Breath analysis in dairy cattle:
going beyond methane emission

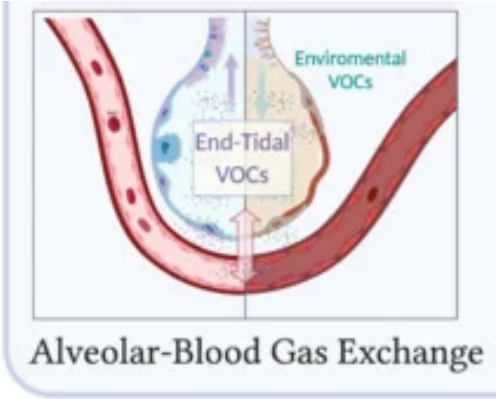
István Fodor[1], Elaine van Erp-van der Kooij[2], Ingrid van Dixhoorn[3]

[1] Animal Breeding and Genomics, Wageningen University and Research; [2] Department of Animal Husbandry, HAS green academy; [3] Animal Health and Welfare, Wageningen University and Research

WAGENINGEN
UNIVERSITY & RESEARCH

Breath analysis in dairy cattle – Why?

- Non-invasive
- Near-real time
- Reflects blood volatiles



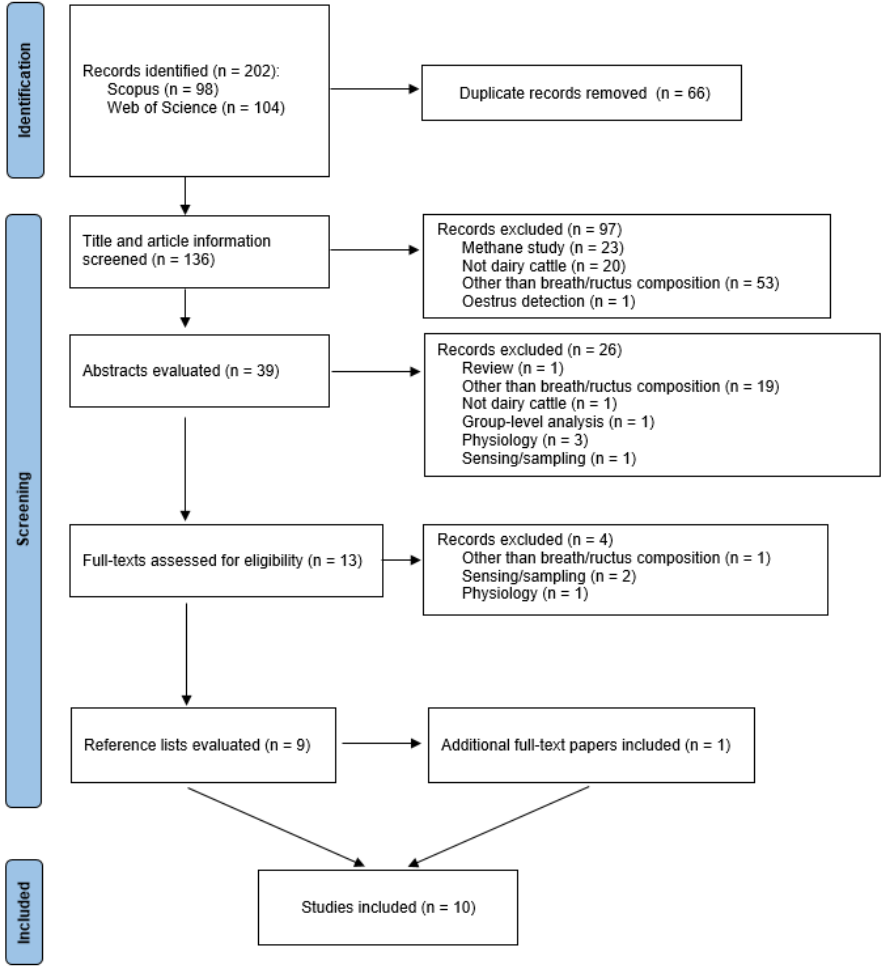
Tsou et al., 2021

Breath analysis in dairy cattle – Why?

