Lipogenic and glucogenic compounds: their interaction with rumen metabolism, animal health, product quality and potential as biomarker

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Lipogenic vs glucogenic compounds

Udder

- milk fat (lipogenic)
- milk protein (aminogenic)
- milk lactose (glucogenic)
Lipogenic vs glucogenic compounds

Rumen → Small intest. or liver → Udder

acetate

butyrate

microbial protein

propionate

fatty acids

milk fat (lipogenic)

milk protein (aminogenic)

milk lactose (glucogenic)

milk fat

milk protein

milk lactose

amino acids

glucose
Lipogenic vs glucogenic compounds

Chemical composition feed → Rumen → Small intest. or liver → Udder

- cellulose, hemicellulose
- sugars, fructosans
- fat
- bypass protein
- rum.degr.protein
- bypass starch
- rum.degr.starch
- pectin

Rumen:
- acetate
- butyrate
- propionate

Small intest. or liver:
- fatty acids
- microbial protein
- amino acids

Udder:
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CH$_4$ mitigation: alternative H$_2$ sinks

Feed (carbohydrate polymer)

- Microbial hydrolysis
- Monomer

- Microbial fermentation
- Acetate
- Propionate
- Butyrate

CO$_2$

- Archaea methanogens → CH$_4$
- Acetogens → CH$_3$COO$^-$
- Sulfate-reducers → H$_2$S
- Nitrate reducers
  - + SO$_4^{-}$
  - + NO$_3^{-}$ → NO$_2^{-}$ → NH$_4^+$
- Fumarate-reducers

H$_2$

- Fumarate
  - O·OC-CH = CH-COO$^-$ → Succinate
  - O·OC-CH$_2$-CH$_2$-COO$^-$

- Propionate
Rumen stoichiometry

Glucose → 2 P-Enol Pyruvate → 2 Oxaloacetate → 2 Malate → 2 Succinate → CO₂ + 4H₂ → CH₄

2 CO₂ + 4H₂ → CH₄

2 ATP → 2 Acetyl-Co A → 2 Acetyl-P → 2 Acetate

2 H₂ → 2 Lactate → 2 Acrylate

2 ATP → 2 Crotonyl-Co A → Butyrate
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Negative energy balance (NEB)

- Phase 3: Fresh
- Phase 4: Peak Milk
- Phase 5: Peak DMI
- Phase 6: Tail End

- Milk Production
- Dry Matter Intake
- Body Weight

Adopted University of IL Urbana-Champaign
NEB $\Rightarrow$ ketosis & fatty liver?
Fertility

Peripheral metabolism

Lipolysis
  → Ketogenesis
Lactose synthesis
Protein rich diet
Energy rich diet

Blood

NEFA
  → β-OHB
GLUCOSE
  → UREA
Total CHOLESTEROL

Dominant follicle

NEFA
  → B-OHB
GLUCOSE
  → UREA
Total CHOLESTEROL

Ovulation

Fertilization failure

Physiological status: lactation

Embryo quality

Embryo mortality

Breed or genetic merit

Leroy, 2005
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Milk odd chain FA ~ propionate
Milk iso FA ~ acetate

linear odd-chain (C15:0, C17:0)

iso branched-chain (even & odd)

anteiso branched-chain (odd)
Specific milk FA to diagnose ketosis & NEB

Milk fatty acids

Diagnosis

biomarker: C18:1c9 & C18:1c9/C15:0

NEB & Ketosis

Jorjong et al, 2014 & 2015
Conclusion

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## Conclusion

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