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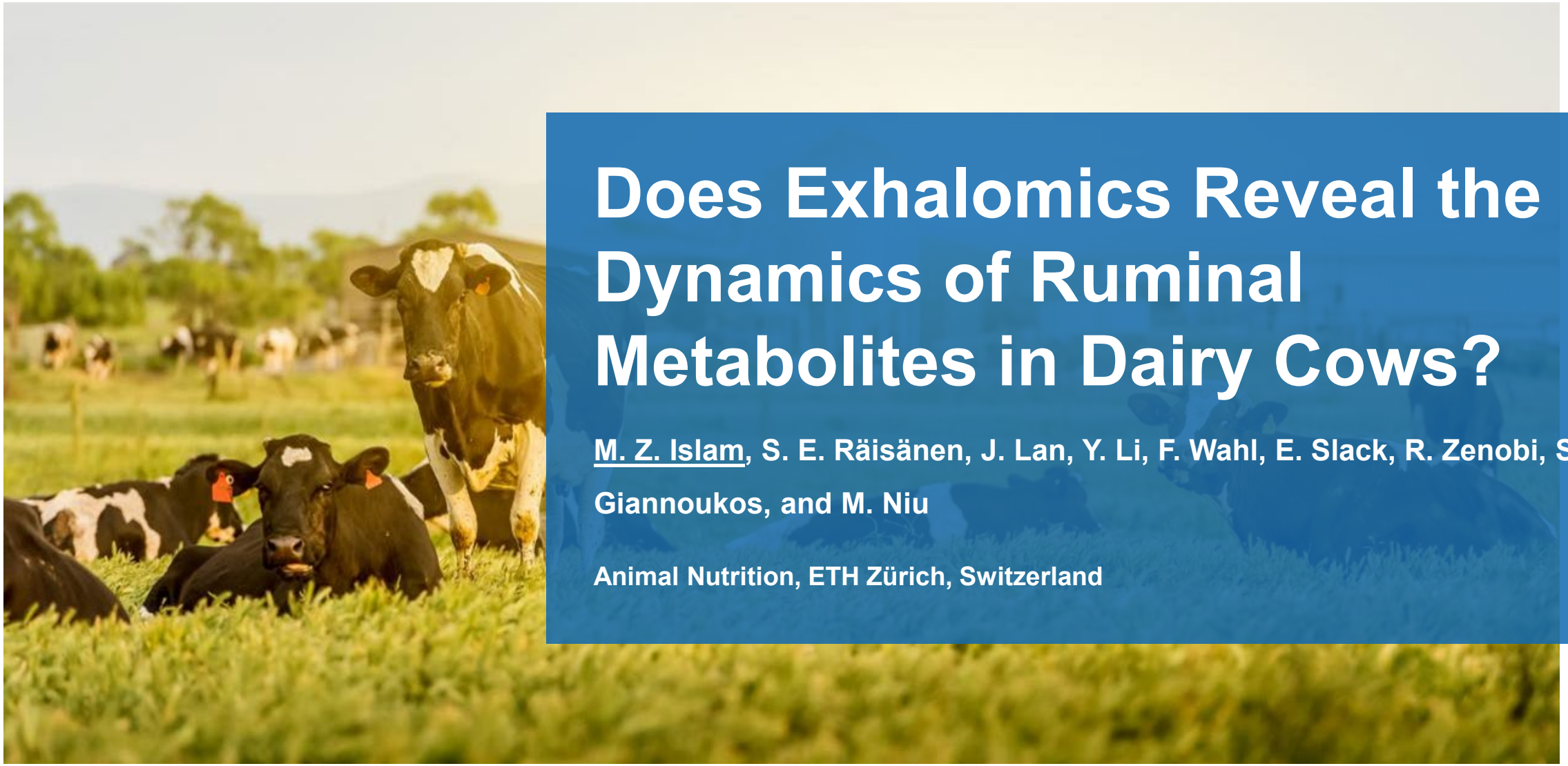

Does Exhalomics Reveal the Dynamics of Ruminal Metabolites in Dairy Cows?

M. Z. Islam, S. E. Räisänen, J. Lan, Y. Li, F. Wahl, E. Slack, R. Zenobi, S. Giannoukos, and M. Niu

Animal Nutrition, ETH Zürich, Switzerland

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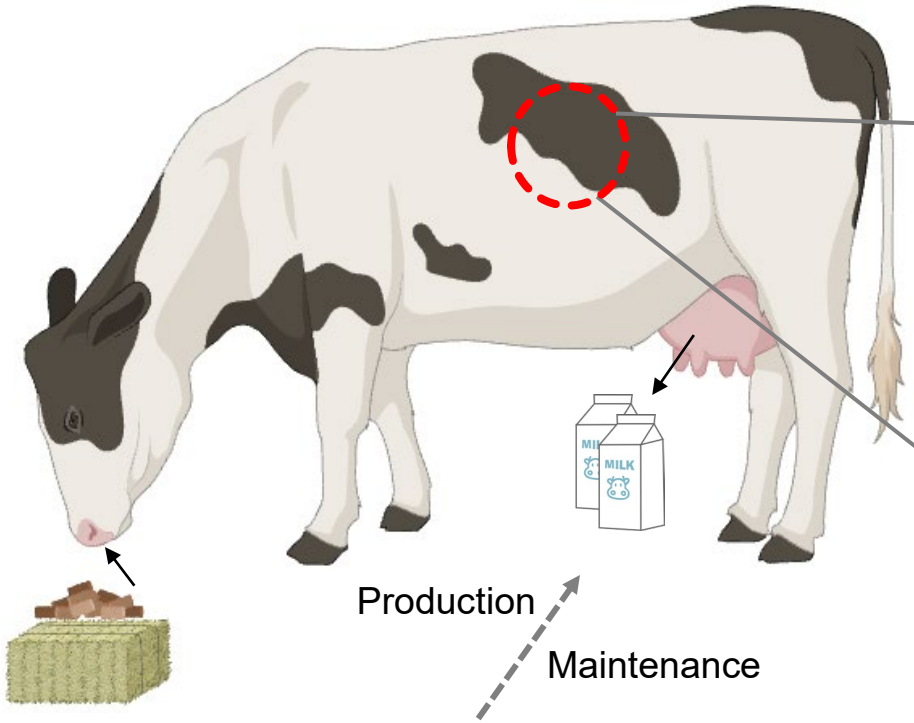
Plant Biomass to Quality Animal Protein : A Unique Conversion



Production

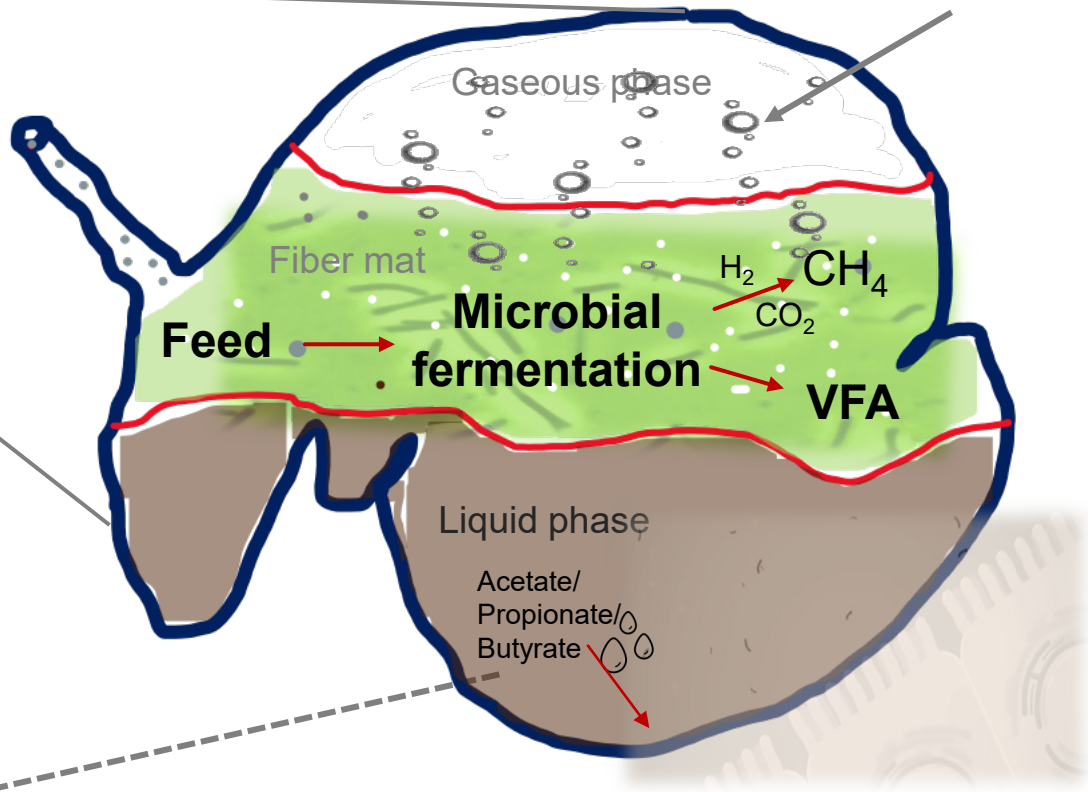
Maintenance

Acetate Propionate Butyrate

>70%

Main Energy Source

Gaseous pool
(CO_2, CH_4, VFA, VOCs)



