UNIVERSITY OF SASKATCHEWAN

Have we been missing risk factors for ruminal acidosis?

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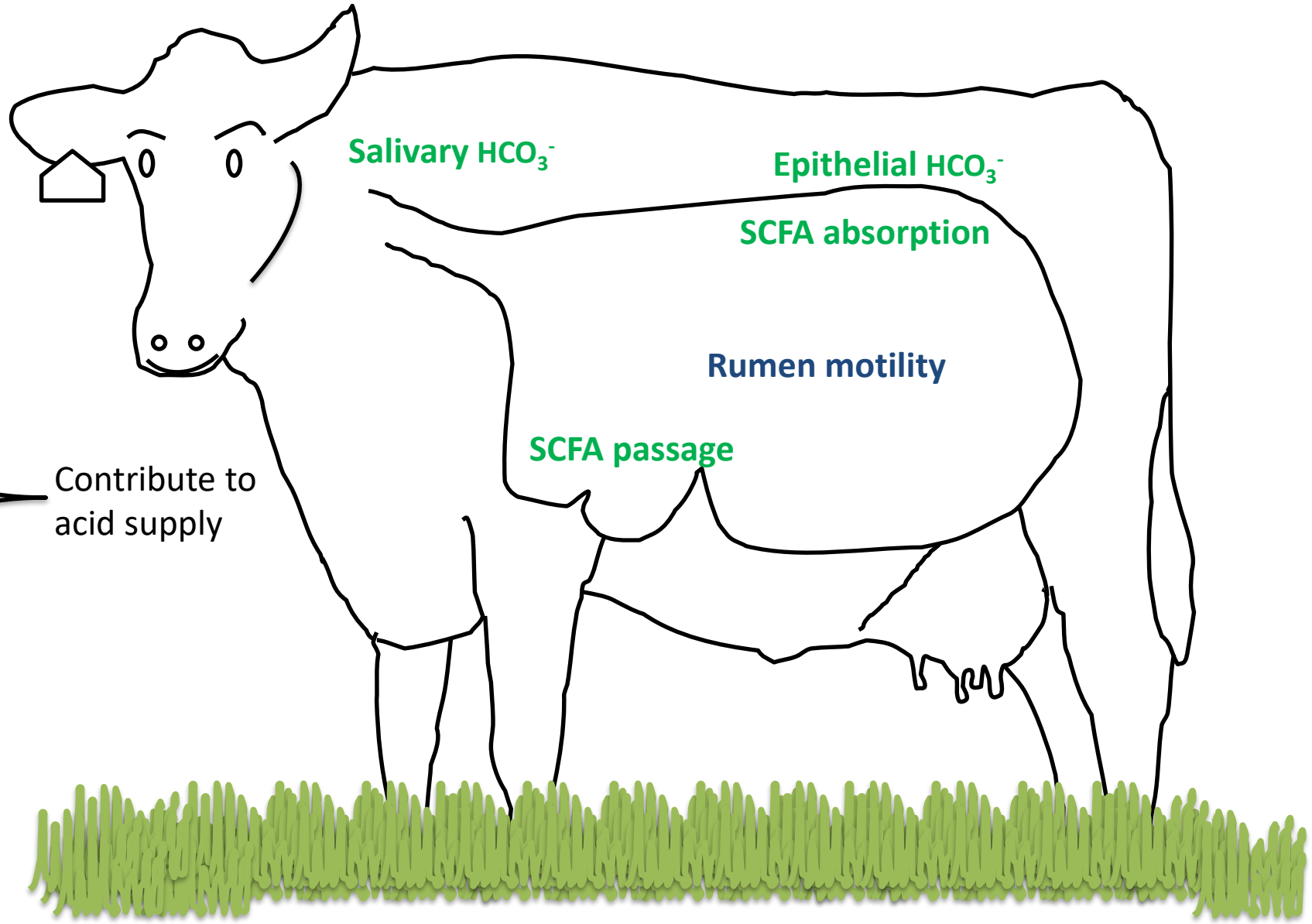
Regulation of ruminal pH

Dietary characteristics
Amount of cereal grain
Type of cereal grain
Ruminally degradable starch
Sugar
peNDF
Fiber digestibility

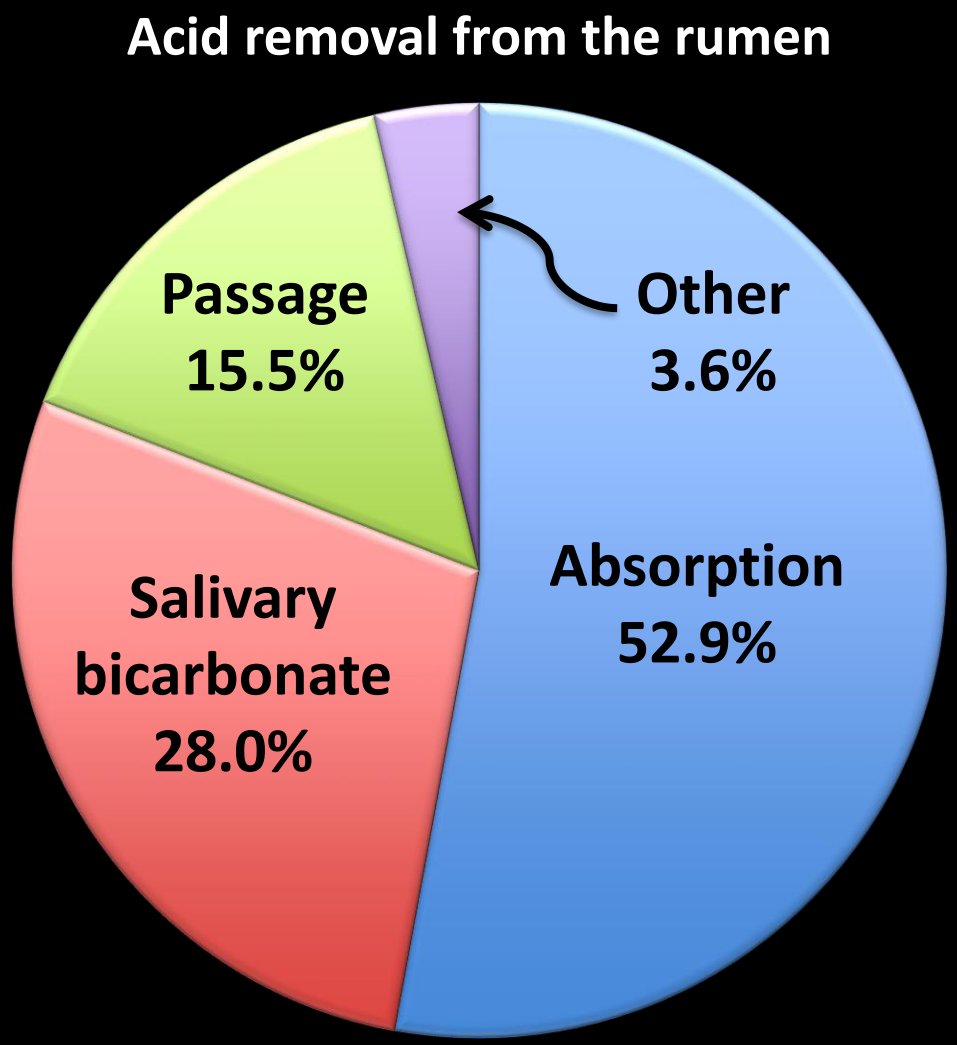
Dry matter intake

Feeding behaviour
Meal size and frequency
Feed sorting

Contribute to acid supply



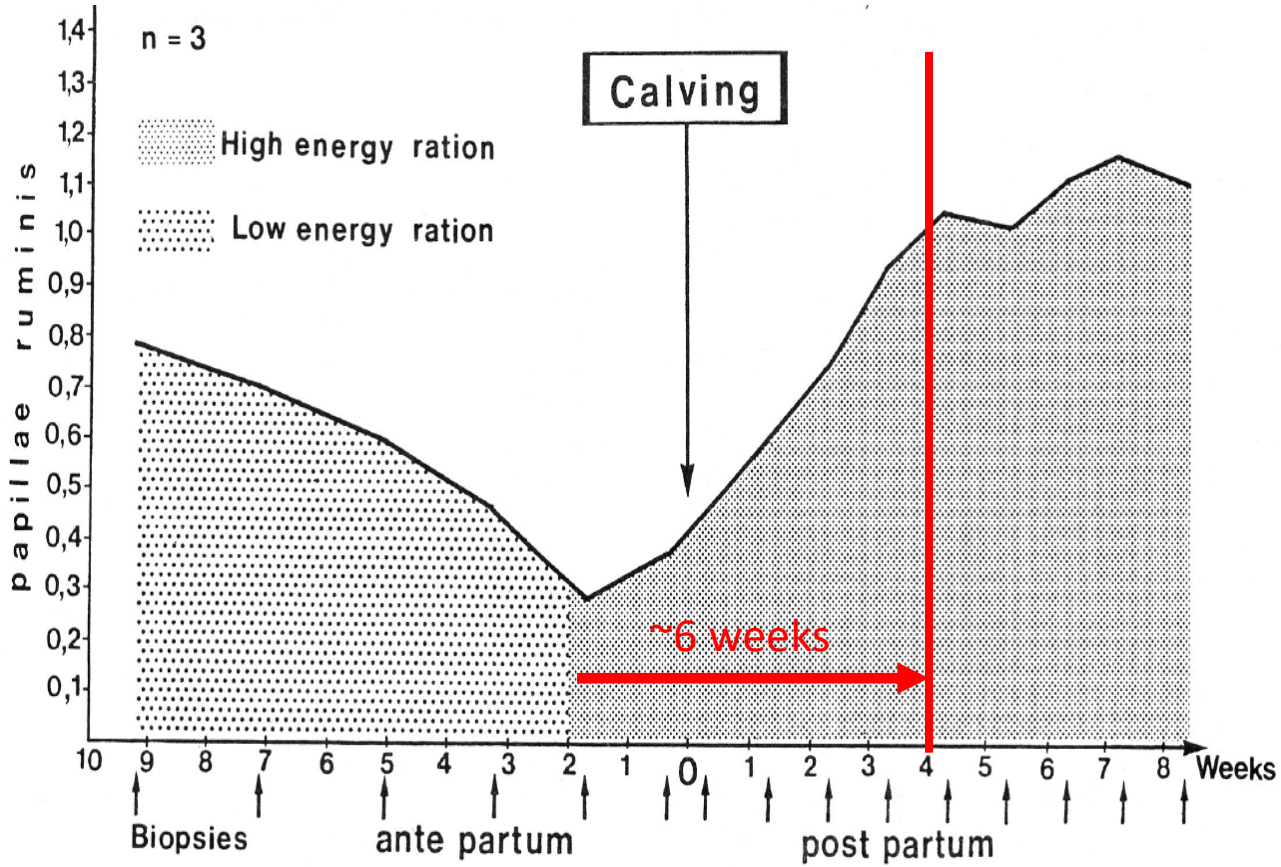
Removal of acid from the rumen



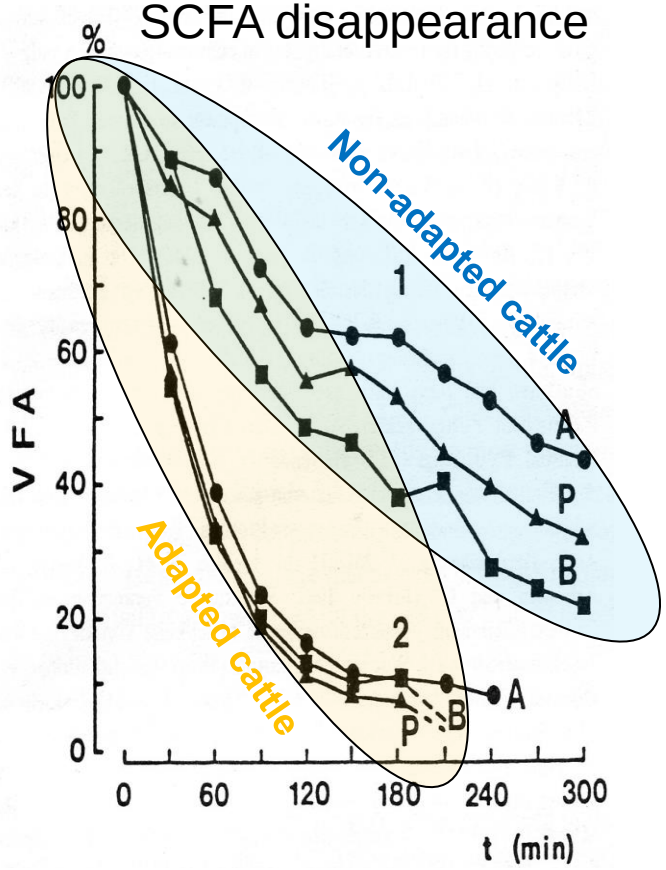
Allen, 1997

Dirksen et al., 1985; Bov. Pract.

