Milk Branched-Chain Fatty Acids
Emerging Perspectives

Rachel Gervais*

P. Yvan Chouinard

Eric Baumann

14th Euro Fed Lipid Congress
18-21 September 2016
Ghent, Belgium

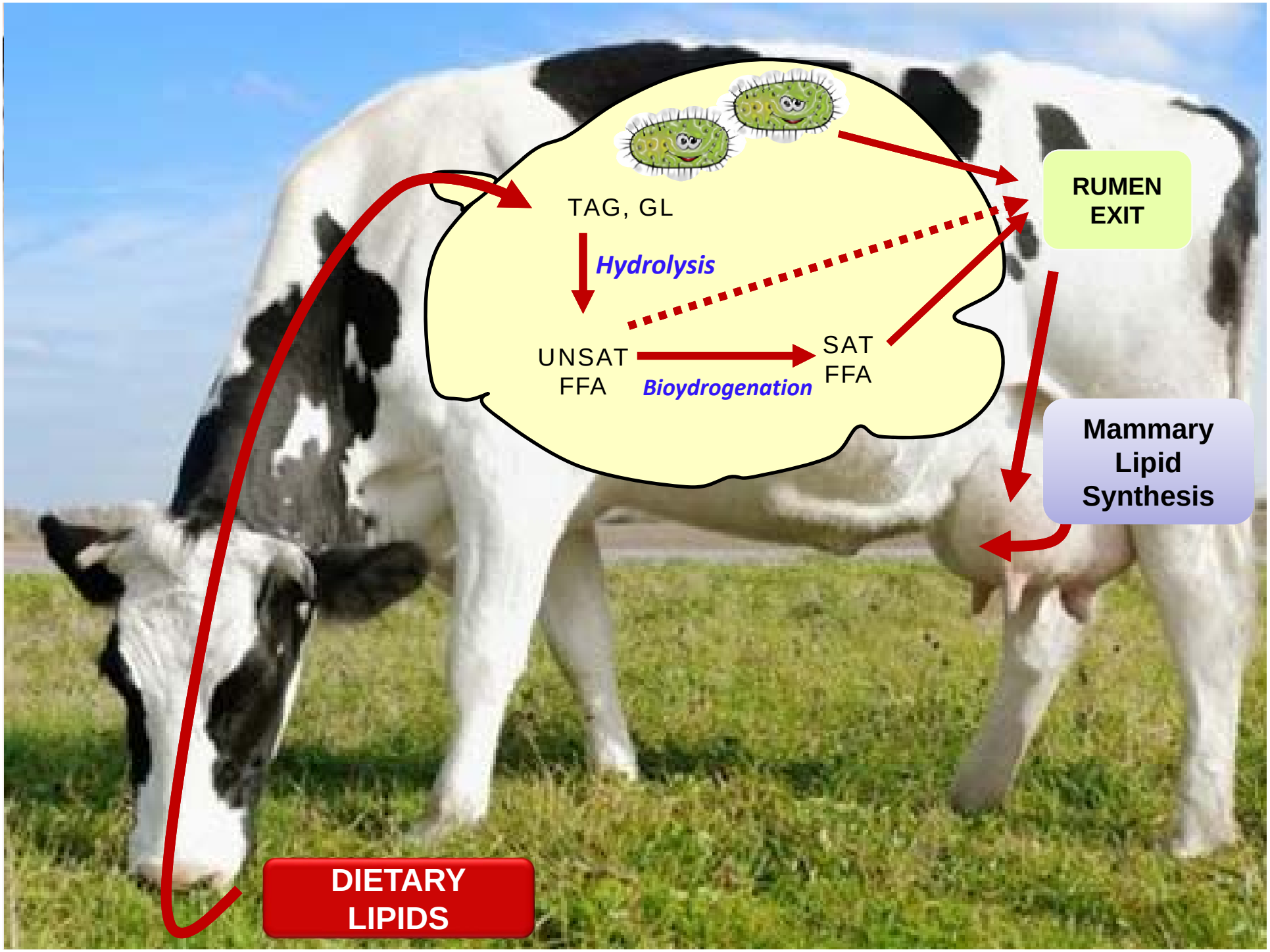
UNIVERSITÉ LAVAL

GRIPHA

STELA

Presentation outline

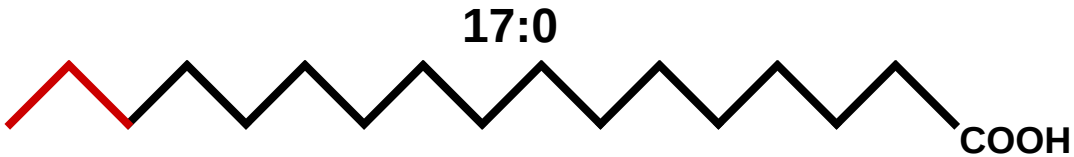
- Odd- and branched-chain fatty acids (OBCFA)
  - Synthesis of OBCFA
  - Interest as a diagnostic tool in ruminants
- Branched-chain fatty acids (BCFA)
  - Interest in human nutrition
  - Manipulation of their concentrations
  - Future perspectives


TAG, GL
Hydrolysis
UNSAT FFA
Bioydrogenation
SAT FFA
RUMEN EXIT
Mammary Lipid Synthesis
DIETARY LIPIDS

