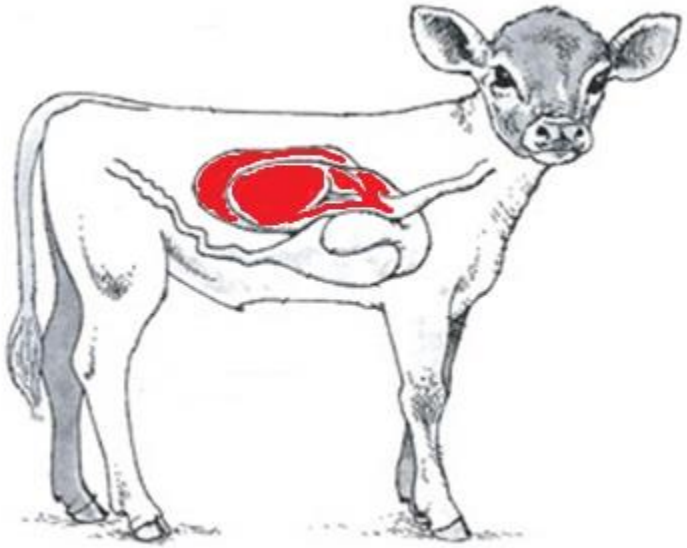
Is ruminal acidosis also a problem in calves?



Paweł Górka
Katedra Żywienia, Biotechnologii Zwierząt i Rybactwa
Uniwersytet Rolniczy im. Hugona Kołłątaja w Krakowie
pawel.gorka@urk.edu.pl

Presentation plan

1. Specificity of calves nutrition
2. pH in rumen of calves
3. Negative effects of subacute ruminal acidosis in calves
4. Prevention of subacute ruminal acidosis in calves
5. Acute ruminal acidosis in calves
6. Summary

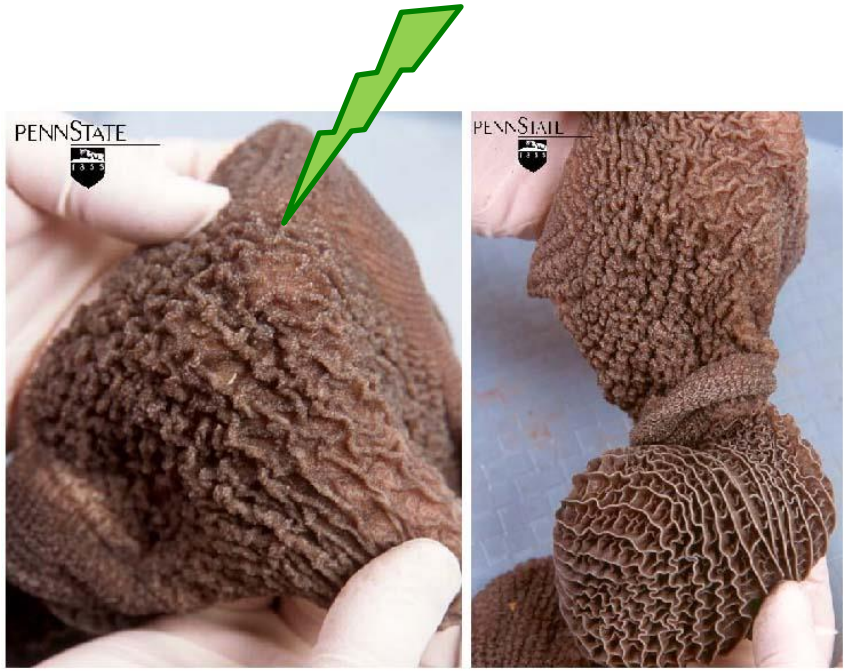
1. Specificity of calves nutrition

Specificity of calves nutrition

Specificity of calves nutrition

Mleko i siano

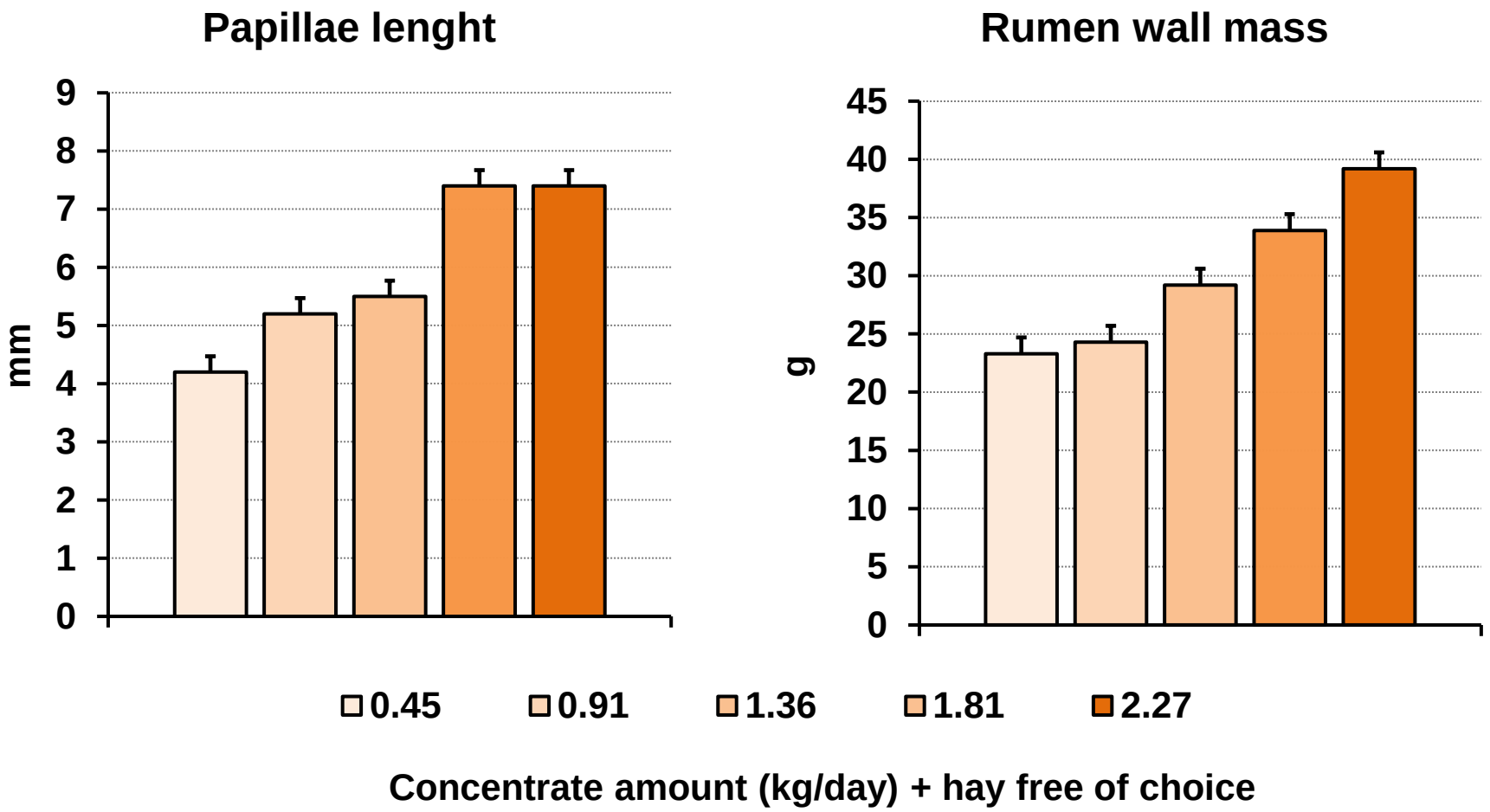
Pasze treściwe
Stymulacja rozwoju nabłonka żwacza