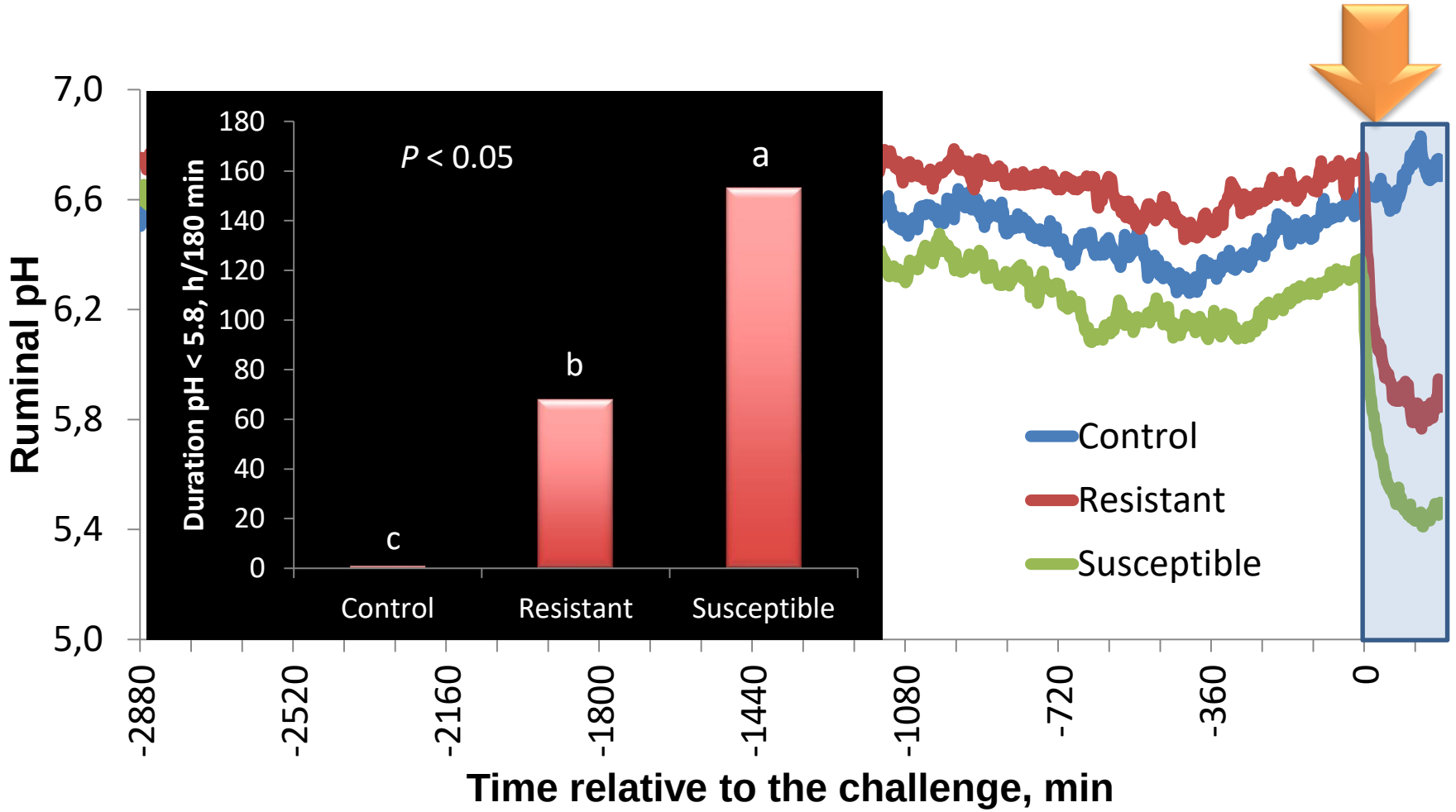
Long-term adaptation



SCFA disappearance

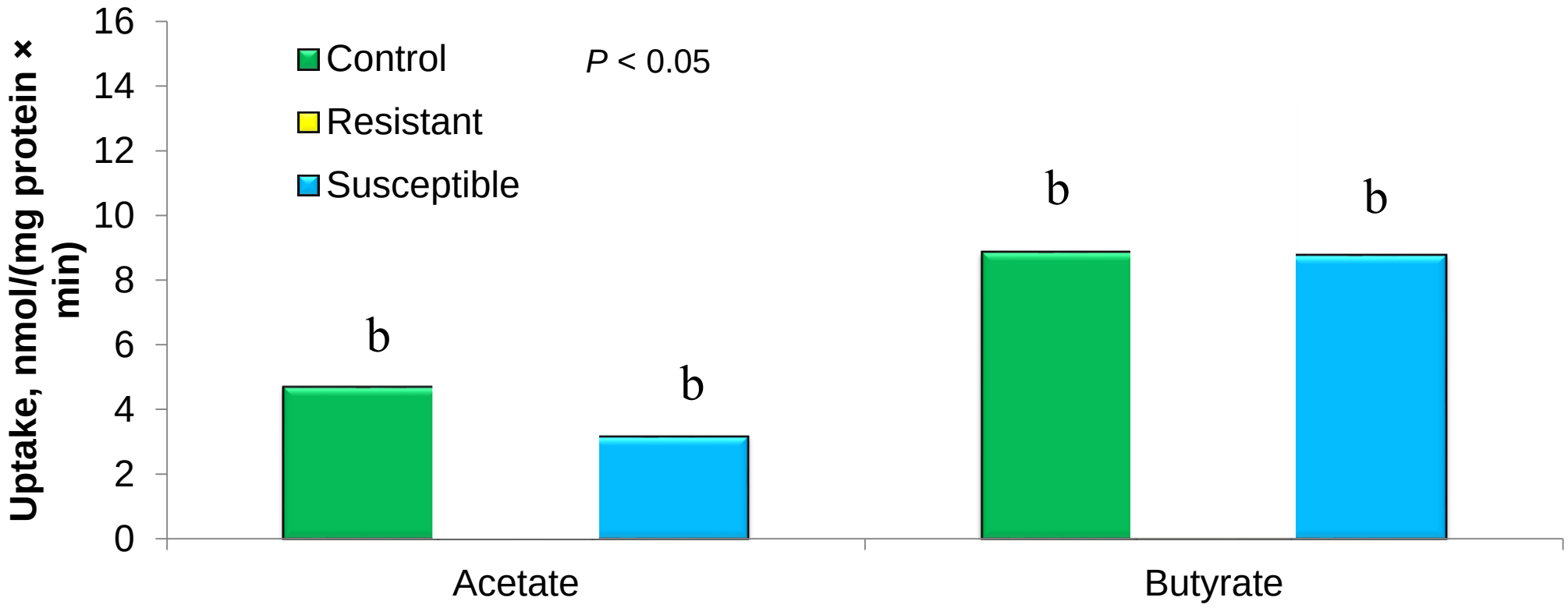


SCFA absorption promotes regulation of ruminal pH



Penner et al., 2009: J. Nutr.

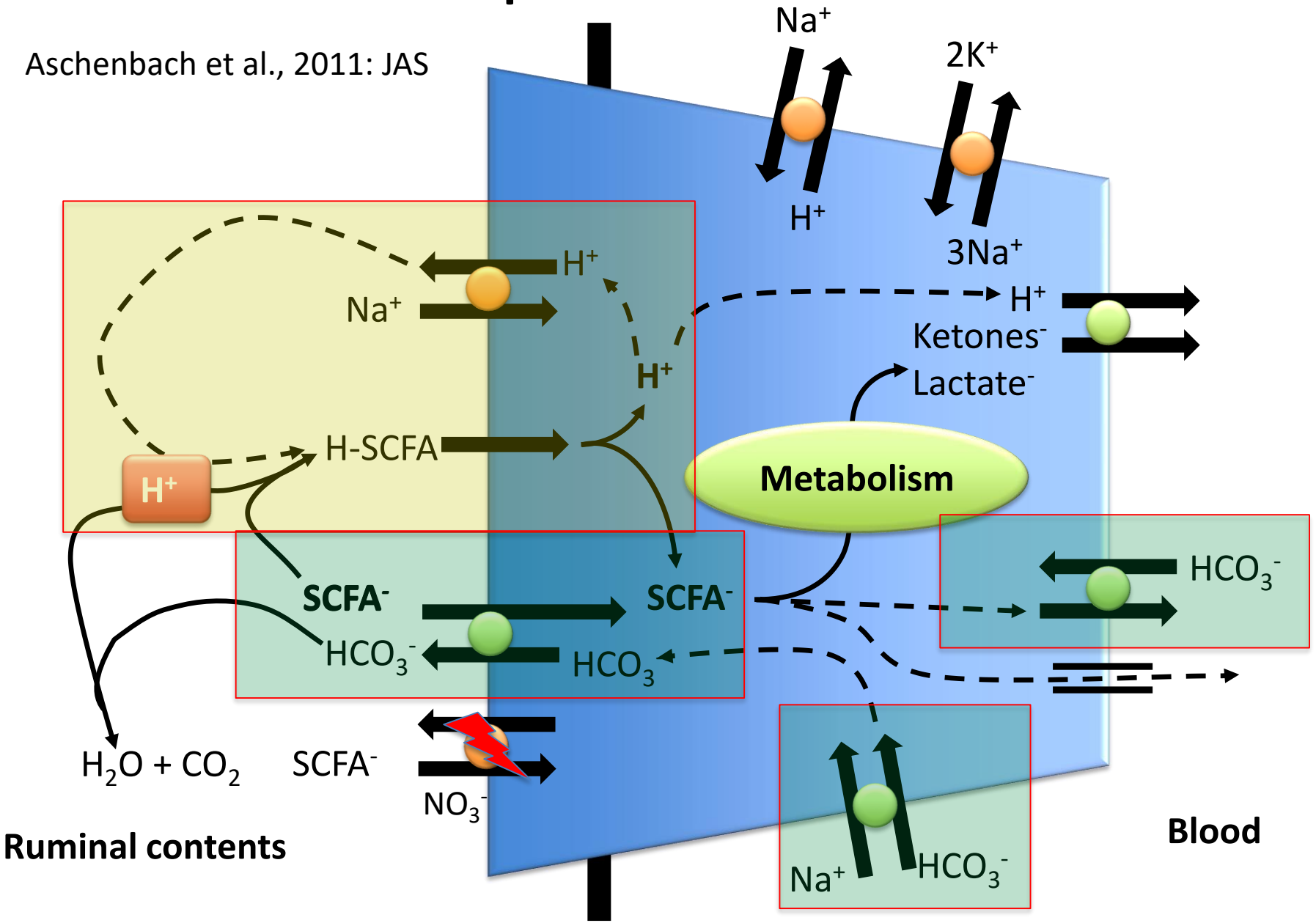
Lambs resistant to ruminal acidosis have greater SCFA absorption



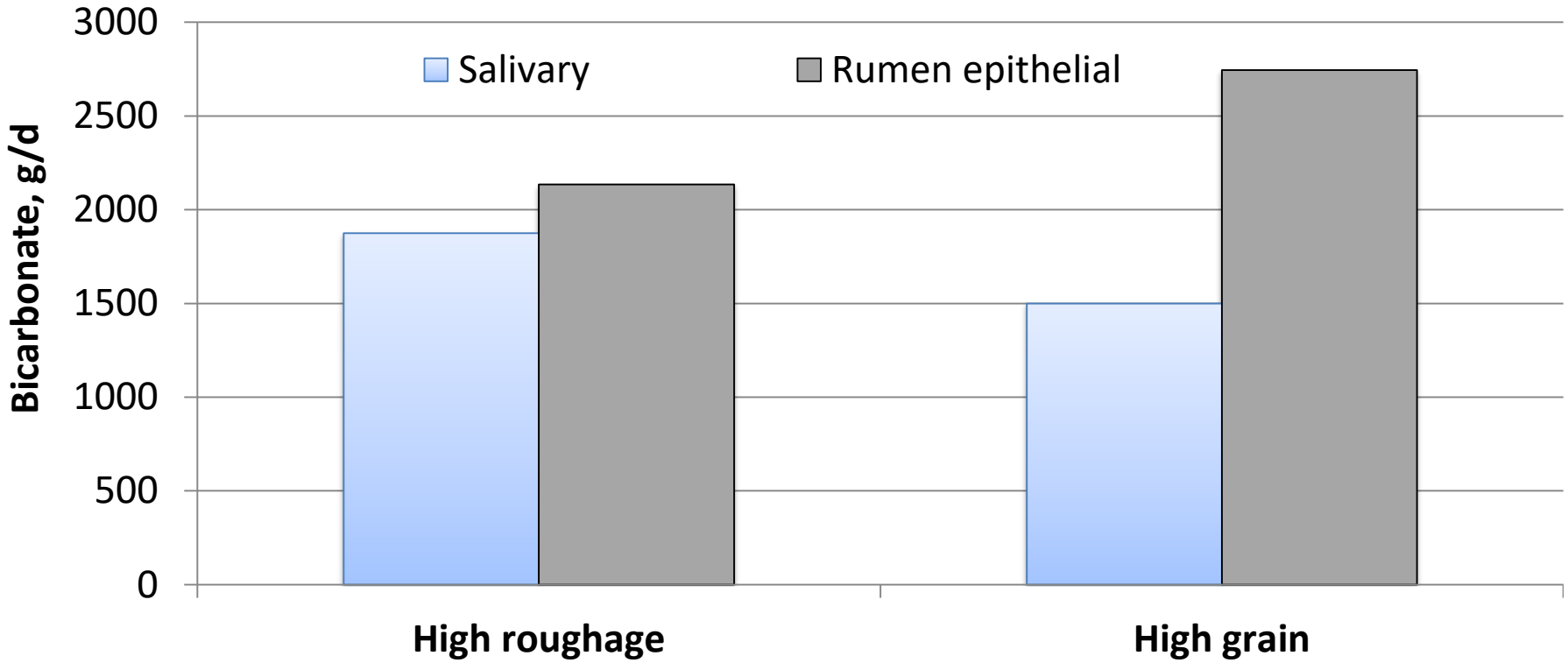
Penner et al., 2009: J. Nutr.

SCFA absorption and H^+ removal

Aschenbach et al., 2011: JAS



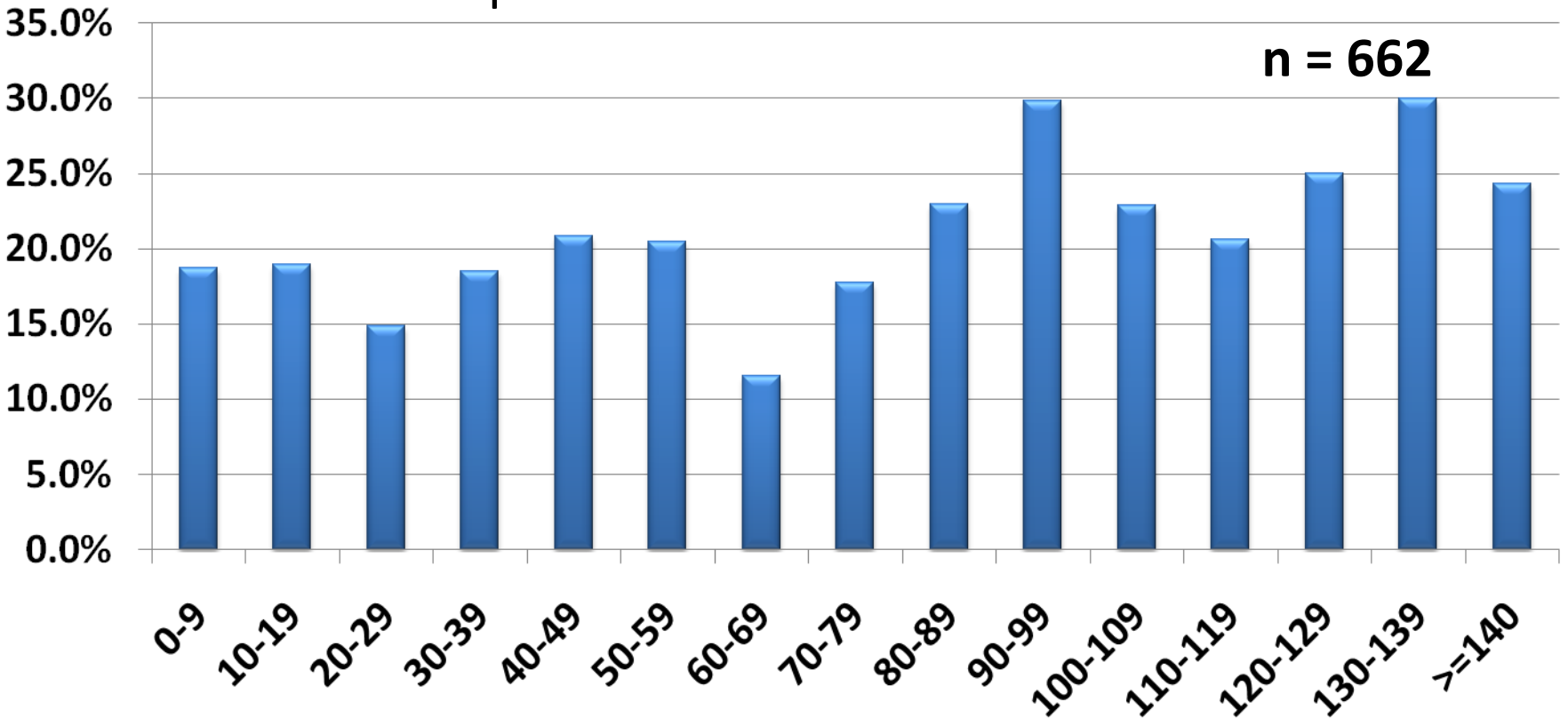
The rumen wall, via SCFA transport, supplies an important quantity of bicarbonate to the rumen