VFA absorption

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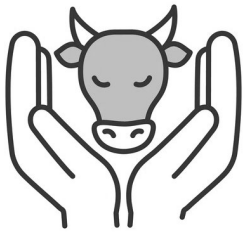
Evaluation of Rumen Fermentation: Practices and Animal Welfare

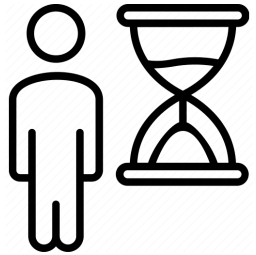
Current Sampling Practices



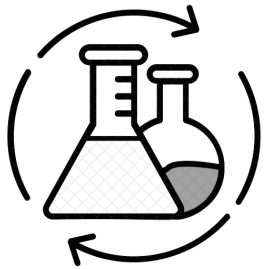

Pashudhanpraharee; Nairaland Forum; VetEnt; Agroscope



- Affect welfare



- Intensive labor + time

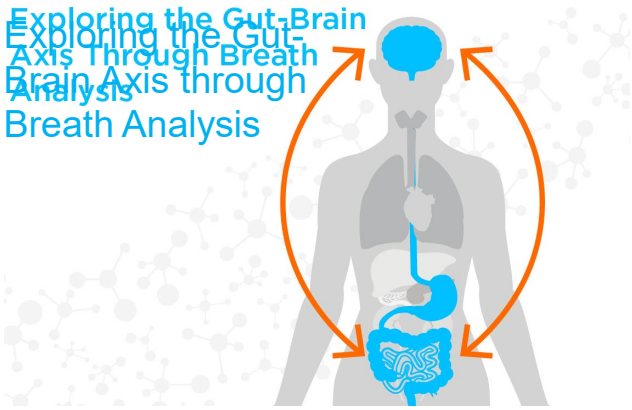


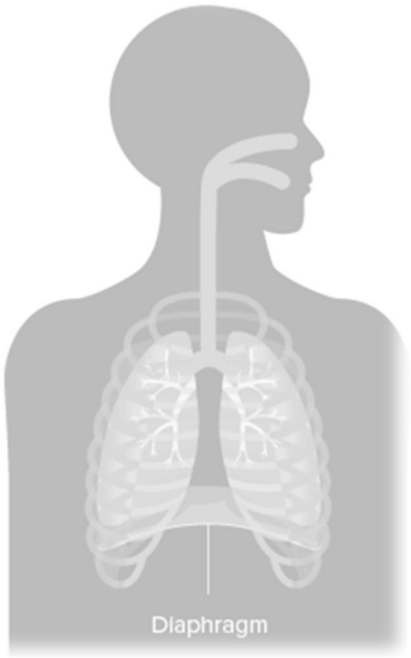
- Sample processing

- Contamination

Other Non-invasive Alternative Approaches?

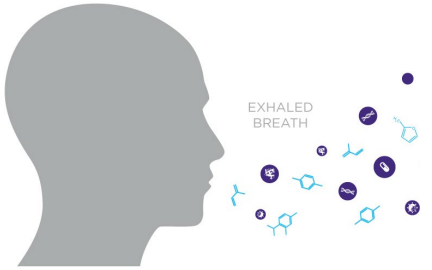
Exhalomics in Human Research



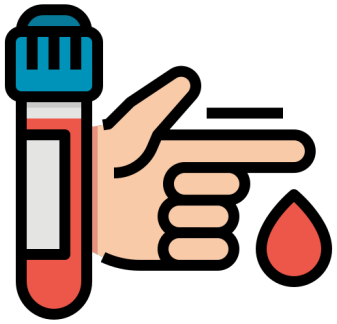


- Diagnostics of asthma in children

- Breath instead of a blood test



Vs.