- Non-invasive
- Near-real time
- Reflects blood volatiles

- Ethanol breath test
- Nitric oxide ~ asthma[1]
- Acetone ~ diabetes[2]

[1] Gustafsson et al., 1991; [2] Righettoni et al., 2010

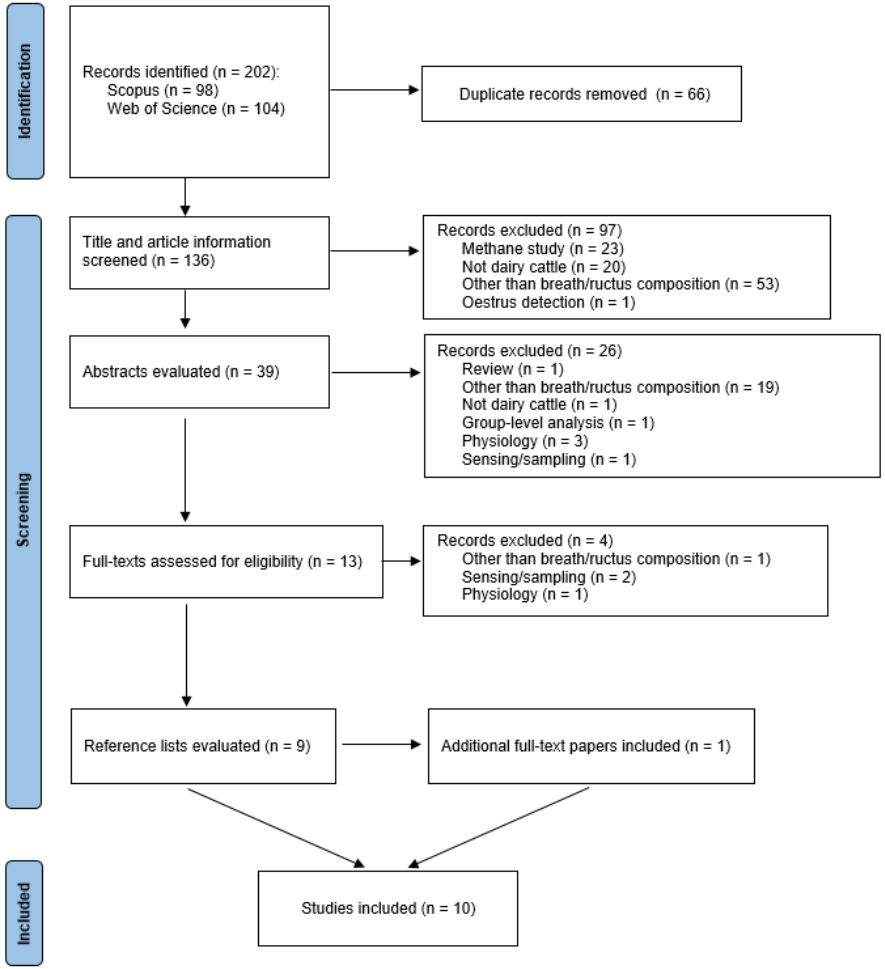


Systematic review

Which diseases have been studied using **breath or ructus composition** in dairy cattle?

What is the authors' **conclusion** on the ability to distinguish diseased vs. not diseased dairy cattle based on breath or ructus composition?