Dijkstra et al., 2012; AFST

Prevalence rates of SARA in dairy cows

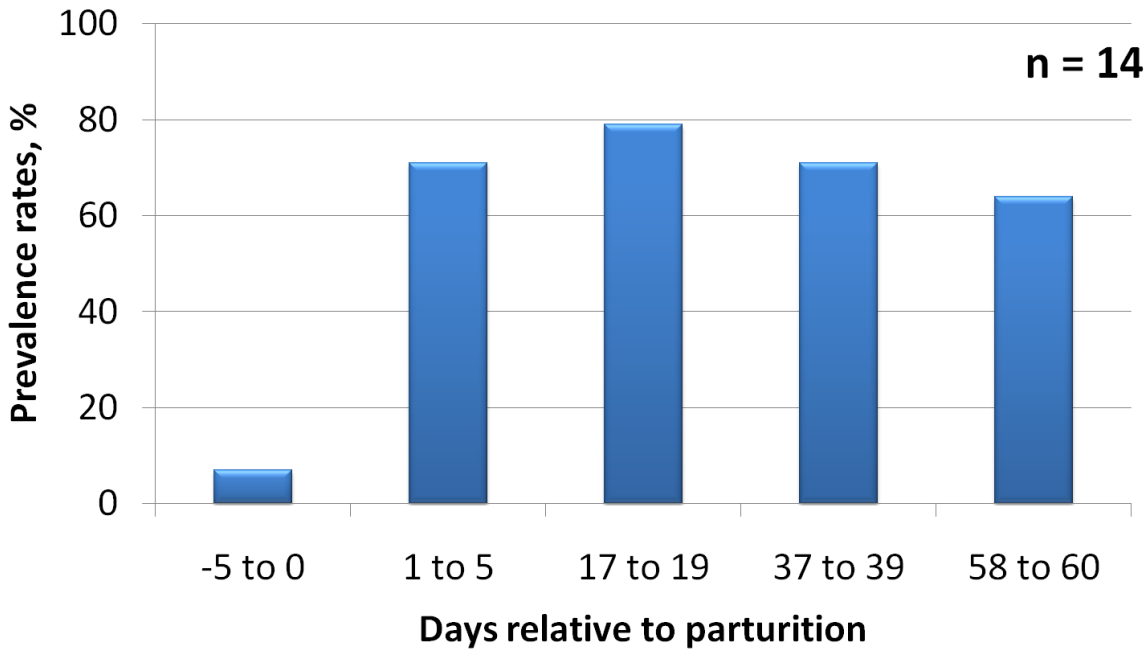
- 19 and 26% in early lactation and mid-lactation cows, respectively (Garrett et al., 1999)
- 12-30% prevalence across lactation

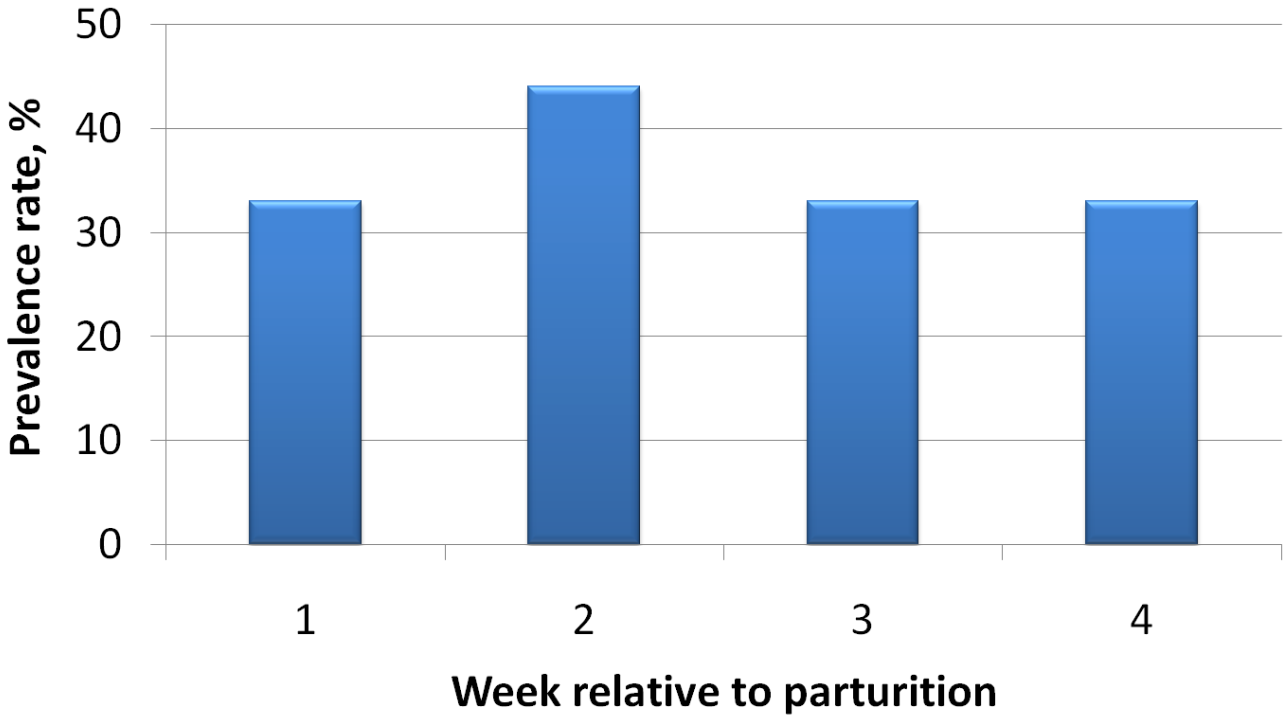


Krause and Oetzel, 2006; Anim. Feed Sci. Technol.

n = 9

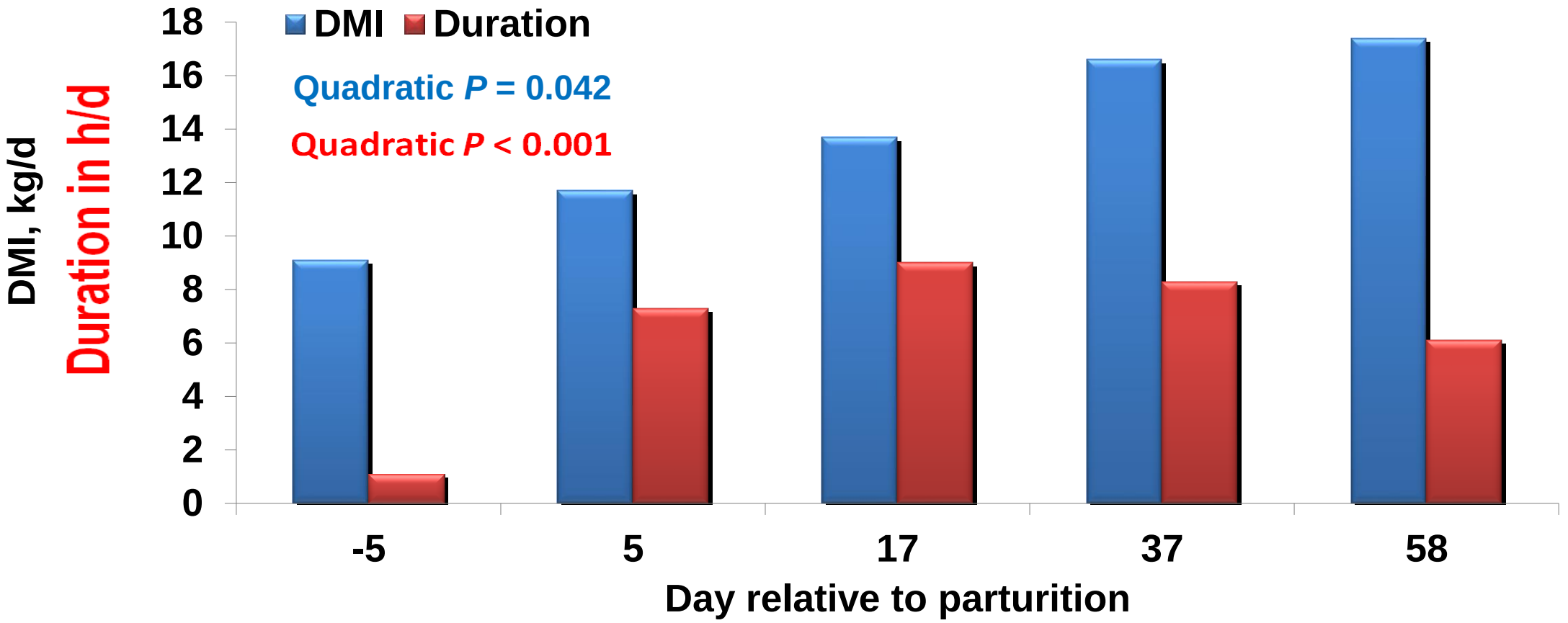
Prevalence of SARA in early lactation





Penner et al., 2009; JDS

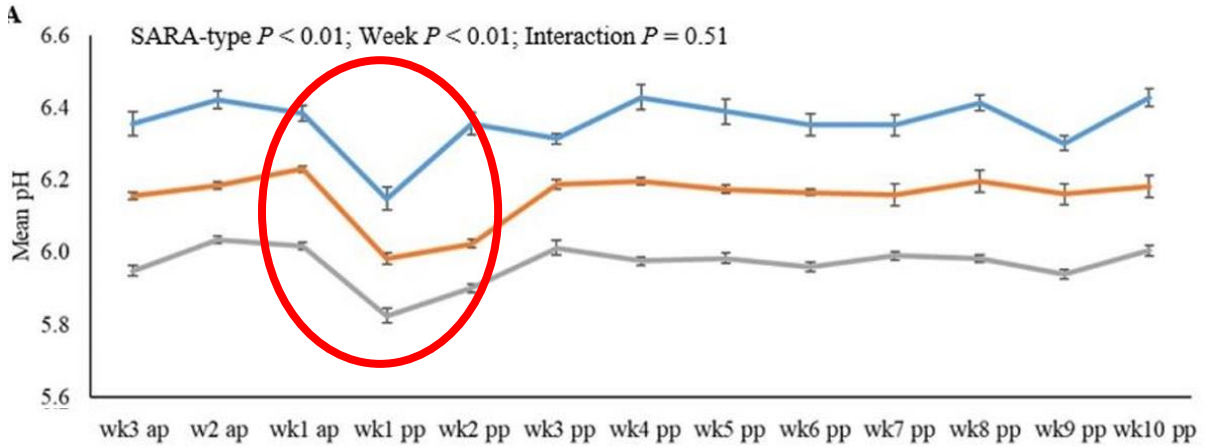
Severity is not always related to DMI

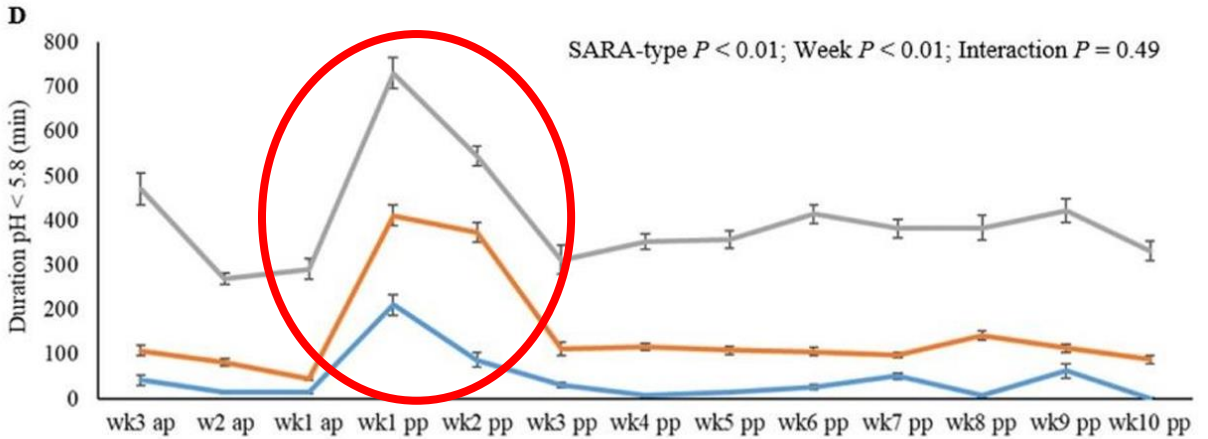


Penner et al., 2007; JDS

Hartinger et al., 2024; JAS

Cows are at risk in early lactation





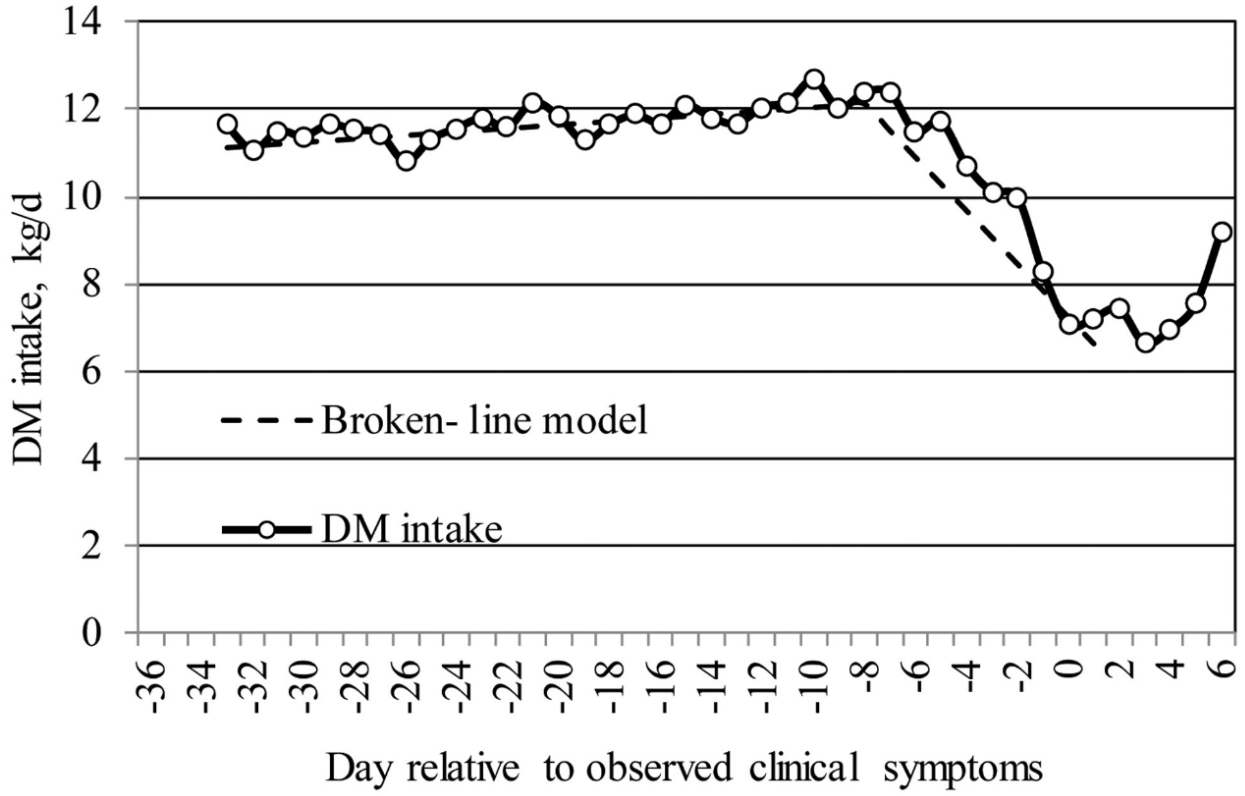
Proposed theory

- Primary ruminal acidosis
  - Over consumption of ruminally degradable starch
  - Low dietary fiber (peNDF and uNDF)
- Secondary ruminal acidosis
  - Diet formulation could be adequate
  - Lack of epithelial capacity for SCFA absorption and ruminal buffering
  - Due to transient off-feed events or off-feed events of short duration