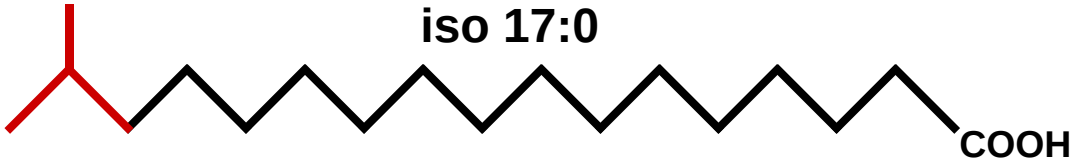
Odd- and branched-chain fatty acids

acetate **C2** →

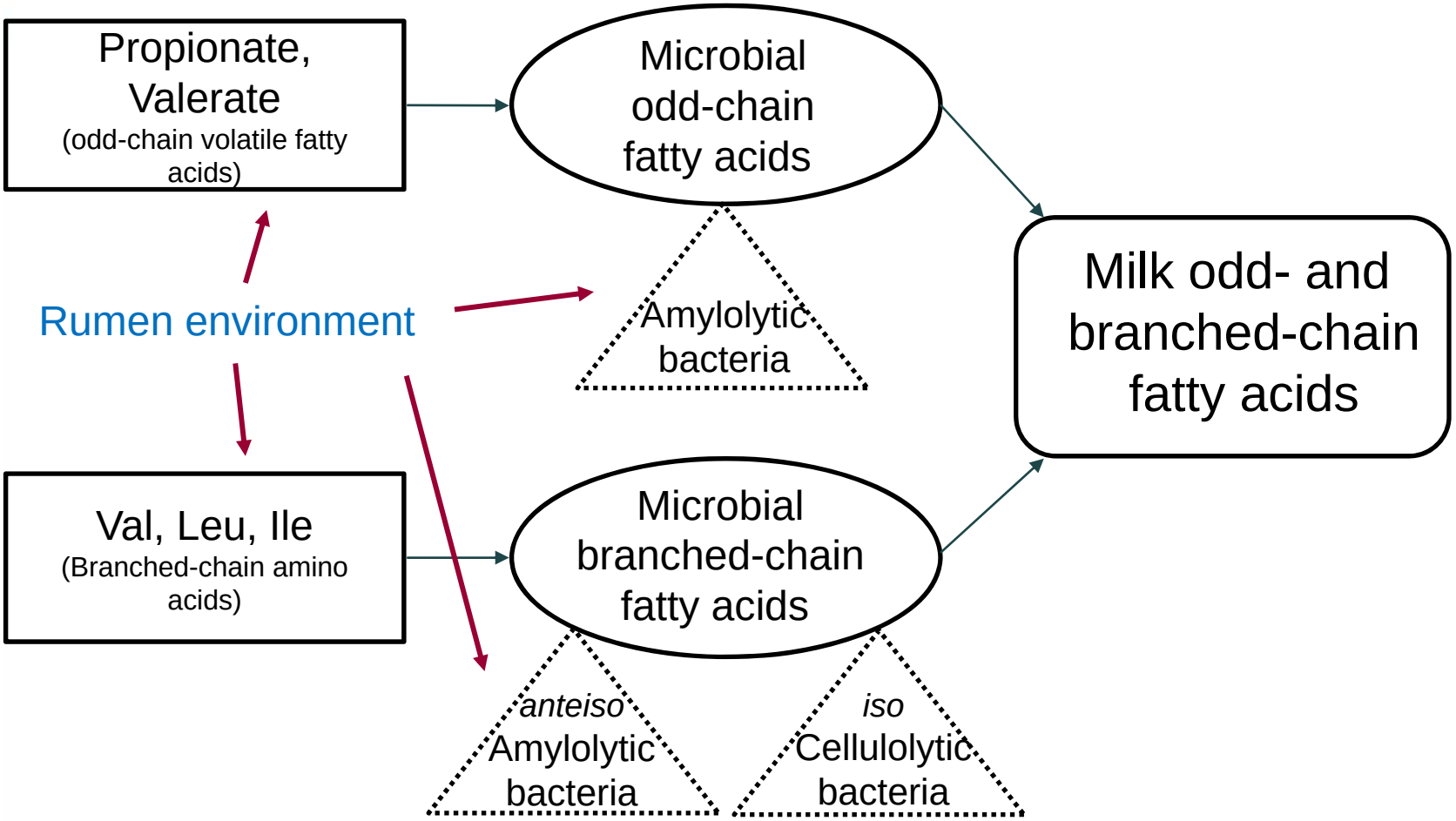
propionate **C3** →



branched
volatile fatty acids

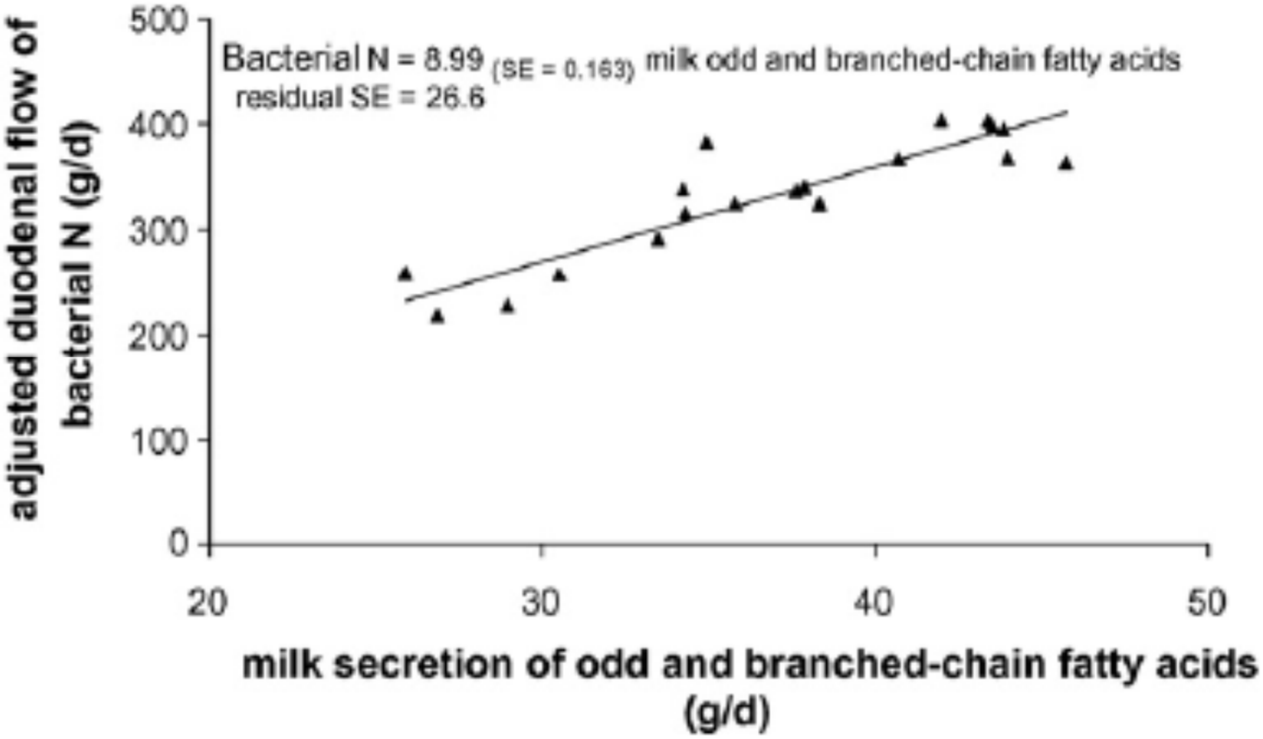


Synthesis of odd- and branched-chain fatty acids



Vlæminck *et al.* 2005
Fievez *et al.* 2012

Odd- and branched-chain FA



Vlaeminck et al., 2006a

Impact of lipid supplementation

i) Inhibits microbial growth
(Jenkins *et al.* 2008)