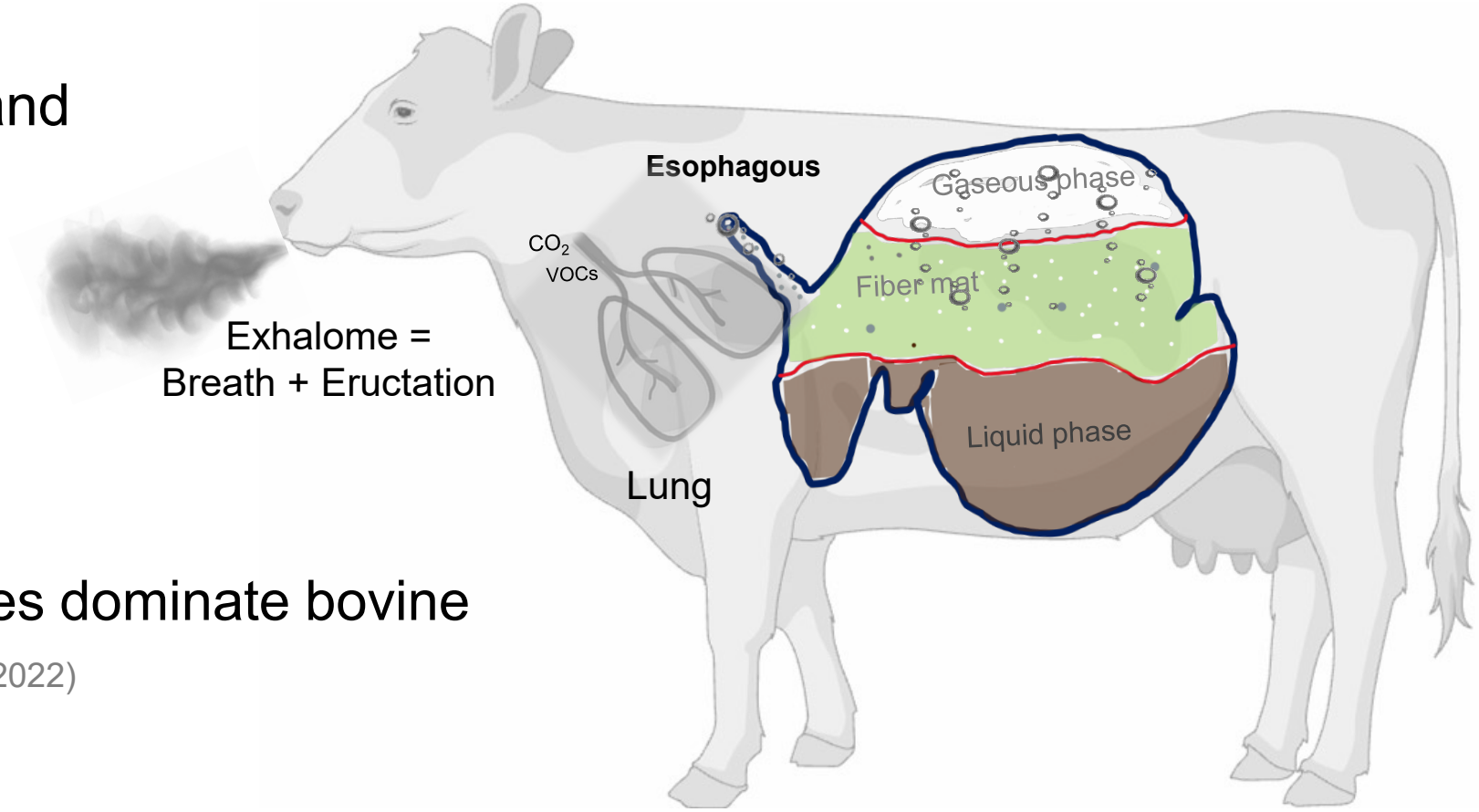


- Human breath biomarker-based diagnosis

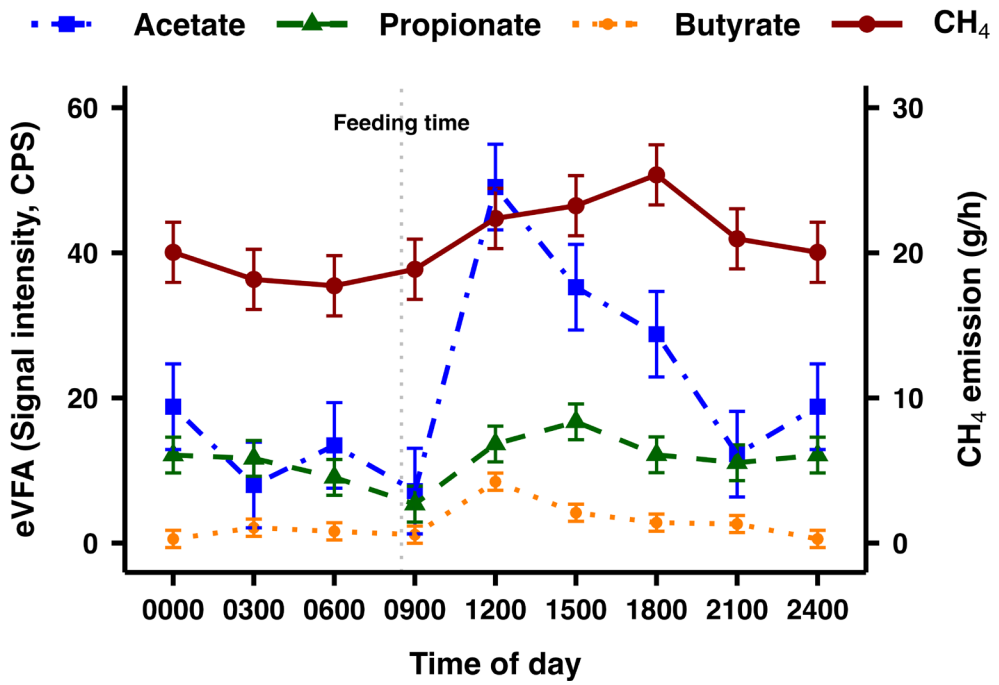
Owlstone Medical; Zurich Exhalomics

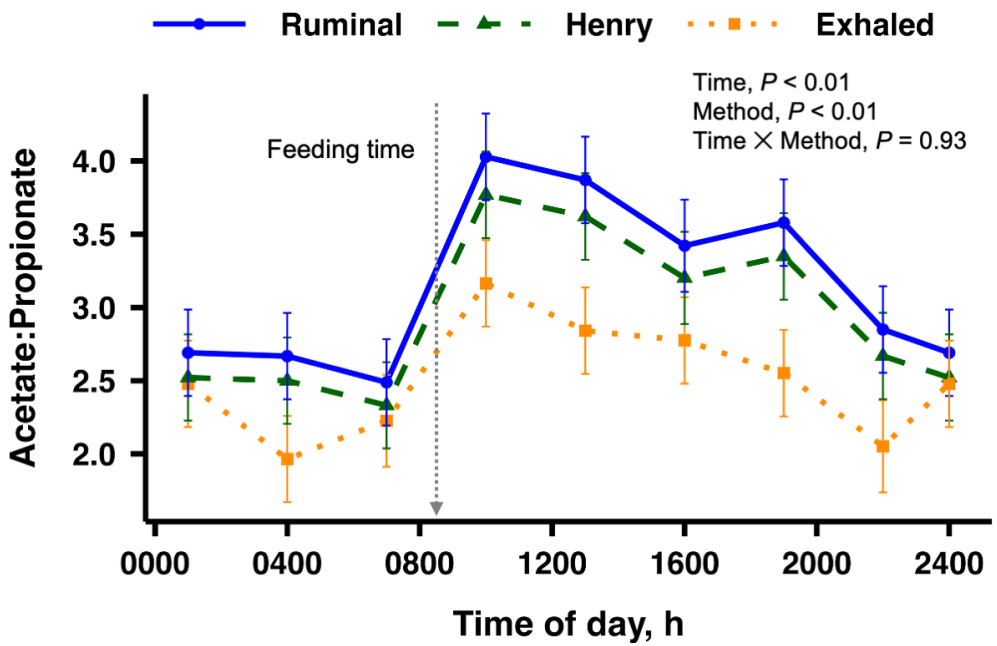
Bovine Breath Research and Exhalomics

- Early disease diagnosis and health monitoring
- Rumen fermentation and metabolic assessment
- Proof-of-the-concept studies dominate bovine breath research (Haddadi et al., 2022)



Exhalomics in Characterizing VFA Profile in Dairy Cows





Research goal: Compare exhalome with ruminal metabolome profile in dairy cows to assess metabolic status.

Islam et al., J. Dairy Sci. 2023, 2024

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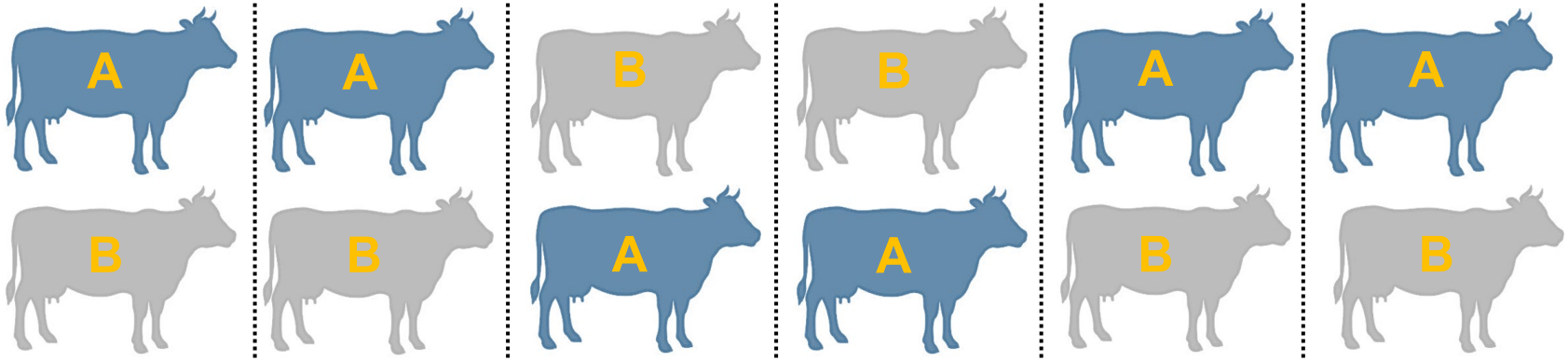
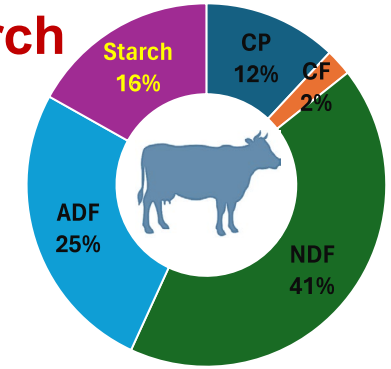
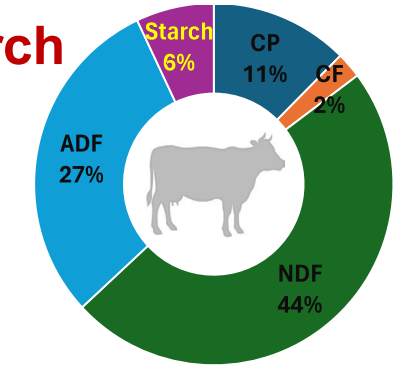
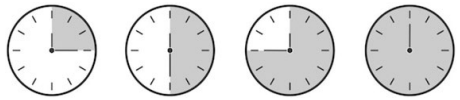
Experimental Design: Switchback

Four cannulated cows (Original Brown)			
Period	**1** (9-d)	**2** (9-d)	**3** (9-d)
Experimental diet	**A = High-starch** 		**B = Low-starch** 
Sampling/period	8 times to represent every 3-h of a day 		