Transient off-feed events as a relevant challenge

- Transition dairy cattle (Hayirli et al., 2003)
  - Hypocalcemia
  - Metritis
  - Displaced abomasum
  - Ketosis
- Rumen acidosis (Dohme et al., 2008)
- Heat stress (Rodes and Baumgard, 2013)
- Diseased states
  - BRD (Toaff-Rosenstein et al., 2016)
  - Mastitis
- Management events
  - Feed delivery challenges

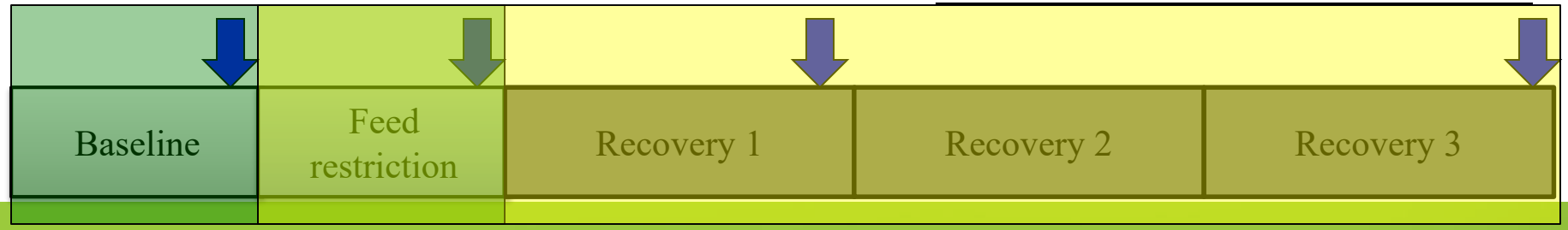
Jackson et al., 2016; JAS



Evaluating off-feed events

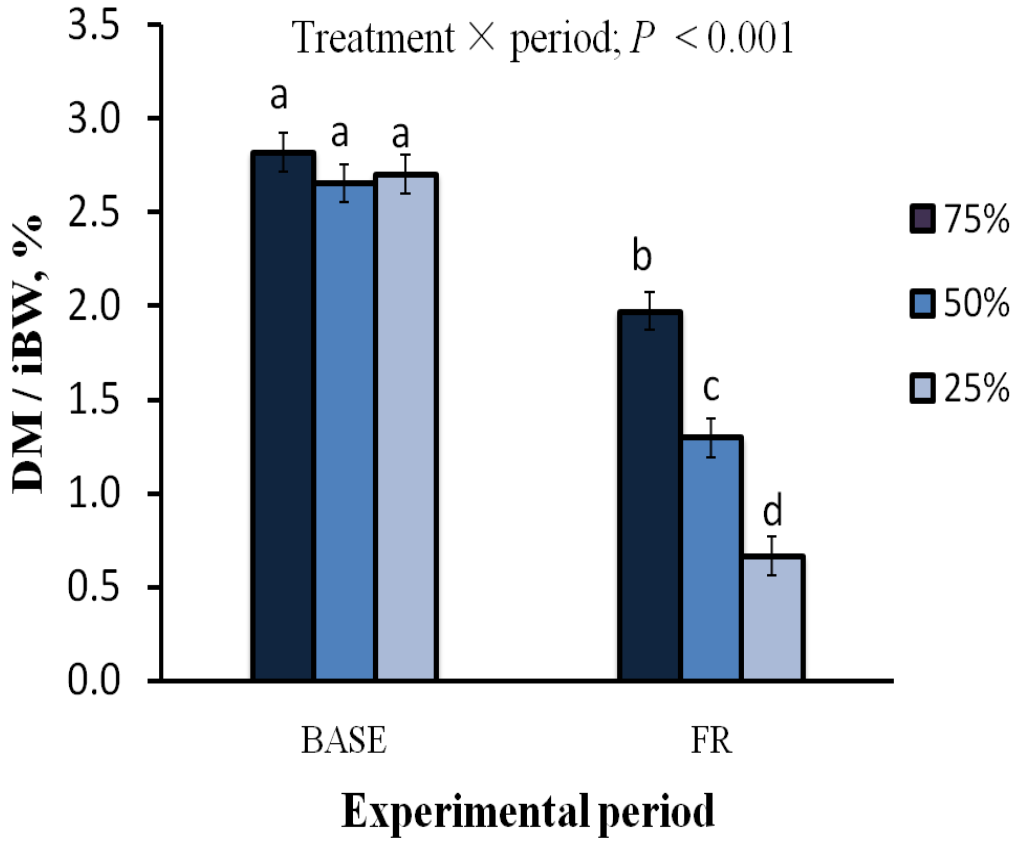
- 18 cannulated Angus heifers
  - 3 treatments
    - 75% of feed ad libitum
    - 50% of feed ad libitum
    - 25% of feed ad libitum
- 5 periods

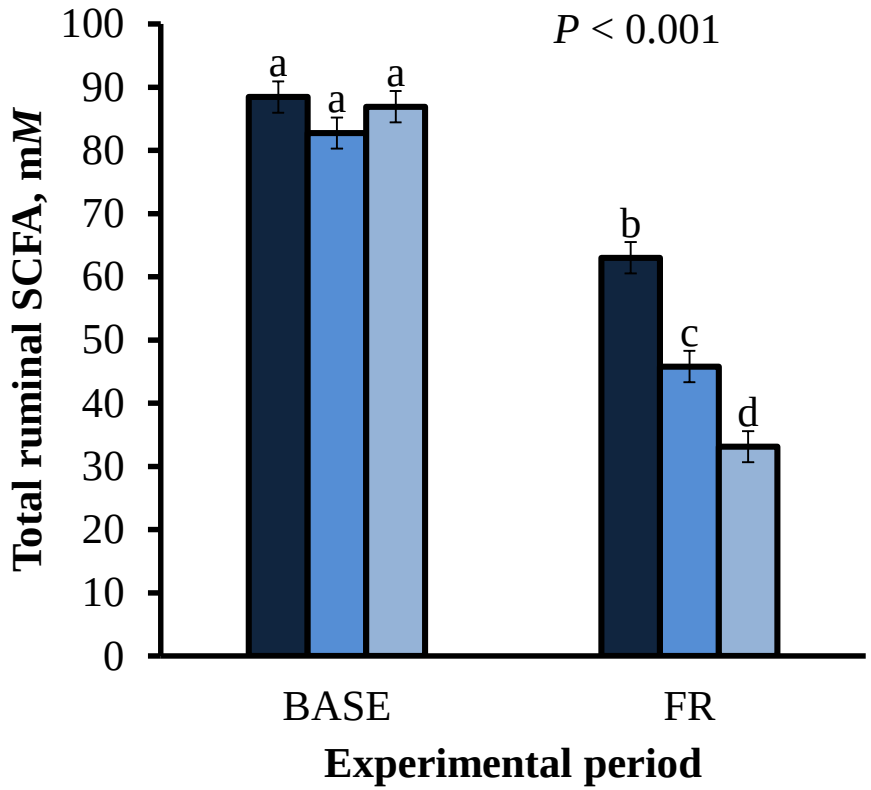
Ingredient , % of DM	
Barley silage	30
Grass-Alfalfa hay	30
Barley grain (rolled)	32
Pellet	8
Nutrient composition	
DM,%	65.8 ± 1.9
OM,% of DM	92.3 ± 1.2
CP,% of DM	11.2 ± 0.4
Fat, % of DM	1.8 ± 0.0
NDF,% of DM	40.1 ± 0.4



Zhang et al., 2013; JAS

Short-term off feed events decrease ruminal SCFA concentration





Zhang et al., 2013: JAS

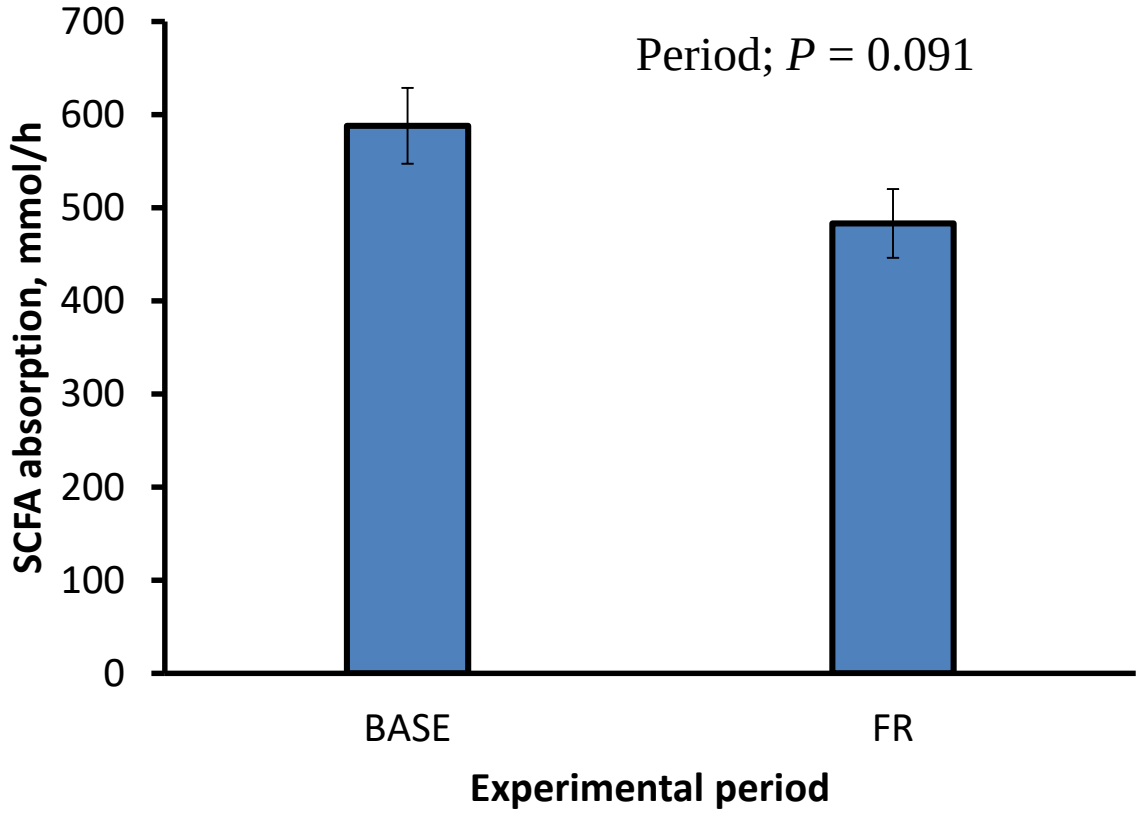
Luminal pH in the rumen and prox. colon increase when off-feed

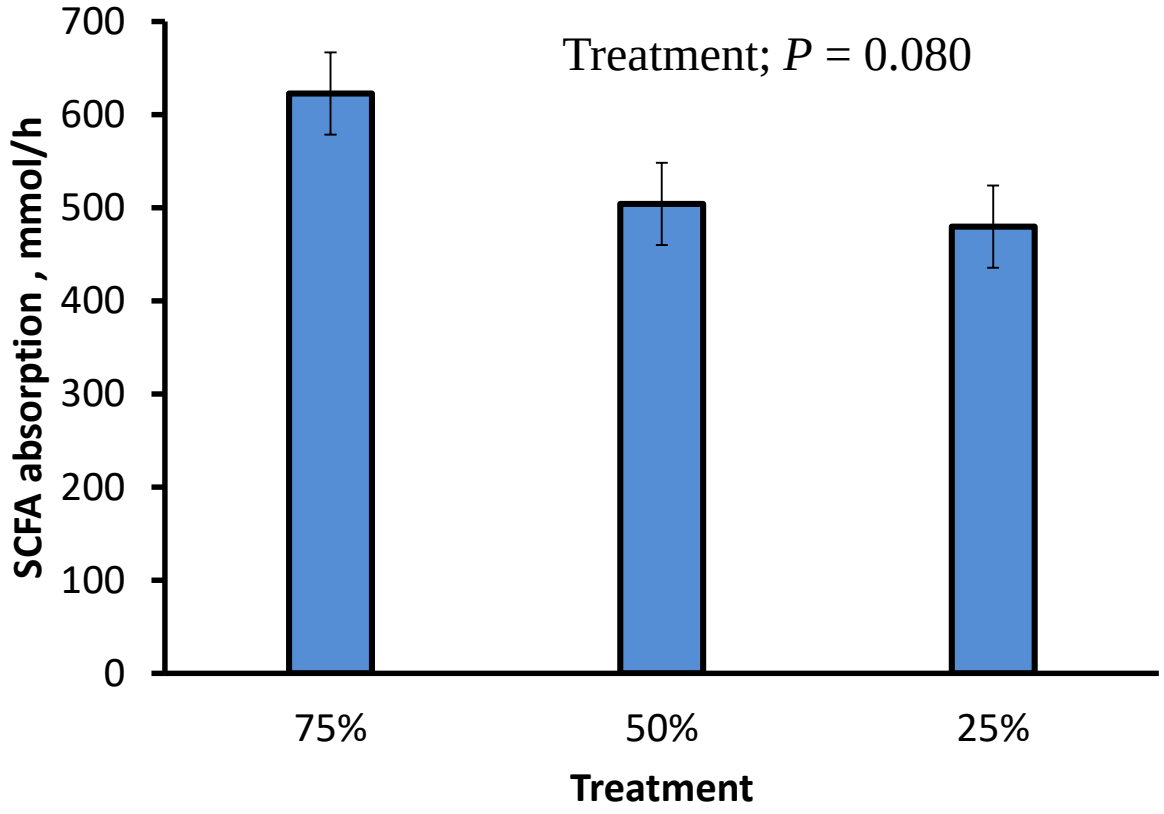
	Treatment				*P* Value	
Region[1]	CON	RA	LFI	SEM	CON vs. RA	CON vs. LFI
Reticulo-rumen	6.14	5.33	6.61	0.14	0.001	**0.032**
Duodenum	5.28	4.99	5.18	0.35	0.71	0.82
Jejunum	7.03	6.98	7.31	0.16	0.82	0.22
Cecum	6.96	6.33	7.05	0.15	0.012	0.68
Proximal colon	6.94	6.52	7.30	0.10	0.010	**0.023**
Distal colon	6.90	6.52	7.13	0.14	0.06	0.26