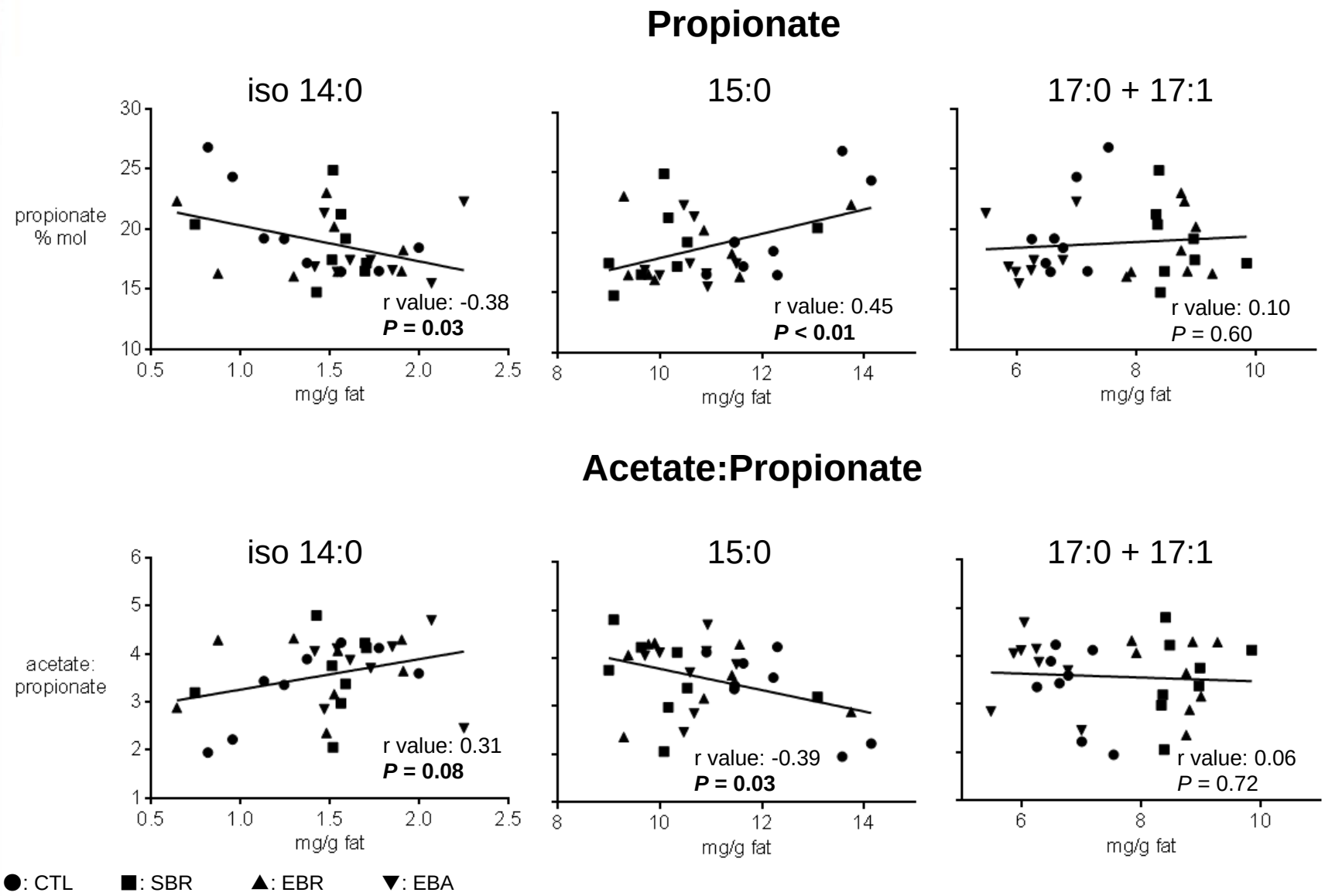
ii) Decreases *de novo* microbial FA synthesis
(Weisbjerg *et al.* 1992)

iii) Affects mammary gland lipogenesis
- Increases uptake of preformed FA of dietary origin
(Palmquist and Jenkins, 1980)
- Inhibits overall mammary gland lipogenesis (*trans*-10, *cis*-12 CLA)
(Bauman and Griinari, 2003)

– Addition of fat in the diet may therefore affect relationships established between milk FA and rumen fermentation patterns

VFA and milk OBCFA

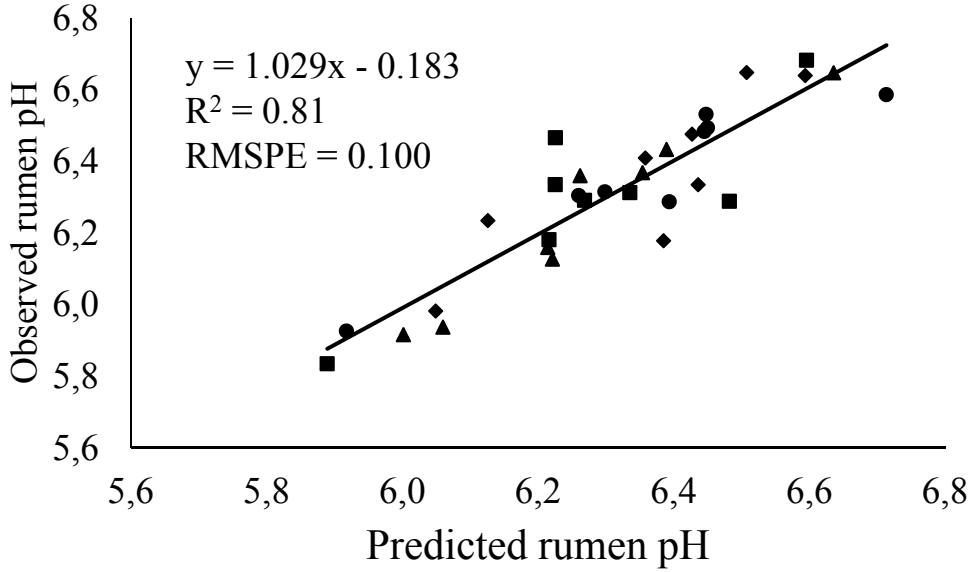
Baumann *et al.* 2016. J. Dairy Sci. 99: 6311–6323



Fatty acid profile of supplemental prilled fatty acids – *Energy Booster*

	%
14:0	3.2
15:0	0.6
16:0	37.8
trans-9 16:1	0.1
cis-9 16:1	0.3
17:0	1.9
18:0	40.0
cis-9 18:1	6.5
cis-11 18:1	0.3
cis-9, *cis*-12 18:2	0.7
20:0	0.5
Others	8.1

Rumen pH and milk OBCFA



pH = 6.24 – (0.56 × **4:0**) + (1.67 × ***iso* 14:0**) + (4.22 × ***iso* 15:0**) + (9.41 × **22:0**)

●: CTL ■: SBR ▲: EBR ▼: EBA

Conclusions

- Previously established relationships between certain milk OBCFA remained valid under conditions of lipid supplementation

- OBCFA profile of lipid supplement **must be considered** when studying relationships between milk OBCFA and rumen function

A lot of work still to do…

- Importance of other factors that could influence established relationships

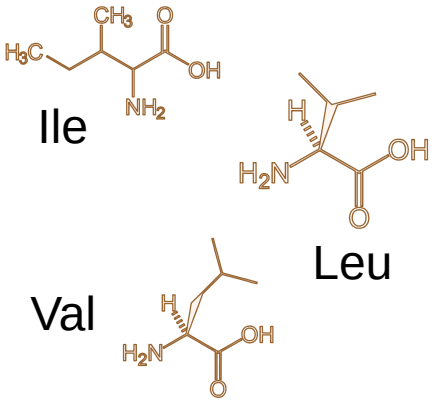
- Rapid and cost-effective determination of these minor FA in milk fat… a major drawback.