Mleko i ziarno

Źródło: http://www.das.psu.edu/research-extension/dairy/nutrition/calves/rumen

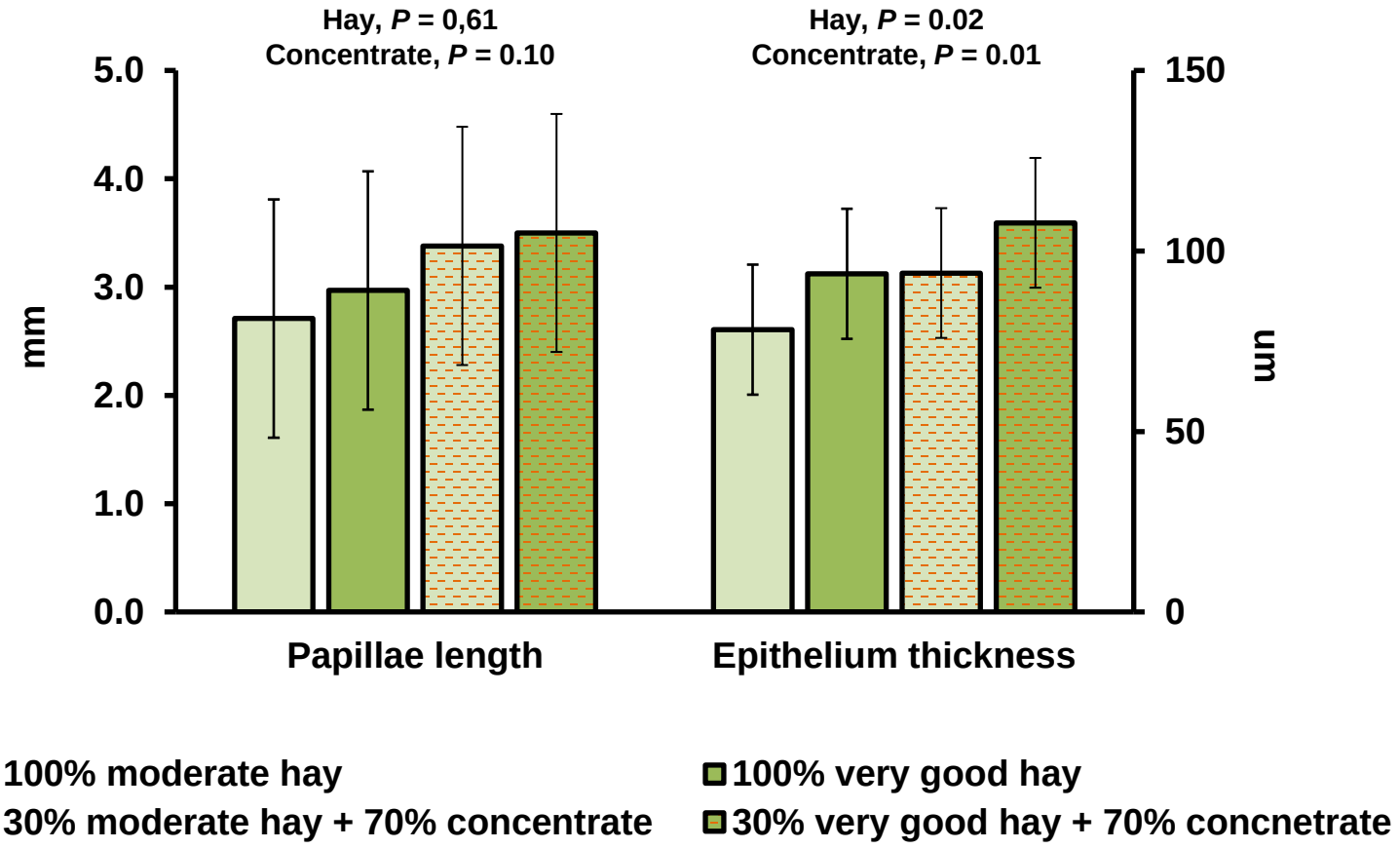
Diet and papillae development



*Rumen wall of 6 × 6 cm

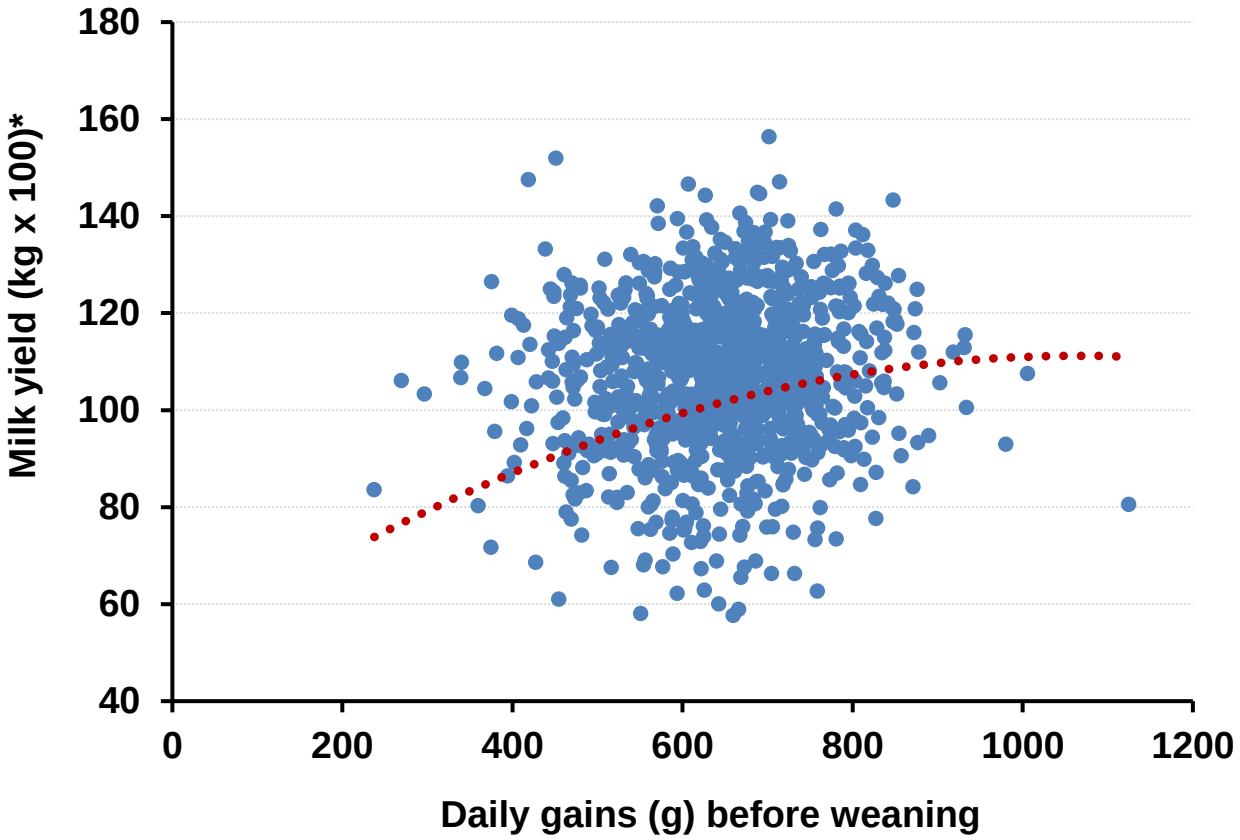
Stabo et al. (1996)

Diet and papillae development



Terler et al. (2023)

Daily gains and milk yield



*305-day milk yield in 1st lactation

Garus-Piętak et al. (unpublished)

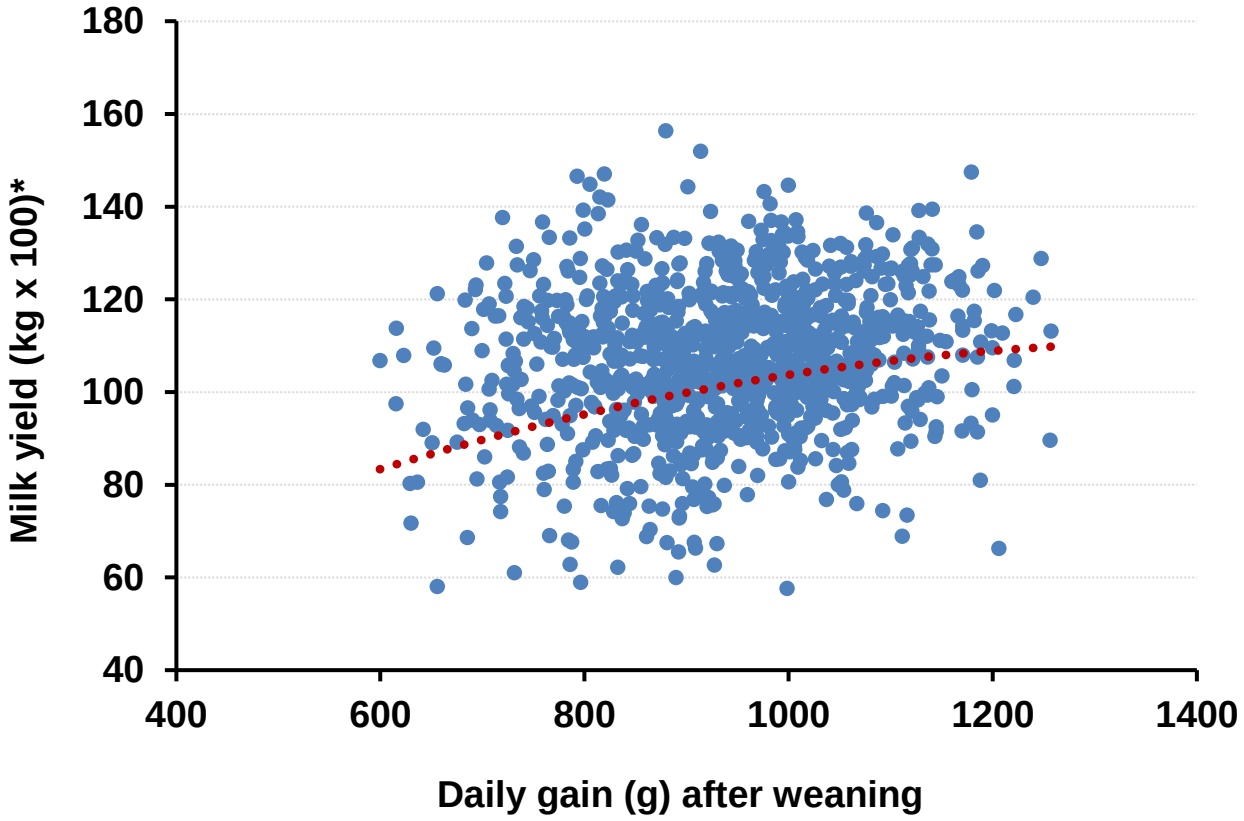
Effects of rearing and future milk yield

Analysis of 21 studies

- An increase of milk replacer intake of 100 g/day = **66.2 kg milk** more in 1st lactation
- An incerase of starter intake of 100 g/day = 50.4 kg milk more in 1st lactation
- An increase of dry matter inake (milk + starter) of 100 g/day = **128-138 kg milk** more in 1st lactation
- An increase of gain of 100 g/day = 130 kg milk more in 1st lactation

Gelsinger et al. (2016)

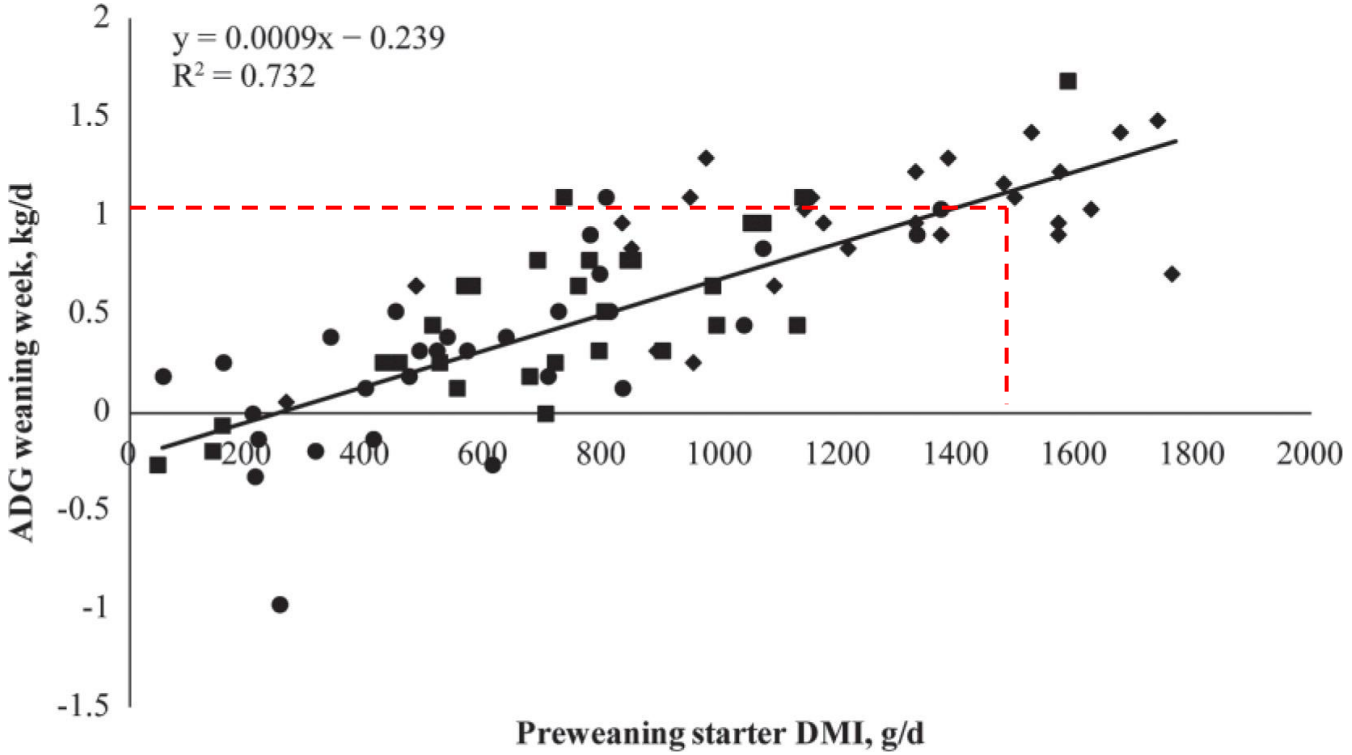
Daily gains and milk yield



*305-day milk yield in 1st lactation

Garus-Piętak et al. (unpublished)