[1]pH was measured using a ratio of 1:1 g/g of digesta and double distilled water

Pederzolli et al., 2018: JAS

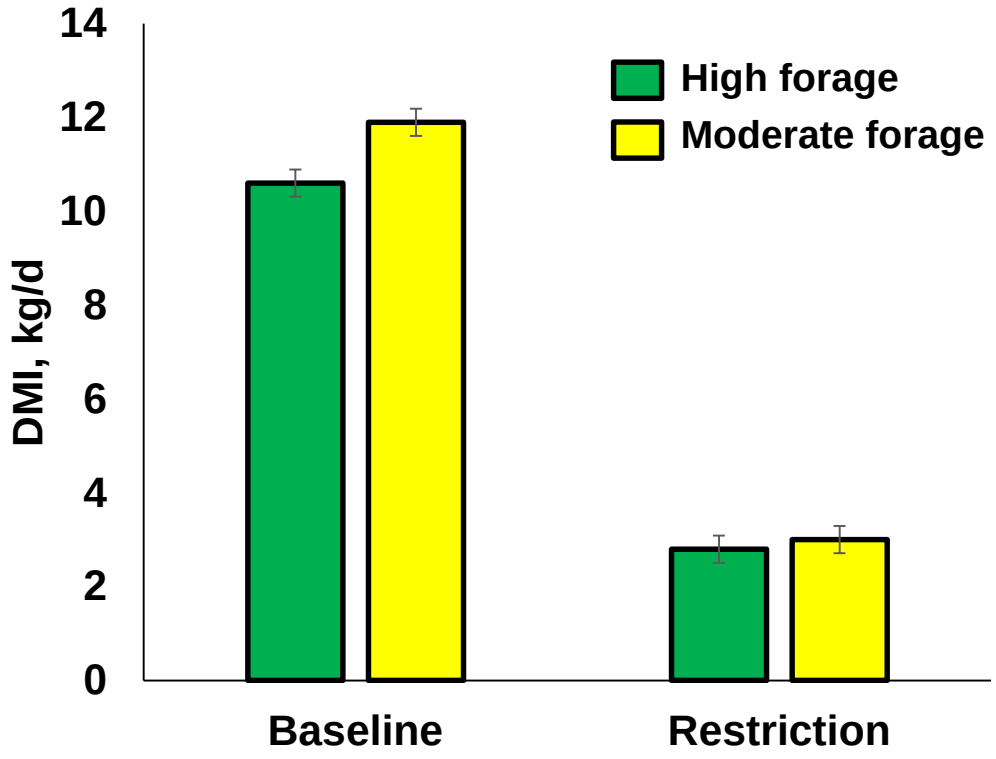
SCFA absorption is reduced with low feed intake

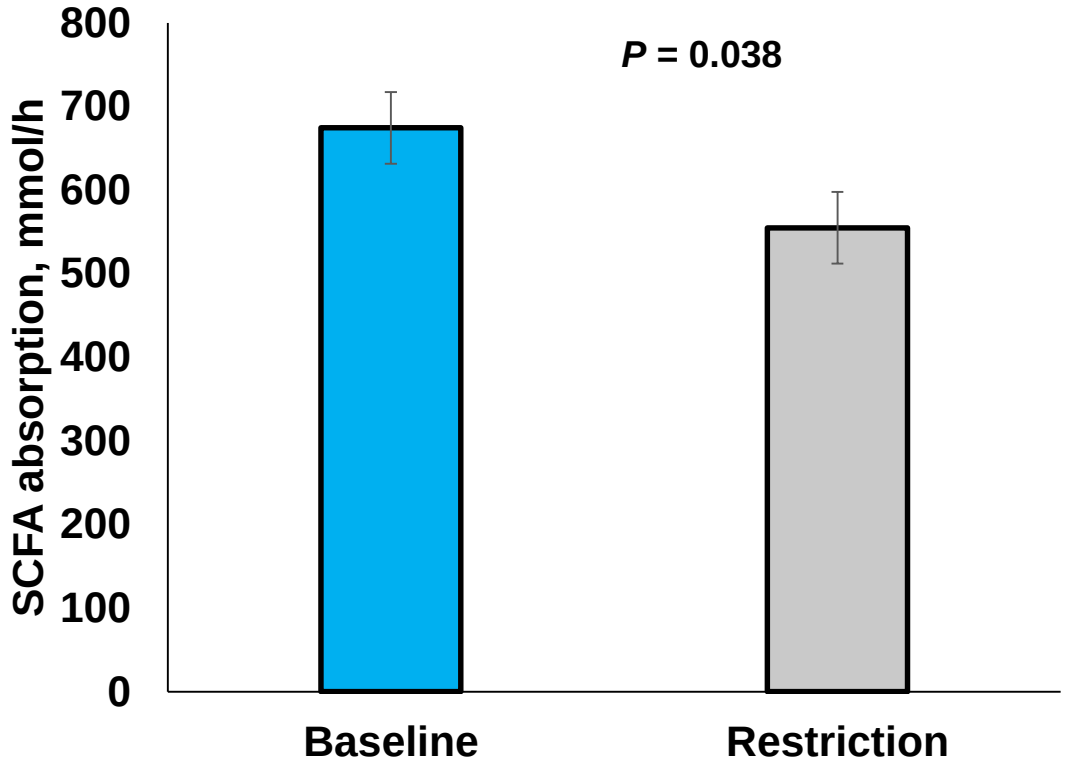




Zhang et al., 2013: JAS

Low feed intake decreases SCFA absorption





Albornoz et al., 2013; JAS

Low feed intake rapidly decreases absorptive surface area

5 d at 25% of voluntary intake

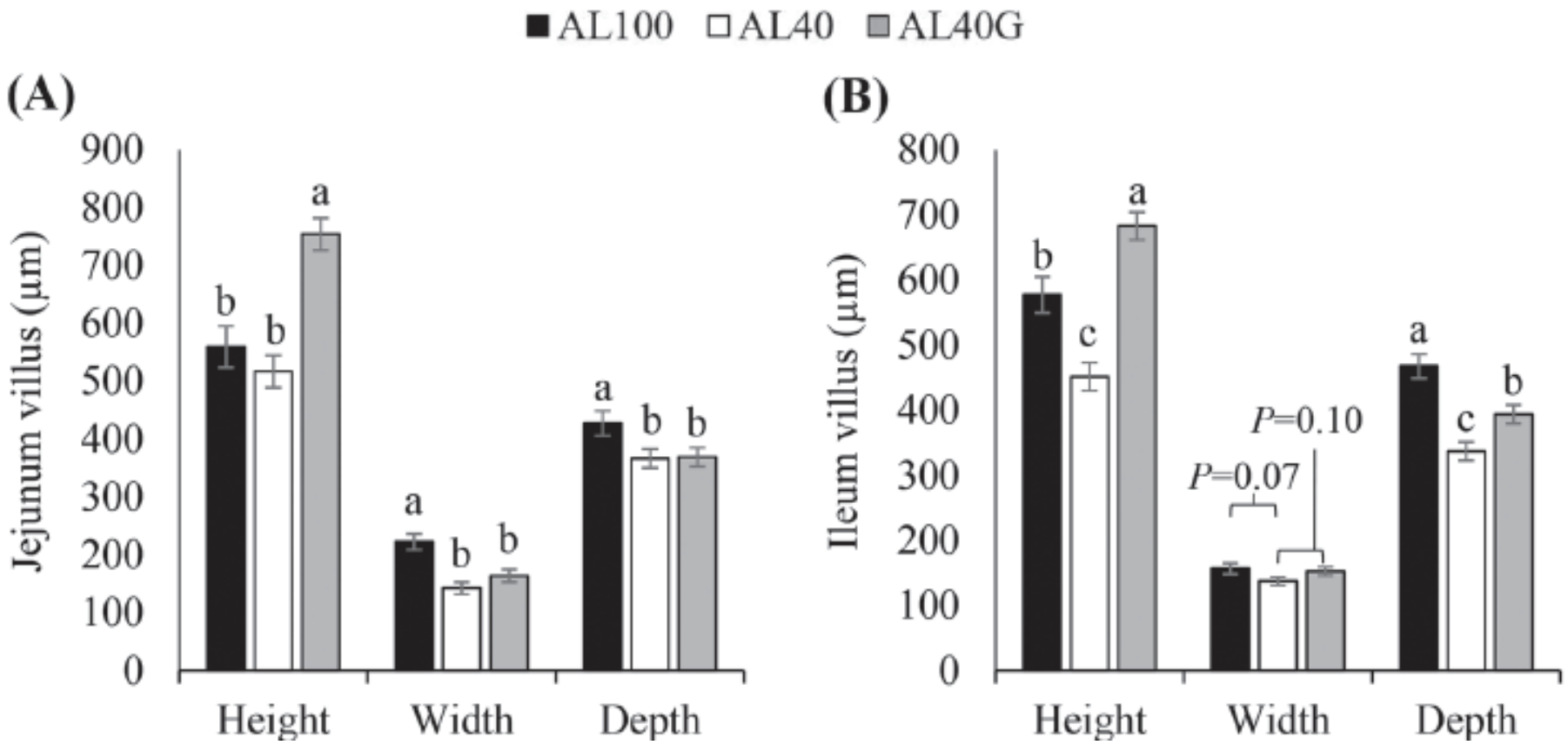
	Treatment				*P* value	
Item	CON	RA	LFI	SEM	CON vs. RA	CON vs. LFI
Length, mm	5.11	4.33	3.90	0.44	0.17	**0.043**
Width, mm	2.37	1.85	1.59	0.13	0.026	**0.002**
Perimeter, mm	13.81	11.43	9.97	0.98	0.09	**0.012**
Surface area[1], mm^2	18.71	13.18	7.72	1.86	0.08	**0.002**

[1]Surface area was estimated as the surface area of one side of the papillae multiplied by 2

59% reduction in surface area

Pederzolli et al., 2018: J. Anim. Sci.

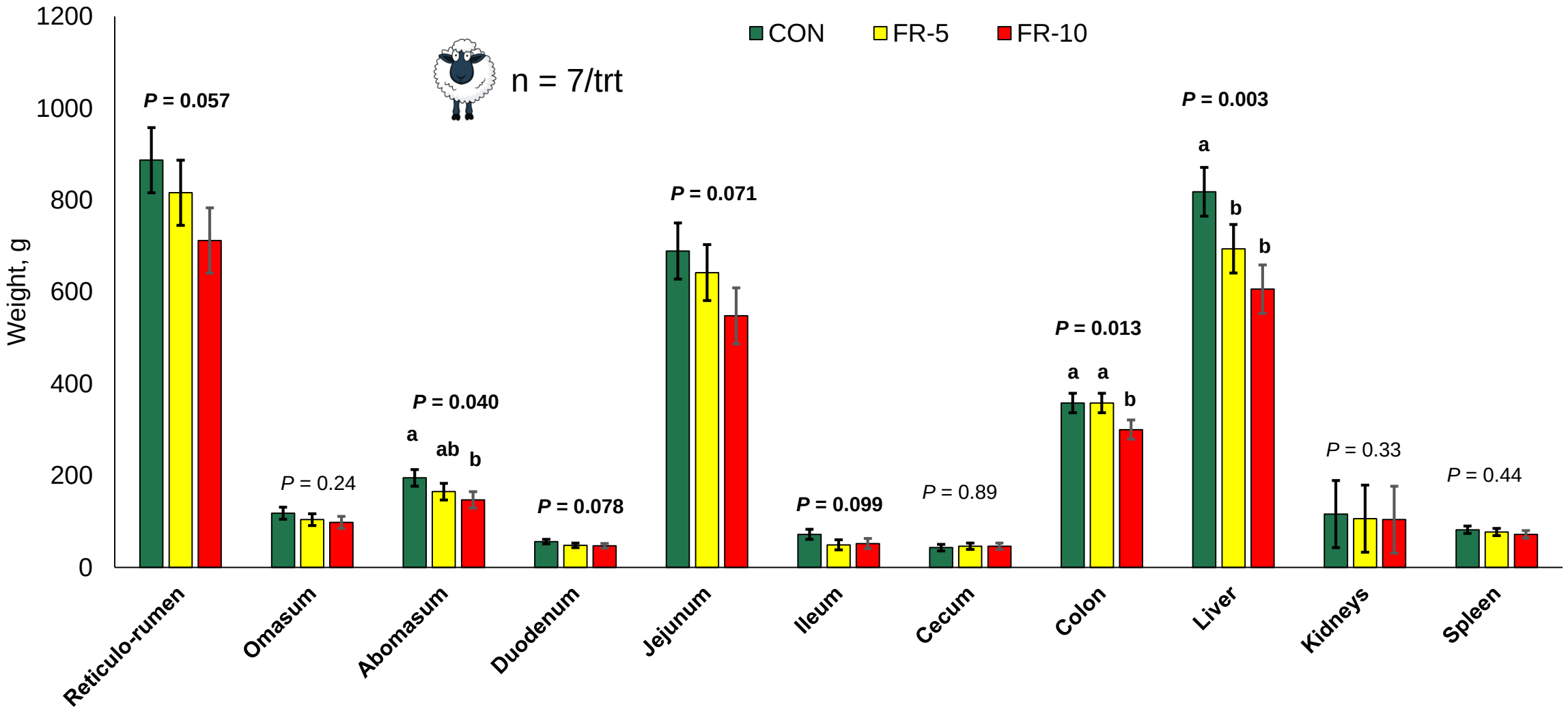
Low feed intake reduces intestinal surface area