Branched-chain fatty acids and human health

Where are BCFA found, in nature

- Bacteria
  - For certains: 20 to 100% of cellular FA (Kaneda, 1991)
- Plants and fungi
- Human tissues (and other mammals)
  - Skin
  - Vernix
  - Harderian and sebaceous glands
  - Hair
  - Brain
  - Blood

BCFA and human health



Branched-chain α-ketoacid dehydrogenase

Short BCFA
iso-butyryl-CoA
iso-valeryl-CoA
α-methyl-butyryl CoA

Fatty acid synthase

iso and anteiso FA

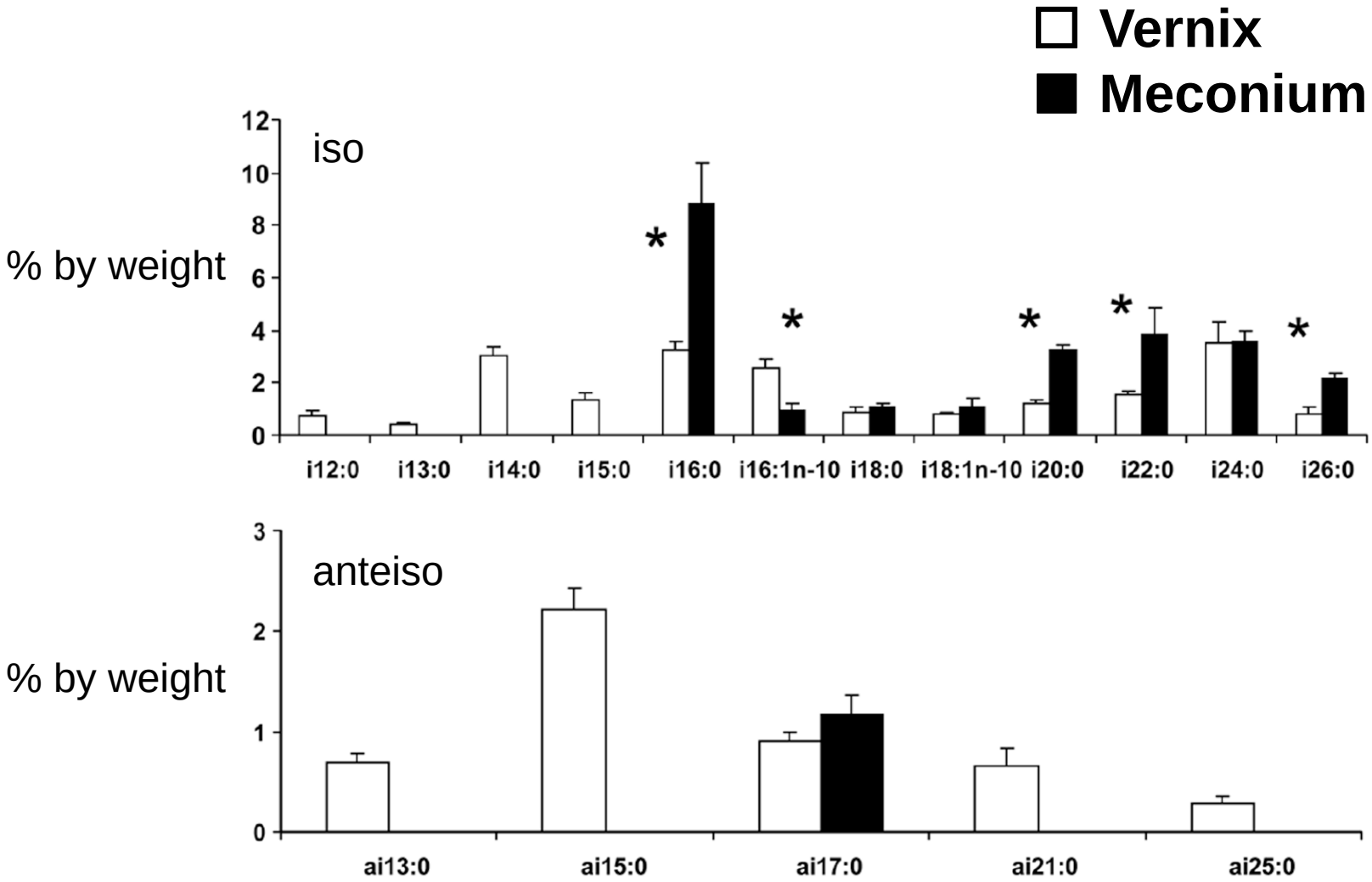
Branched-chain AA

- Maple syrup urine disease
- Autism
- Other neurological disorders