Specificity of calves nutrition

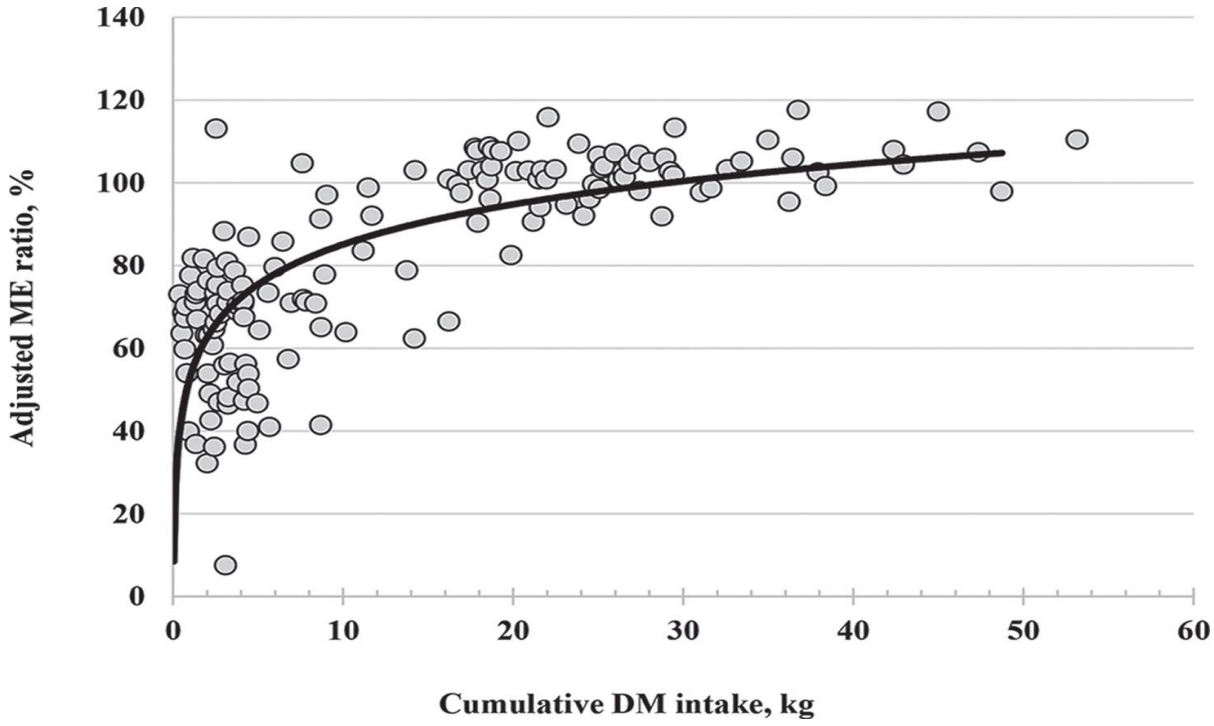


In oder to sustain gain of 1 kg/day after weaning calf has to consume at least 1.5 kg of starter feed/day !!!

Stamey et al. (2012)

Starter intake before weaning

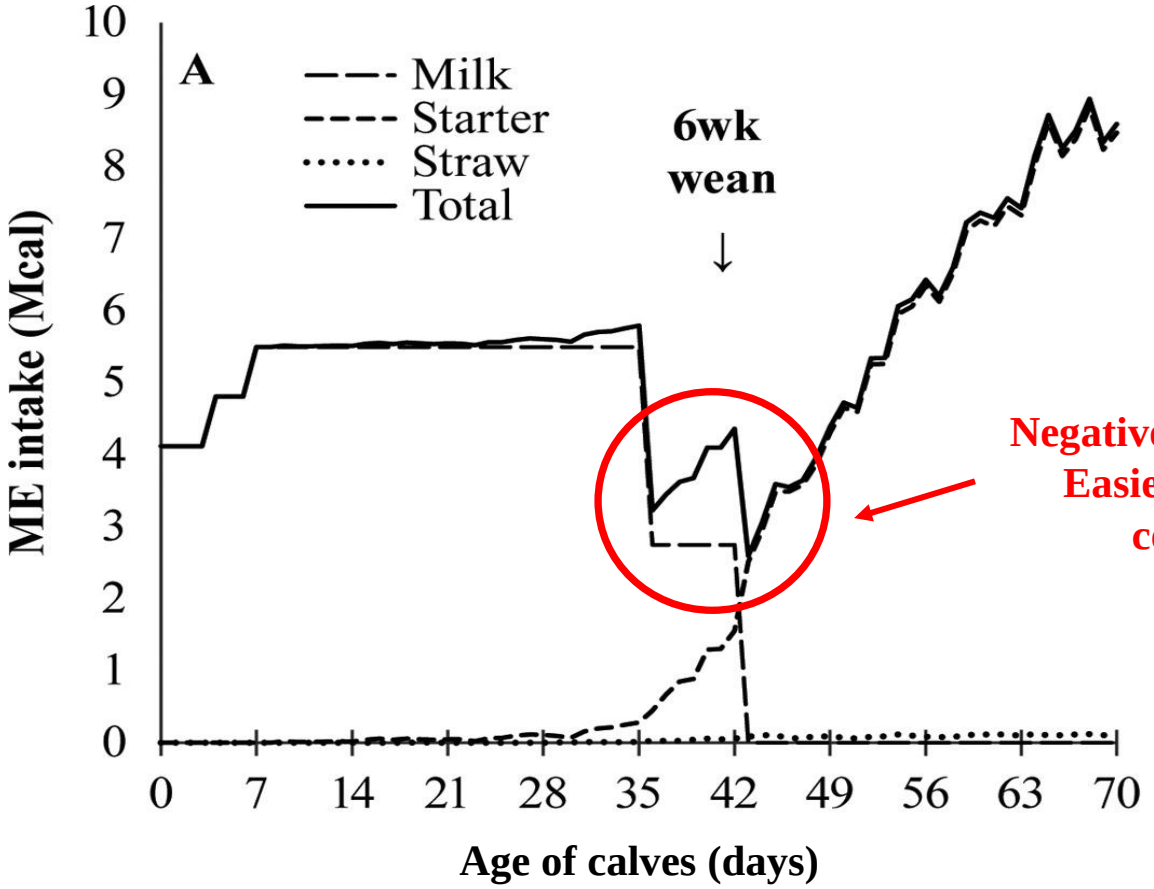
Effect on feed efficiency



Calf should consume 30 kg of starter before weaning in order to use this feed efficiently

Quigley et al. (2019)

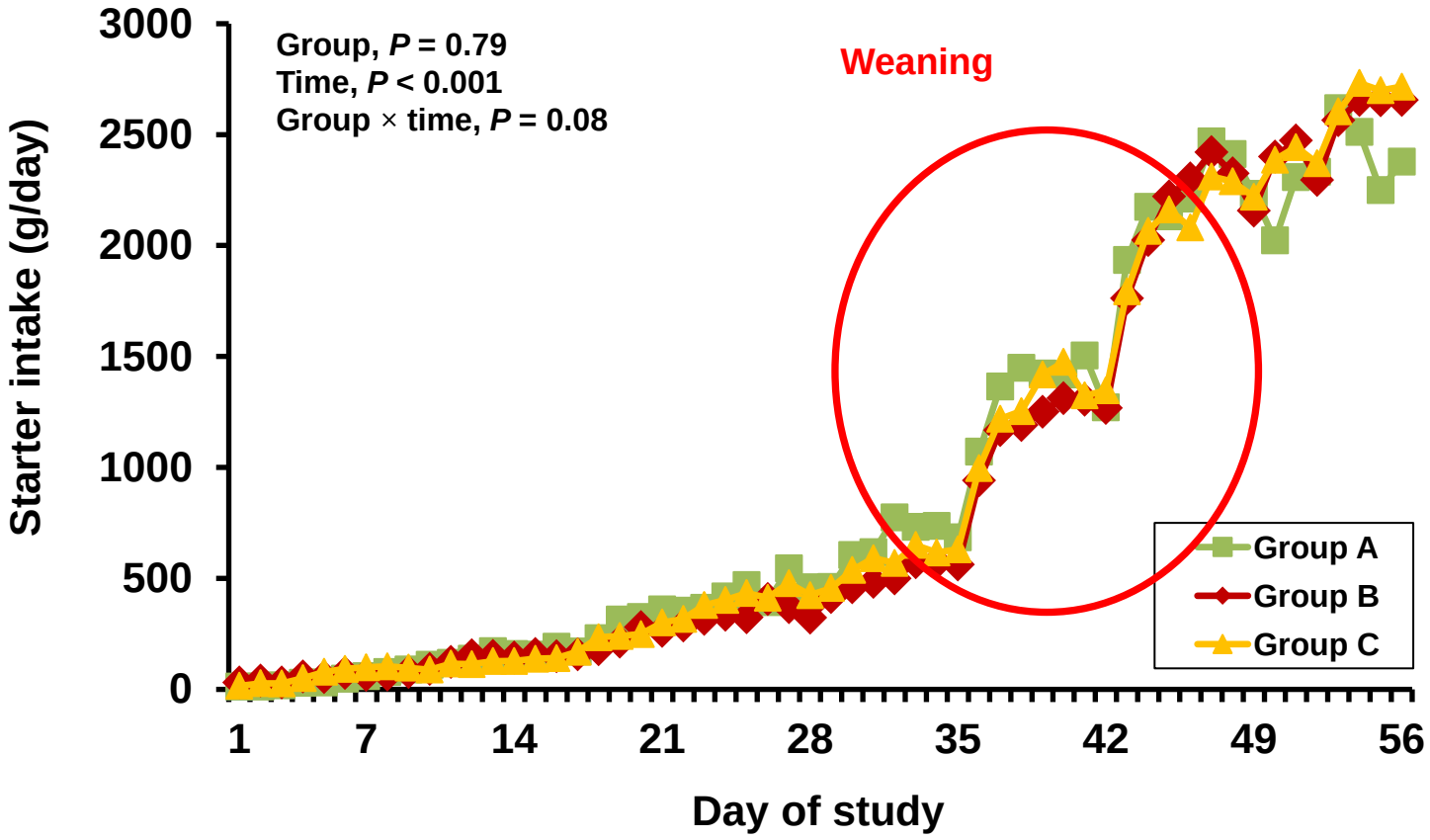
Specificity of calves nutrition



Negative energy balance; Easiest to cover by concentrate

Eckert et al. (2015)

