Incomplete Milking for metabolic relief of dairy cows

R. Joest, K.-H. Südekum, U. Müller*
University of Bonn, Institute of Animal Science

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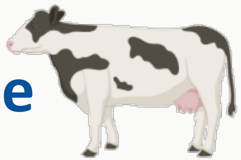
robin.joest@uni-bonn.de

Lactation induced metabolic challenge



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Requirements of the mammary gland lead to high metabolic load
(Gross und Bruckmaier, 2019)

Milk production level and lactation stage affect metabollic challenge

→ can cause production-related diseases (Bruckmaier and Gross, 2017)

➡ Modify energy requirements for milk production to reduce metabolic load ⬅

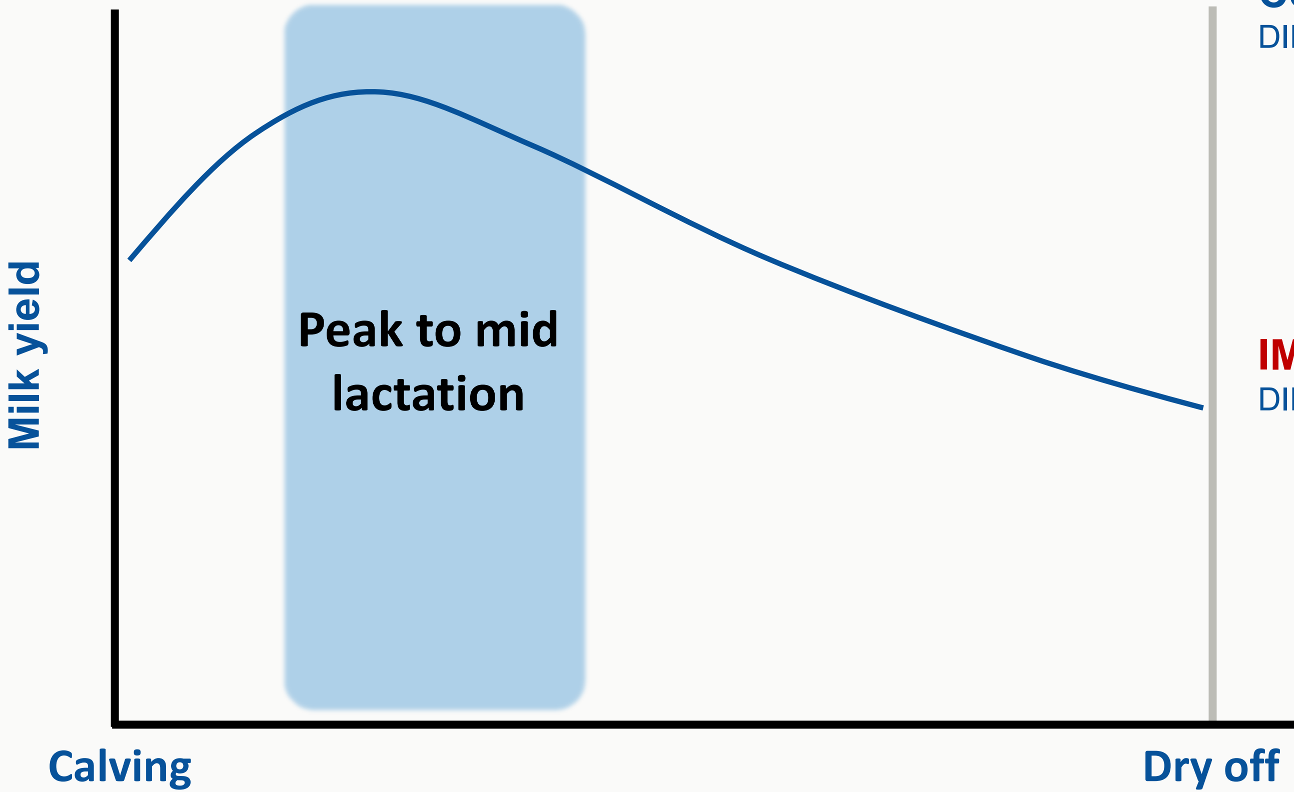
Objectives:

→ Temporally lowering milk withdrawal by incomplete milking **(IM)** and

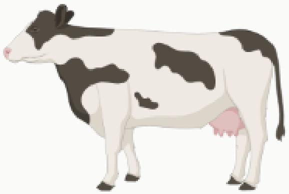
- assess the reaction of the milk yield, udder health and milk fat,
- as well as the reaction of the metabolism through fatty acids (FA)

of multiparous german Holstein cows during peak to mid lactation

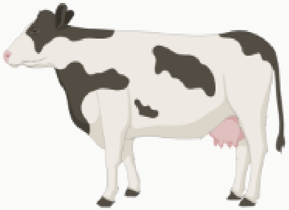
Study design



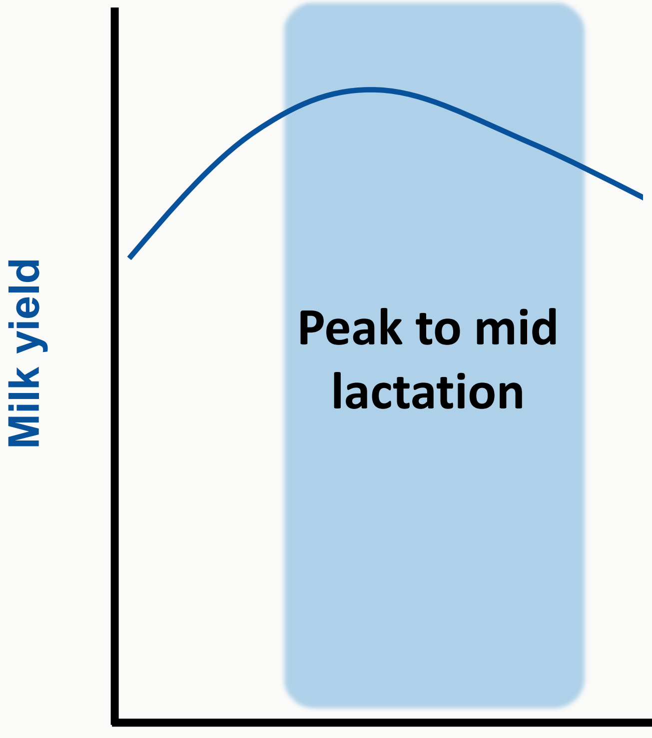
Control (CON) group (n = 23)
DIM: 95 ± 49; Milk yield: 39.1 ± 1.42 (kg/d)



IM group (n = 23)
DIM: 93 ± 46; Milk yield: 40.2 ± 1.66 (kg/d)



Study design



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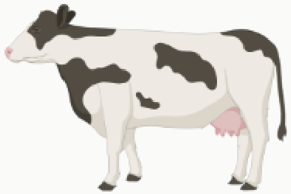

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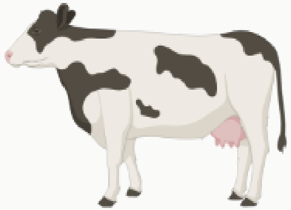
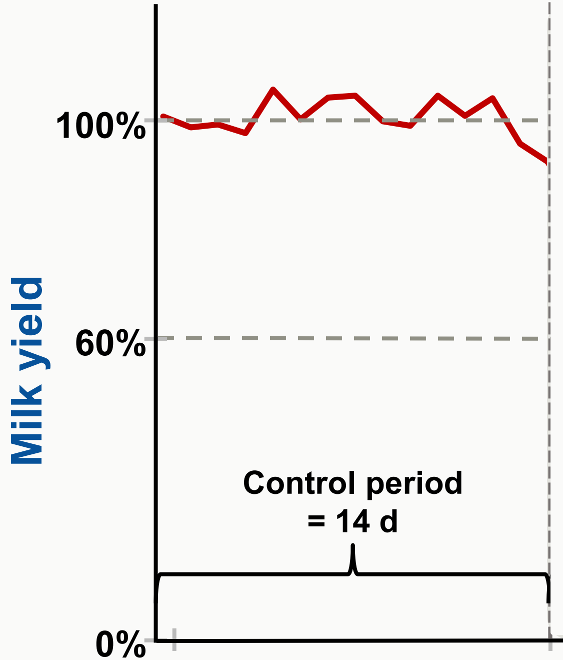


Calving **Dry off**

„Unchallenged“ dairy cows, as a **model**

- Feasibility of **IM**
- Reaction of the metabolism to **IM**

Study design for IM group



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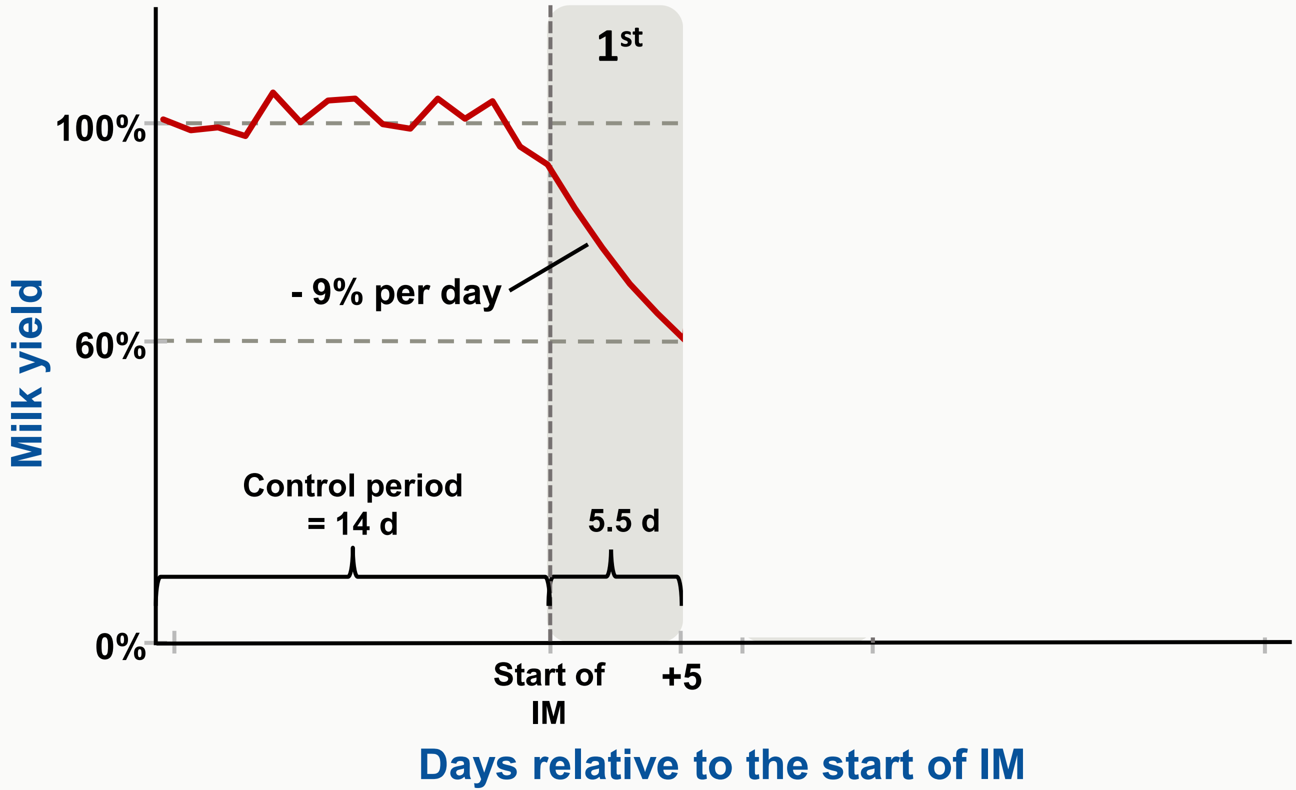
Software-module by Schmidt et al. (2017)