BCAA accumulation *vs* lacking BCFA

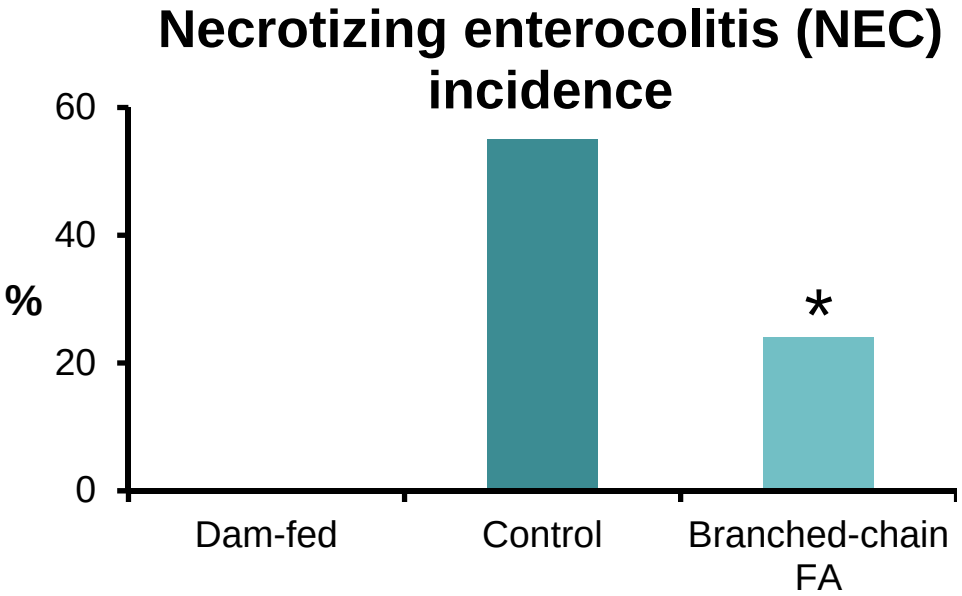
Jia et al. 2016

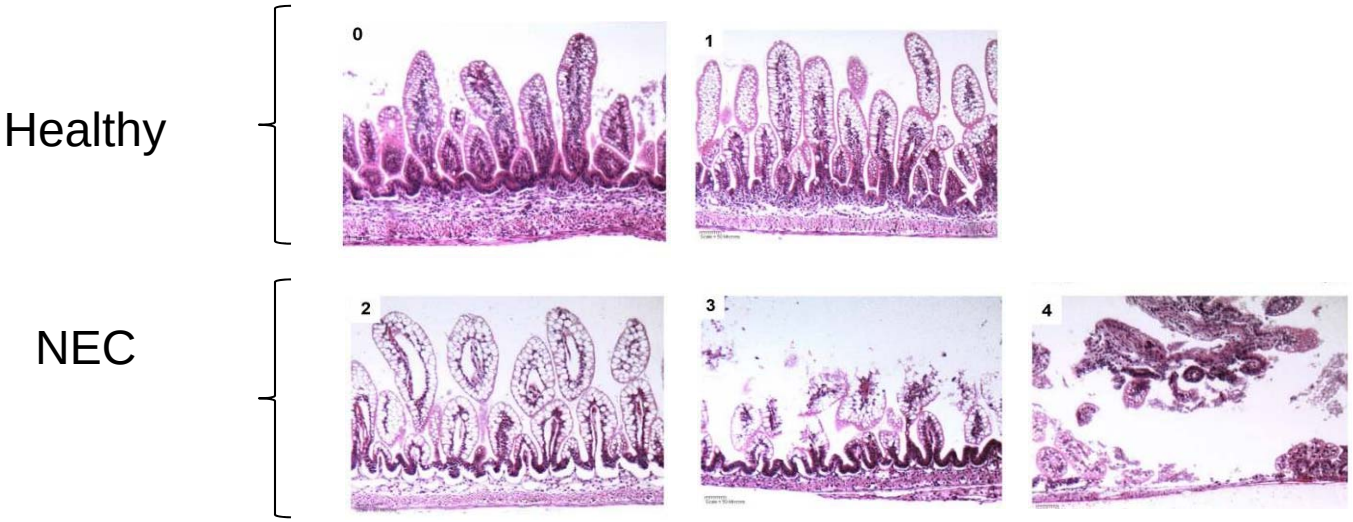
BCFA and newborn health



Ran-Ressler *et al.* 2008

BCFA and newborn health

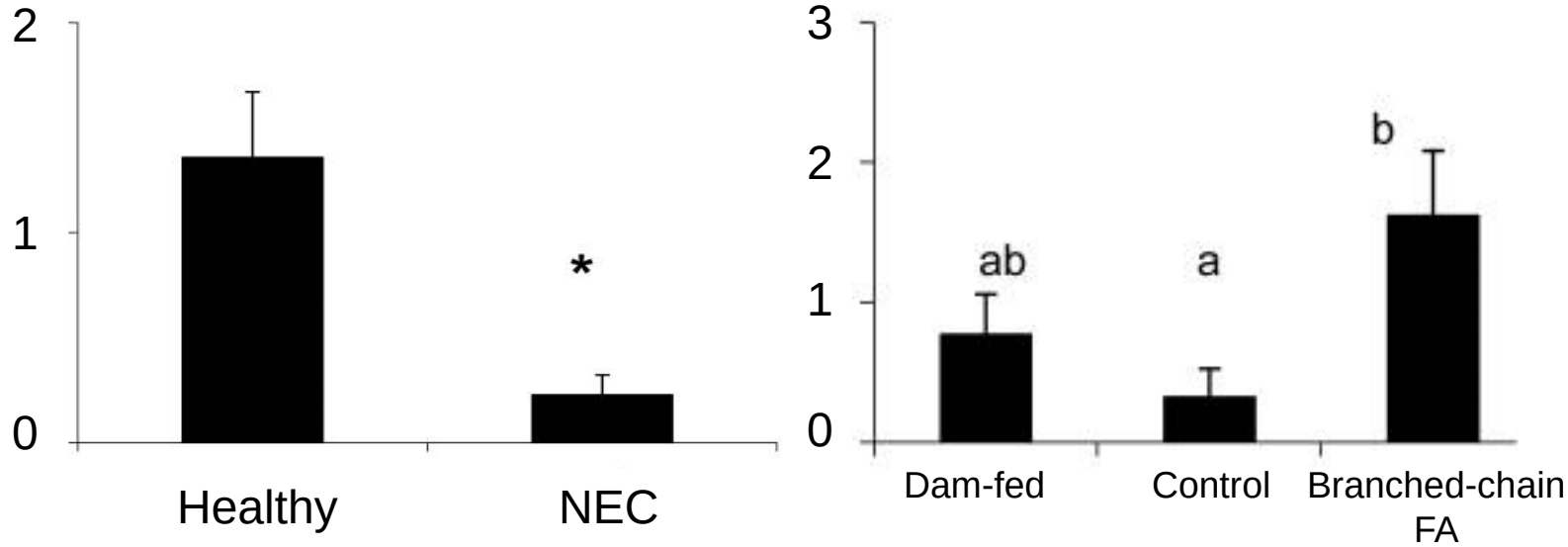




Ran-Ressler *et al.*, 2011

BCFA and newborn health

Relative abundance of *bacillus subtilis*



Ran-Ressler *et al.*, 2011

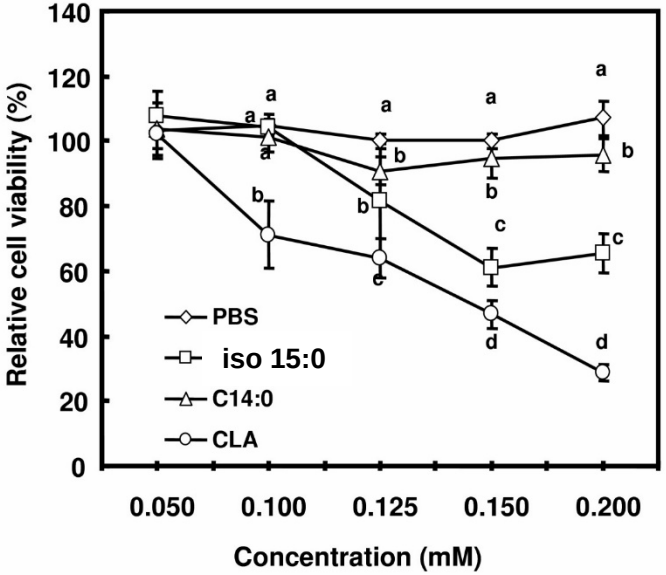
BCFA and cancer prevention

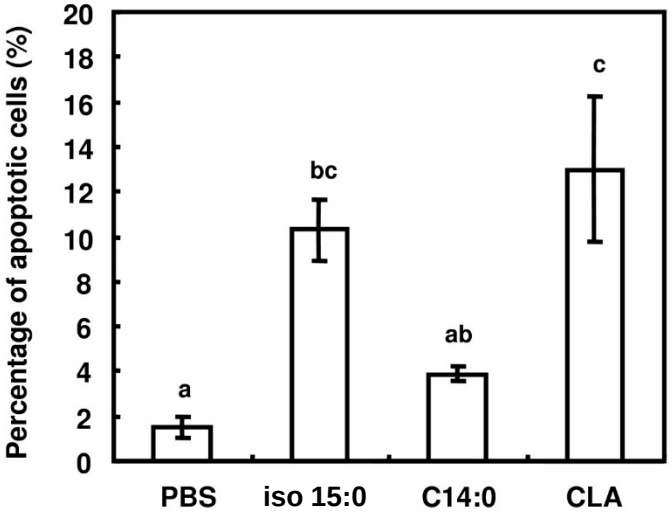
- iso 15:0
  - inhibited cell proliferation and induced apoptotic cell death in cancer cells:
    - Prostate, breast, leukemia

