

Use of metabolomics to uncover shelf-life differences of vacuum-packed beef and lamb

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This research has been funded by Meat and Livestock Australia and Tasmanian Institute of Agriculture, University of Tasmania

Metabolic profiles of vacuum-packed (VP) beef and lamb were analysed during storage at 2°C. The data revealed that amino acid metabolism likely drives VP red meat spoilage. However, compared to beef, lamb spoils faster because of upregulated pathways (e.g., taurine and hypotaurine metabolism) producing offensive off-odours earlier. This study significantly advances our understanding of red meat spoilage and could assist industry with the development of novel approaches to assure and/or extend the quality shelf-life of VP red meat.

BACKGROUND and AIM

- Australian VP **lamb meat** has around **13-week shelf-life** while **beef** has almost double the shelf-life of around **26-weeks** at -0.5°C [1].
- This shorter shelf-life of VP lamb can **restrict** market distributions, **limiting** market access, and can lead to product **wastage**.
- The basis of shelf-life **differences** between beef and lamb is currently **poorly understood**, highlighting the **need for** in-depth understanding of how spoilage occurs in red meat throughout the shelf-life.
- The **objective** of this study was to **understand** red meat spoilage and to **uncover potential mechanisms** underpinning the **differences** in the shelf-life of VP lamb and beef.

METHODS

- VP lamb rump and beef ribeye, previously shown to have **similar pH** but **different shelf-lives** based on odour scores [2], were analysed with LC-MS/MS for their **metabolomic profiles** at various storage times at 2°C.
- Enrichment analysis was used to annotate metabolites into specific **metabolic pathways**.
- Calculated Normalised Enrichment Scores allowed to compare pathways in spoiled and fresh products, and between meat types at various storage stages.

RESULTS and DISCUSSION

- Overall, the metabolic pathways of both VP beef and lamb were similar over time at 2°C (Figs 1 and 2).
- For both meat types, **butanoate**, **tryptophan**, and other amino acid **metabolism** pathways were highly upregulated on spoiled meat compared to fresh (Figs. 1 and 2).
- This indicates that **spoilage** of VP beef and lamb is likely driven by **amino acid degradation**, which typically produces acidic or vinegar-like to sweet off-odours, while butanoate produces rancid cheese-like off-odours. These off-odours typically have **high detection thresholds** [3], meaning they need to reach relatively high concentrations to impact the odour profile of meat.
- To further **investigate** the potential mechanisms underpinning the **differences** in VP red meat shelf-lives, beef was compared to lamb at various storage periods (Fig. 3).