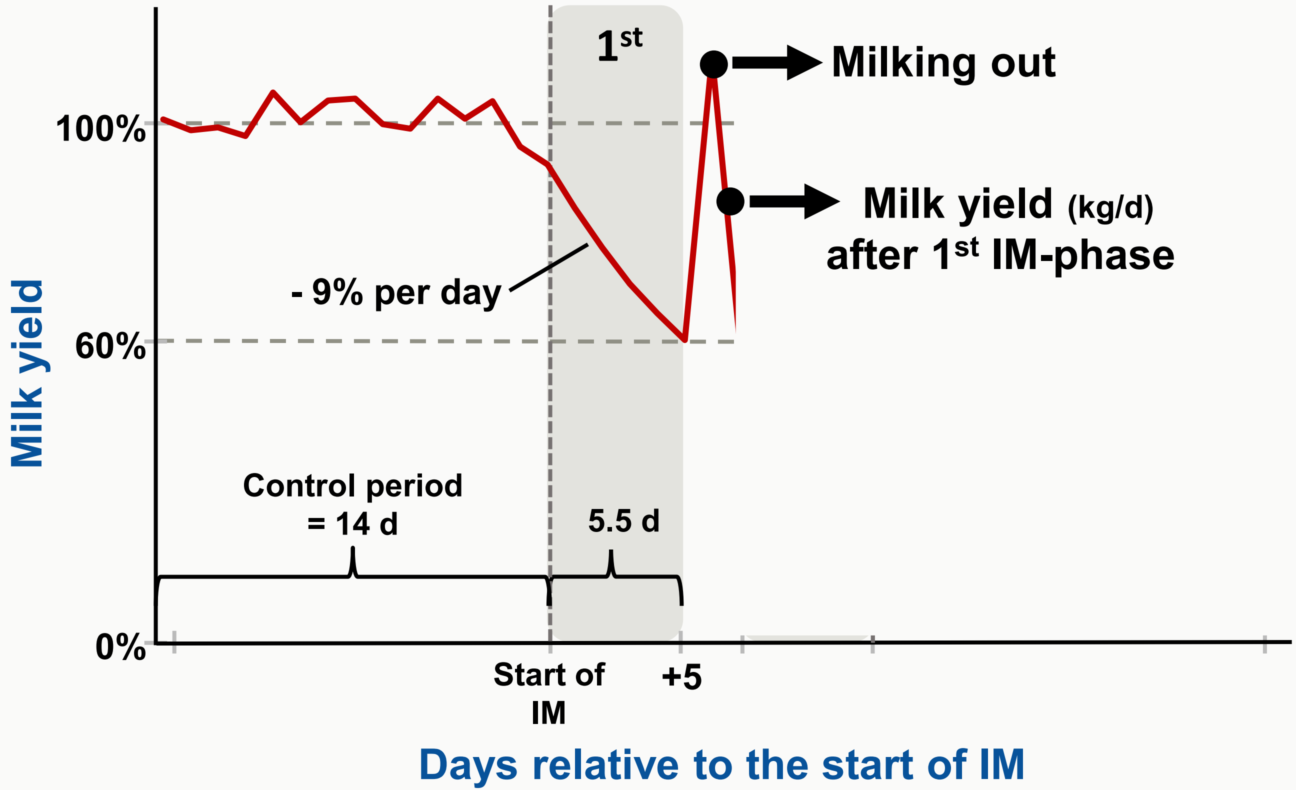
International patent WO 2019/048,521 A1

Days relative to the start of IM

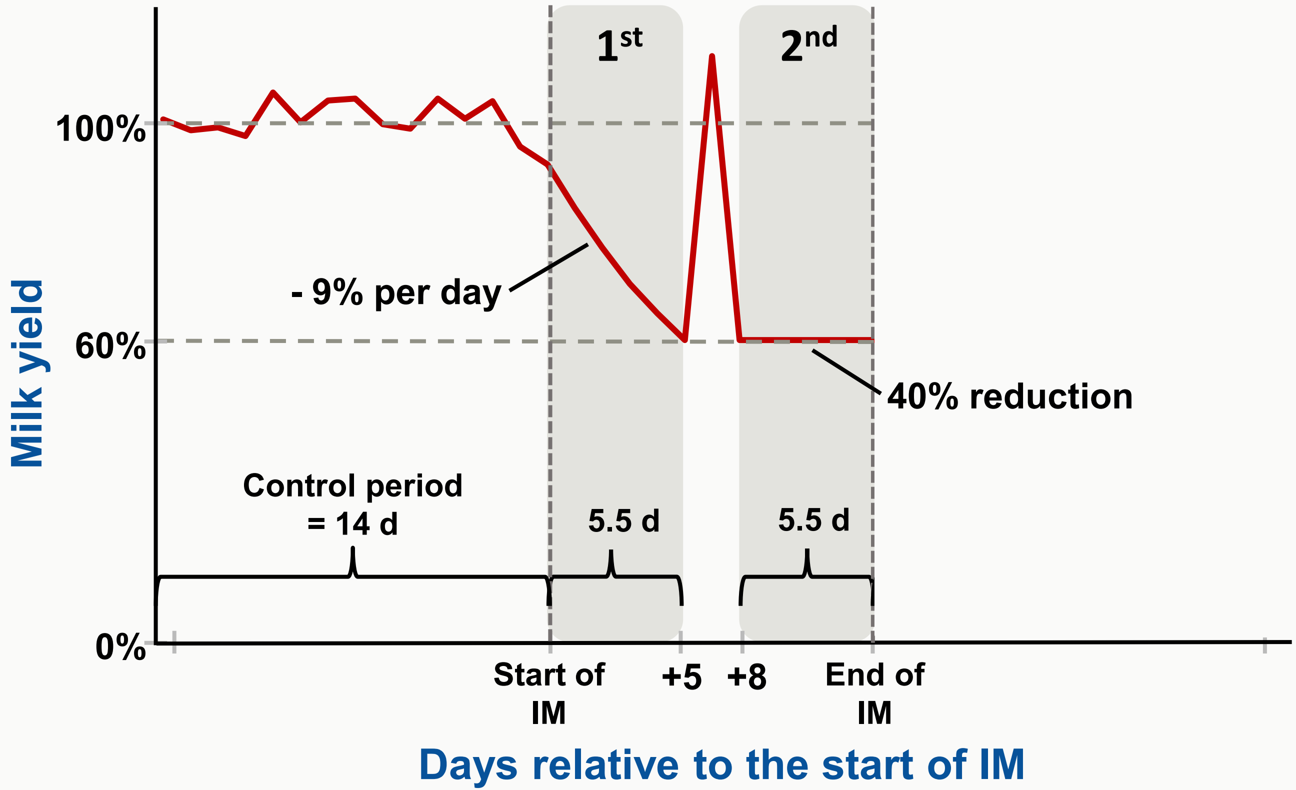
Study design for IM group



Study design for IM group



Study design for IM group



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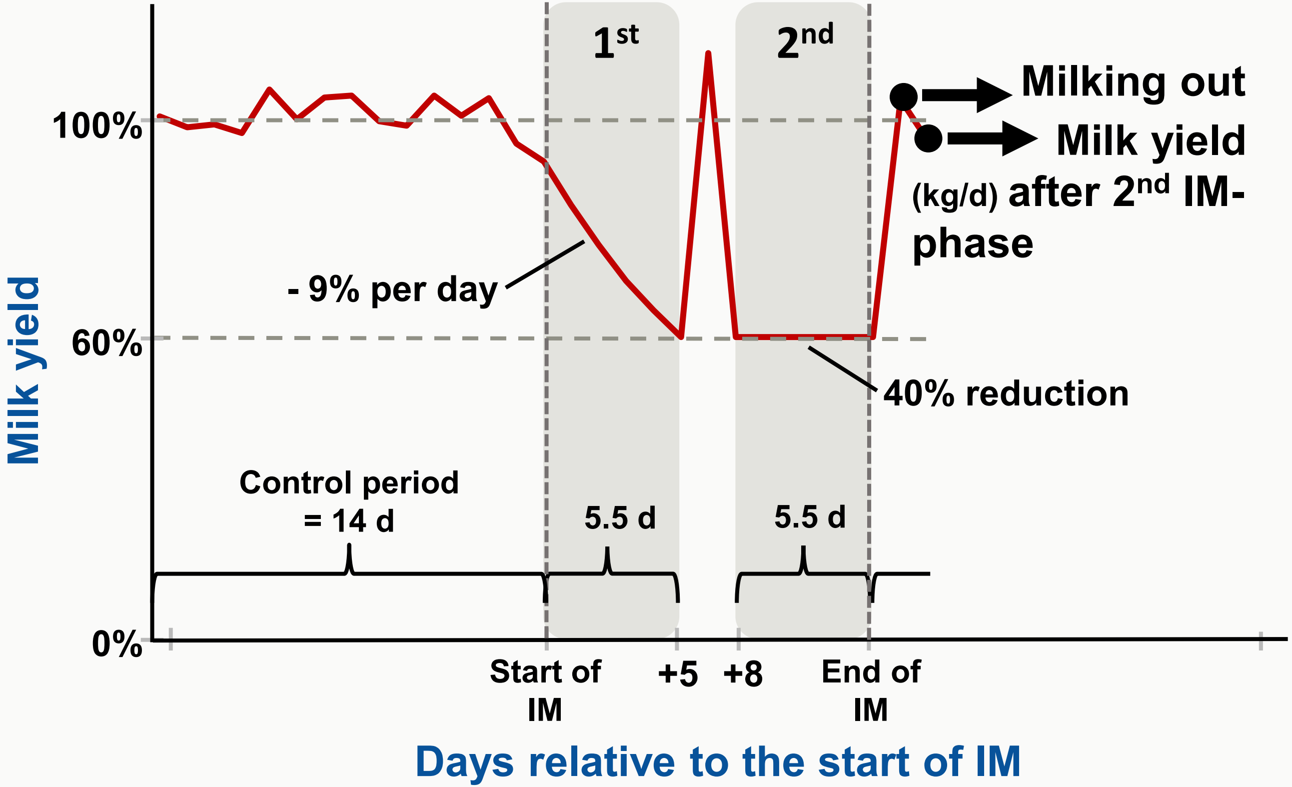
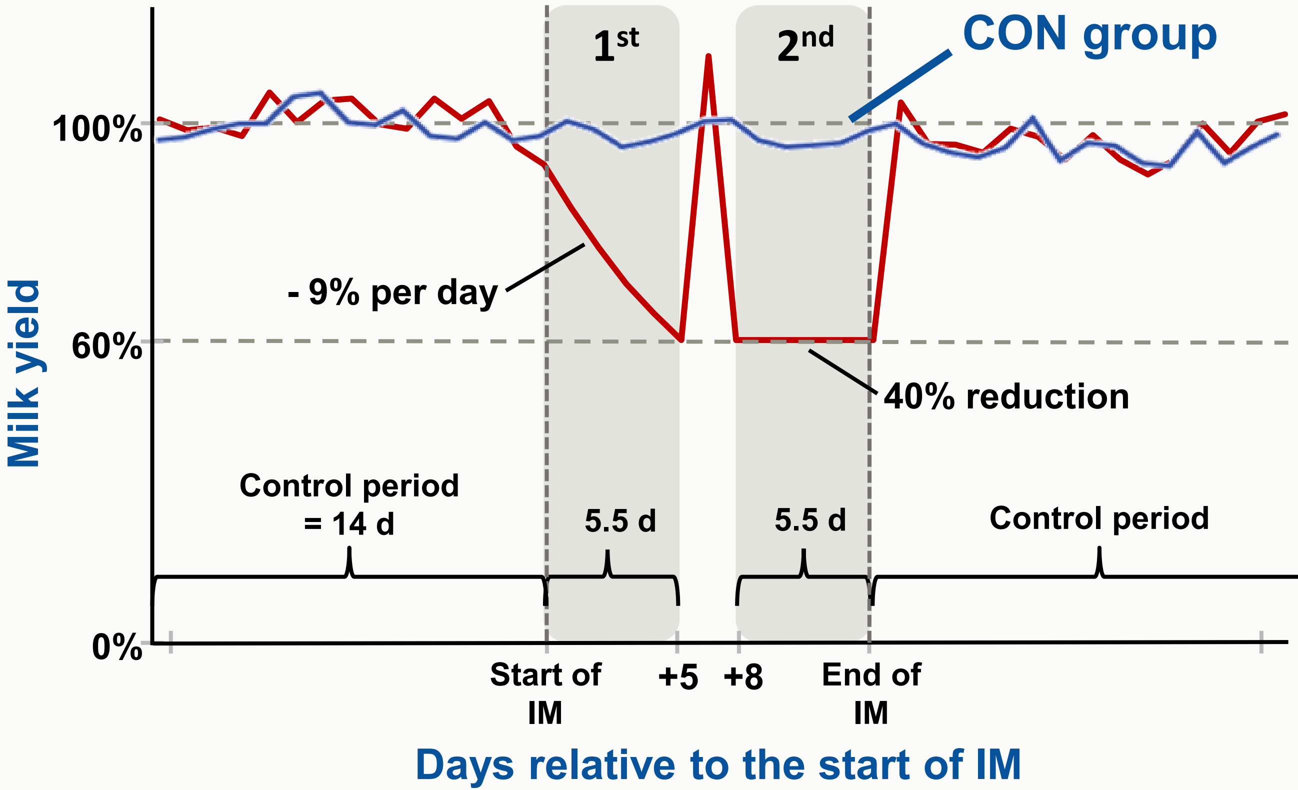