Yang *et al.*, 2000

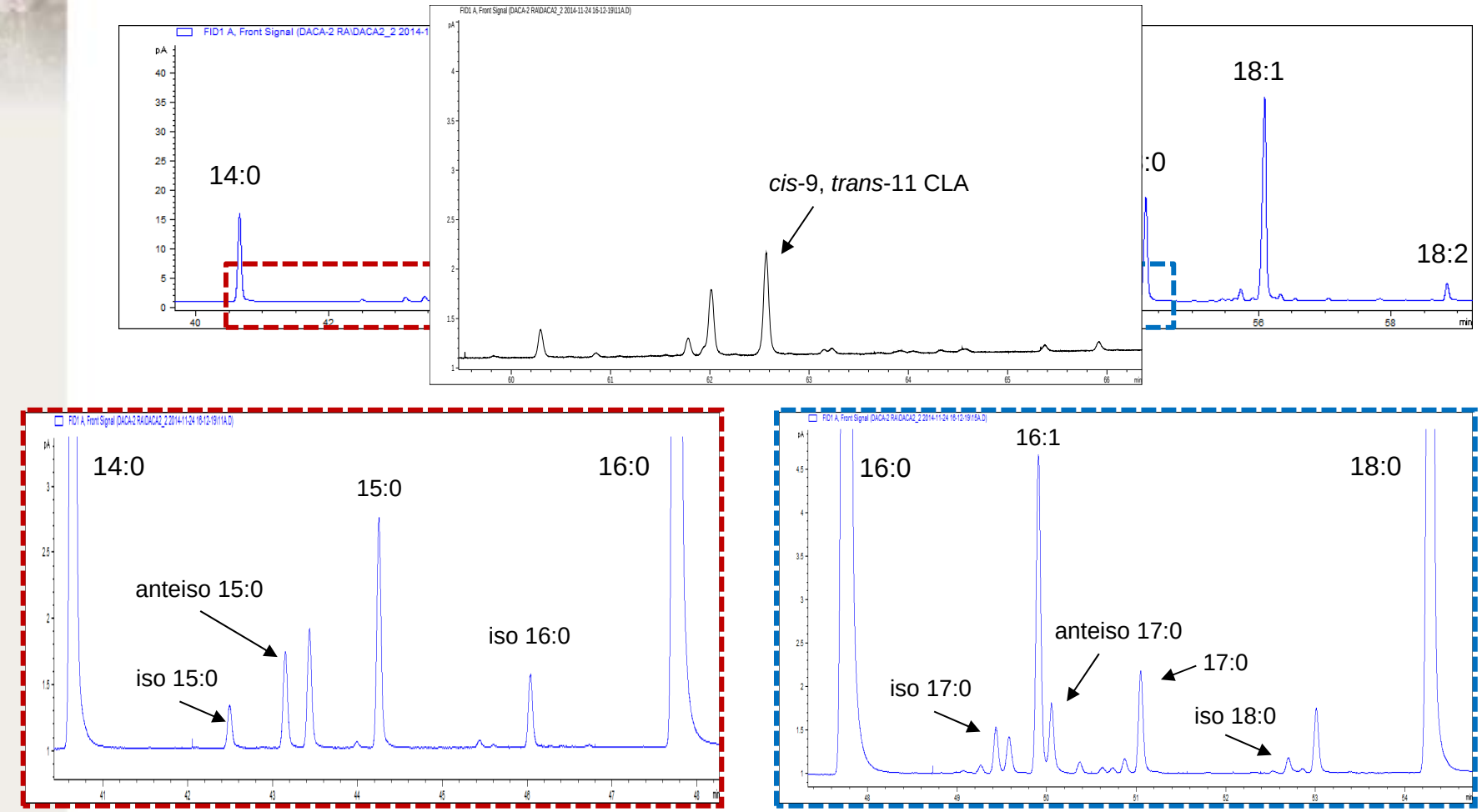
  - Human breast cancer lines

Wongtangtintharn *et al.*, 2005





Branched-chain FA in milk



Consumption of dairy products during pregnancy increases branched-chain FA concentration of human milk

Dingess et al., 2015

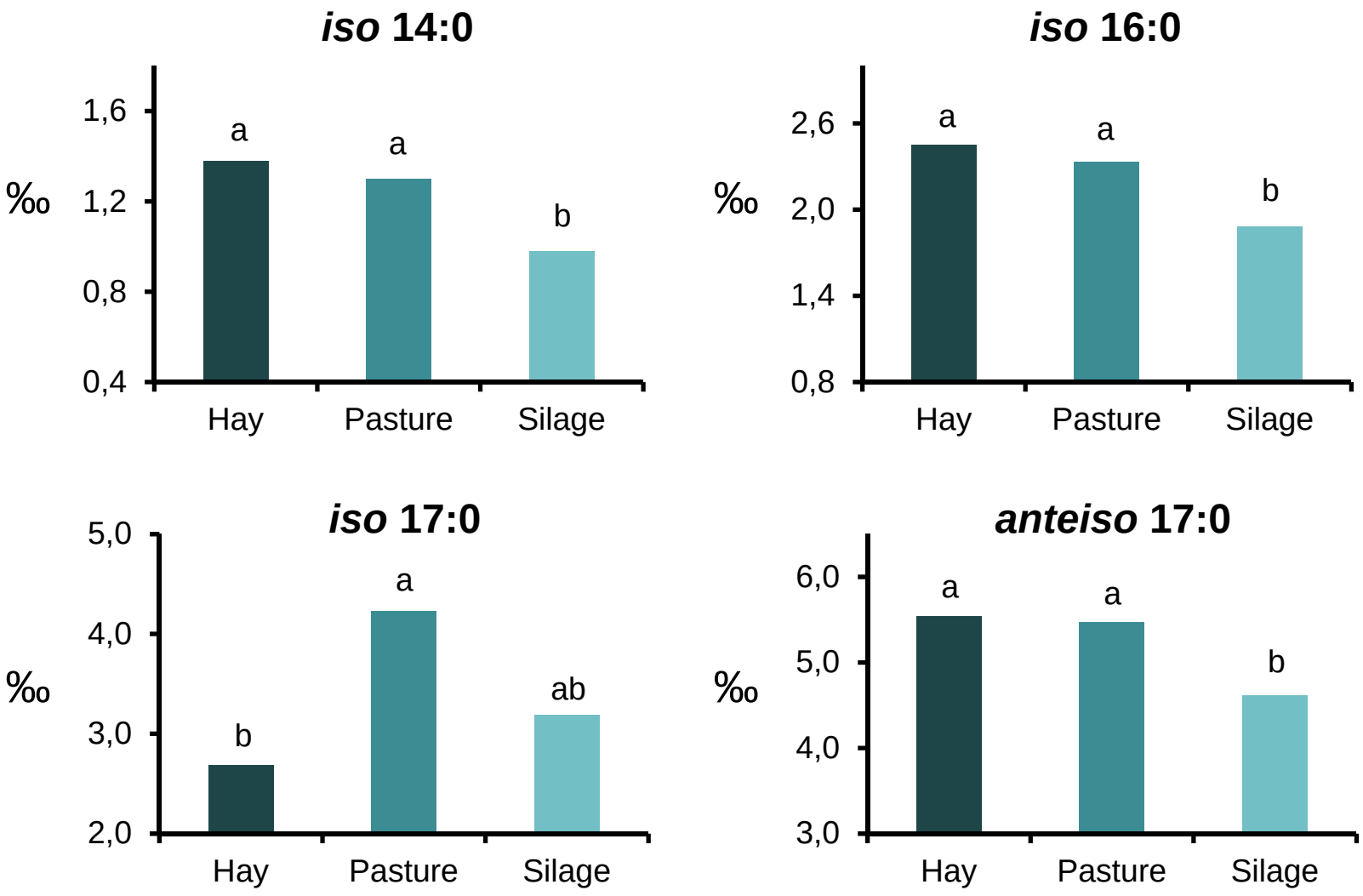
- Pregnant women of Cincinnati, Shangai, and Mexico City
  n = 115 / region
- 4 wk postpartum → milk FA profile
- Intake of dairy products was associated with an increase in
  iso 14:0, anteiso 15:0, and iso 16:0

even *iso*	mg/g fat
***iso* 14:0**	1.36
***iso* 16:0**	3.51
***iso* 18:0**	0.17

odd *iso*	mg/g fat
***iso* 13:0**	0.31
***iso* 15:0**	1.90
***iso* 17:0**	1.12

anteiso	mg/g fat
***anteiso* 13:0**	0.22
***anteiso* 15:0**	8.17
***anteiso* 17:0**	3.34