Specificity of calves nutrition



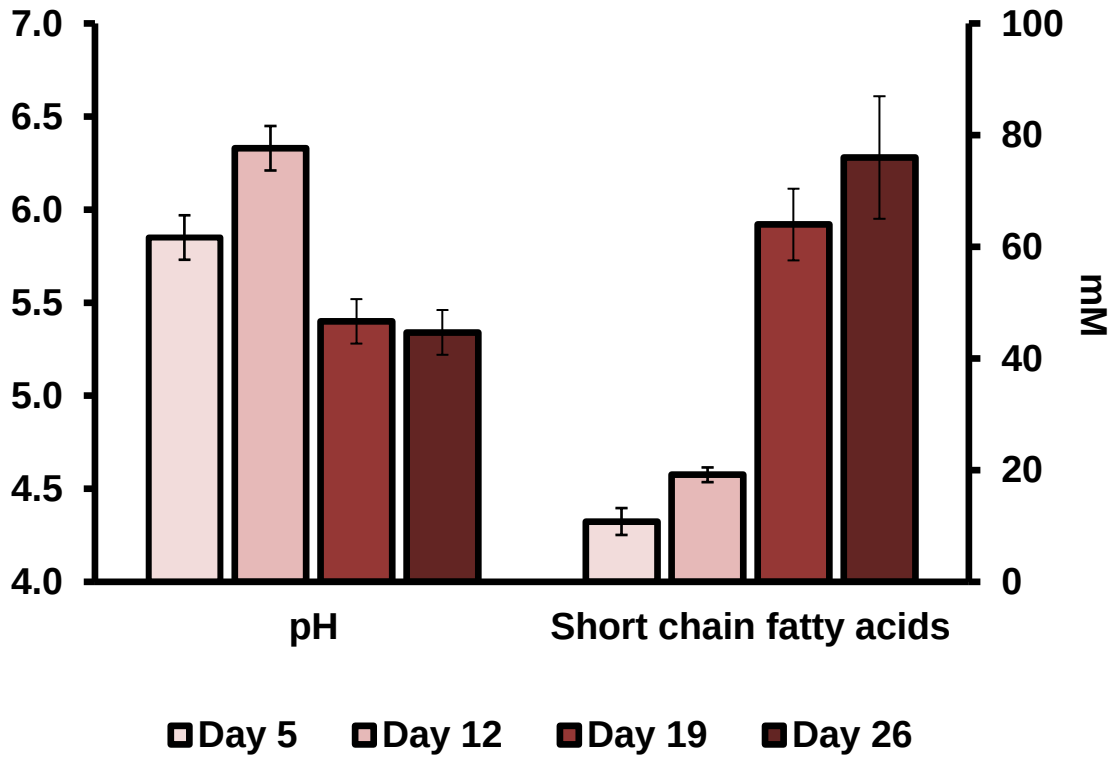
Hadam et al. (2016)

Specificity of calves nutrition

Excessive concentrate intake is considered as the main factor contributing to subacute or acute ruminal acodisis

2. pH in rumen of calves

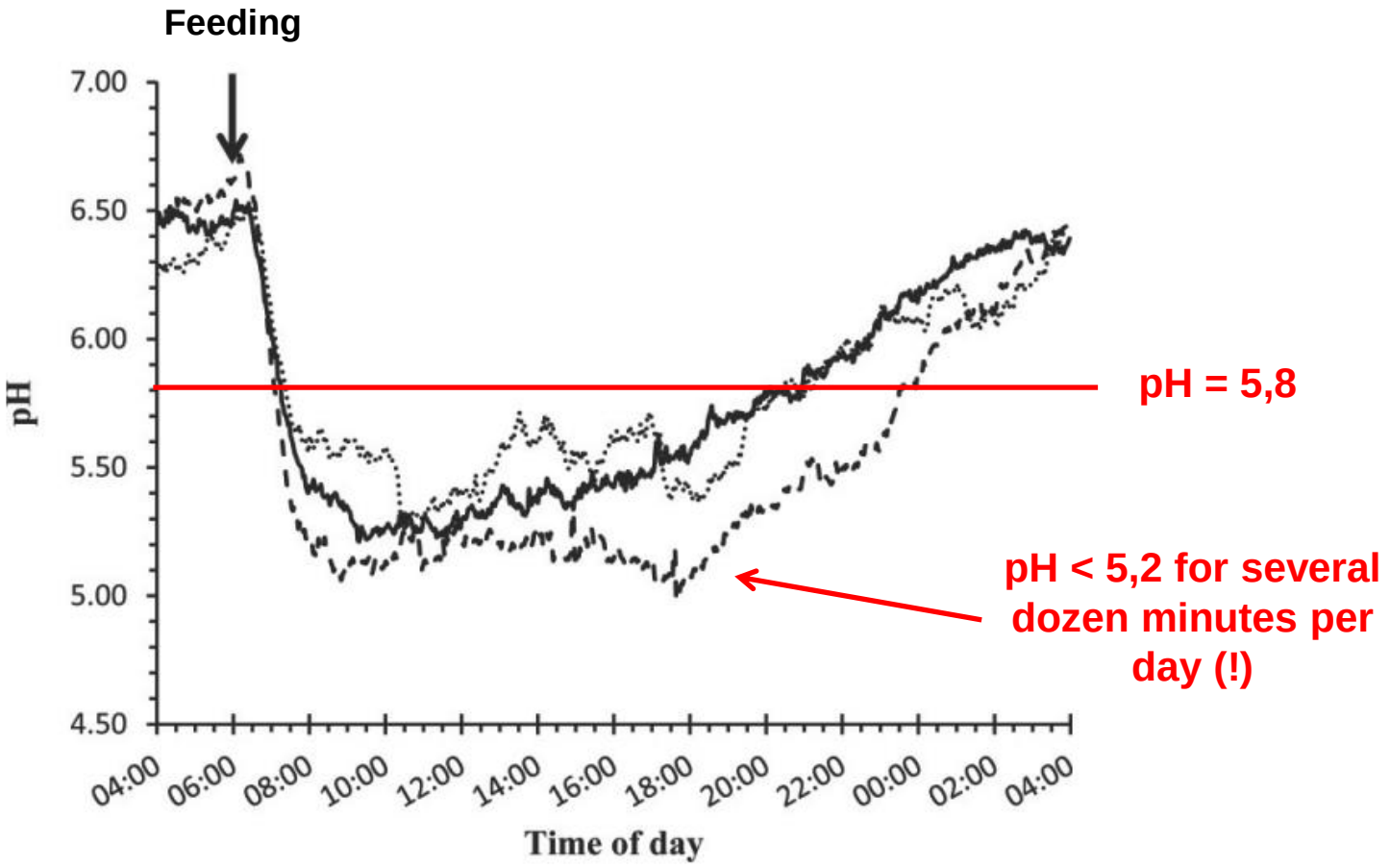
pH in rumen of calves



Flaga et al. (2015)

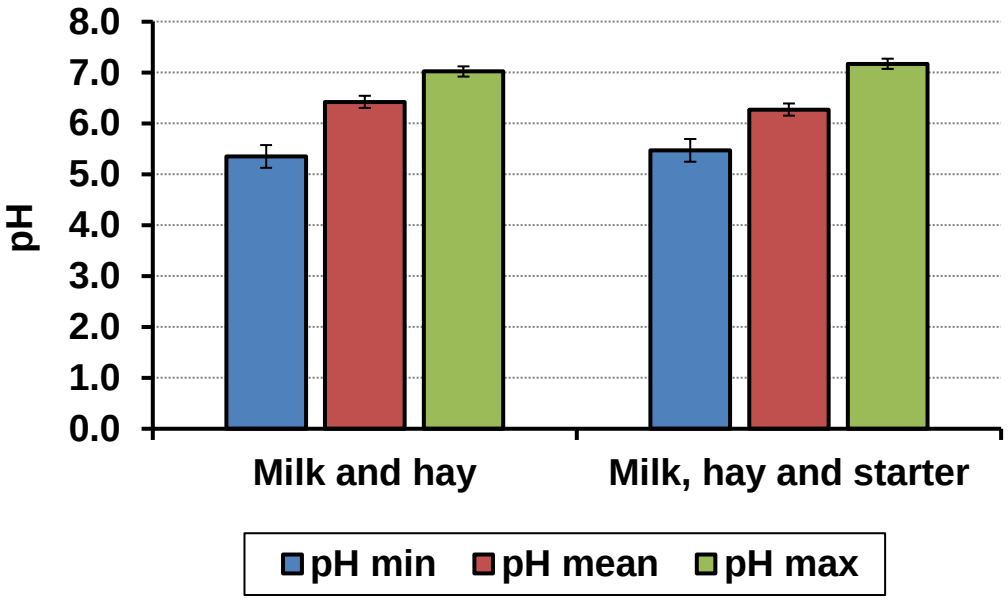
pH in rumen of calves

Problem of acidosis in calves



Laarman et al. (2012)

pH in rumen of calves



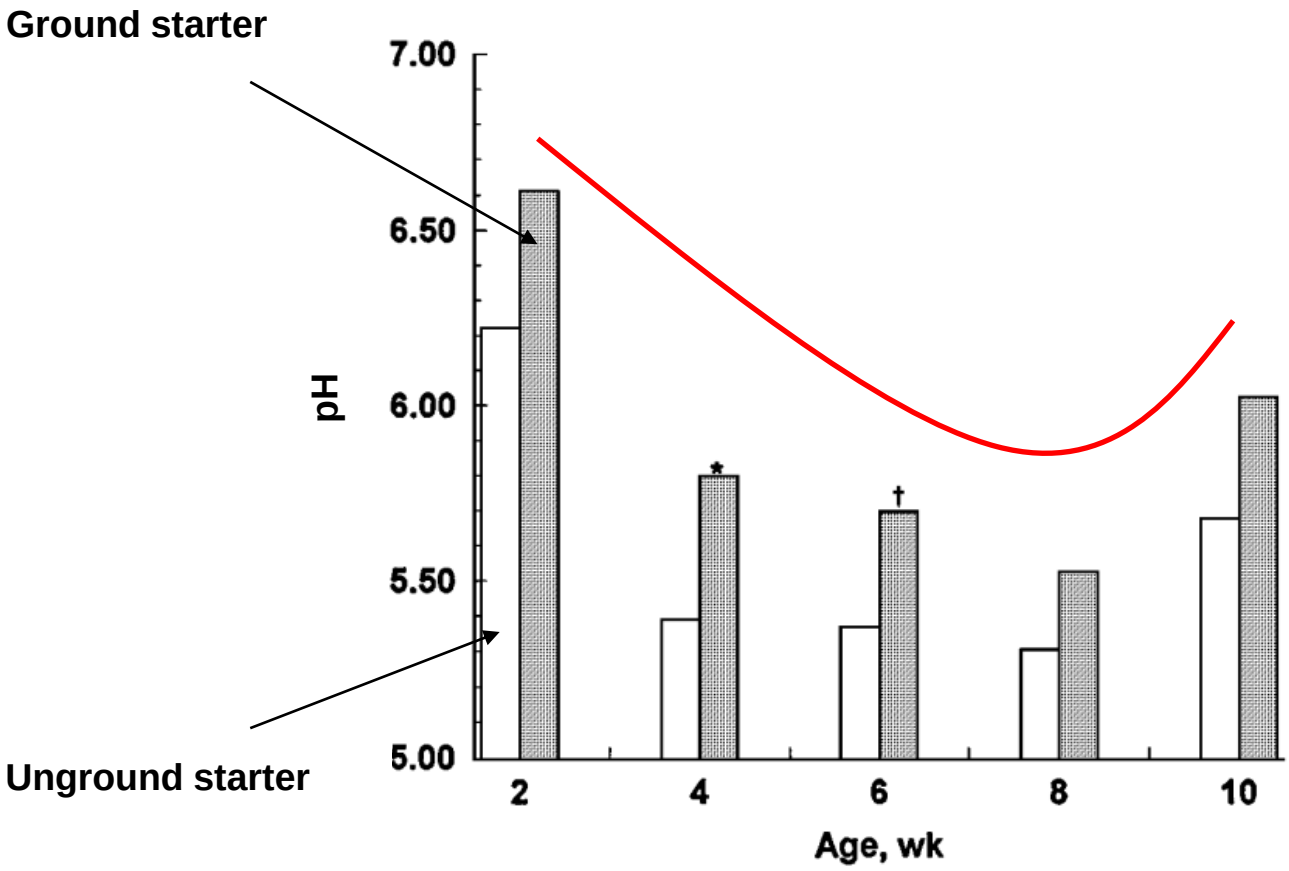
Żywienie izoenergetyczne cieląt:

- Group „hay”: 1443 g of milk replacer i 229 g hay/day during measurements
- Group „starter”: 750 g of milk replacer, 344 g hay i 759 g starter/day during measurments