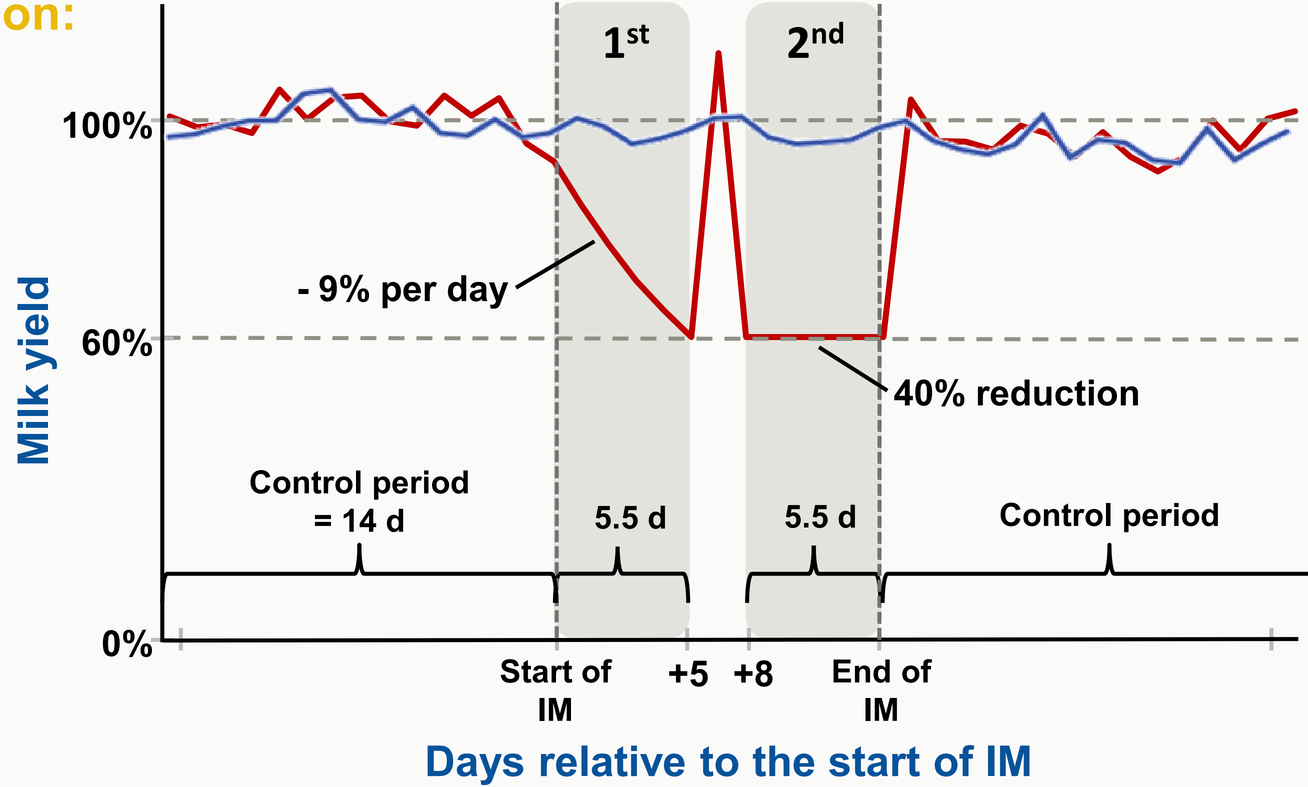
Study design



Study design

Evaluate the effect of IM on:

- Milk Yield

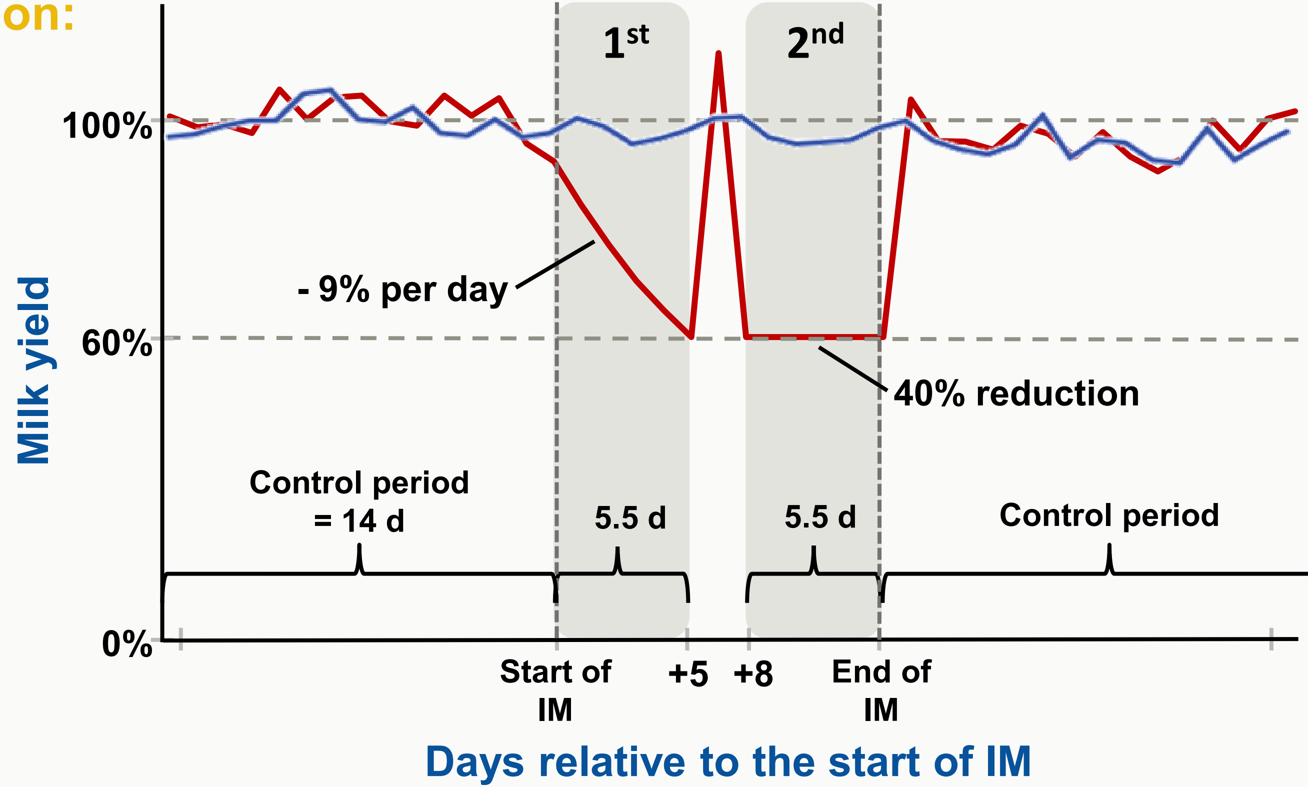


Study design

Evaluate the effect of IM on:

- Milk Yield

- Udder health



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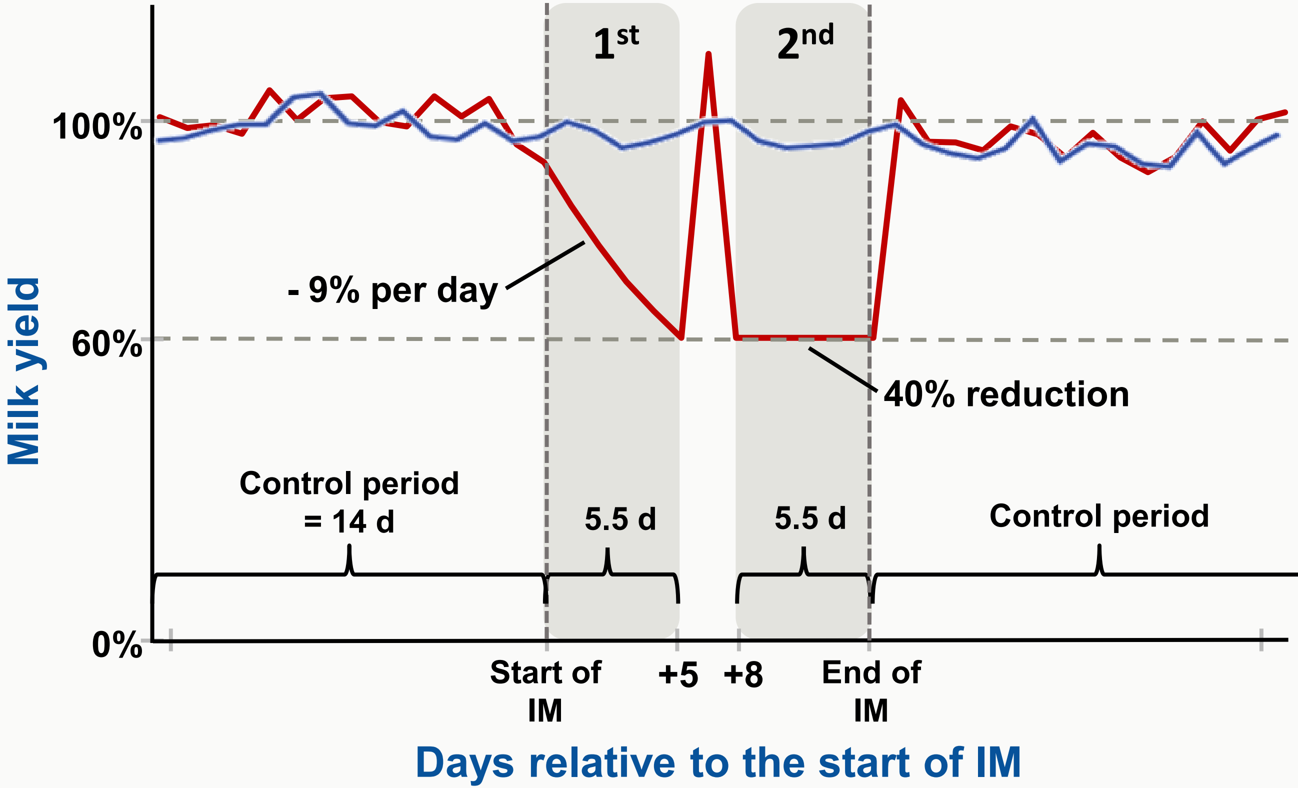

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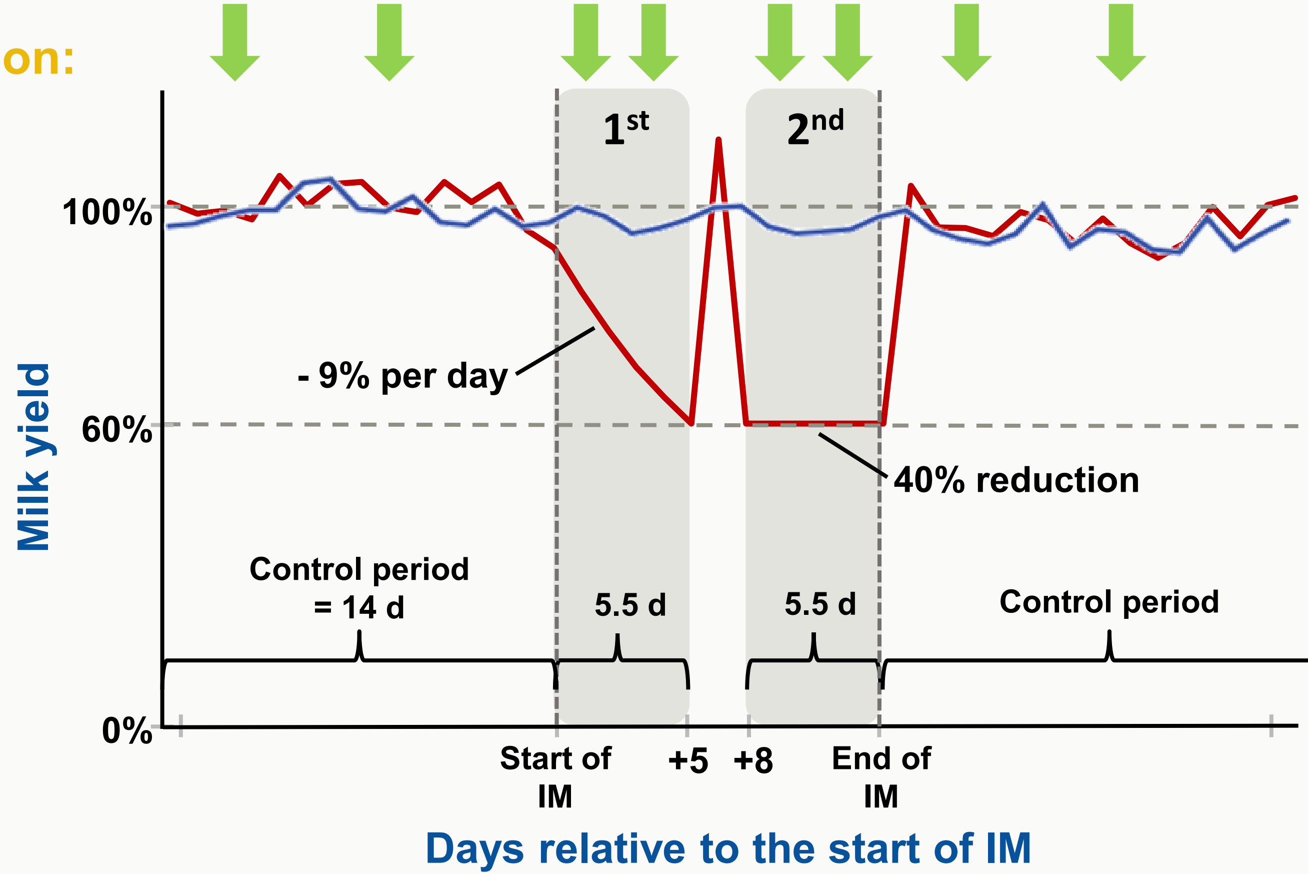