Kvidera et al., 2017; JDS

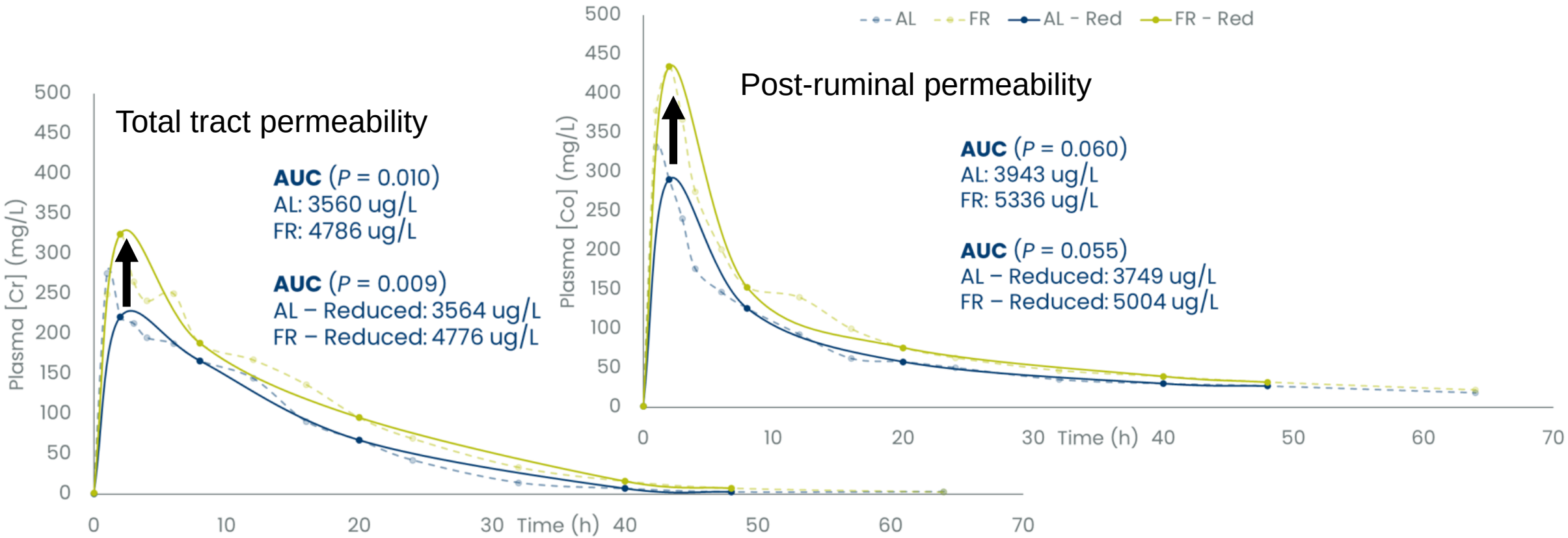
Lambert et al., 2023; unpublished

5 or 10 d of low feed intake (30%) reduces splanchnic tissue weights

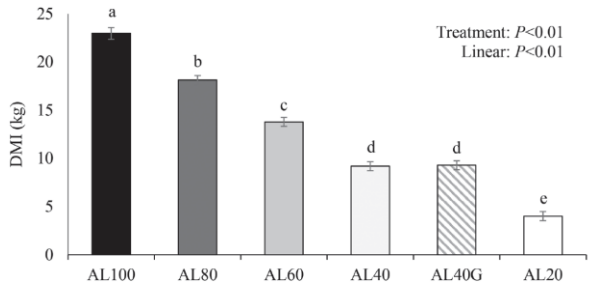


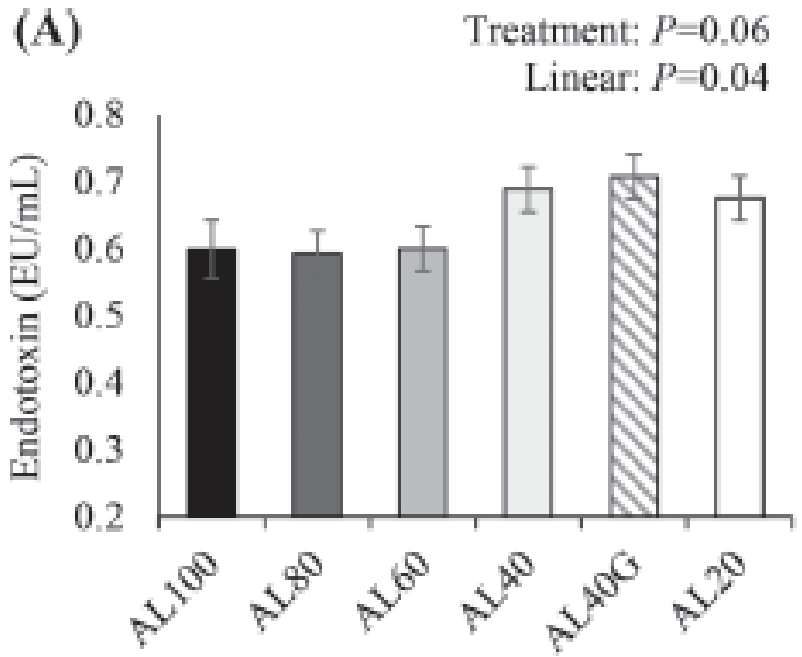
Bertens et al. unpublished

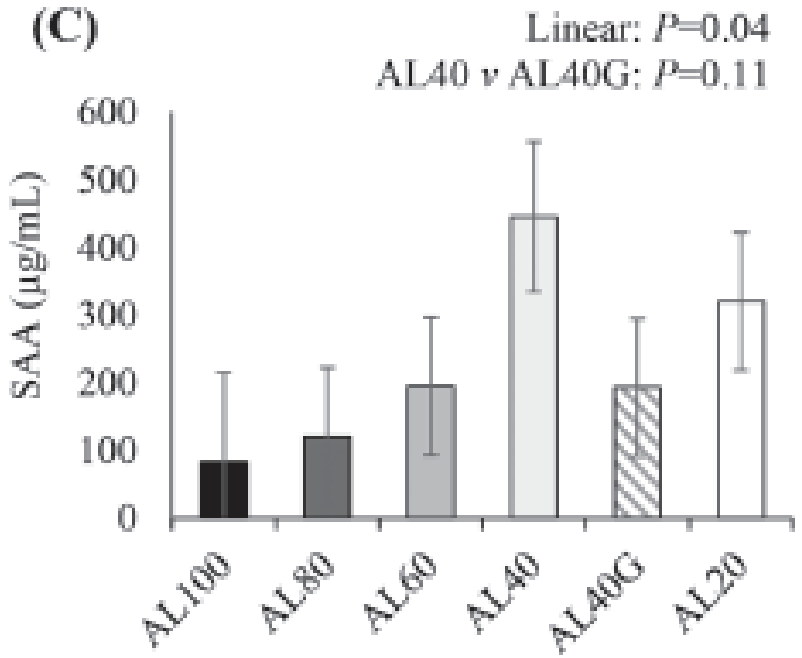
Low feed intake increases gastrointestinal permeability



Low feed intake increases risk for inflammation

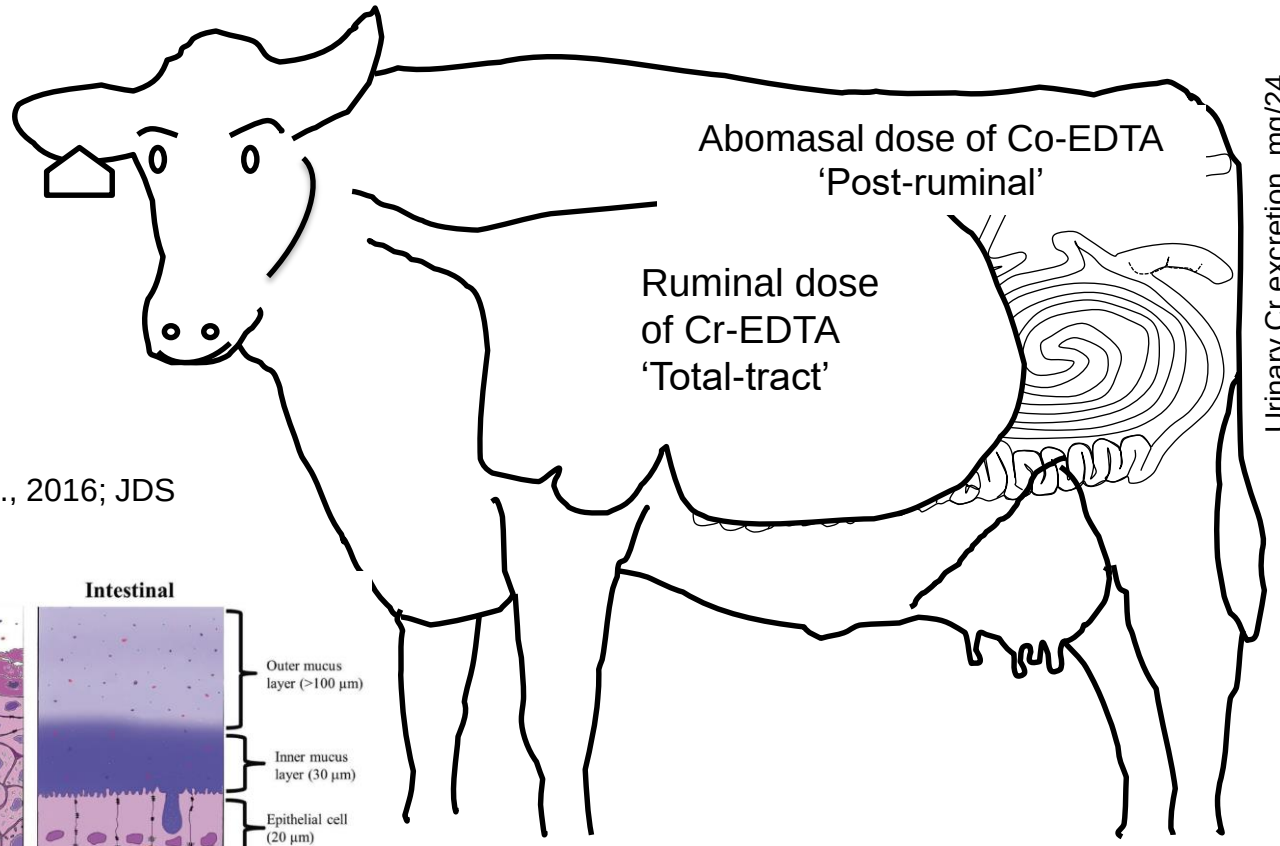




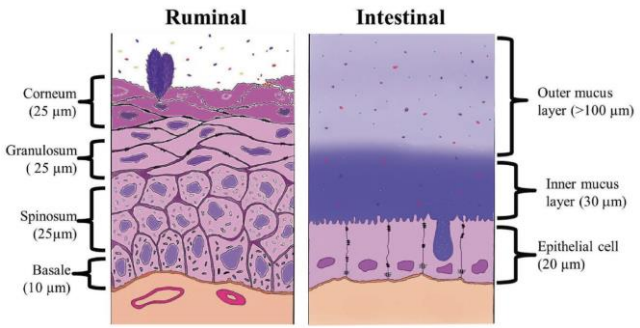


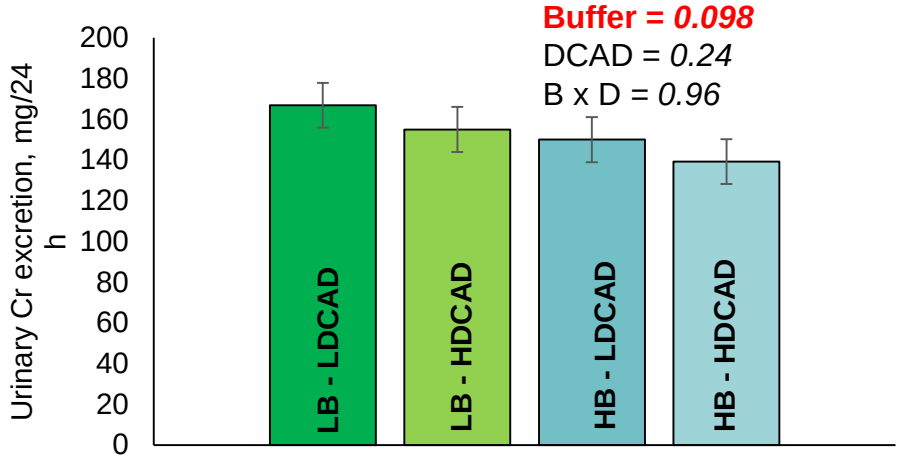
Kvidera et al., 2017; JDS

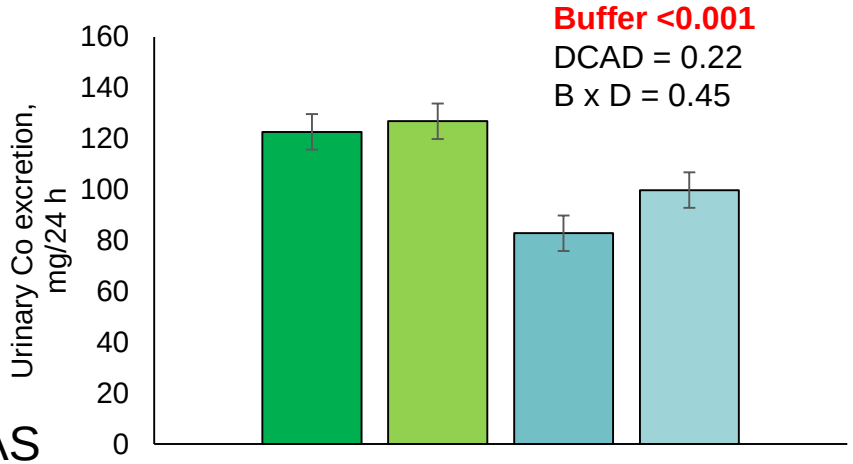
Heat stress increases gastrointestinal and post-ruminal permeability



Steele et al., 2016; JDS







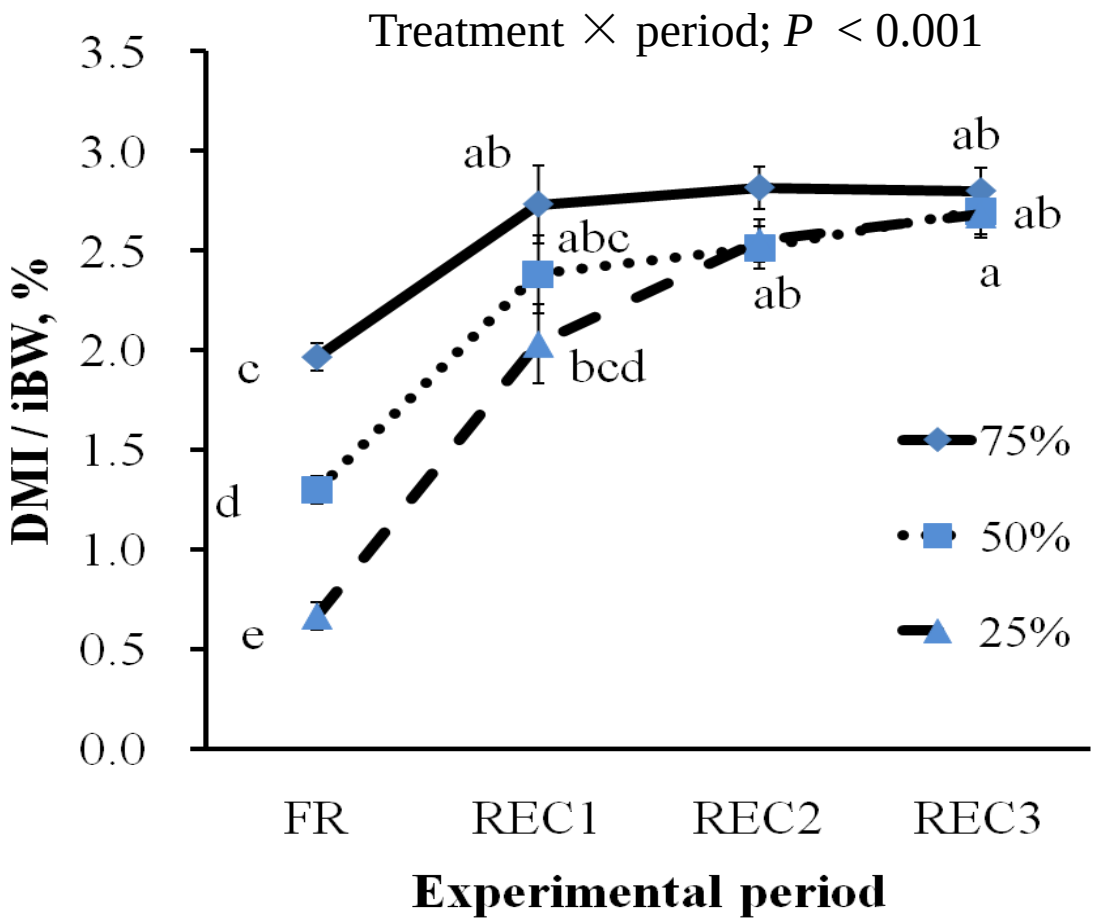
Supports results of Koch et al., 2019; PNAS