Laarman and Oba (2011)

pH in rumen of calves

Observations similar across several studies

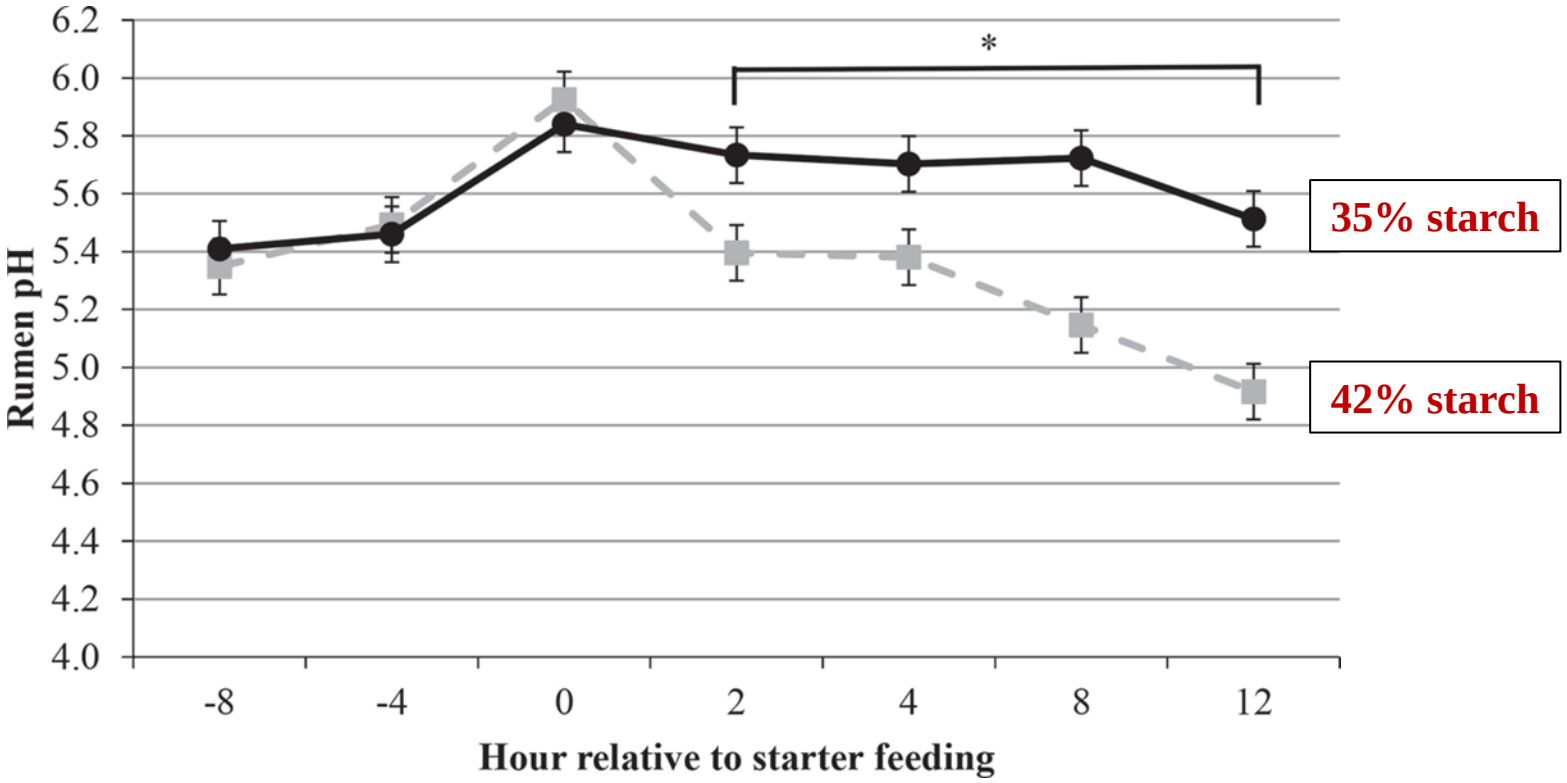


Beharka i wsp. (1998)

Is low rumen pH in calves something that can be considered normal?

https://www.sciencefocus.com/the-human-body/why-do-people-scratch-their-heads-when-confused

pH in rumen of calves



Gelsinger et al. (2020)

pH in rumen of calves

Chopped oat straw (≈ 2 cm)
Intake ≈ 150 g/day

Castells et al. (2013)

pH of rumen in calves is low or very low (< 5.5)

Although there is no clear definition, ruminal fluid pH below 5.6 for 3 hours or below 5.8 for 5-6 hours is considered subacute ruminal acidosis

Subacute ruminal acidosis

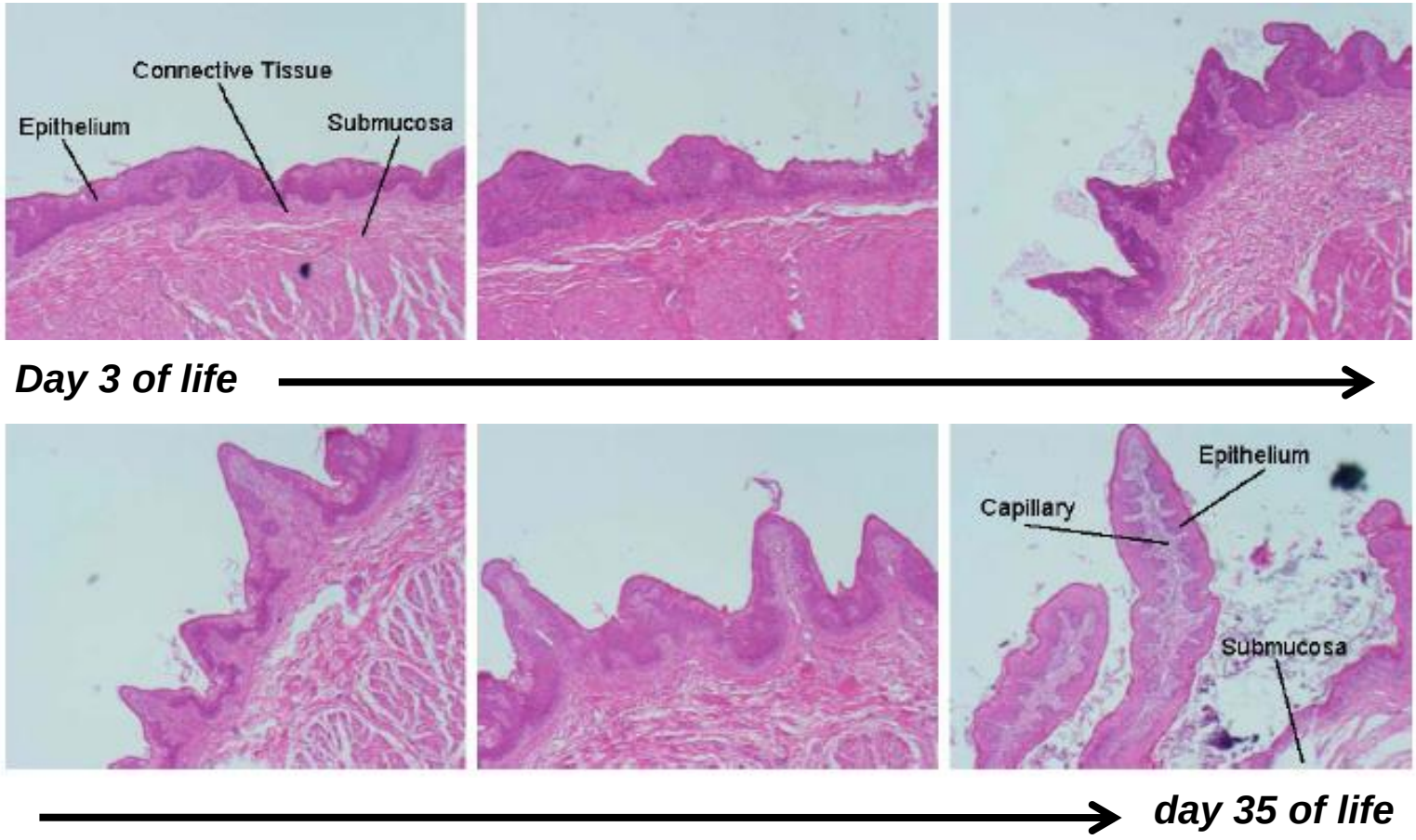
http://www.biomin.net/at/artikel/tackling-acidosis-and-the-dangers-of-sara/

pH of rumen in calves

Depends on:

- Effectivenes of short chain fatty acids absroption (removal of H^+ from rumen)
- Saliva production (buffering of rumen fluid)
- Passage of digesta to lower regions of the gastrointestinal tract (removal of H^+ from rumen)

Rumen papillae development

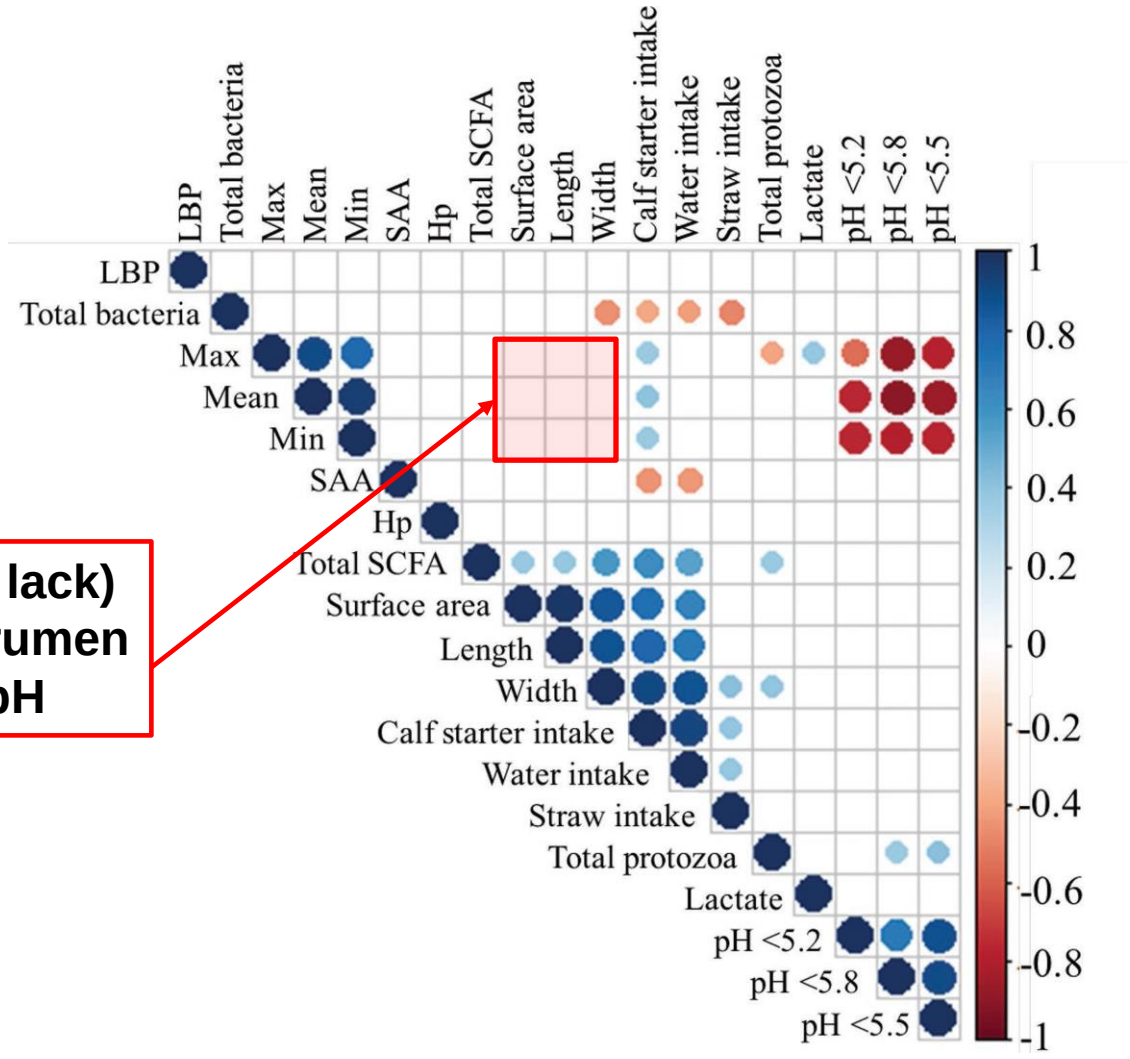


Heinrichs (2005)