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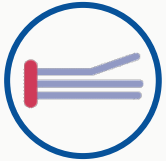
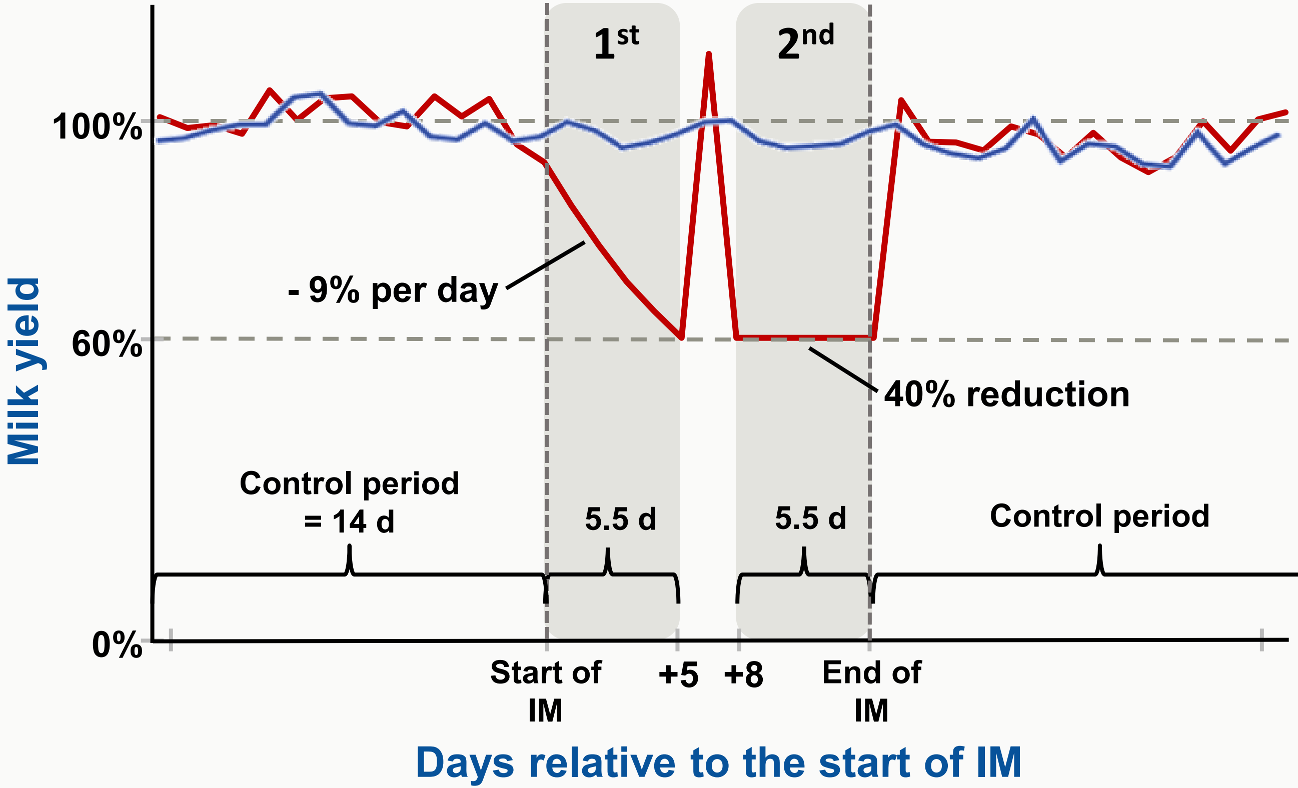


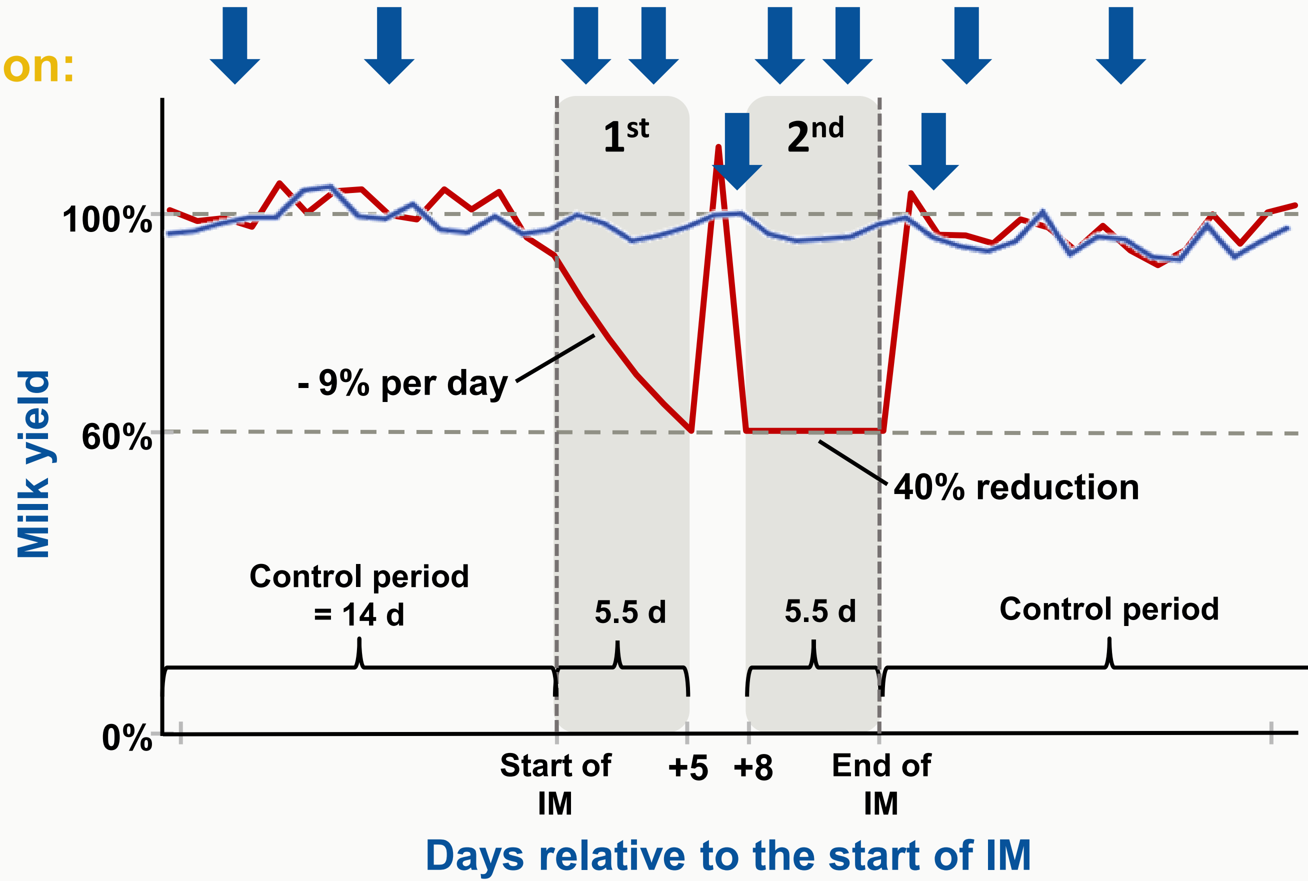
- Milk fat



Study design

Evaluate the effect of IM on:

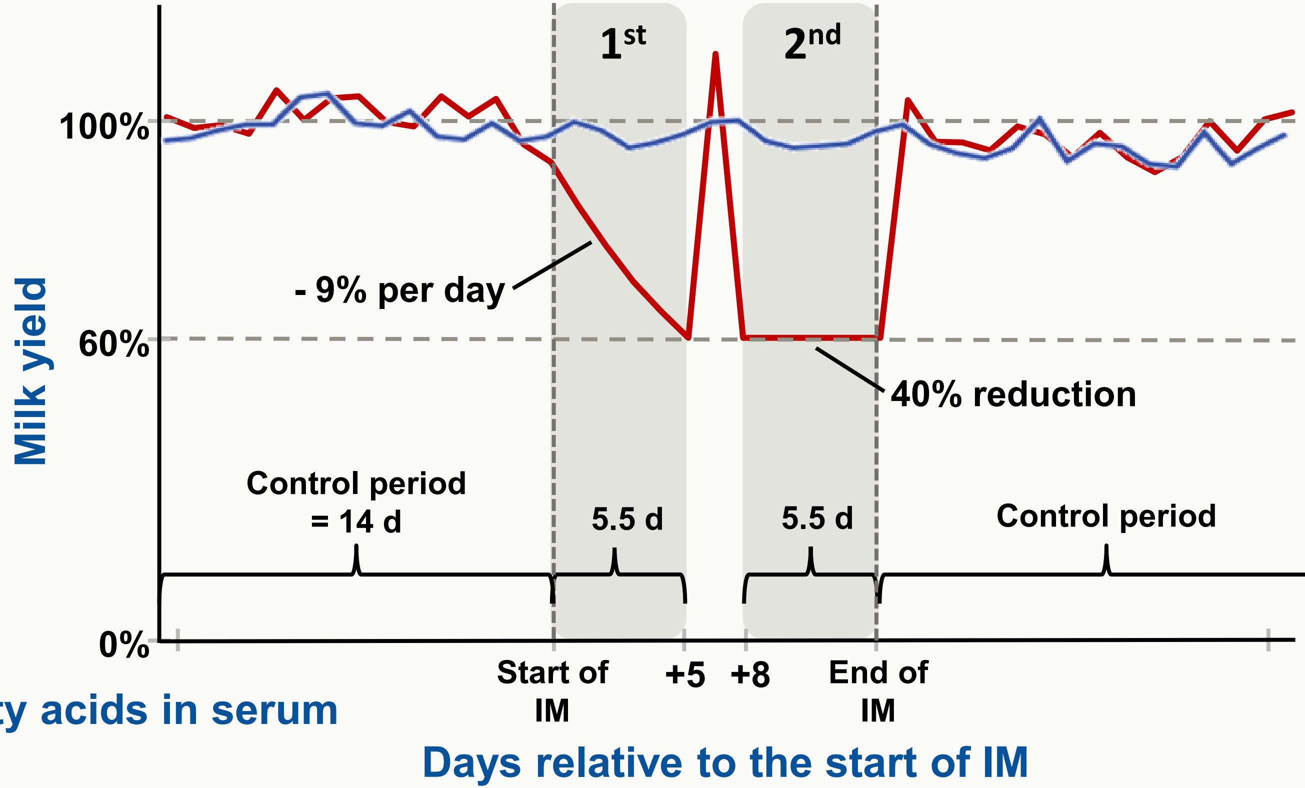
- Milk Yield
- Udder health
- Milk fat



Study design

Evaluate the effect of IM on:

