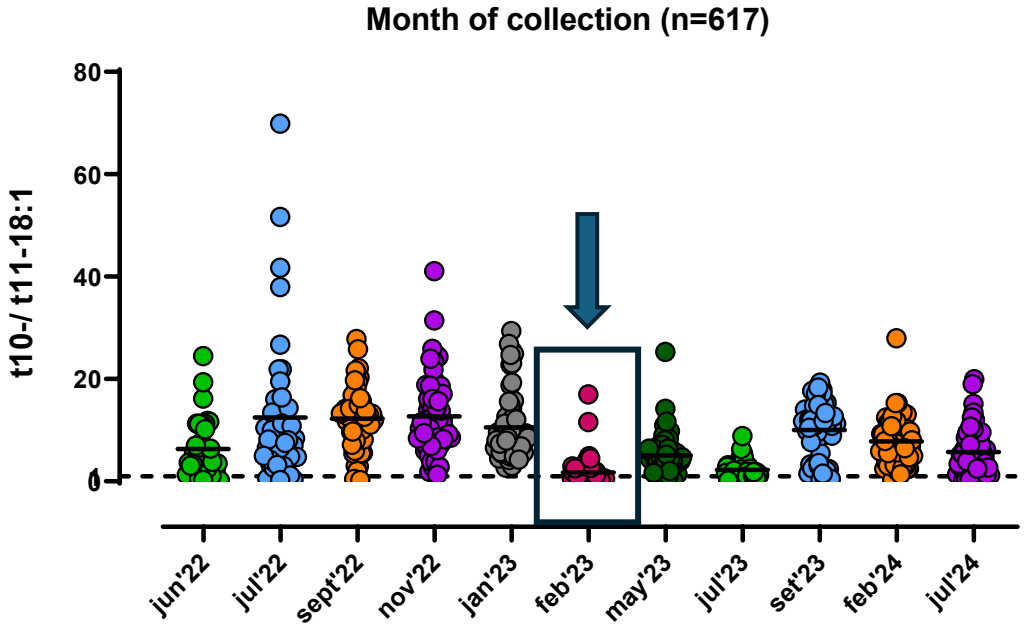


Variation in the proportion of t10-/t11-18:1 across animal origins

Results: Phenotyping for the t10-shift occurrence



Proportion of the t10-/t11-18:1 of 7 genotypes sampled.



t10-/t11-18.1 Content regarding the Collection Periods

Conclusion

The supplementation with UFA and type of basal diet (i.E. Forage vs. Concentrates) fed to ruminants has a major effect on the trans-18:1 isomer formed from the RBH of dietary linoleic (18:2n-6) and linolenic acids (18:3n-3).

In these study, it has become evident that there is a significant difference in how animals respond to the t10-shift, even when they are all fed the same diet. This demonstrates a high degree of variability in susceptibility among the animals, even though they are under identical feeding conditions.

Future work

Gene2Rumen: New insights into the variability of ruminal lipid metabolism in lambs

Task 1

animals fed grain-based diets

Phenotyping (stage 1)

Fatty acid analysis

Task 2

t10-shift Susceptible
t10/t11-R > 1

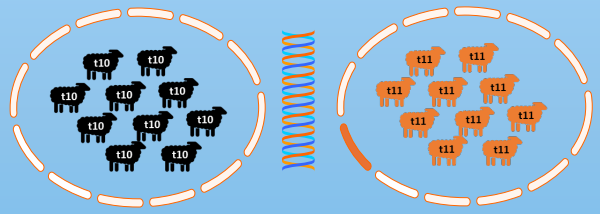
(160 animals)

t10-shift Resistant
t10/t11-R < 0.7

(160 animals)

Validation - Controlled lamb experiment

Task 8

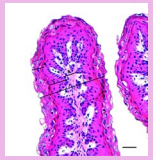


- ✓ Productive performance
- ✓ Rumen parameters
- ✓ Rumen mucosa lesions
- ✓ Meat quality

Validation of the genetic marker for the t10-shift resistance

Phenotyping (stage 2)

Task 3



Rumen anatomic histological morphology

Task 4

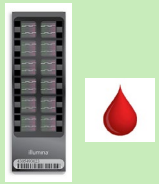
Rumen metabolome

Task 5

Rumen microbiome

Genotyping

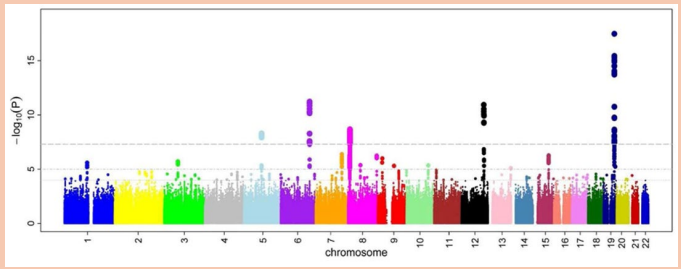
Task 6



High-density 600K Ovine SNP chip

Genome-wide association studies (GWAS)

Task 7



Putative genetic markers Gene functional analysis

Acknowledgments

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Thank you for your attention...