Slajd z rozwojem brodawek po odsadzeniu obrazujący, że w tym okresie jest on intensywniejszy (przyspiesza zdecydowanie)

Rumen epithelium development

Weak correlation (or its lack) between parameters of rumen papillae and rumen pH



von Niekerk et al. (2021)

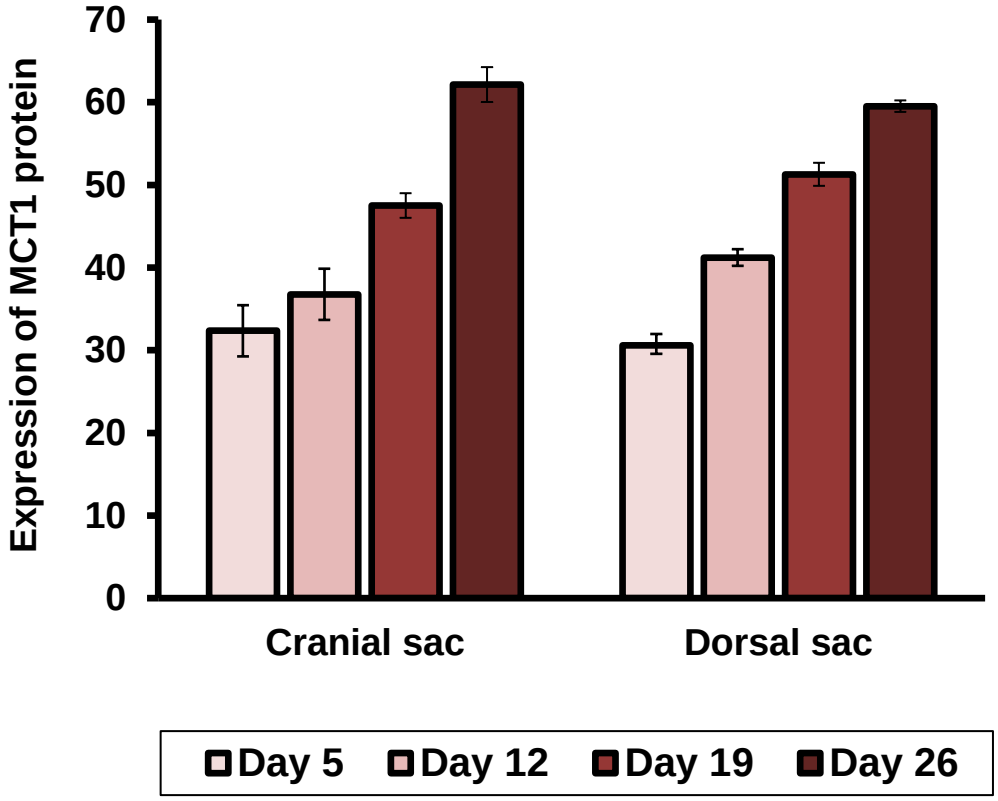
Rumen epithelium development

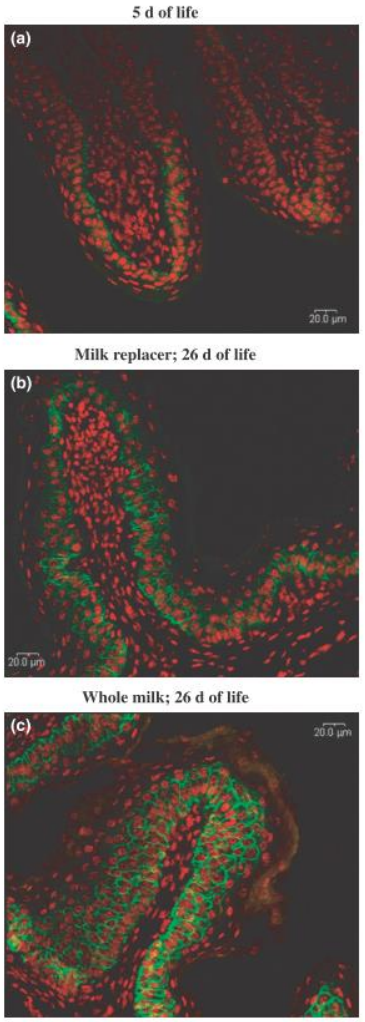
Variables[2]	Min	Mean	Max	Min < 6.0	Min < 5.6	Mag	Min 0.5	Min 0.3	AUC 0.5	AUC 0.3
Min										
Mean	0.86									
Max	0.57	0.88								
Min < 6.0	-0.67	-0.89	-0.86							
Min < 5.6	-0.82	-0.82	-0.58	0.75						
Mag	-0.36	0.14	0.56	-0.30	0.18					
Min 0.5	-0.42	-0.25	-0.14	0.09	0.43	0.30				
Min 0.3	-0.39	-0.27	-0.18	0.17	0.46	0.25	0.95			
AUC 0.5	-0.42	-0.33	-0.22	0.15	0.44	0.21	0.89	0.76		
AUC 0.3	-0.45	-0.32	-0.21	0.15	0.46	0.24	0.95	0.85	0.99	
Full RR	0.06	-0.10	-0.21	0.07	-0.18	-0.34	-0.22	-0.14	-0.14	-0.16
Full RR %	0.09	-0.10	-0.22	0.11	-0.14	-0.39	-0.23	-0.16	-0.13	-0.15
Emp RR	-0.08	-0.18	-0.21	0.14	-0.01	-0.20	-0.20	-0.15	-0.06	-0.10
Emp RR %	-0.09	-0.21	-0.23	0.21	0.06	-0.24	-0.22	-0.18	-0.04	-0.09
REL	0.25	0.24	0.17	-0.20	-0.28	-0.06	-0.22	-0.23	-0.15	-0.17
RCKL	0.20	0.14	0.03	-0.04	-0.15	-0.16	-0.08	-0.03	-0.18	-0.15
RML	0.42	0.37	0.31	-0.27	-0.35	-0.11	-0.10	-0.05	-0.17	-0.15
RSL	0.07	0.05	0.03	-0.14	-0.10	-0.03	-0.20	-0.18	-0.23	-0.23
RPL	-0.05	-0.18	-0.17	0.19	0.14	-0.18	-0.14	-0.05	-0.01	-0.04
RPW	-0.23	-0.22	-0.07	0.21	0.24	0.09	0.01	0.01	0.19	0.14
RPA	0.42	-0.20	-0.18	0.22	0.17	-0.16	-0.10	-0.02	0.05	0.01

Weak correlation (or its lack) between parameters of rumen papillae and rumen pH

Yohe et al. (2022)

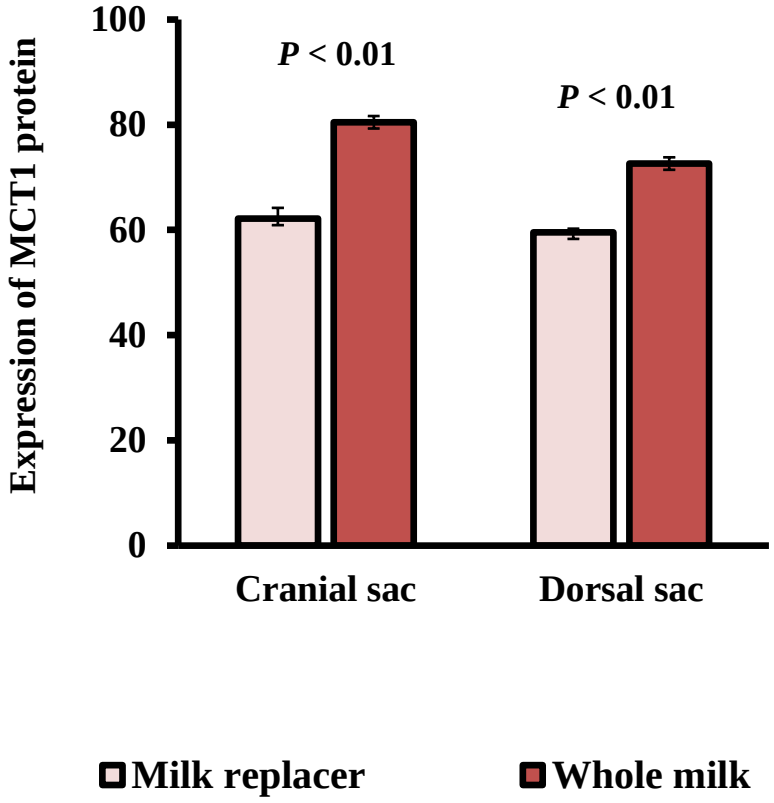
Absorption of short chain fatty acids





Flaga et al. (2015)