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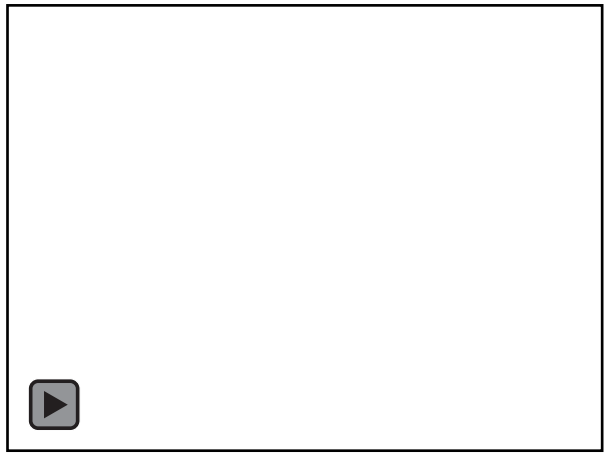
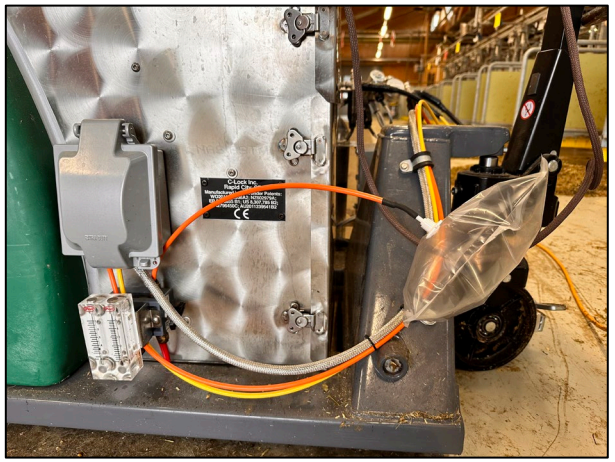
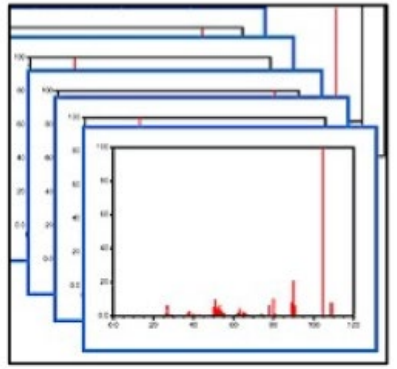
Exhalome Sampling via GreenFeed System and Mass Spectrometry



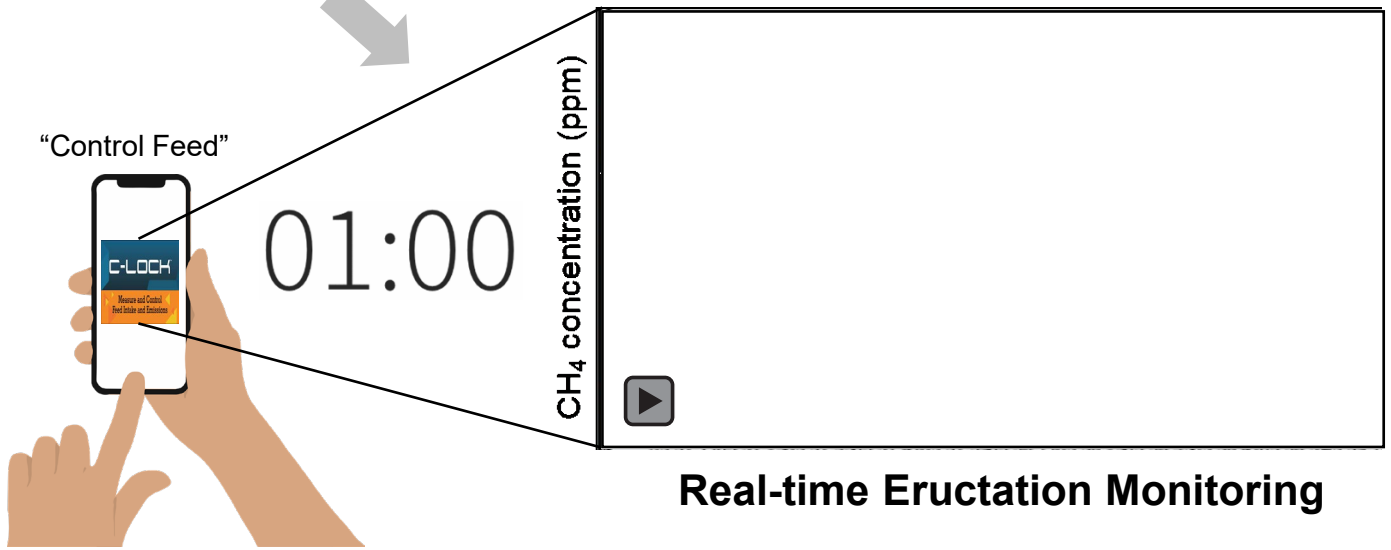
A Sampling Event



Exhalome Sampling



Analyzed via SESI-HRMS



Real-time Eructation Monitoring

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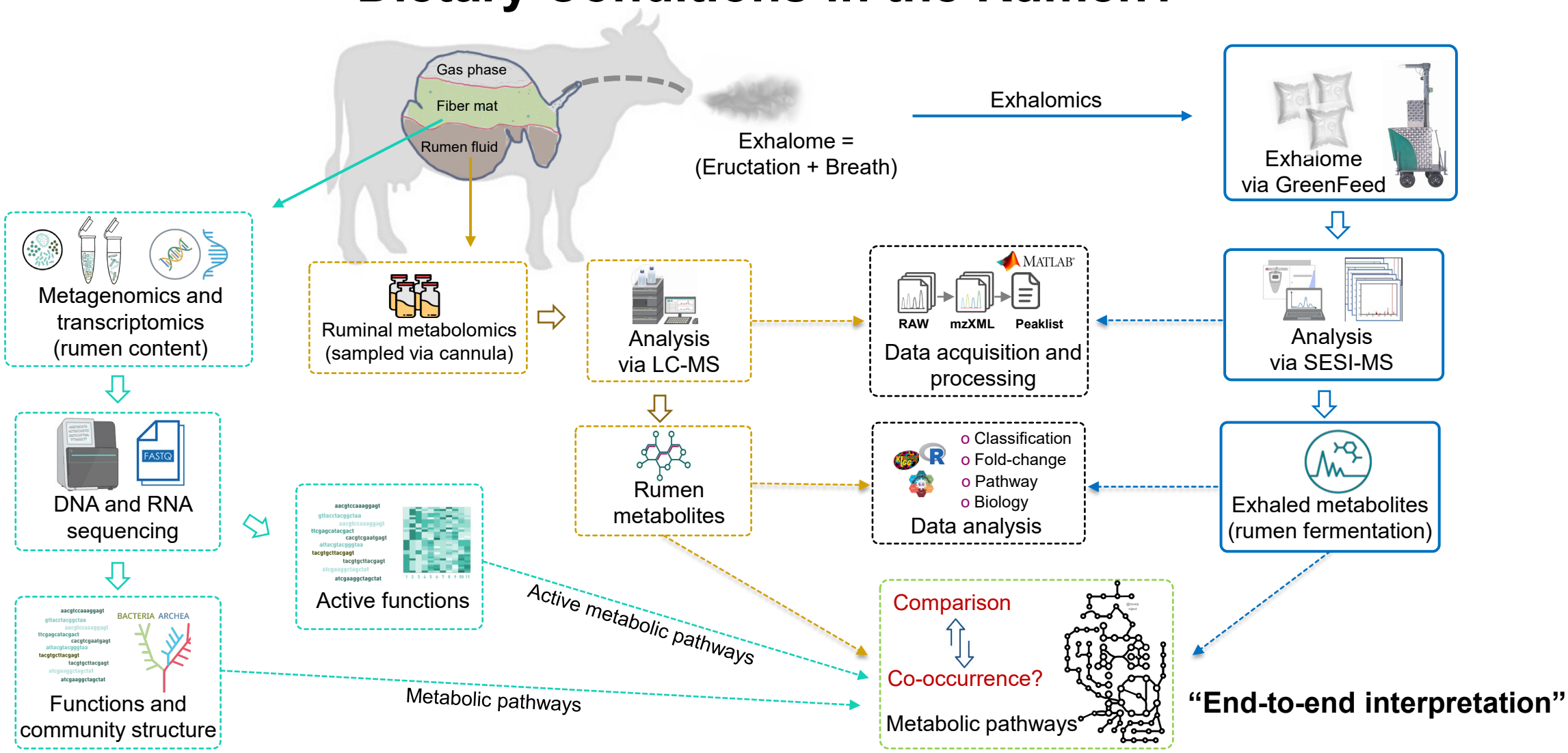
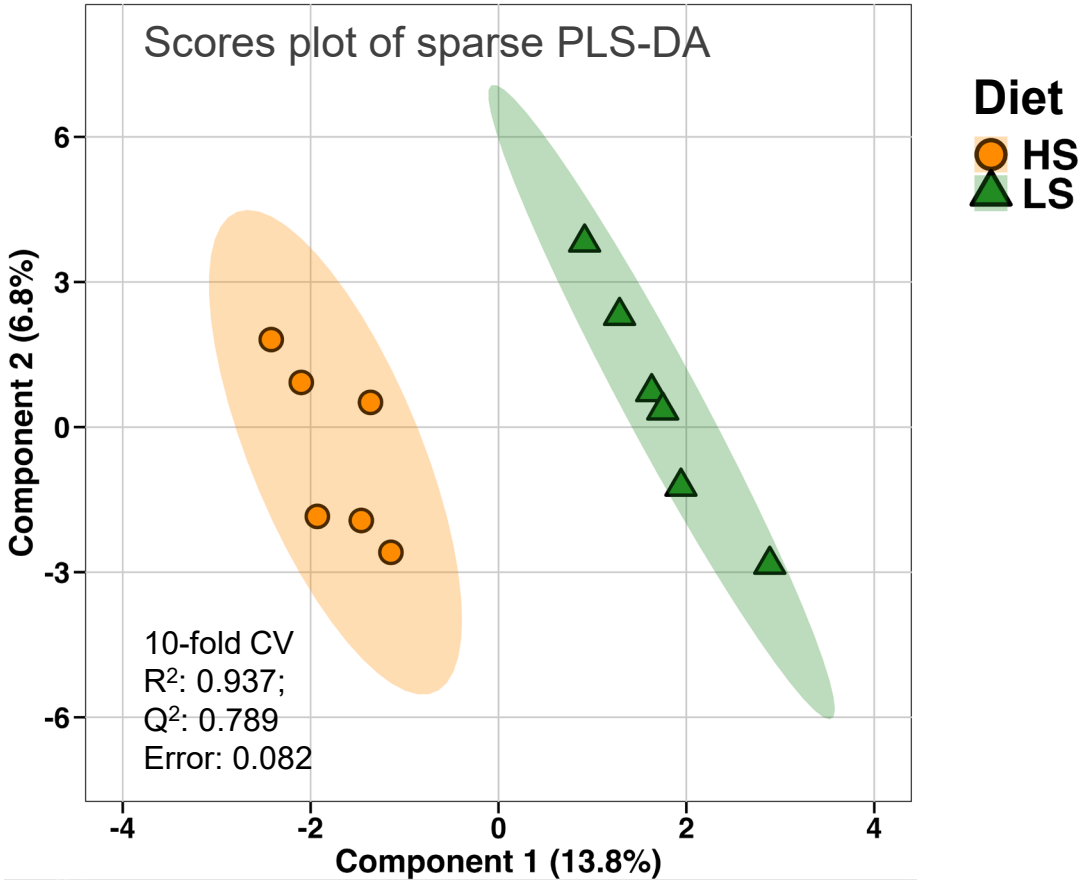
A Workflow to Assess How Exhalome Profile Reflects the Dietary Conditions in the Rumen?