- Milk Yield
- Udder health
- Milk fat
- Metabolism: Fatty acids in serum



Study design

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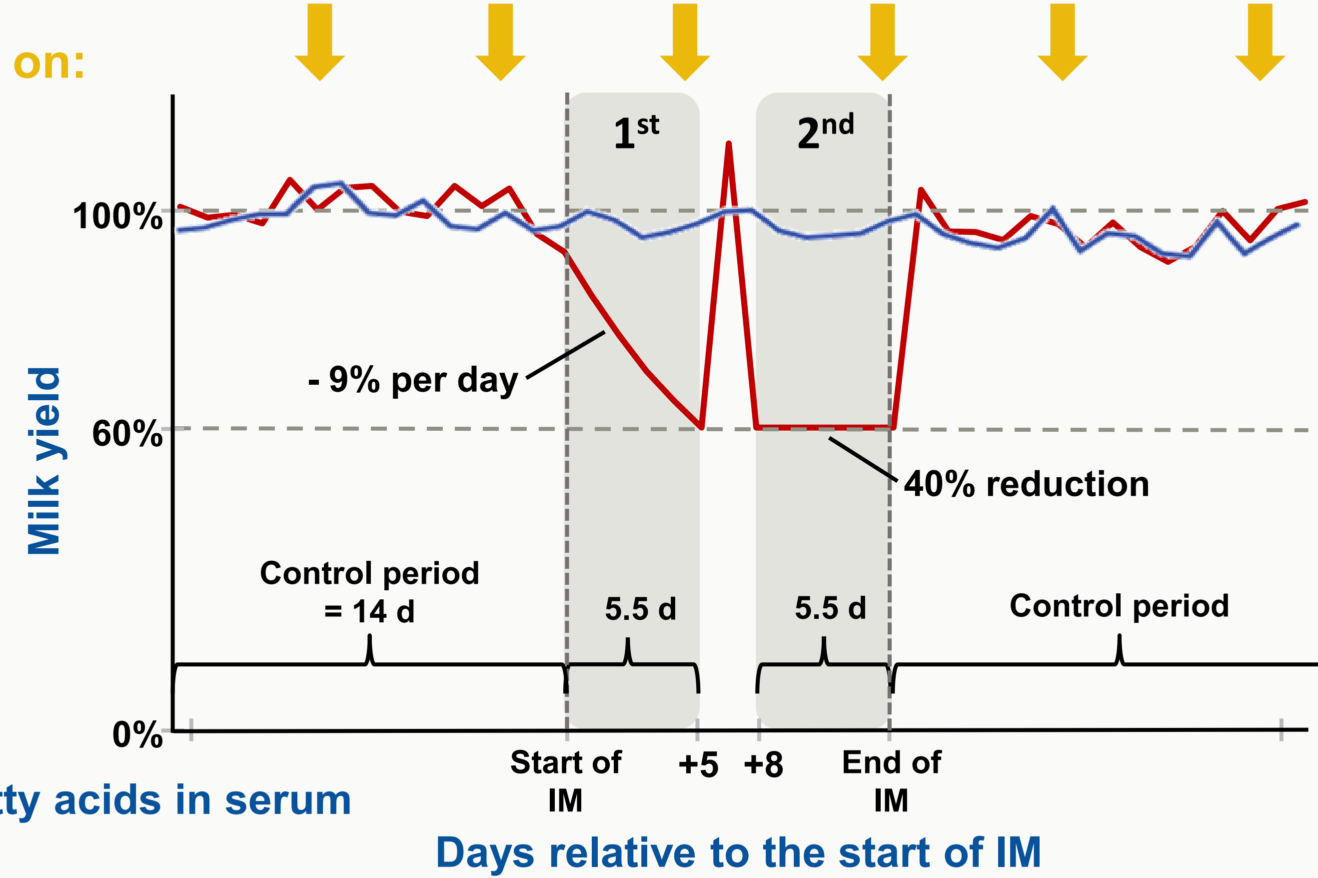

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Evaluate the effect of IM on:

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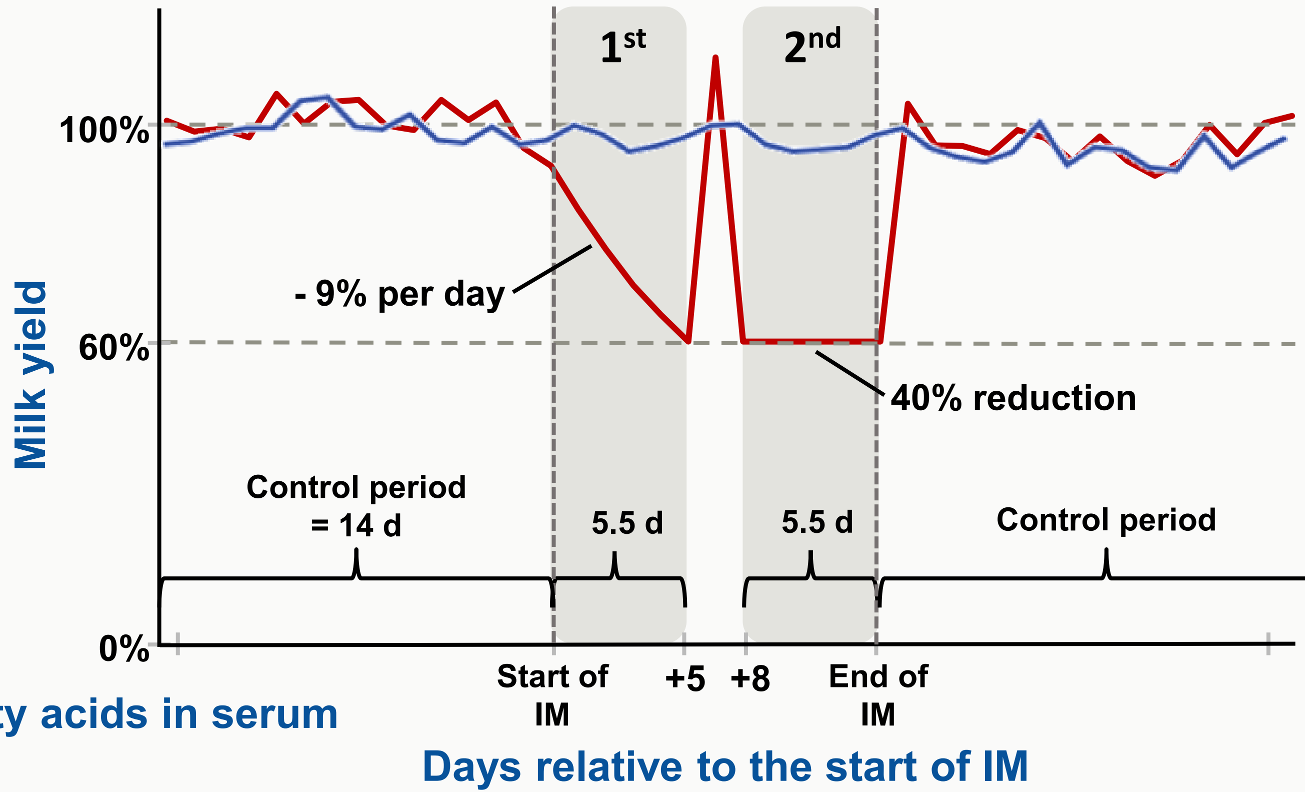
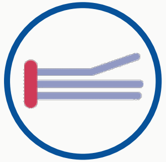
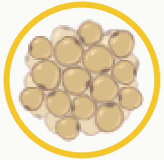


Milk yield

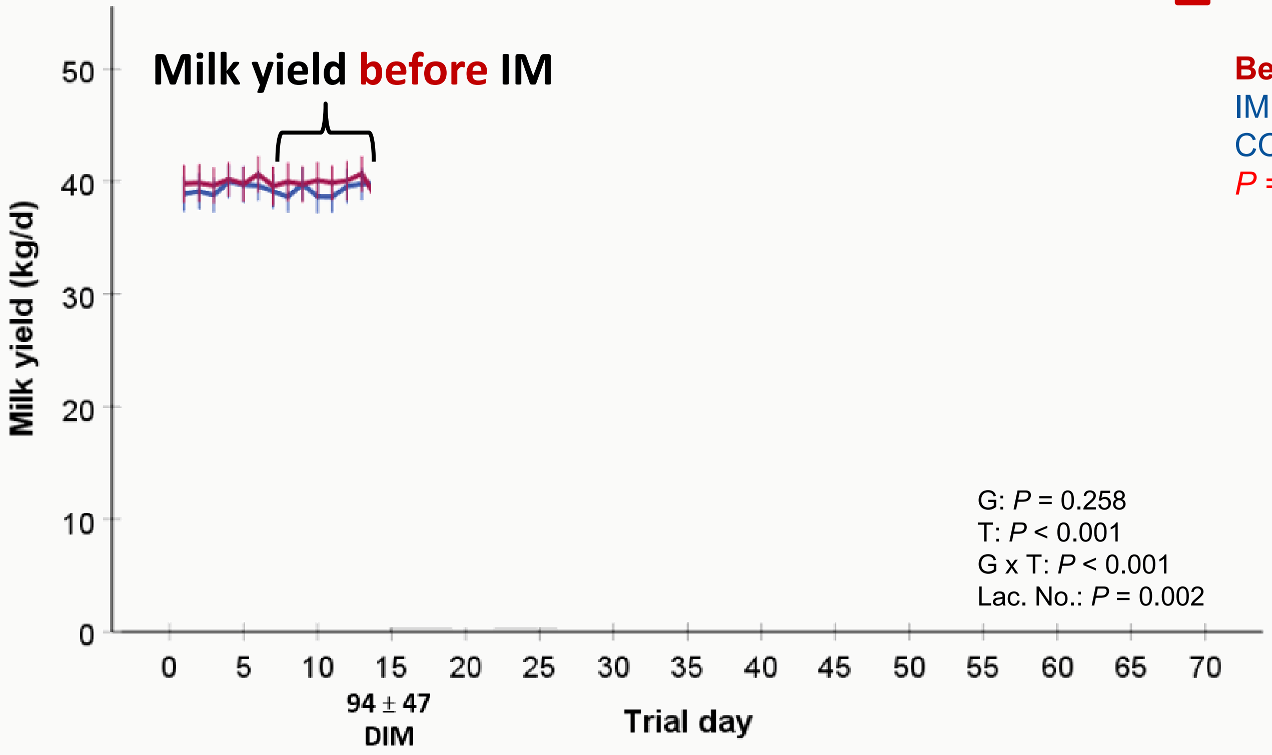
(Mean ± SEM)





CON group (n = 23)

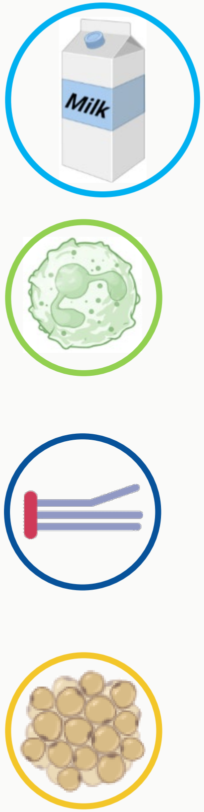
IM group (n = 23)

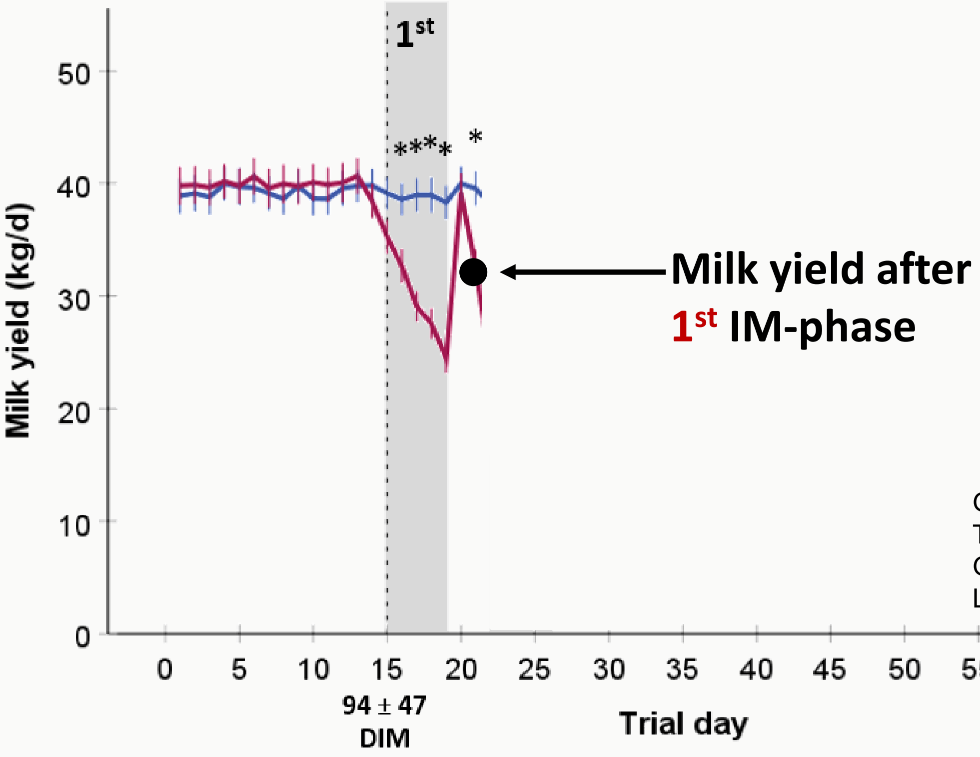


Before IM
IM: 40.2 ± 1.66 (kg/d)
CON: 39.1 ± 1.42 (kg/d)
P = 0.602

Milk yield

(Mean ± SEM)





CON group (n = 23)

IM group (n = 23)

Before IM

IM: 40.2 ± 1.66 (kg/d)

CON: 39.1 ± 1.42 (kg/d)

P = 0.602

After 1st IM-phase:

IM: 32.7 ± 1.54 (kg/d)

CON: 39.4 ± 1.53 (kg/d)

P = 0.003

***P* < 0.05**

G: *P* = 0.258

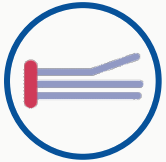
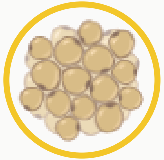
T: *P* < 0.001