Absorption of short chain fatty acids

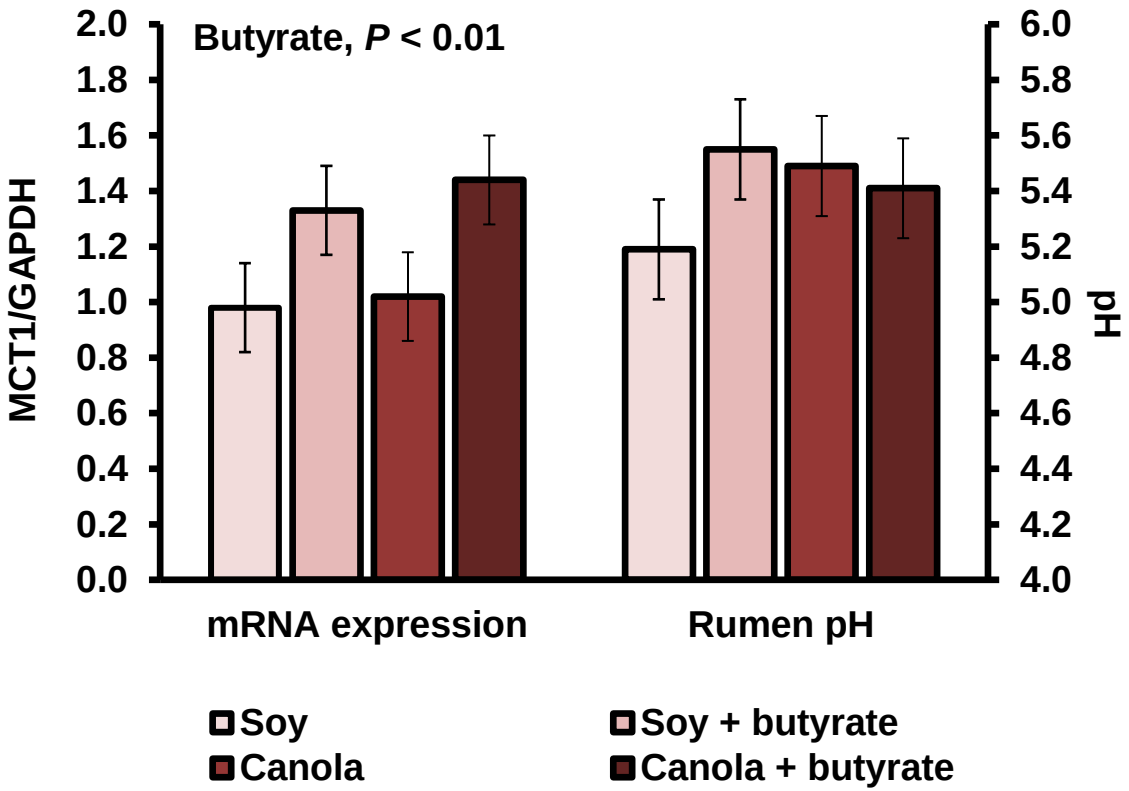


Most important results

- Higher cocnetration of short chani fatty aicids in rumen for calves fed milk replacer
- Lonter papillae for calves fed whole milk
- Lack of difference for ruminal pH

Górka et al. (2011), Flaga et al. (2015)

Absorption of short chain fatty acids



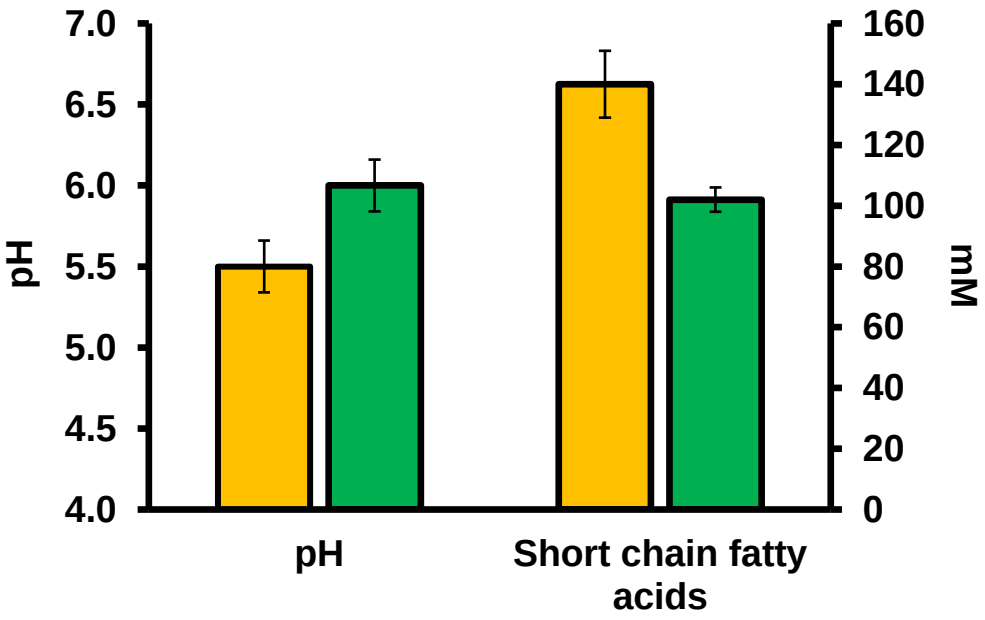
Burakowska et al. (2021)

Rumen papillae development

Fot. Kowalski et al.

Motility development

Motility development



Chopped oat straw (≈ 2 cm)
Intake ≈ 150 g/day

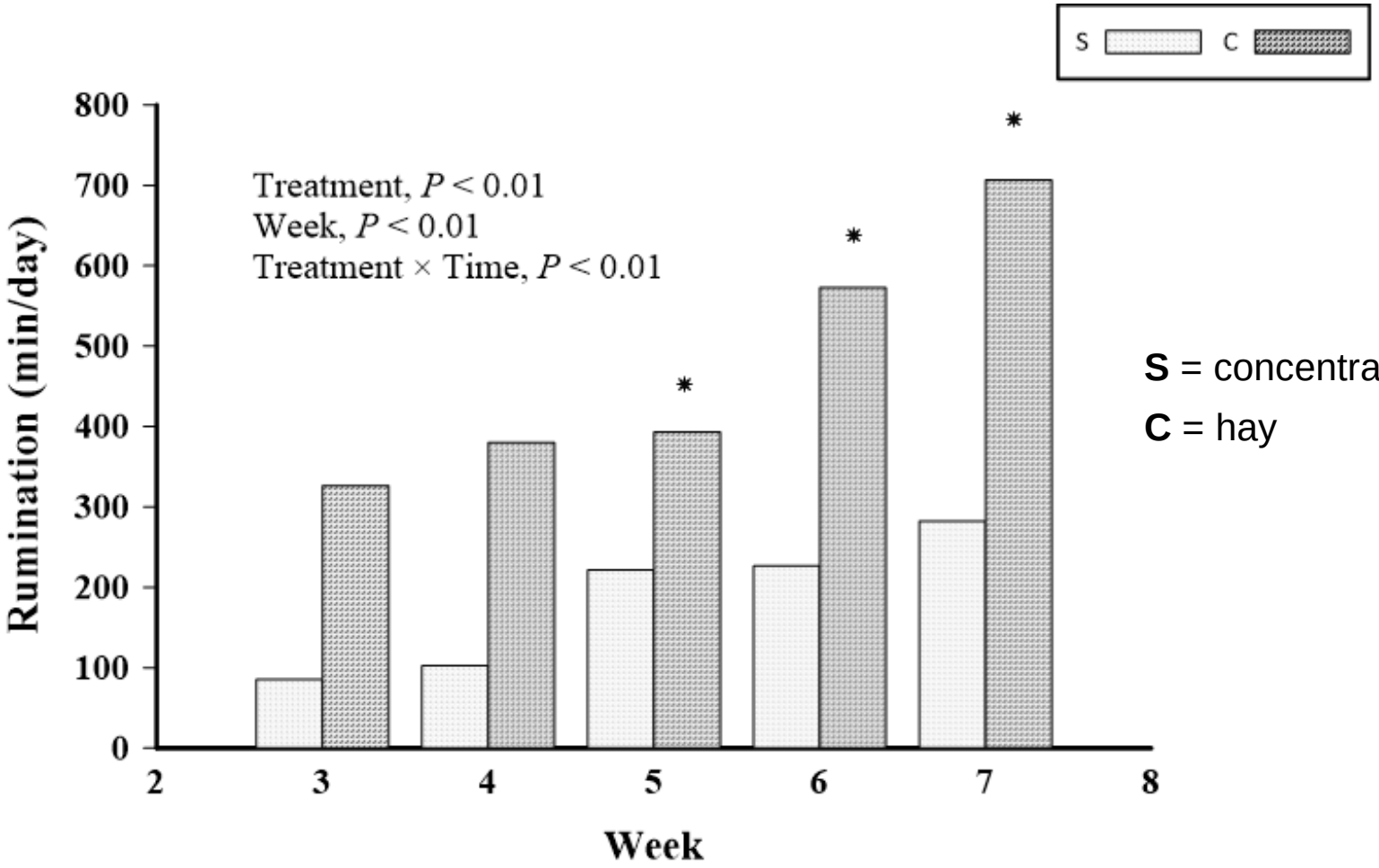
Chopped straw in diet:

- Longer rumination time
- Faster digesta passage
- Higher MCT1 expression
- Higher daily gains

Castells et al. (2013)