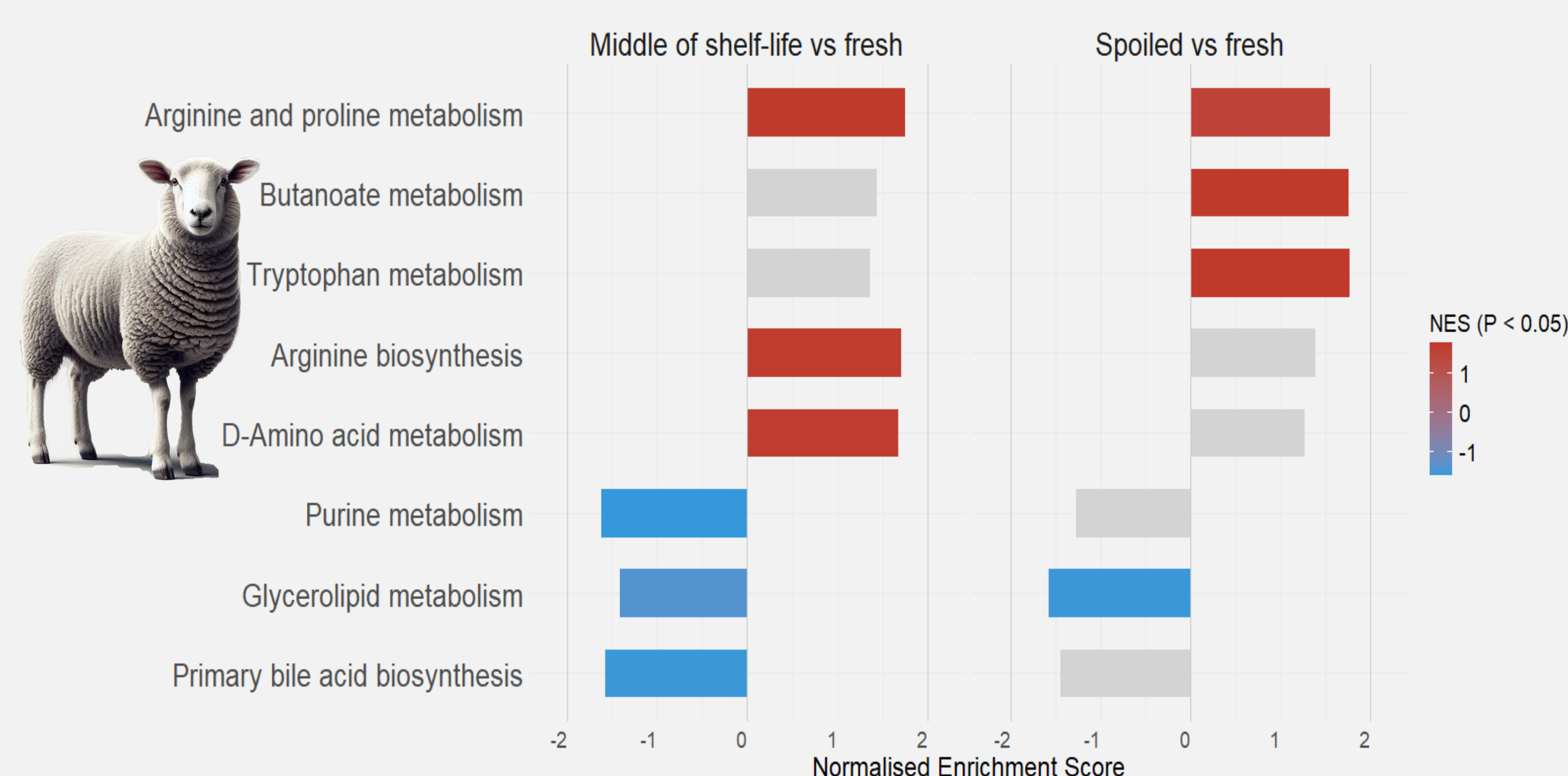


Fig. 1. Significantly up or down regulated metabolic pathways on **lamb** meat in the middle of the shelf-life and at spoiled stage compared to fresh meat at 2°C