G x T: *P* < 0.001

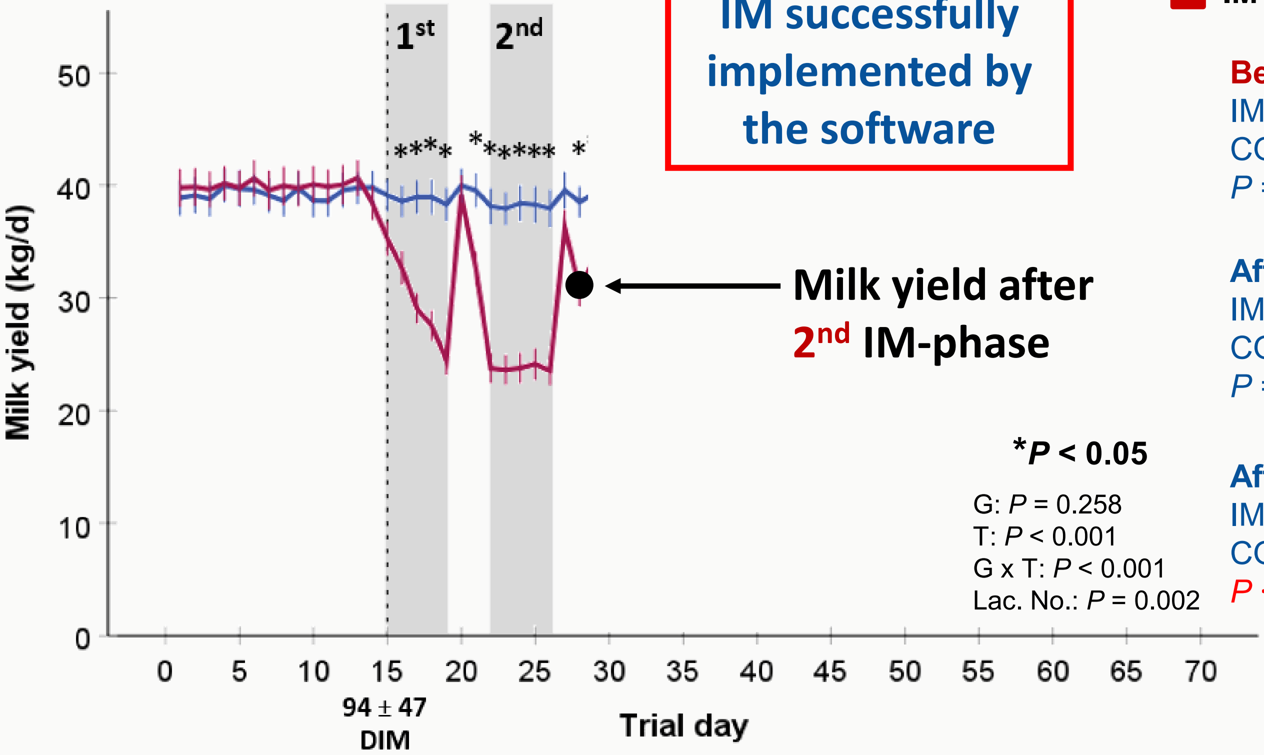
Lac. No.: *P* = 0.002

Milk yield



(Mean ± SEM)



IM successfully implemented by the software

Milk yield after 2nd IM-phase

CON group (n = 23)

IM group (n = 23)

Before IM
IM: 40.2 ± 1.66 (kg/d)
CON: 39.1 ± 1.42 (kg/d)
$P = 0.602$

After 1st IM-phase:
IM: 32.7 ± 1.54 (kg/d)
CON: 39.4 ± 1.53 (kg/d)
$P = 0.003$

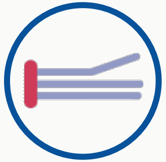
After 2nd IM-phase:
IM: 30.7 ± 1.54 (kg/d)
CON: 38.6 ± 1.38 (kg/d)
$P < 0.001$

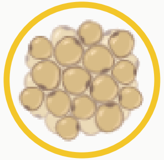
$^{*}P < 0.05$

G: $P = 0.258$
T: $P < 0.001$
G x T: $P < 0.001$
Lac. No.: $P = 0.002$

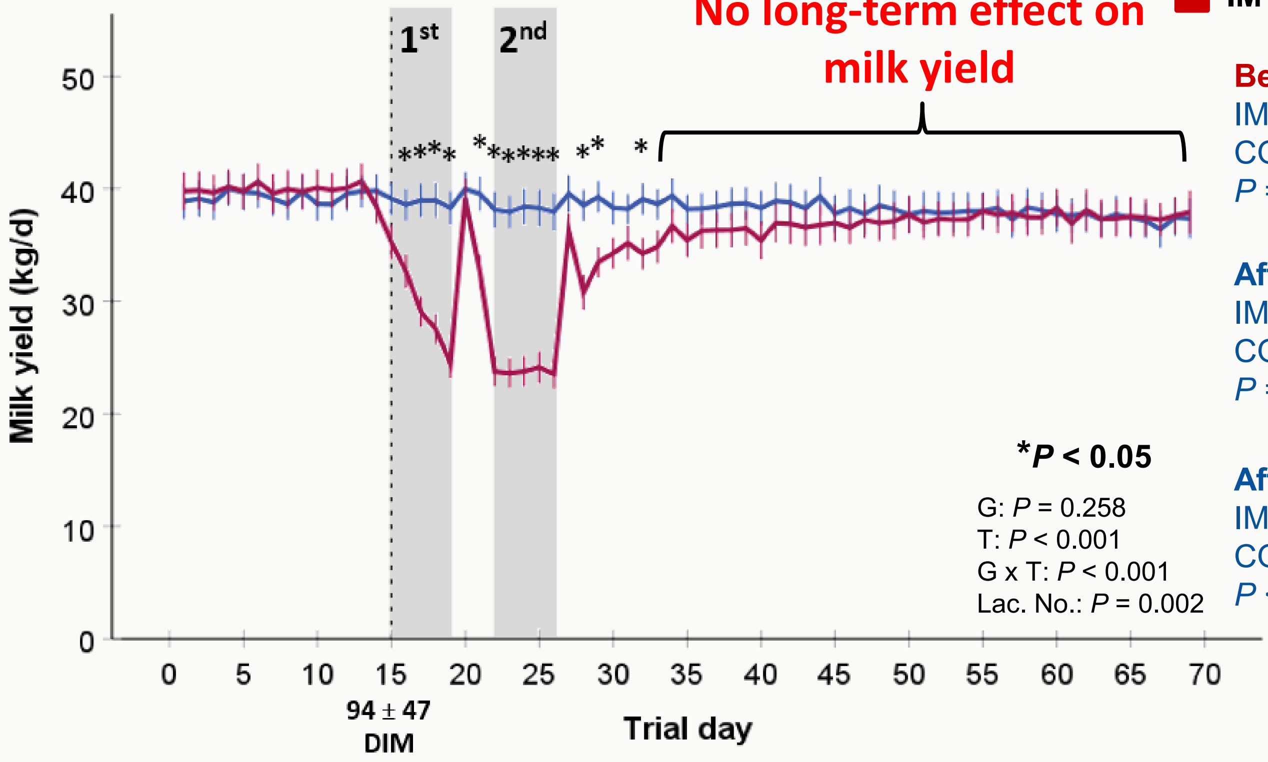
Created with Biorender ®

Milk yield





(Mean ± SEM)



CON group (n = 23)

IM group (n = 23)

Before IM

IM: 40.2 ± 1.66 (kg/d)

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$P = 0.602$

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$P = 0.003$

After 2nd IM-phase:

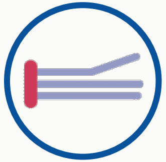
IM: 30.7 ± 1.54 (kg/d)

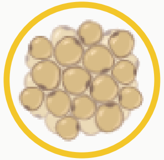
CON: 38.6 ± 1.38 (kg/d)

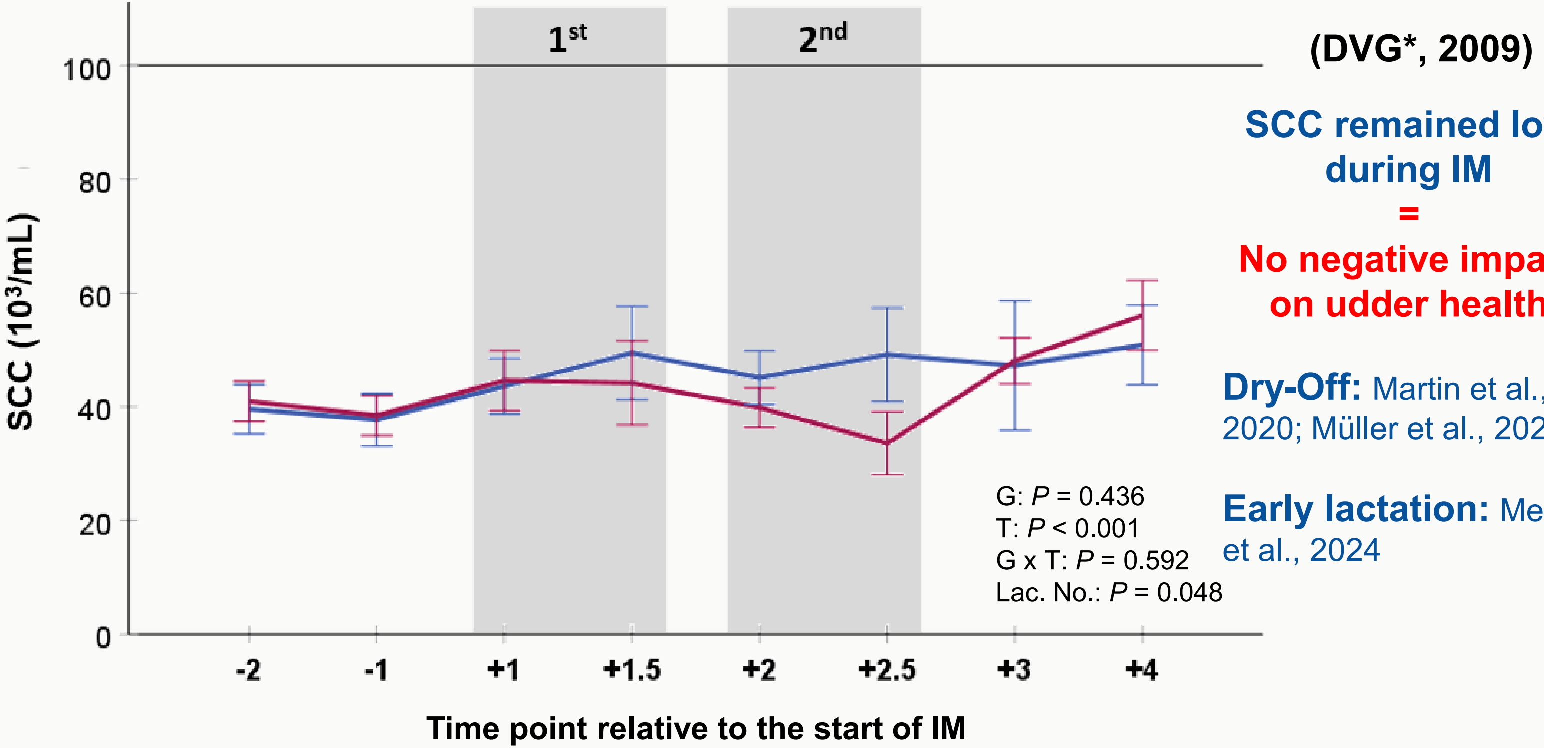
$P < 0.001$

Udder health

(Mean ± SEM)







SCC remained low during IM

=

No negative impact on udder health

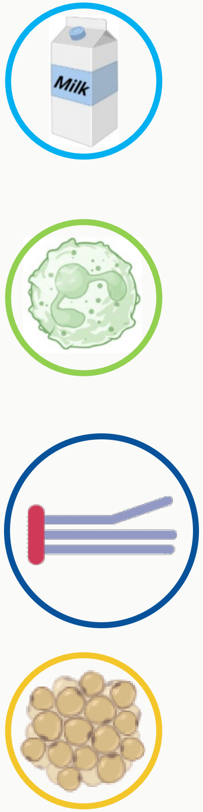
Dry-Off: Martin et al., 2020; Müller et al., 2023