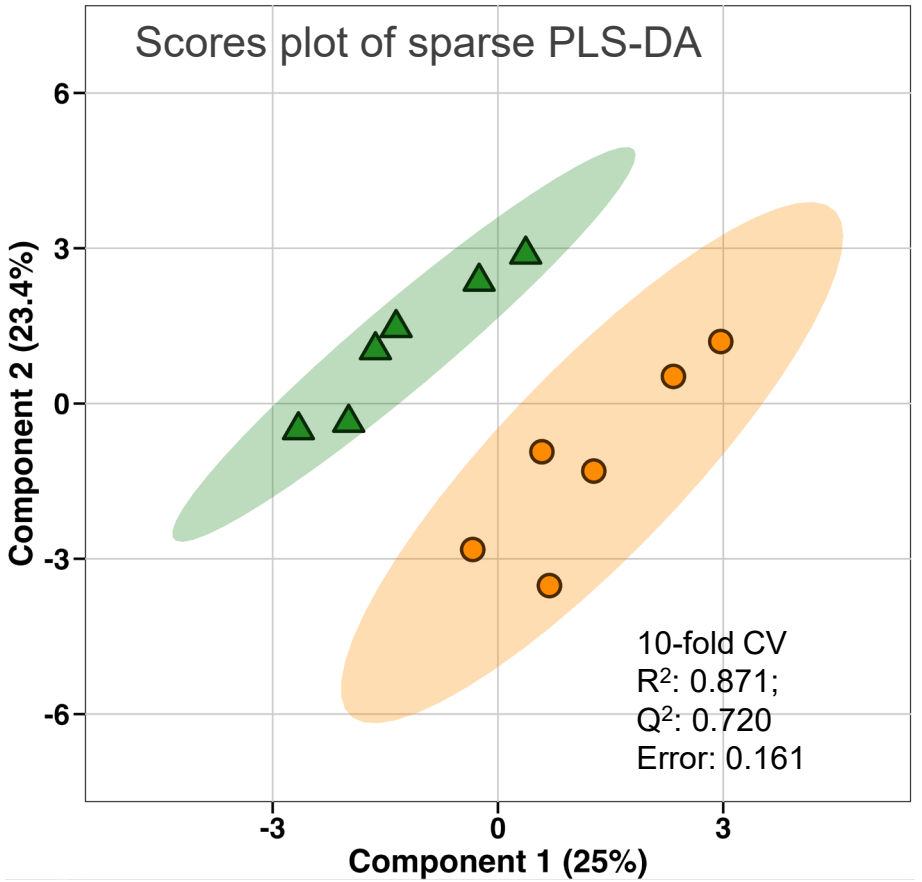
"End-to-end interpretation"

Exhalome Profile Can Predict Dietary Condition (High vs. Low-starch) Similarly to Ruminal Profile