Systematic review

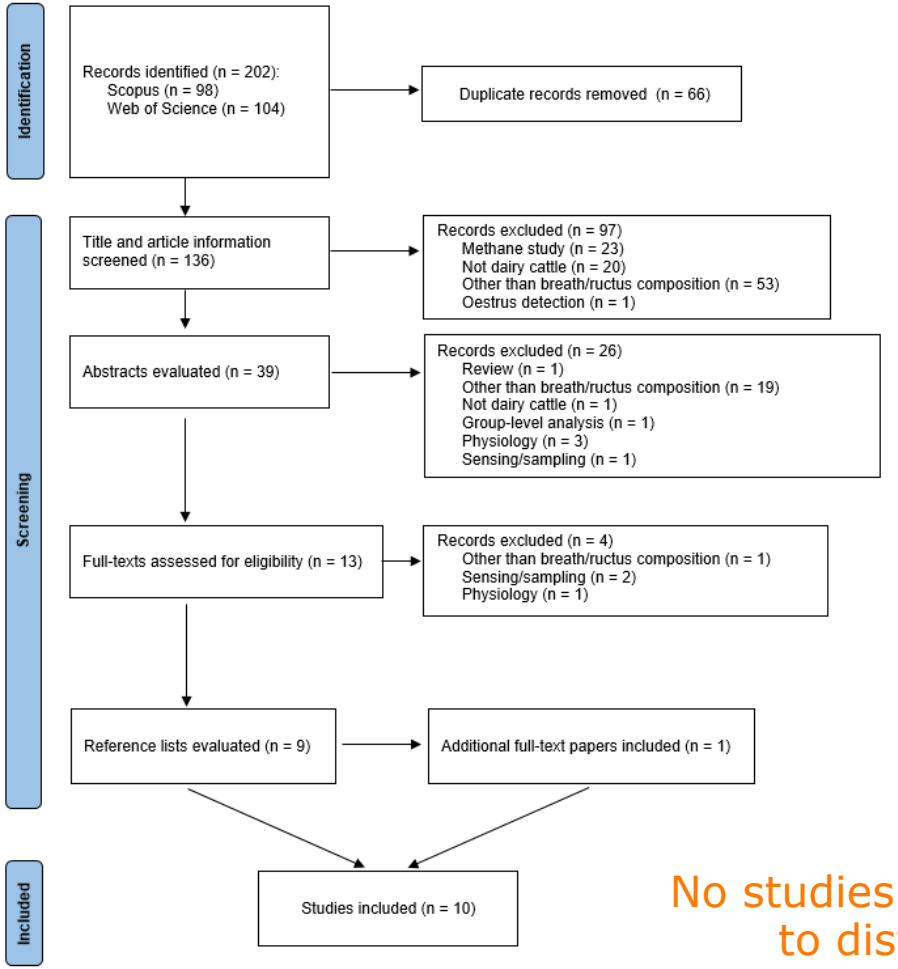


Include:

- Dairy cattle (any maturation stage)
- Breath/ructus composition
- Diseased vs. control (or self-control)
- Individual breath/ructus composition ~ disease status

WAGENINGEN
UNIVERSITY & RESEARCH

Systematic review

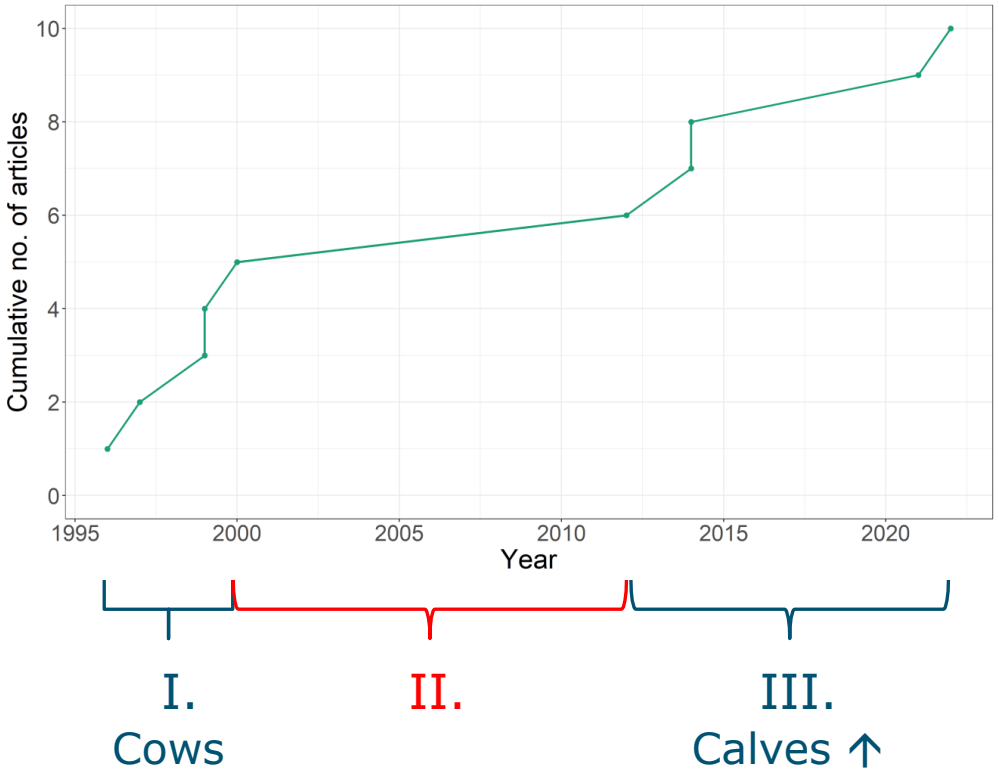


Include:

- Dairy cattle (any maturation stage)
- Breath/ructus composition
- Diseased vs. control (or self-control)
- Individual breath/ructus composition ~ disease status

No studies found on using ructus gas composition to distinguish diseased vs. not diseased