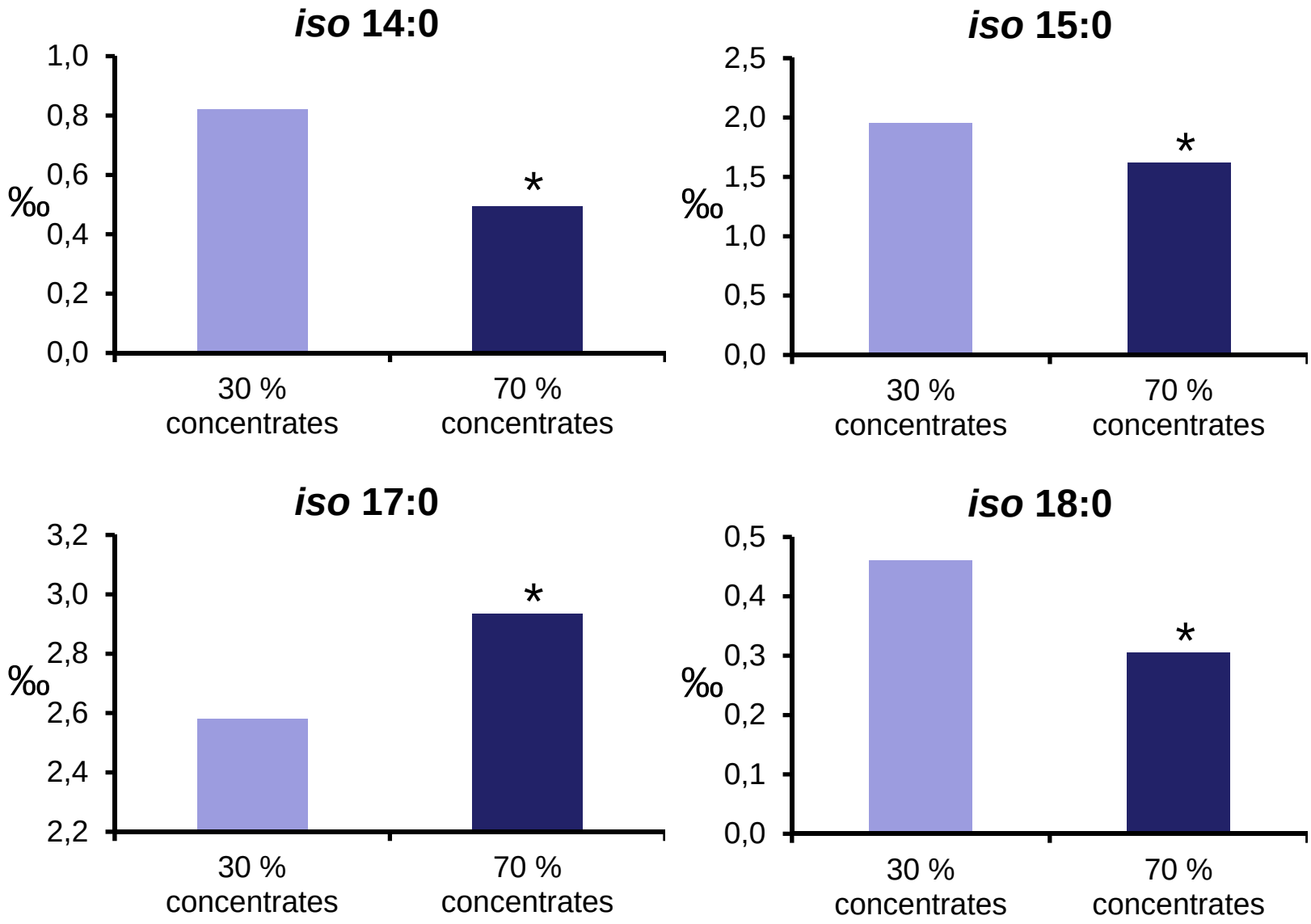
Effects of forage type



a, b: $P < 0.05$

Villeneuve *et al.* 2013

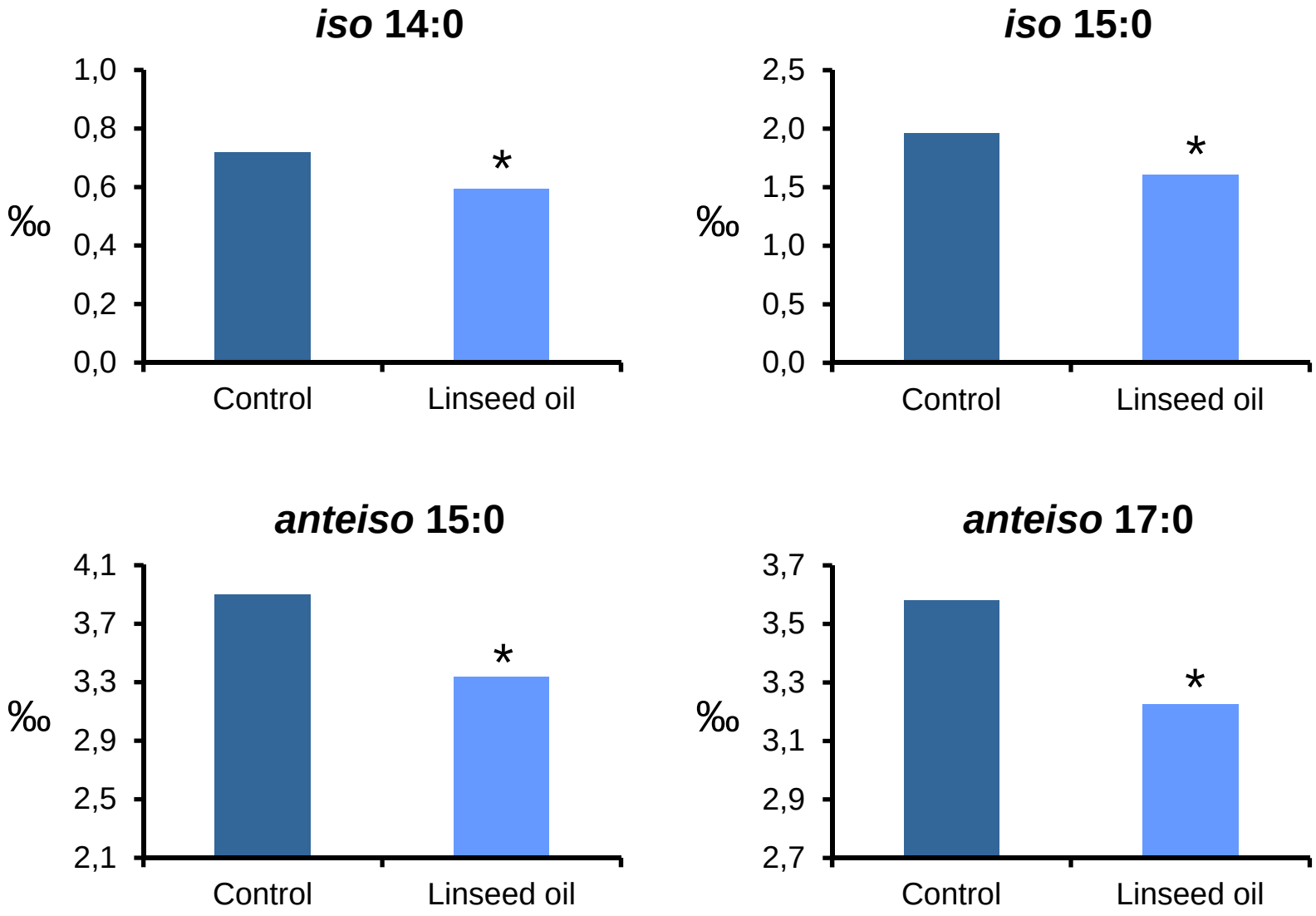
Effects of concentrates



* $P < 0.05$

Saliba *et al.* 2014

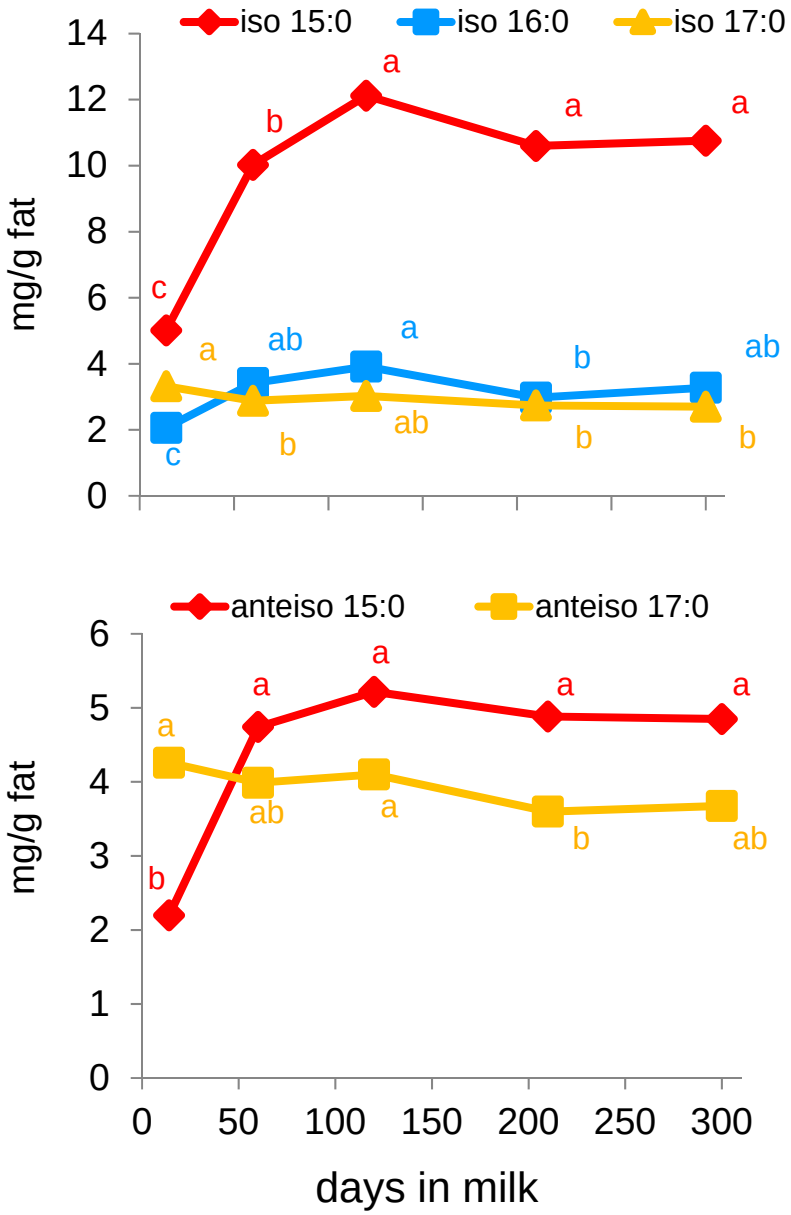
Effects of linseed oil

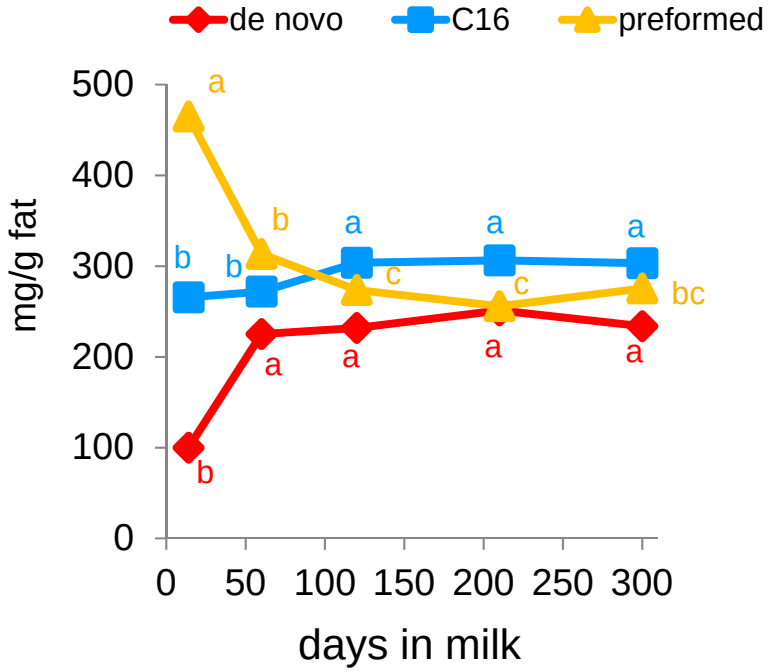


* $P < 0.05$

Saliba *et al.* 2014

Effects of stage of lactation





Baumann *et al.* 2015

Milk branched-chain FA

- Synthesized by rumen microbes
- Diagnostic tool of rumen health in dairy cows
  - Further research is needed.
- Bioactive roles, especially their potential prebiotic role in neonates
- Present in milk at higher concentrations than other identified bioactive fatty acids
- Possible to modulate their concentration in milk fat

Perspectives

- Are all branched-chain FA bioactive ?
- What are their effects in adults ?
- How to maximise their concentration in milk ?

Thank You !

Centre de recherche en sciences animales de Deschambault