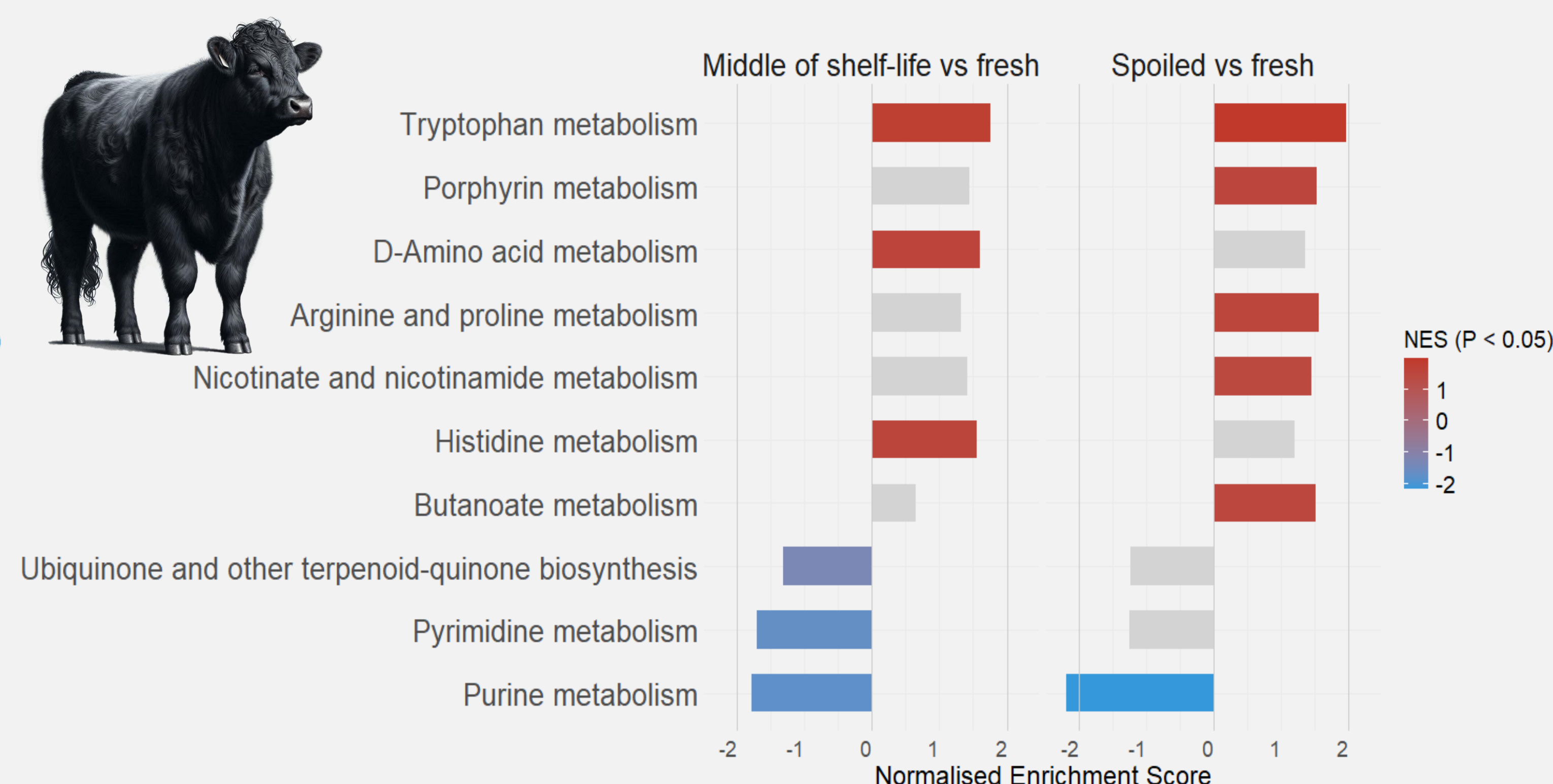


Fig. 2. Significantly up or down regulated metabolic pathways on VP **beef** meat in the middle of the shelf-life and at spoiled stage compared to fresh meat at 2°C

- It was found that throughout storage **histidine** and **tryptophan metabolism** were highly associated with **beef**, while **lamb** was associated with **taurine** and **hypotaurine metabolism** and **folate biosynthesis** (Fig. 3).
- These findings suggest **lamb spoiled faster** due to pathways, such as **taurine** and **hypotaurine metabolism**. Taurine and hypotaurine contain **sulphur** that can be further degraded to produce highly **offensive** rotten egg-like off-odours.
- Compared to amino acid degradation products, **sulphur compounds** are detectable at much lower concentrations [3], making their **impact** on **odour** profile more pronounced earlier.