Trends in publication



Calves: 75% infectious

Cows: 80% metabolic

Avg. **2.1 farms**
(median: 1, range: 1-8)

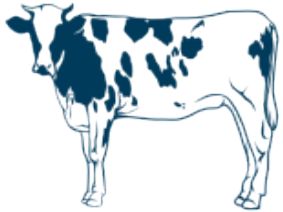
Avg. **18.7 animals** (T + C)
(median: 12, range: 2-77)

WAGENINGEN
UNIVERSITY & RESEARCH

pulmonary inflammation
oxidative stress
brs virus
mycobacterium bovis
ketosis
paratuberculosis

100% of studies **positive** conclusion

Case study 1 – Dynamics of ketone bodies in cows developing ketosis (pilot)



7 cows (all parity 2+) – blood, urine, milk, breath

1 pre-partum sample (Day -17 to Day -3) + post-partum samples up to Day 7

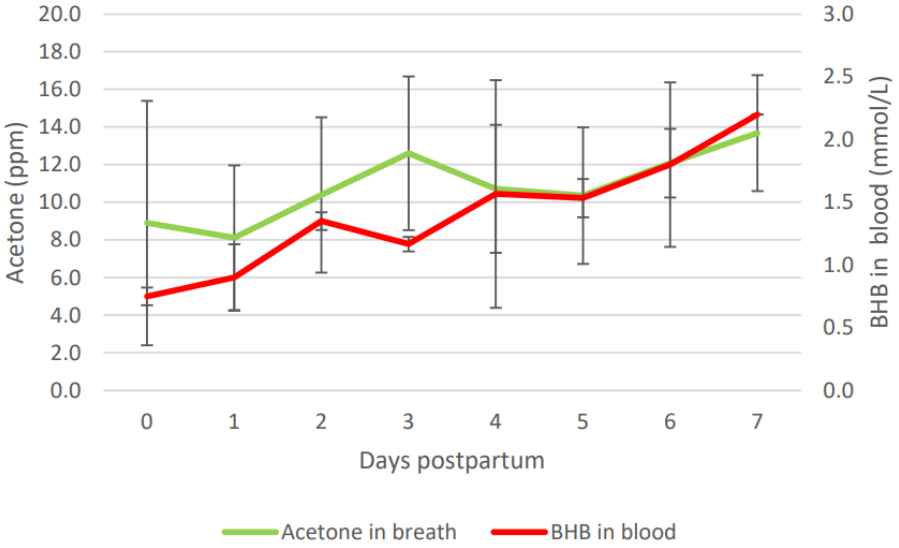
Nostril sampler → nalophan bag

Rumen contractions monitored by palpation (→ sampling stopped)

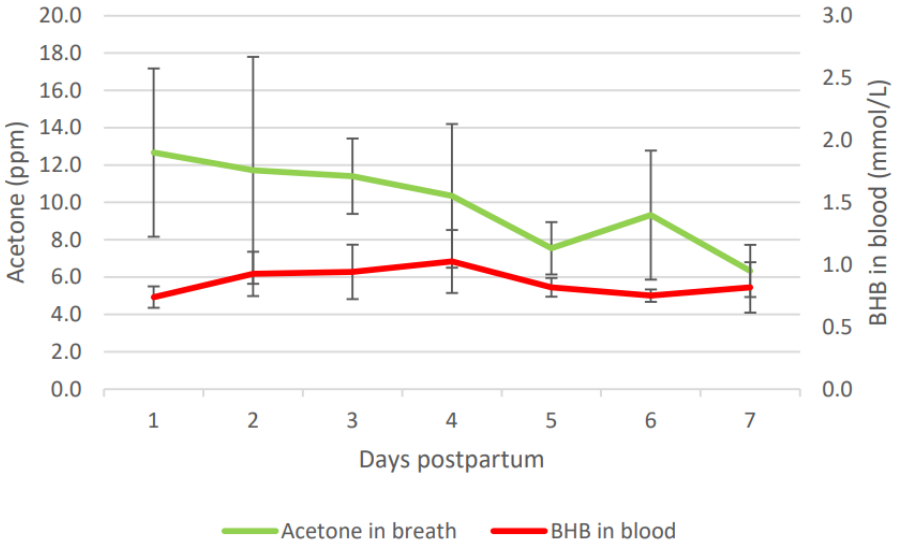
Van Erp-Van der Kooij et al., 2023

Case study 1 – Dynamics of ketone bodies in cows developing ketosis (pilot)