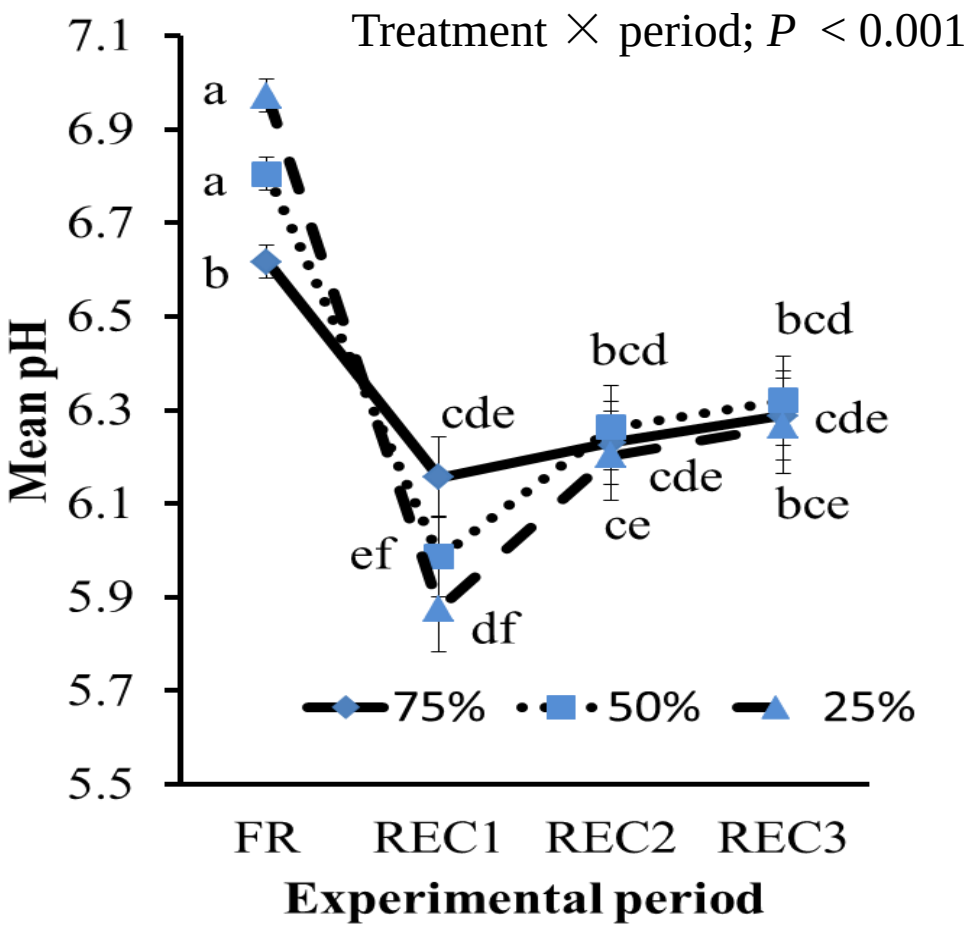
55-82% of total marker excretion was post-ruminal

Buffer (Ca/Mg carbonate) reduced intestinal permeability by 27%

Zhang et al., 2013; JAS

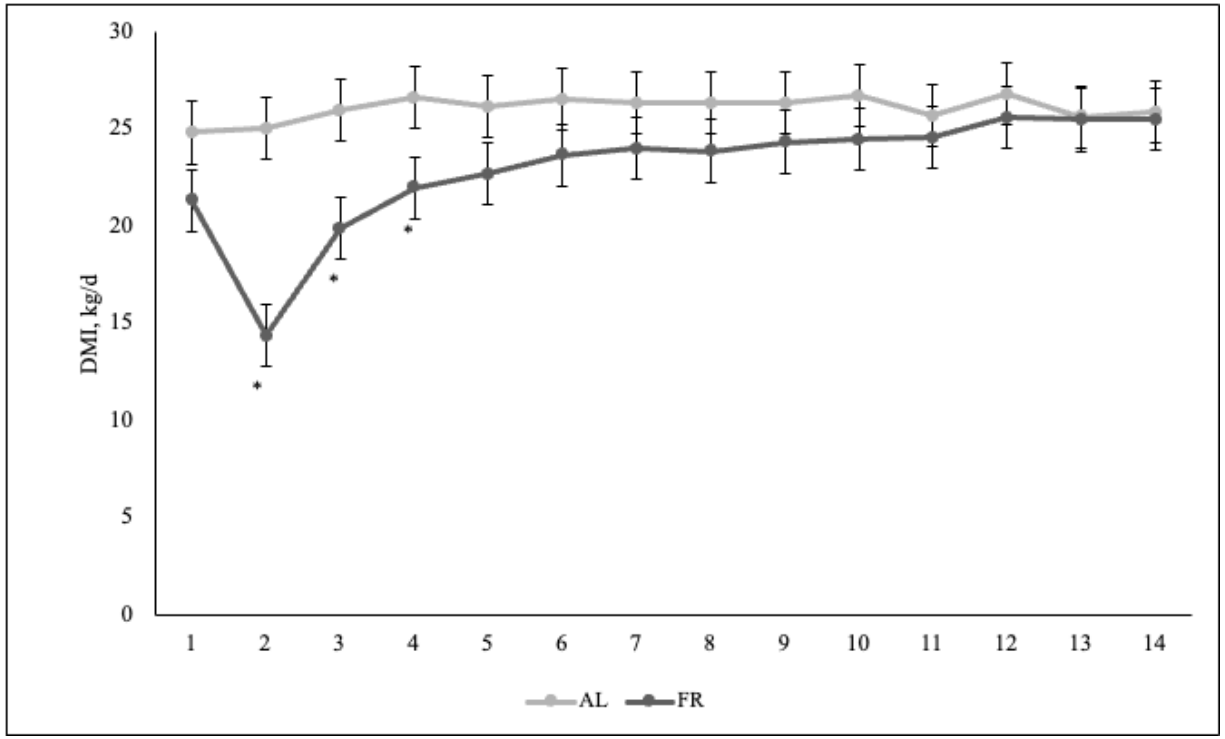
Ad libitum feeding after low feed intake induces low ruminal pH