A. Ruminal



B. Exhalome



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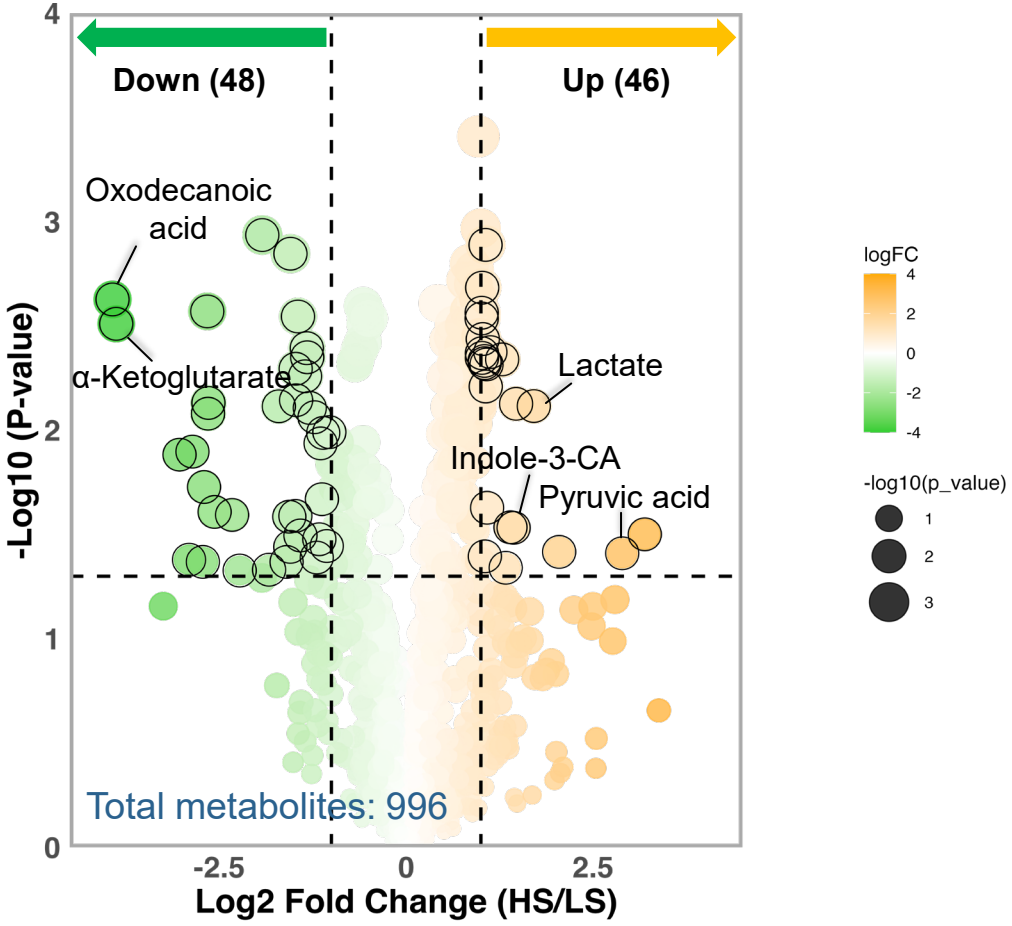
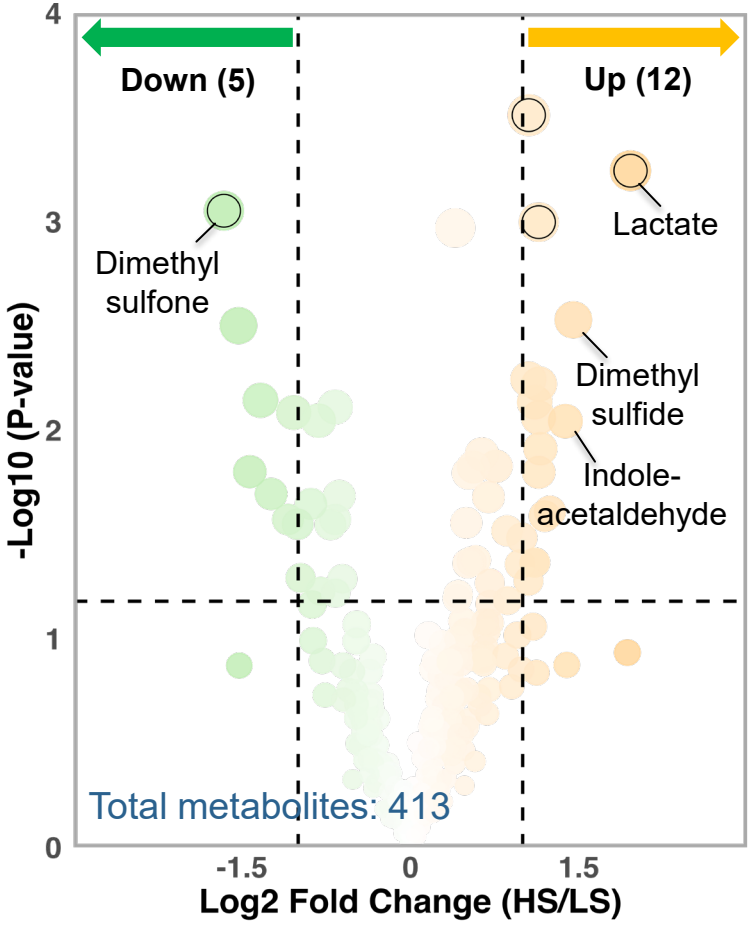
Metabolites Significantly Altered at 2-h Post-feeding Detectable in Both Ruminal and Exhalome Profile

A. Ruminal



B. Exhalome



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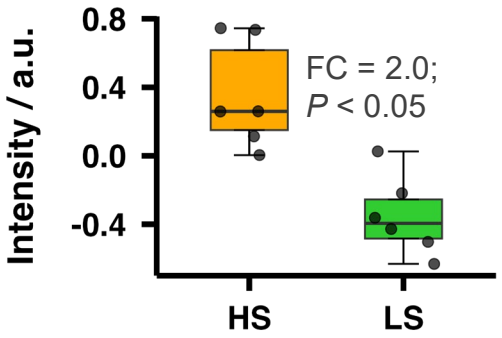
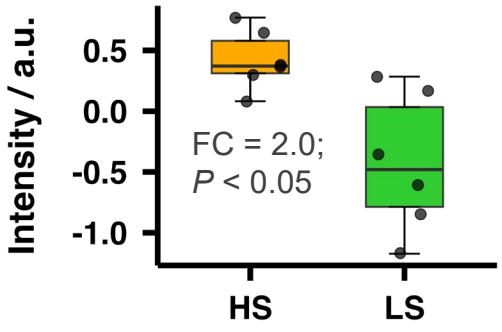
Putatively Identified Metabolites Altered in Both Ruminal and Exhalome Samples Post-Feeding Event