Ketotic cows (n = 4)



Healthy cows (n = 3)



WAGENINGEN
UNIVERSITY & RESEARCH

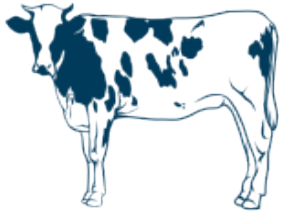
Van Erp-Van der Kooij et al., 2023

Case study 1 – Dynamics of ketone bodies in cows developing ketosis (pilot)

- Within-cow trend more important than absolute value
    - Ketosis (BHB ↑): increasing breath acetone
- High between-cow variations in breath acetone level

→ Longitudinal measurements (↔ 1x)

Case study 2 – Breath analysis for NEB and postpartum diseases



55 cows (parity 1: n = 11, parity 2+: n = 44)

2 weeks pre- to 6 weeks post-partum

Automated breath measurements in the concentrate feeder

Data-driven separation of eructation vs. non-eructating period

WAGENINGEN
UNIVERSITY & RESEARCH

De Bruijn et al., in preparation

Case study 2 – Breath analysis for NEB and postpartum diseases

Respiratory Exchange Ratio (RER; CO_2/O_2, V/V%)

- Reflects source of energy
- Own fat reserves used → lower RER expected

De Bruijn et al., in preparation

Case study 2 – Breath analysis for NEB and postpartum diseases

Respiratory Exchange Ratio (RER; CO_2/O_2, V/V%)

- Reflects source of energy
- Own fat reserves used → lower RER expected

  Higher BCS loss – lower RER

  Ketosis (clinical scoring + blood) – lower RER

De Bruijn et al., in preparation

Conclusions

- Potential to be applied as a non-invasive & near-real-time tool

Conclusions

- Potential to be applied as a non-invasive & near-real-time tool
- We are just starting to understand breath biomarkers
    - Diagnostic value?
    - Early diagnosis?

Conclusions

- Potential to be applied as a non-invasive & near-real-time tool
- We are just starting to understand breath biomarkers
    - Diagnostic value?
    - Early diagnosis?
- Development could be synergistic with upscaling methane measurements in the future (similar sampling, different timing)

Thank you!

istvan.fodor@wur.nl

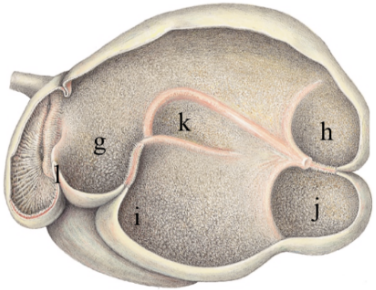
@istvanfodor_

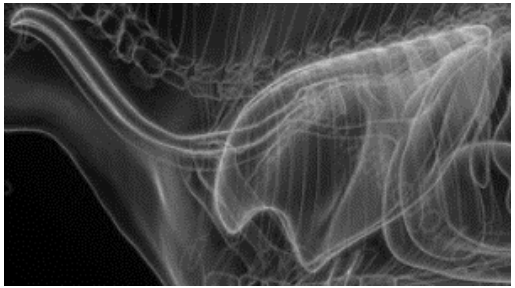
https://agros-smartfarming.nl/

WAGENINGEN
UNIVERSITY & RESEARCH

But cattle are ruminants...

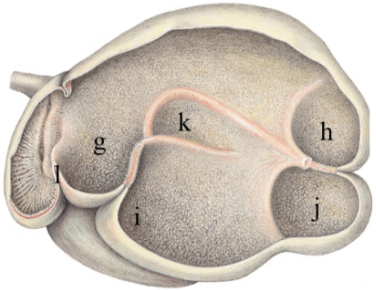
Eructation ⟷ Non-eructating period

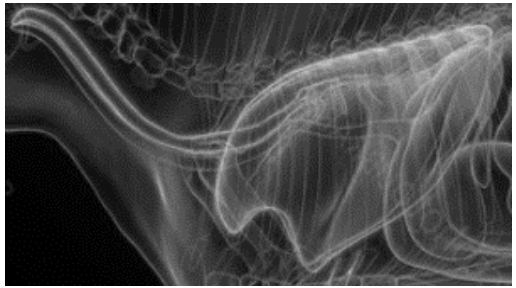




But cattle are ruminants...

Eructation ⟷ Non-eructating period





Inhalation of eructated gasses

Data-driven **separation** of the two periods is possible