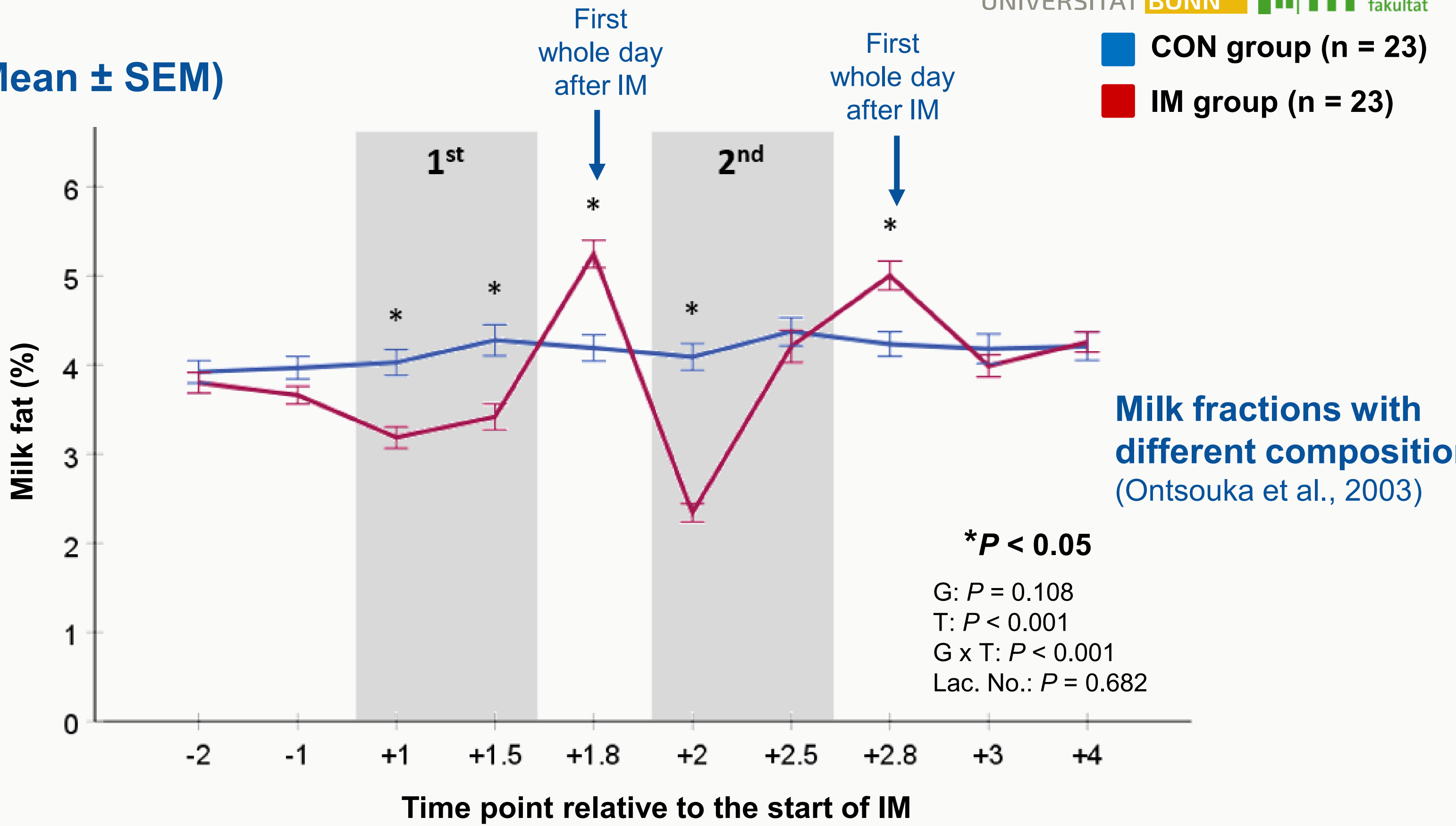
Early lactation: Meyer et al., 2024

*German Veterinary Society

Milk fat

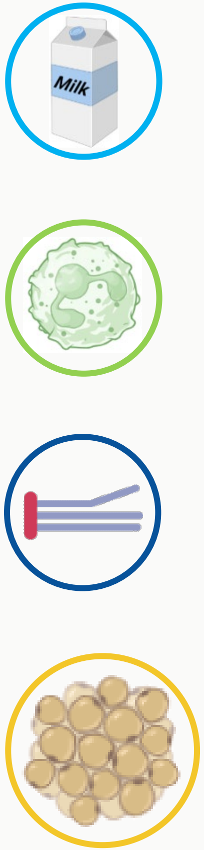
(Mean ± SEM)



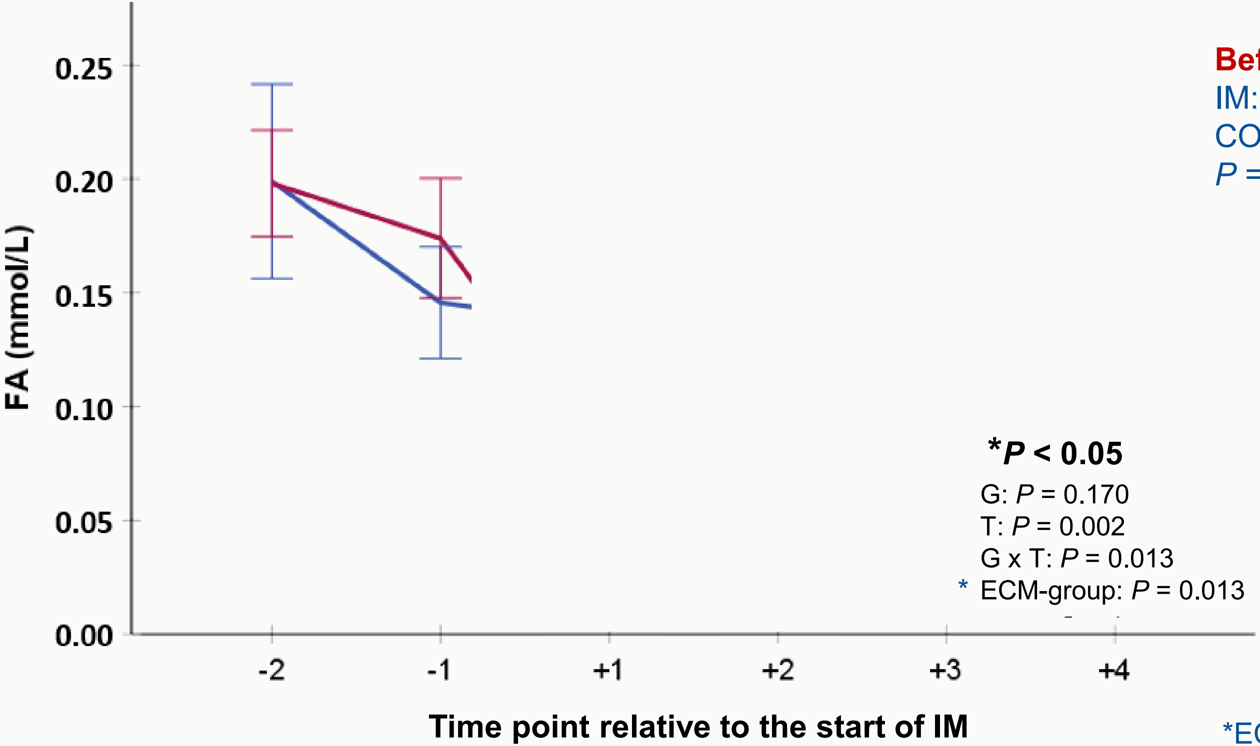


Milk fractions with different composition
(Ontsouka et al., 2003)

Metabolism: Fatty acids



(Mean ± SEM)



CON group (n = 23)

IM group (n = 23)

Before IM

IM: 0.19 ± 0.02 (mmol/L)

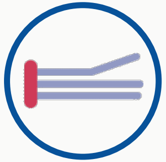
CON: 0.17 ± 0.03 (mmol/L)

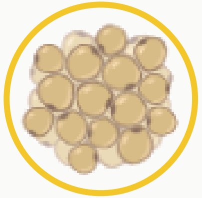
P = 0.445

*ECM-group: > 40 kg ECM/d & < 40 kg ECM/d before IM

Metabolism: Fatty acids

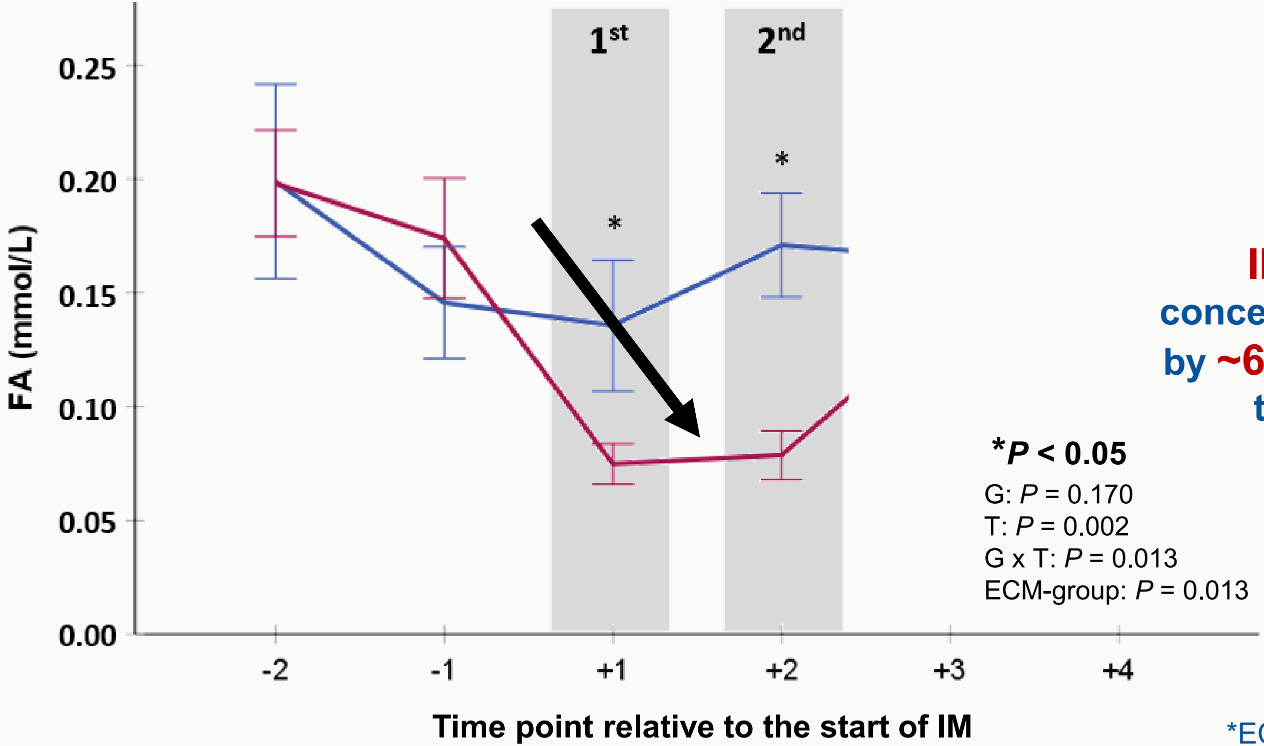
(Mean ± SEM)





CON group (n = 23)

IM group (n = 23)



IM reduce FA concentration in serum by ~60% (*P* < 0.001) in the IM group

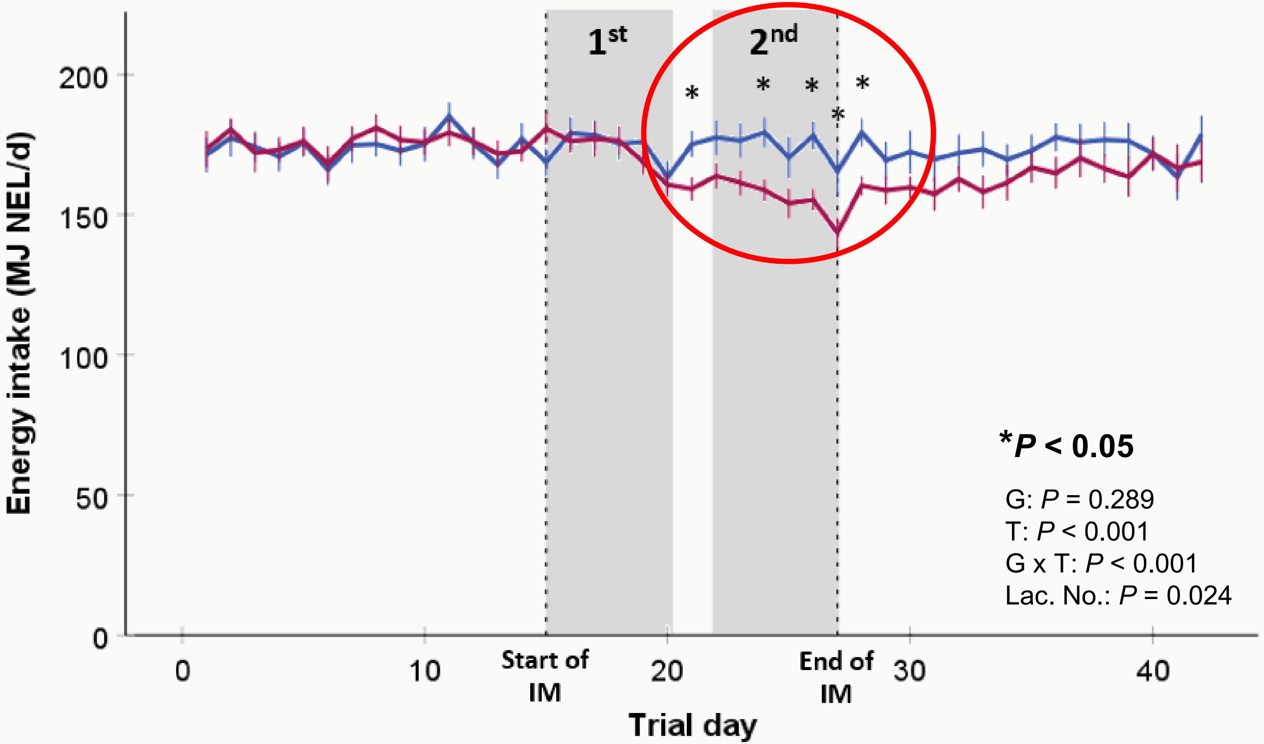
*ECM-group: > 40 kg ECM/d & < 40 kg ECM/d before IM