Ruminal

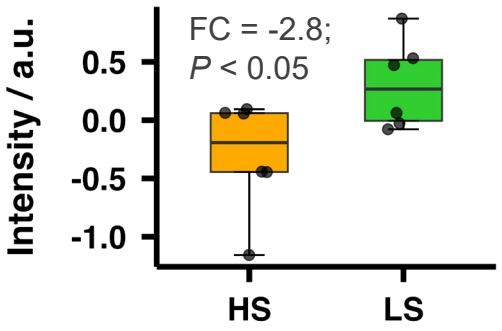
Lactate



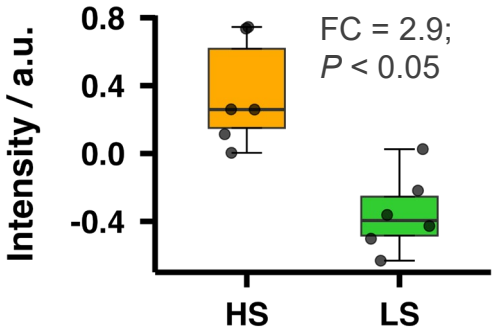
Indole-3-carboxylic acid



Alpha-ketoglutaric acid

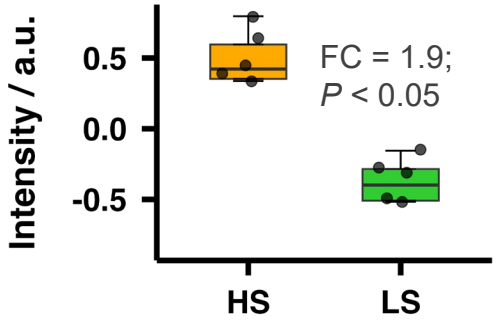


Pyruvic acid

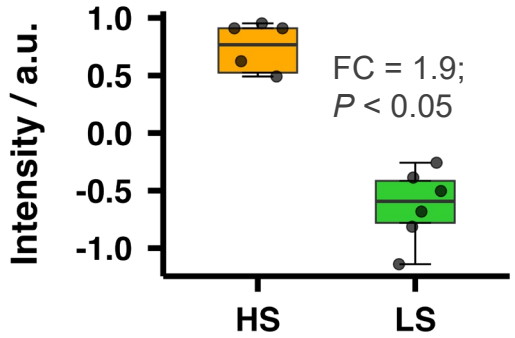


Exhaled

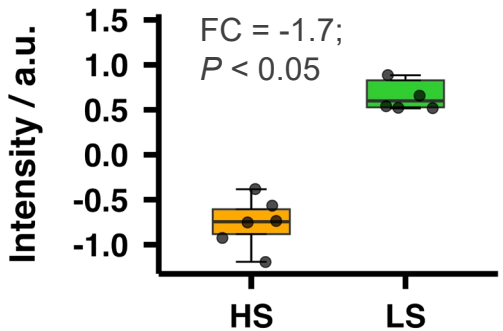
Lactate



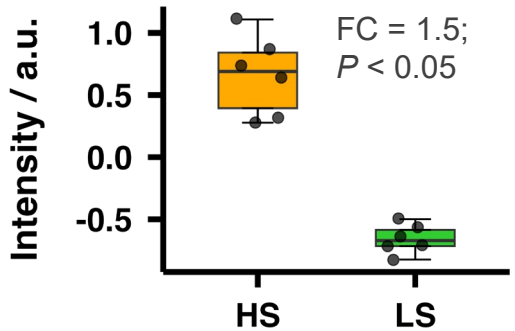
Indole-acetaldehyde



Dimethyl sulfone



Dimethyl sulfide



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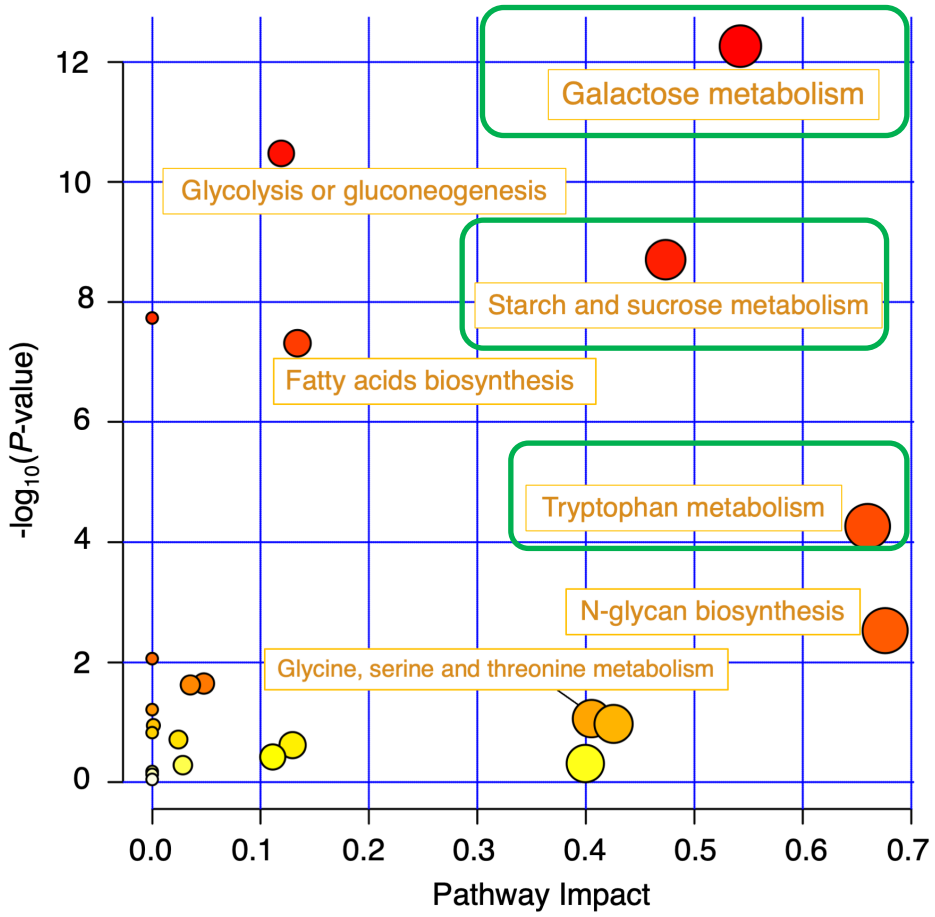
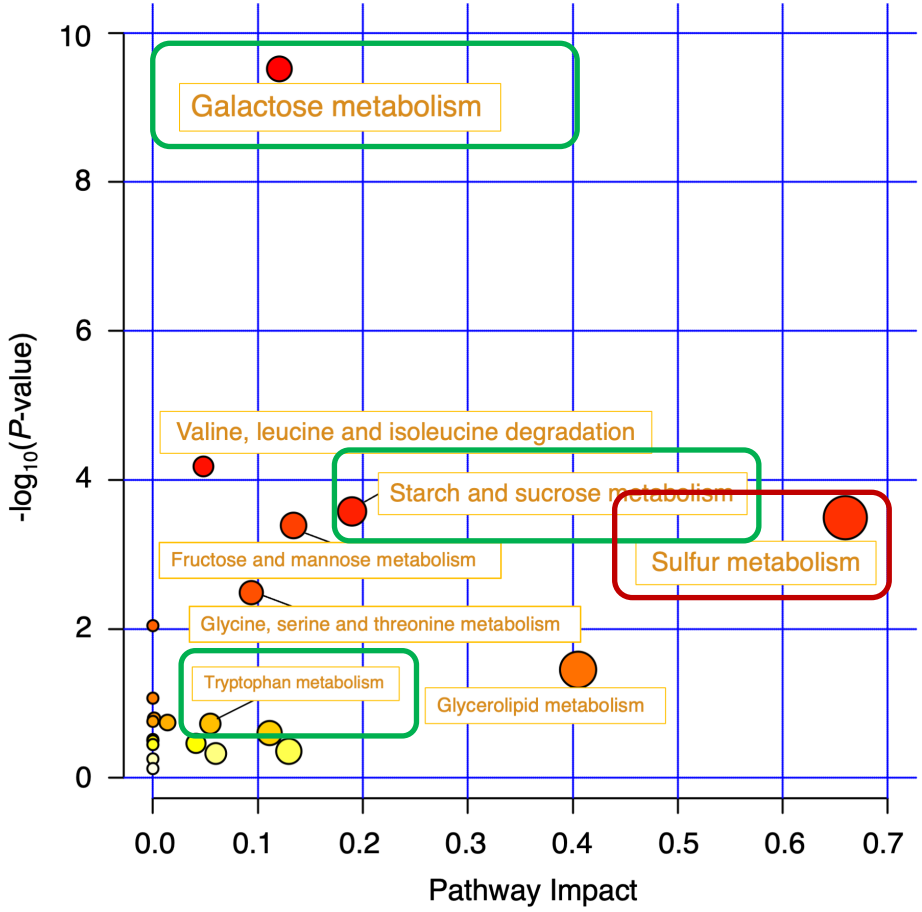
Ruminal and Exhalome Profile Share Metabolic Pathway Activities Associated with Starch Metabolism

A. Ruminal



B. Exhalome



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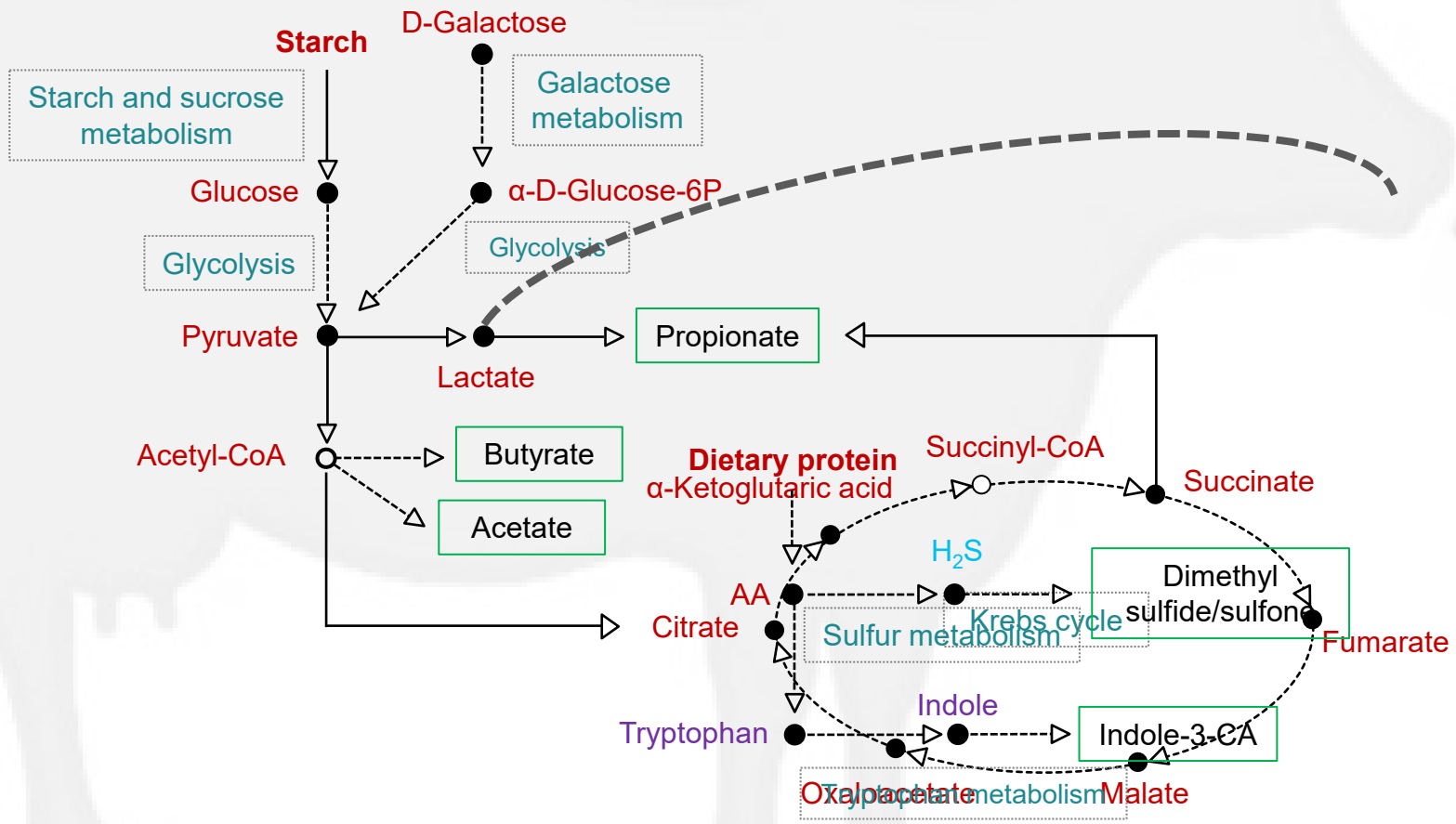
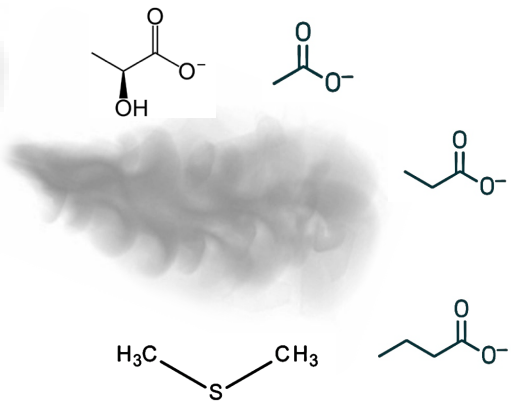
Metabolic Pathway Activities Associated with Starch Metabolism