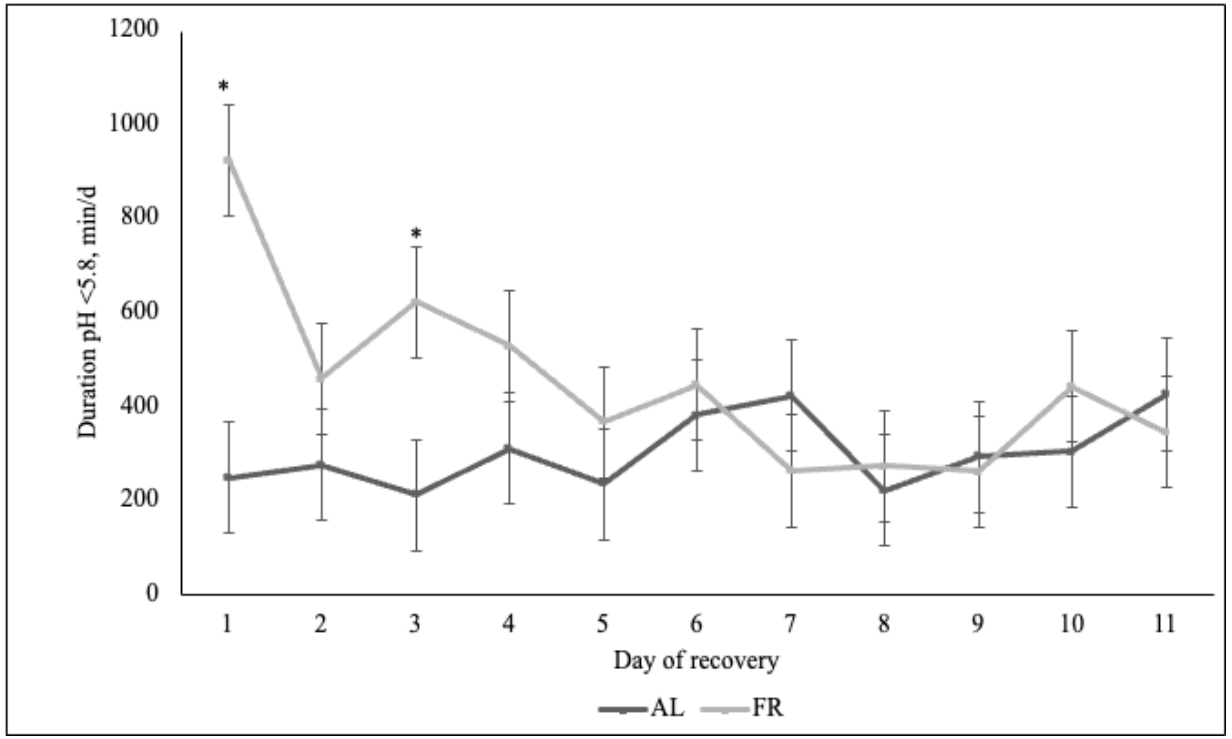




Bertens et al. unpublished

Ad libitum feeding after low feed intake induces low ruminal pH

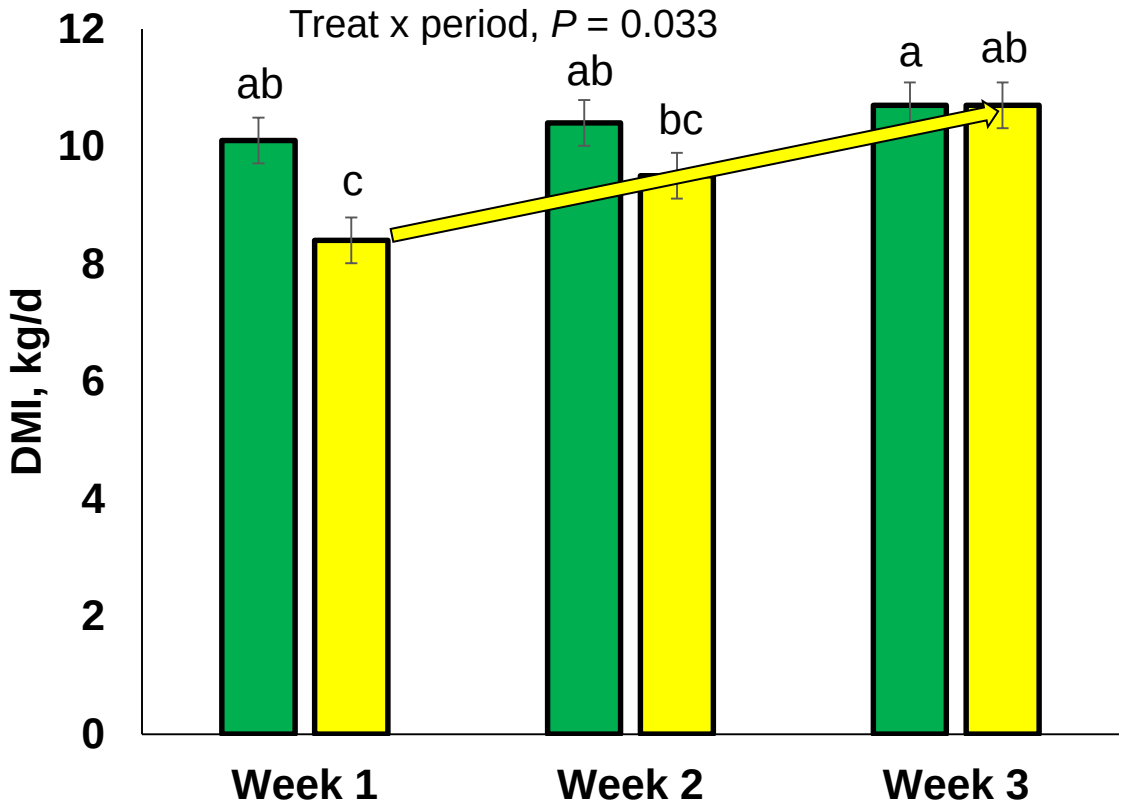


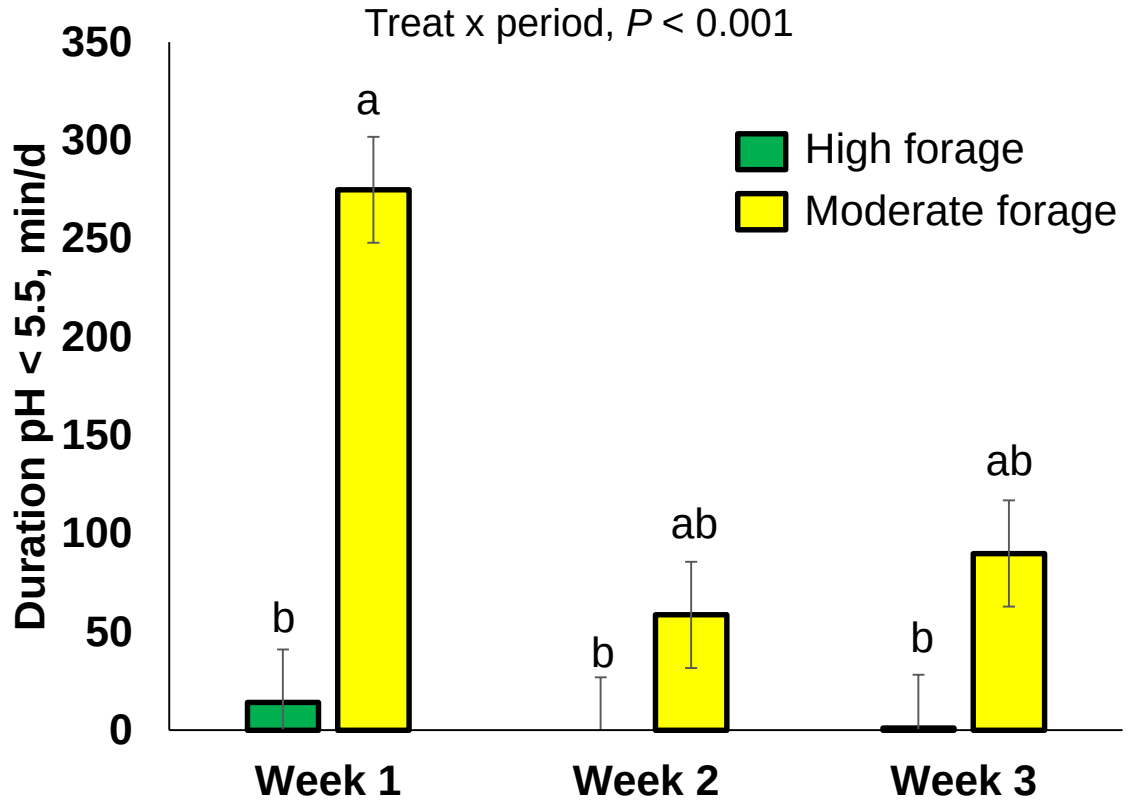


Responses for dairy cattle after being exposed to a 60% reduction in DMI for 5 d

Albornoz et al., 2013; JAS

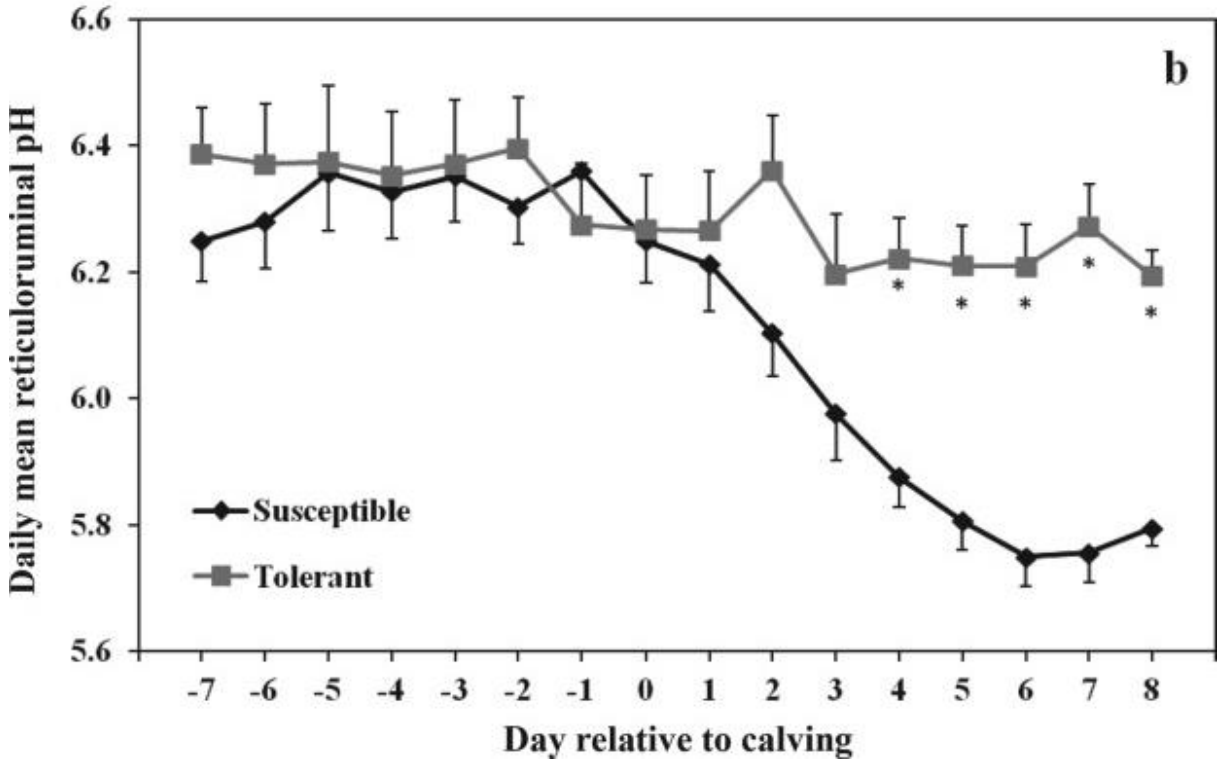
Short-term feeding of a high-forage diet reduces risk for low pH

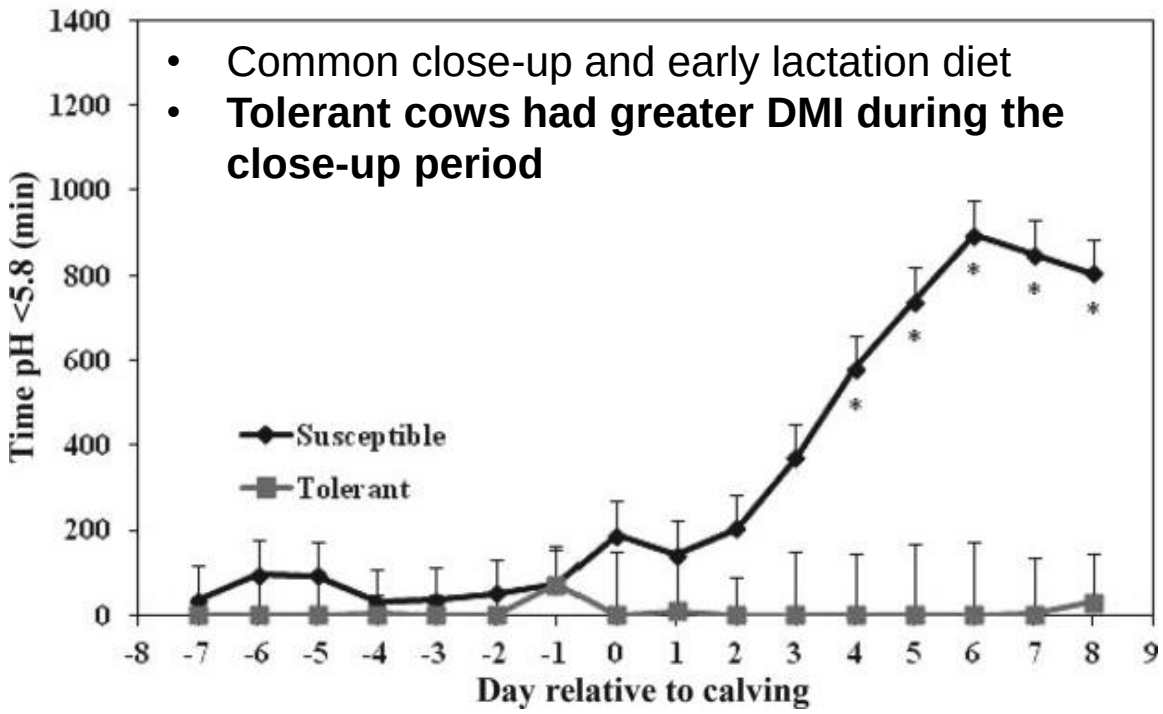




Support for the theory: Low reticulo-ruminal pH in early lactation

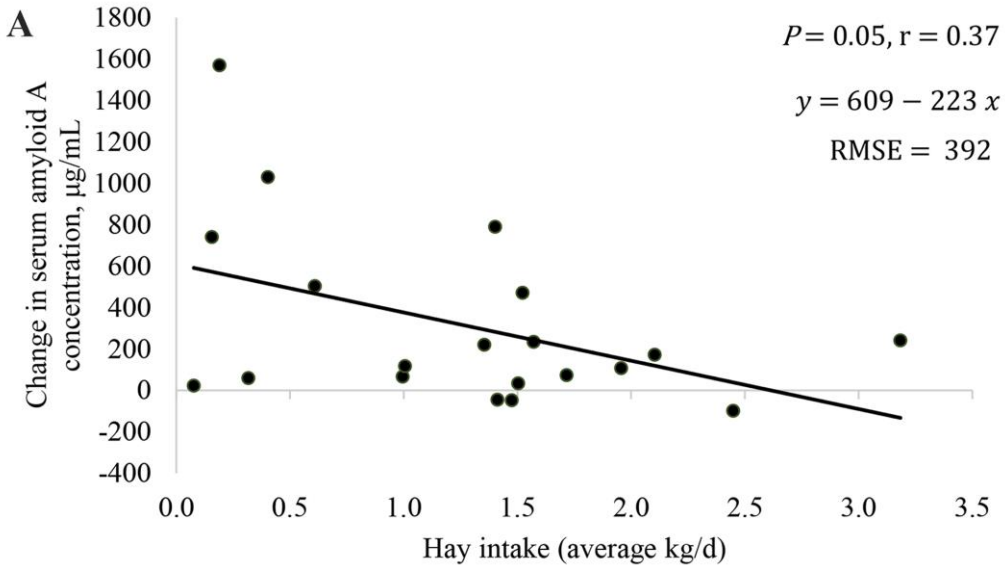
Humer et al., 2015; J. Dairy Sci.

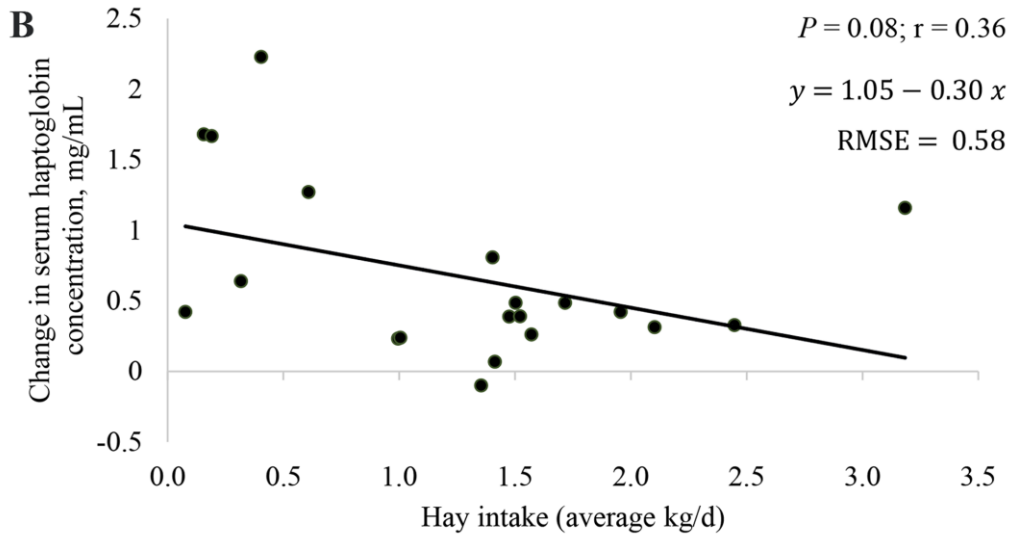


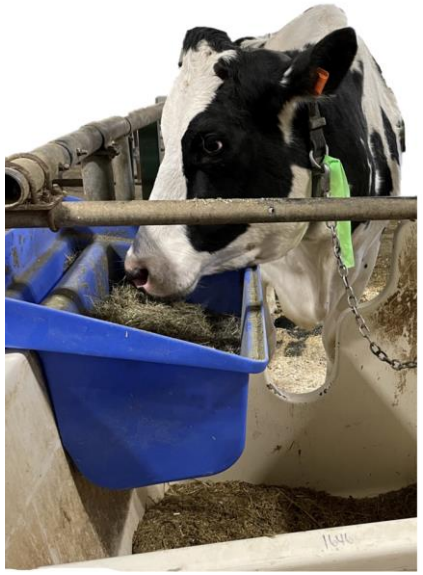


- Common close-up and early lactation diet
- **Tolerant cows had greater DMI during the close-up period**

Provision of free-choice forage post-calving reduced indicators of inflammation – ruminal acidosis?



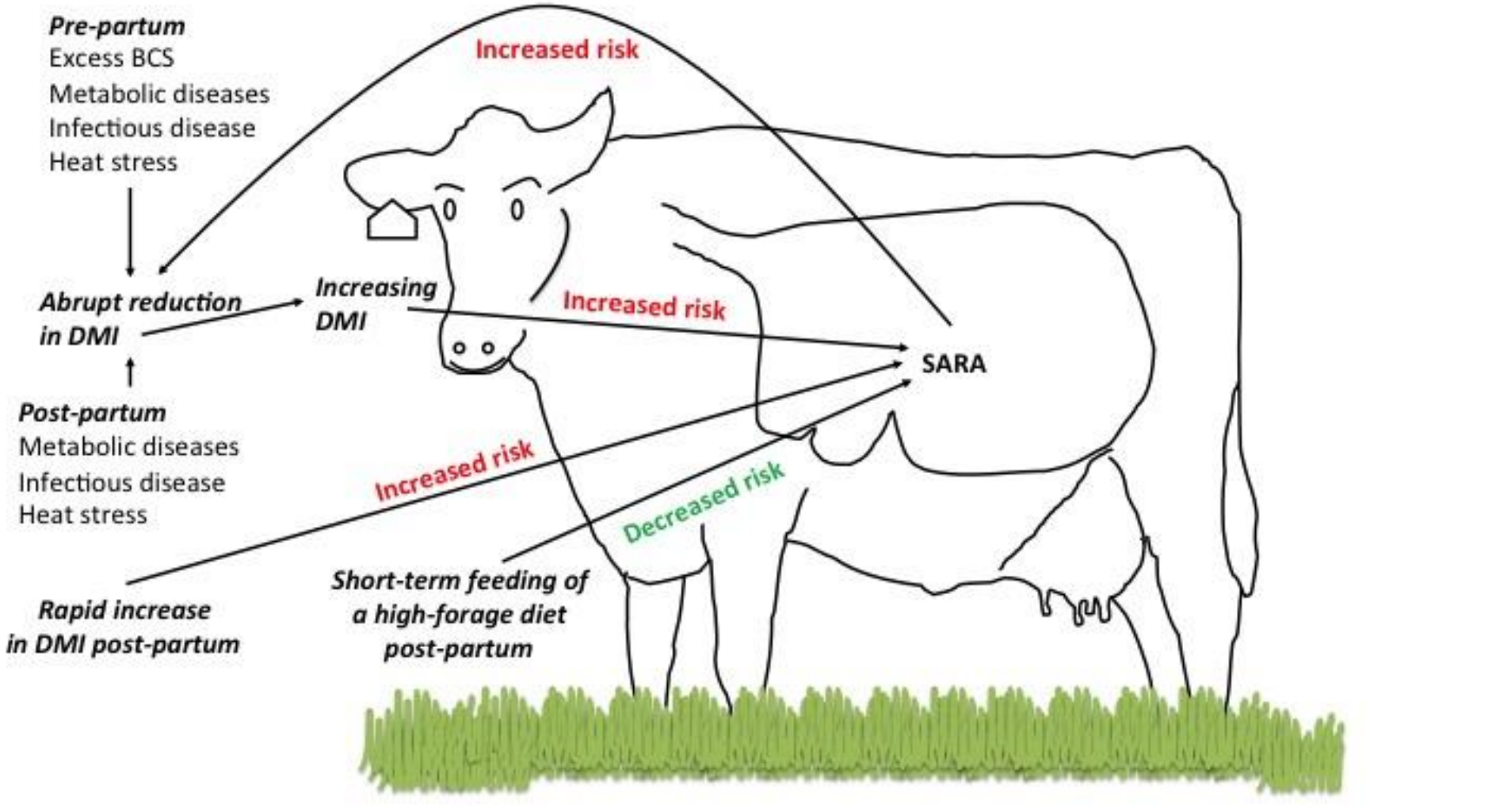




Engelking and Oba, 2024; JDS

Penner, 2019

Transient low DMI as an alternate cause for ruminal acidosis



Acknowledgements

BCRC Beef Cattle Research Council
Alberta Milk
Sask milk
ALMA Alberta Livestock and Meat Agency Ltd.
ACIDF Alberta Crop Industry Development Fund Ltd.
SaskBarley Development Commission
Saskatchewan Ministry of Agriculture
SaskCanola Saskatchewan Canola Development Commission
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