Energy intake

(Mean ± SEM)

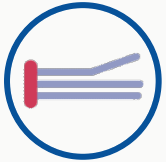
CON group (n = 23)

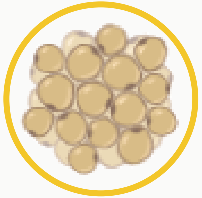
IM group (n = 23)



Metabolism: Fatty acids

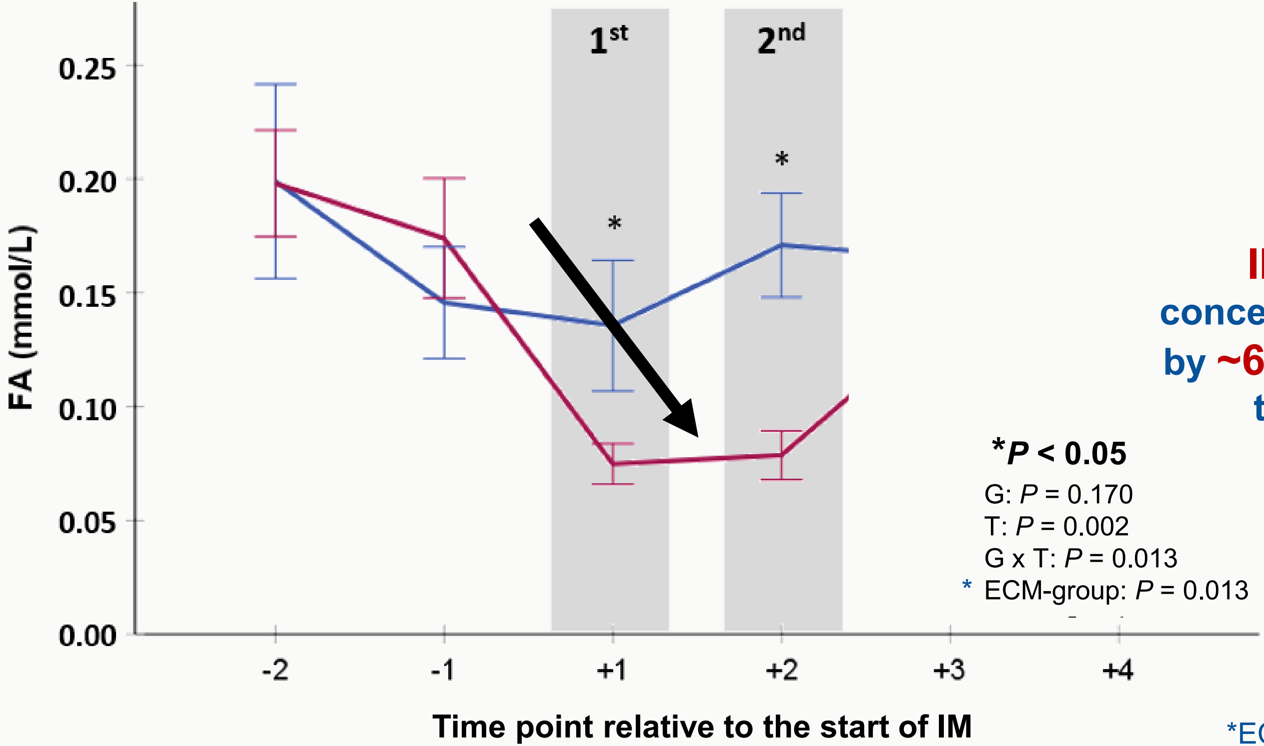
(Mean ± SEM)





CON group (n = 23)

IM group (n = 23)



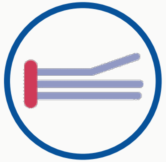
IM reduce FA concentration in serum by ~60% (*P* < 0.001) in the IM group

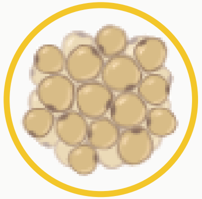
*ECM-group: > 40 kg ECM/d & < 40 kg ECM/d before IM

Metabolism: Fatty acids

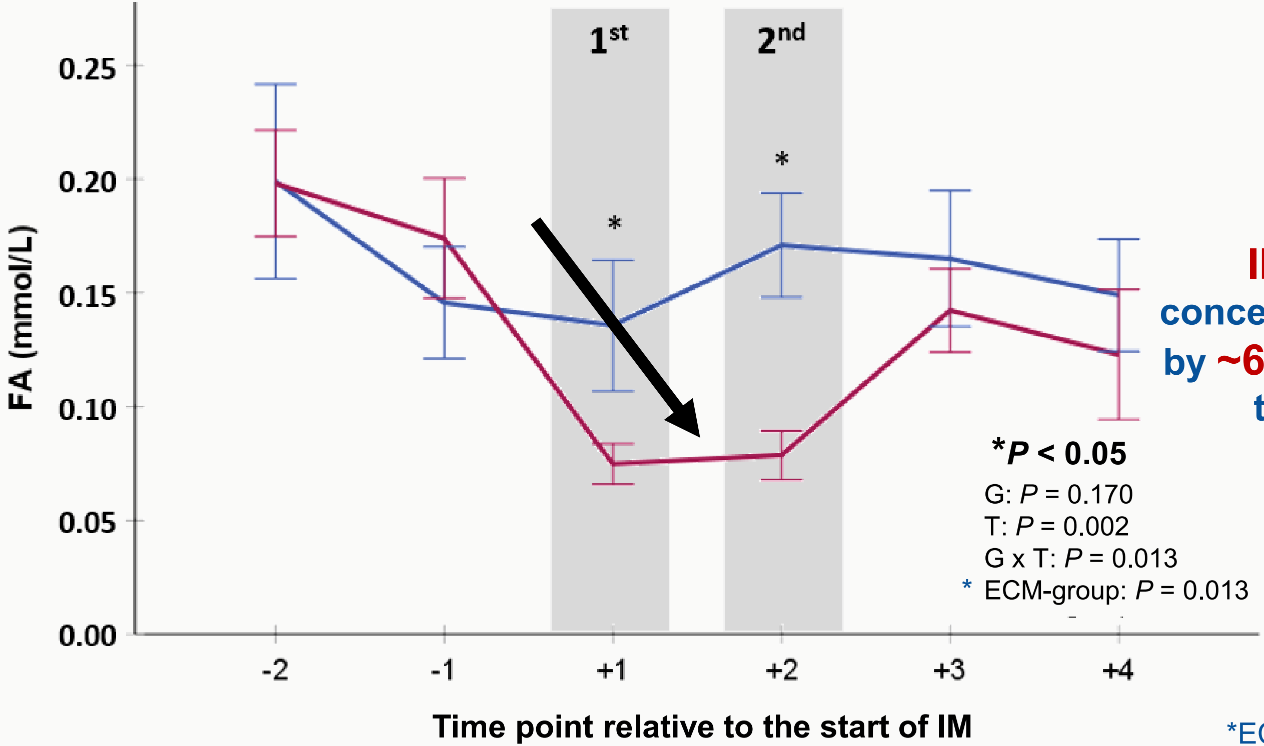
CON group (n = 23)

IM group (n = 23)





(Mean ± SEM)



IM reduce FA concentration in serum by ~60% (P < 0.001) in the IM group

*ECM-group: > 40 kg ECM/d & < 40 kg ECM/d before IM

Summary

Evaluate the effect of IM on:

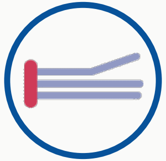
Milk Yield

Short-term adaption of milk yield to IM
No long-term reduced milk yield

Udder health

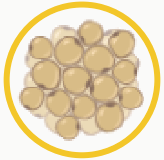
No elevated SCC → healthy udders

Milk fat



Major changes of milk fat content in the IM group

Metabolism:
Fatty acids in serum



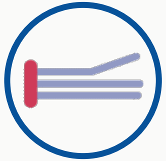
Potential metabolic relief of dairy cows
(further analysis planned)

Conclusion

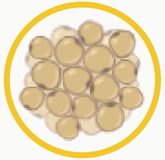
Evaluate the effect of IM on:

Short-term adaption of milk yield to IM
No long-term reduced milk yield

No elevated SCC → healthy udders



Major changes of milk fat content in the IM group



Potential metabolic relief of dairy cows
(further analysis planned)

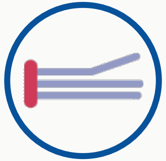
Potential use of IM for maintaining and improving health in dairy cows during stressful conditions

Conclusion

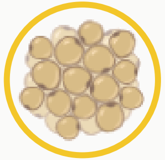
Evaluate the effect of IM on:

Short-term adaption of milk yield to IM
No long-term reduced milk yield

No elevated SCC → healthy udders



Major changes of milk fat content in the IM group



Potential metabolic relief of dairy cows
(further analysis planned)

Potential use of IM for maintaining and improving health in dairy cows during stressful conditions

Outlook:
Application of IM on metabolic stressed cows. (heat stress, feed restriction….)
→ Further analysis ☺

Acknowledgment

UNIVERSITÄT BONN

ITW Institut für Tierwissenschaften

Campus Frankenforst

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Thank you for your attention!

Literature

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Appendix

Material and Methods

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Milking routine

Cows were milked twice daily at 05:30 a.m. and 04:30 p.m. in a double-four in-line milking parlor (GEA Farm Technologies GmbH, Bönen, Germany) with a cluster take off at <0.3 kg/min. Udder cleaning with a wet paper towel and forestripping was followed by mechanical prestimulation through the cluster vacuum. Milk flow, milking duration and milk yield were recorded automatically at the level of the udder for each cow and each milking session by the Metatron C21 (GEA Farm Technologies GmbH).

Udder health

The sampling procedure was performed after the routine premilking treatment and included discarding of the first strippings, disinfecting the teat ends with 70% alcohol and sampling into sterile vials with preservatives. Quarter-wise samples were bacteriological examined (bovicare GmbH, Bernau, Germany) and the somatic cell count (**SCC**) was analyzed using the DCC Cell Counter (DeLaval GmbH, Glinde, Germany).

Milk composition

Whole milk samples were collected (Metatron; GEA Farm Technologies GmbH, Bönen, Germany) on an evening milking and the following morning milking (milk amount of each milking was considered in the sample volume). Preservatives were added to the samples and milk fat, protein and lactose quantification was done via mid-infrared spectroscopy measurement and the SCC was evaluated via flow cytometry (Labor- und Dienstleistungs GmbH & Co KG, Krefeld, Germany).

FA analysis

Serum and Plasma were separated directly afterwards via centrifugation at 2500 x g for 15 min at 15°C (Z 336 K; HERMLE Labortechnik GmbH, Wehingen, Germany) and stored at -20°C until analysis. Frozen serum samples were transferred to the laboratory and FA were analyzed photometrically (SYNLAB.vet GmbH, Leverkusen, Germany).

Statistic

All statistical analyses were performed using SPSS Statistics Version 29.0 (IBM, SPSS Inc., Chicago, Illinois). Assumptions of parametric tests were assessed visually using QQ plots and Box plots, the Shapiro-Wilk test for normal distribution of model residuals, and Levene's test for variance homogeneity. Linear mixed-effects models were fitted, and alpha-error correction for multiple comparisons was applied using the Bonferroni method. Each model included treatment group (TRT vs. CON), time, the interaction between group and time (G × T), and lactation number as fixed effects, with cow included as a random effect. In the FA model, ECM groups (differentiated by > 40 kg and < 40 kg ECM/d as REF (rounded median)) were used as fixed covariate instead of lactation number as a fixed effect. Model selection was based on the lowest Akaike information criterion (AIC). For SCC in foremilk samples, "udder quarter" was considered as experimental unit and random factor instead of “cow”. All models incorporated time periods before, during, and after treatment. Group comparisons were conducted using Student's t-test. All data are presented as mean ± SEM, and the level of significance was set at $P \leq 0.05$.

Energy Balance (EB) Equation

EB = Energy intake (MJ/d) – Energy Requirement (MJ/d)

Energy Intake: Partial-mixed ration, concentrate

Energy requirement: Maintenance, Milk production, Pregnancy

→ Estimation without: activity, thermoregulation …..

Milk components – lactose

(Mean ± SEM)