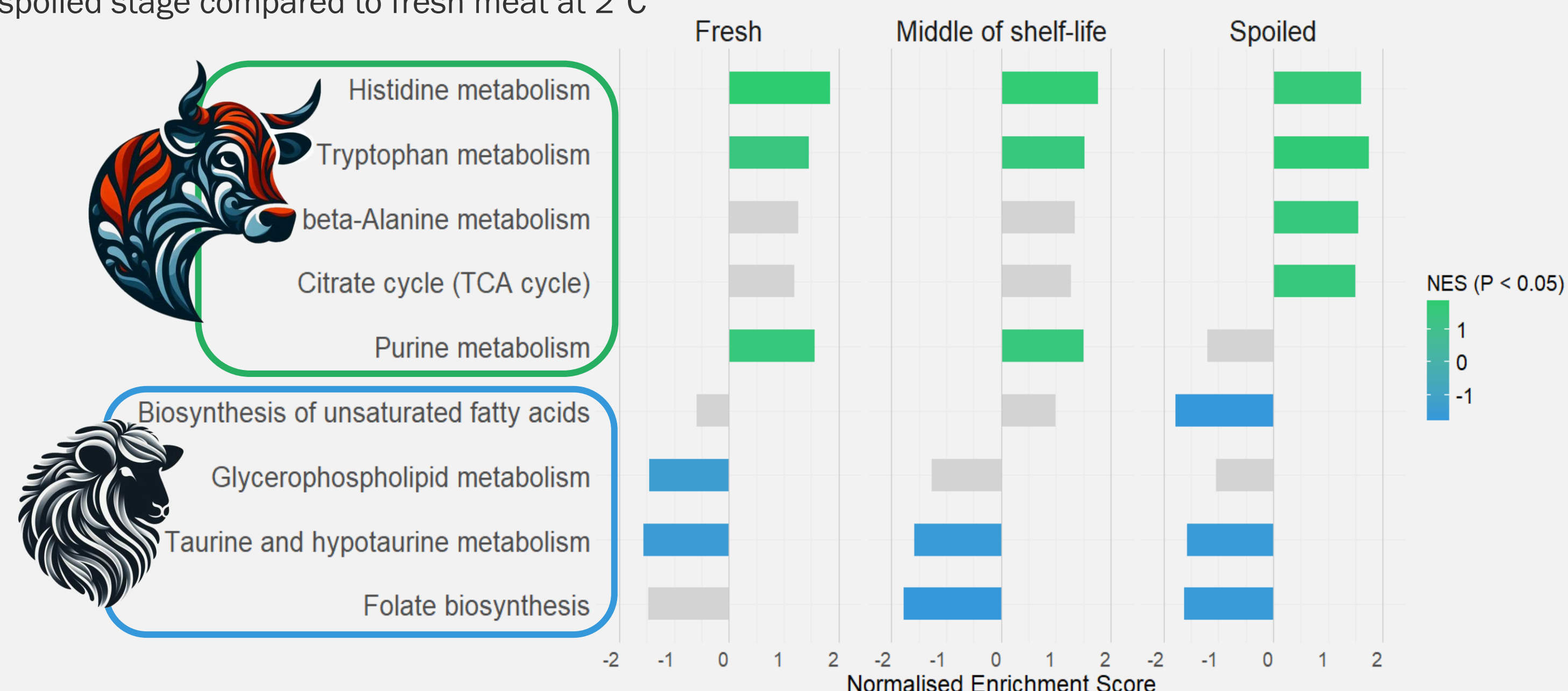


Fig. 3. Significantly up or down regulated pathways on VP **beef** compared to **lamb** throughout storage periods of red meat at 2°C

CONCLUSIONS and FUTURE WORK

- VP red meat **spoilage** was likely driven by various amino acid metabolism pathways.
- Metabolic pathways producing spoilage compounds with low detection thresholds on **VP lamb** may explain its **shorter shelf-life** compared to beef.
- Future work** will aim to characterise these pathways in relation to the activity of microbial community, the main producer of off-odours.
- Overall, this study has significantly **advanced our understanding** of red meat spoilage and could reveal **opportunities** for the future development of targeted approaches to **assure** and/or **extend** the quality **shelf-life of VP meat**, reducing food wastage.

References:

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