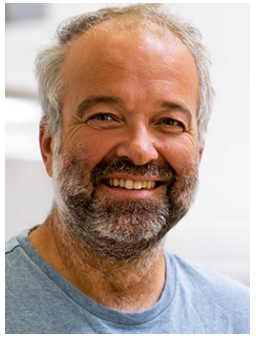
Take Home Message

- Both exhalome and ruminal metabolome profile captured similar diet effect.
- Shared enriched metabolic pathways were associated with carbohydrate metabolism and metabolites altered at high magnitude post-feeding.
- Exhalomics shows the potentiality for non-invasive ruminal metabolic assessment.

Thank You!







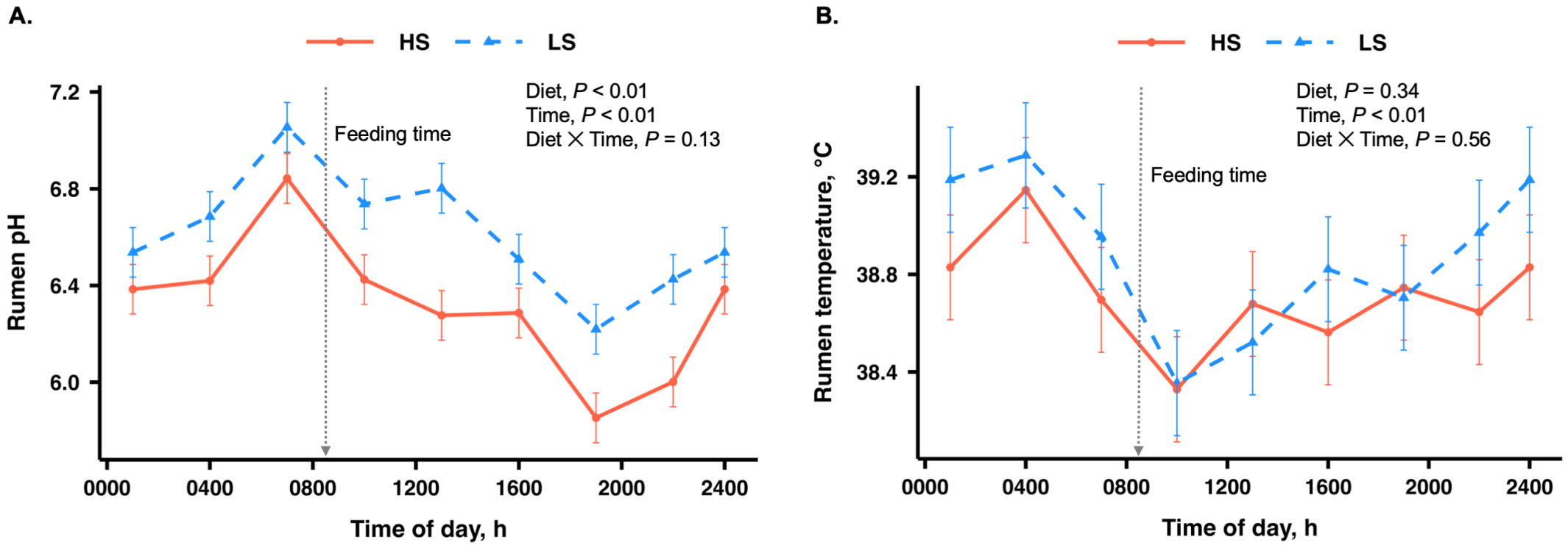
Zakirul Islam
zakirul.islam@usys.ethz.ch

Zurich Exhalomics

Agroscope

AgroVet Strickhof

Rumen pH (A) and temperature (B) of dairy cows fed high-starch (HS) and lowstarch (LS) diets measured in 3-h intervals (LSM ± SE)



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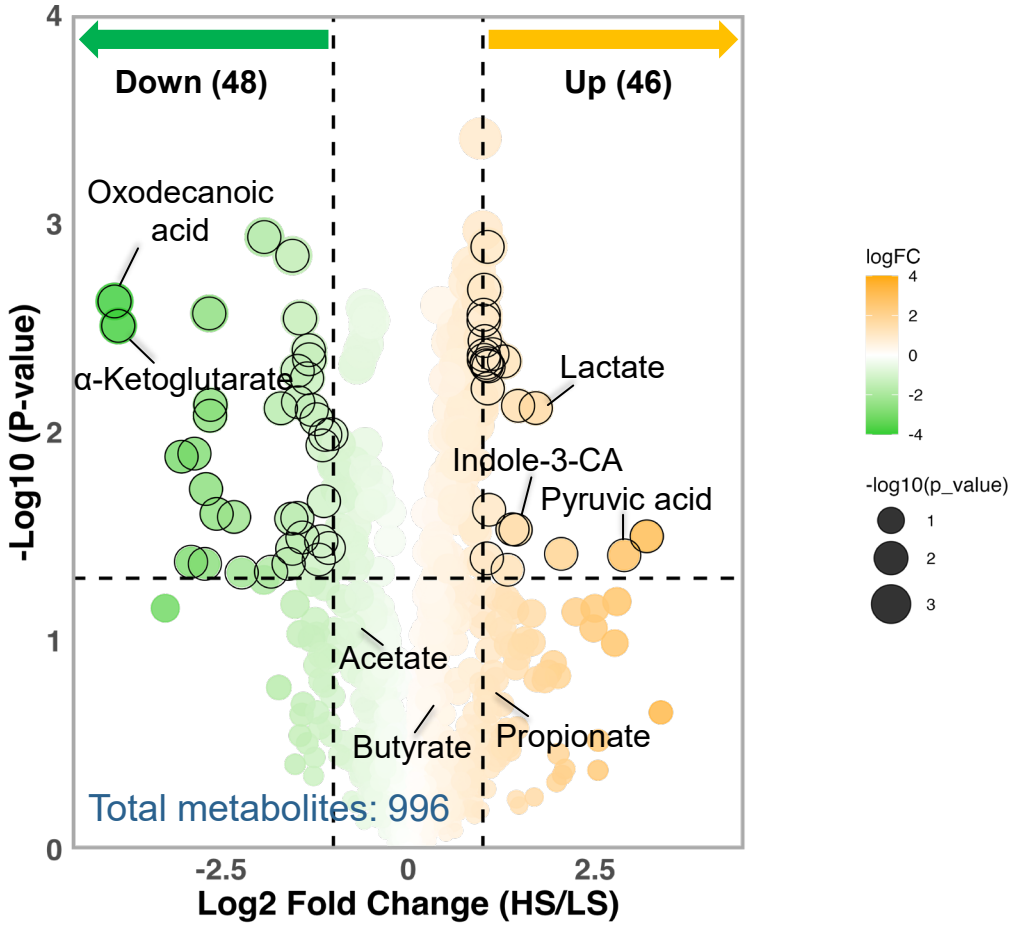
Metabolites Significantly Altered at Post-feeding Detectable in Both Sample Matrices

A. Ruminal



B. Exhalome