Dodać jeszcze jedne wyniki badań z sianem
aby uwiarygodnić ten efekt

Rumination time

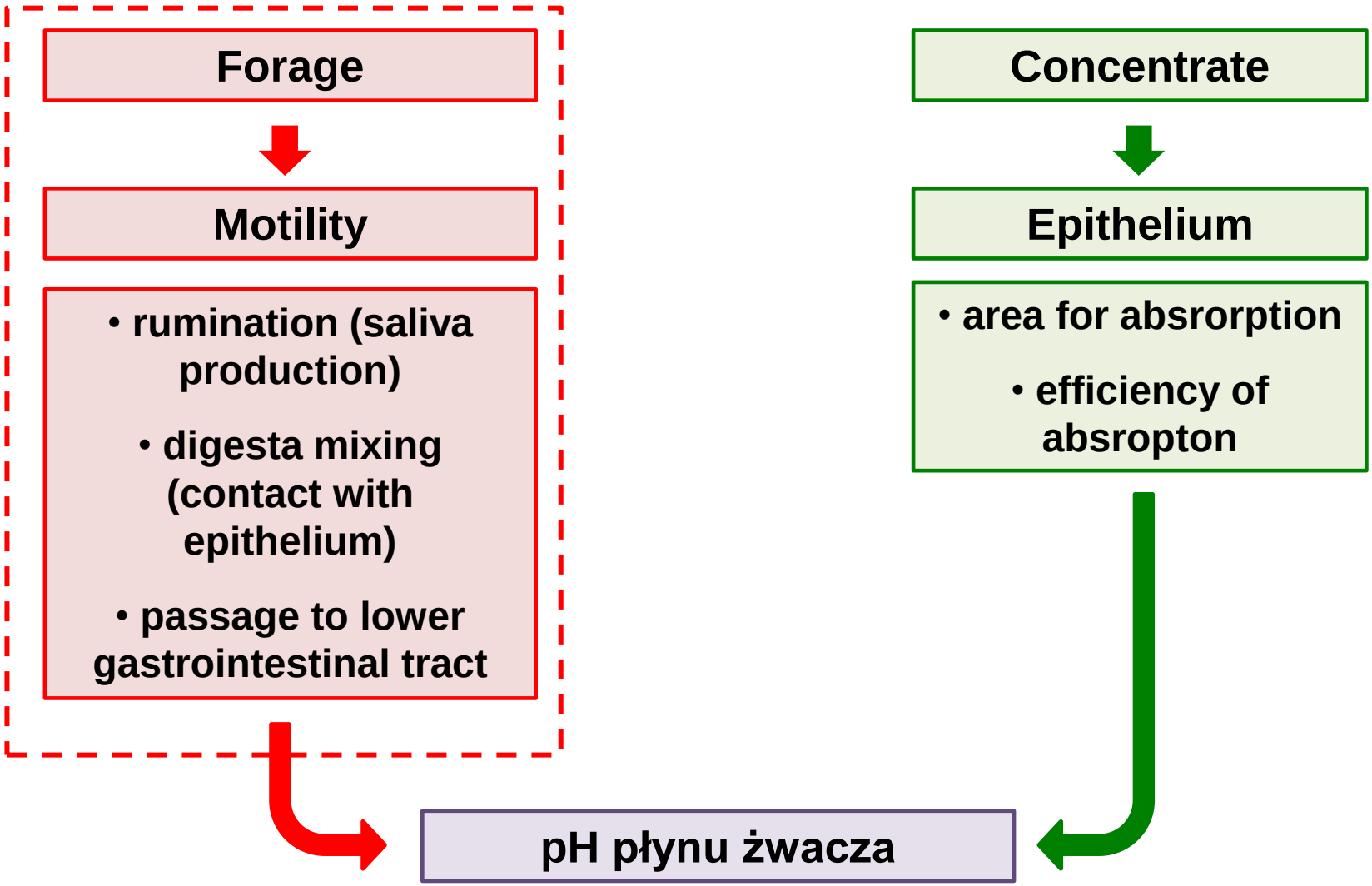


S = concentrate

C = hay

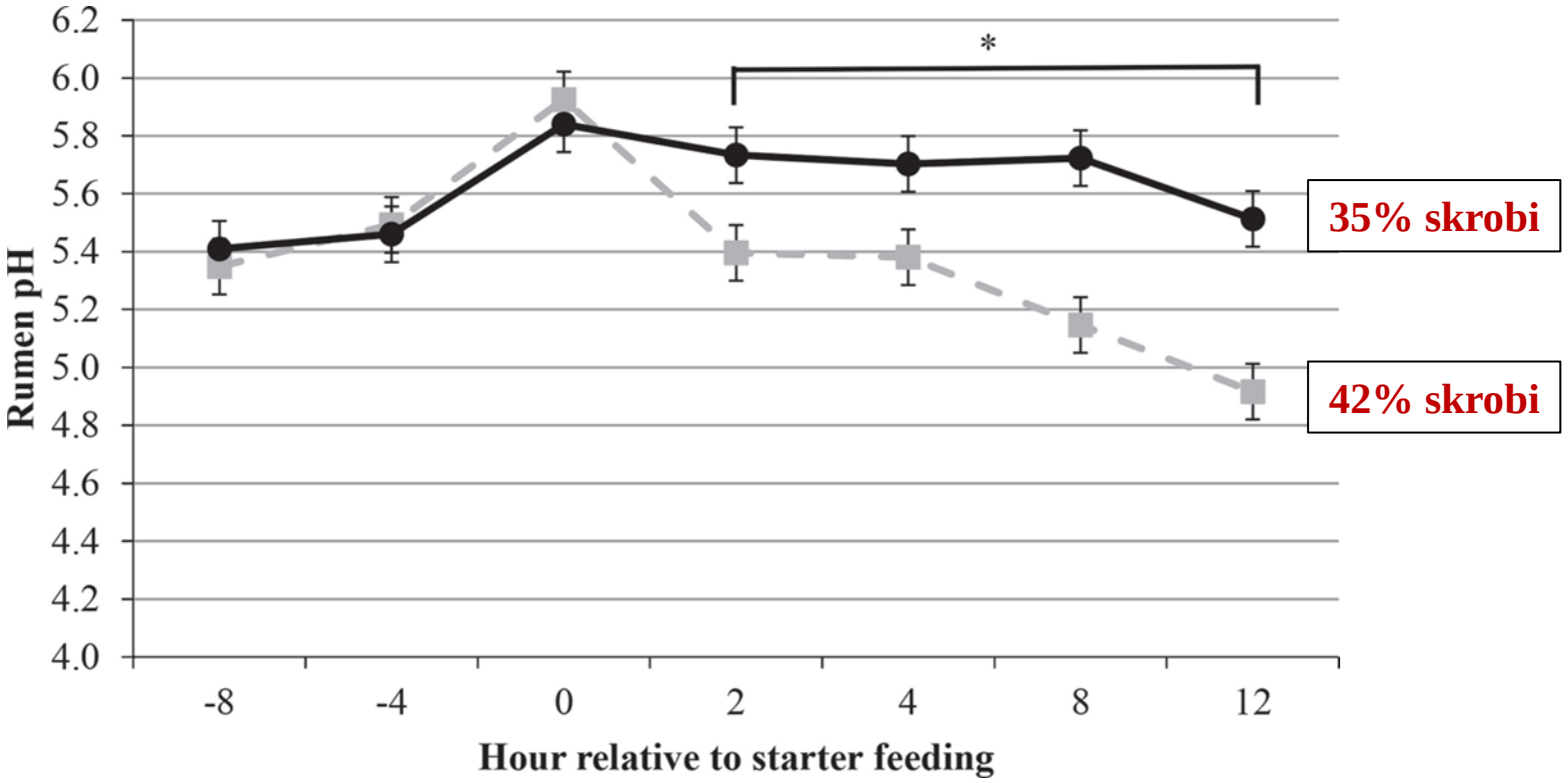
Jamrogiewicz et al. (unpublished)

H^+ removal from rumen



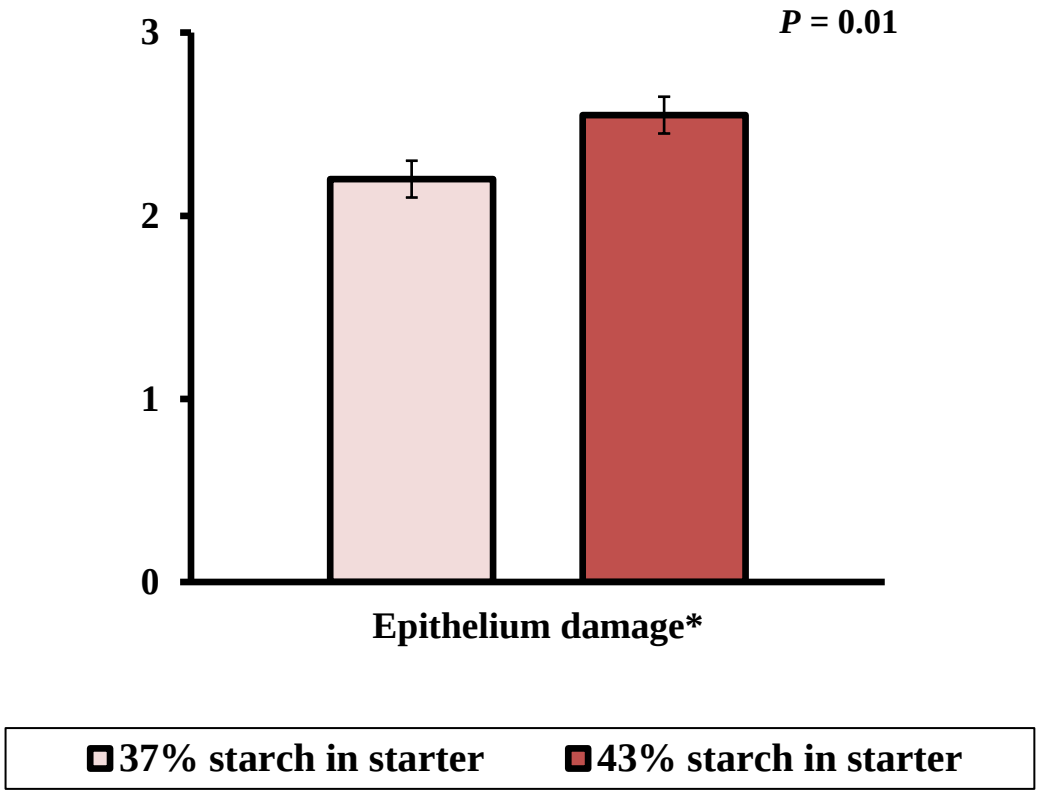
3. Negative consequences of subacute ruminal acidosis in calves

Rumen pH in calves



Gelsinger et al. (2020)

Rumen epithelium damage



*Scale of 1 to 3

Burakowska et al. (2021)

Uszkodzenia nabłonka – dodać zdjęcia
– poprosić J. Wojciechowską

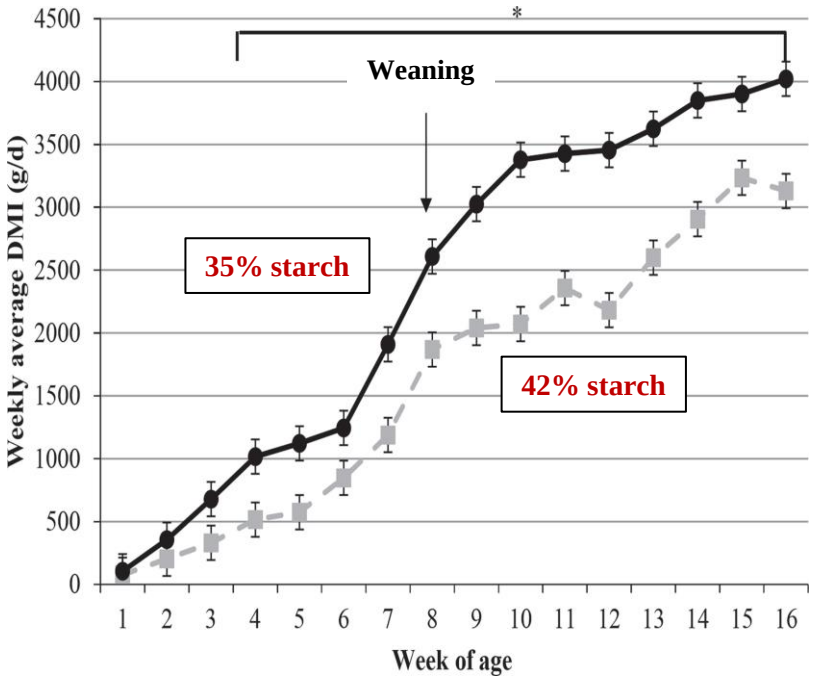
Short chain fatty acids absorption

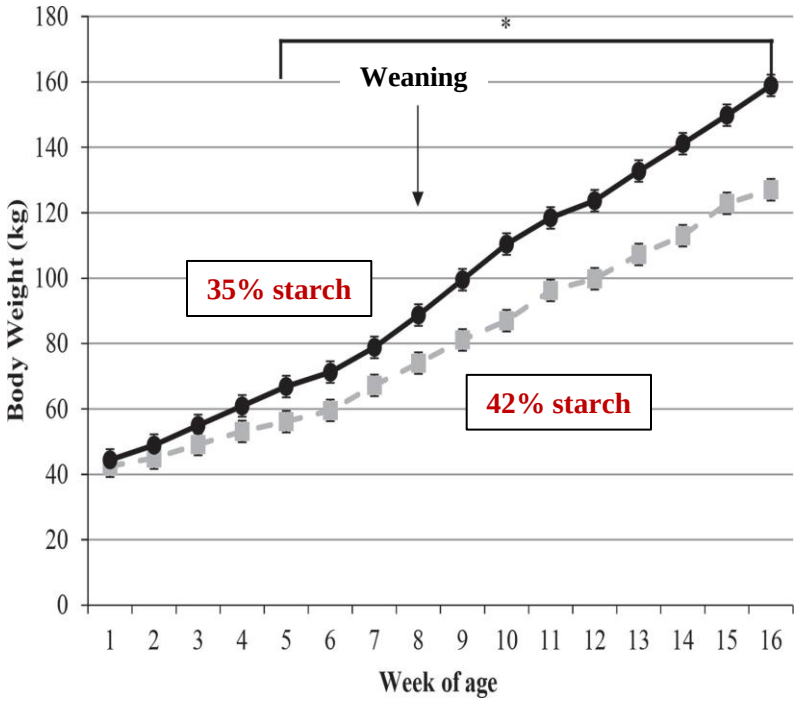
Burakowska et al. (2021)

Li (gelsinger) też zmiany w mikroorganizmach charakterystyczne dla SARA

LPS – stany zapalne

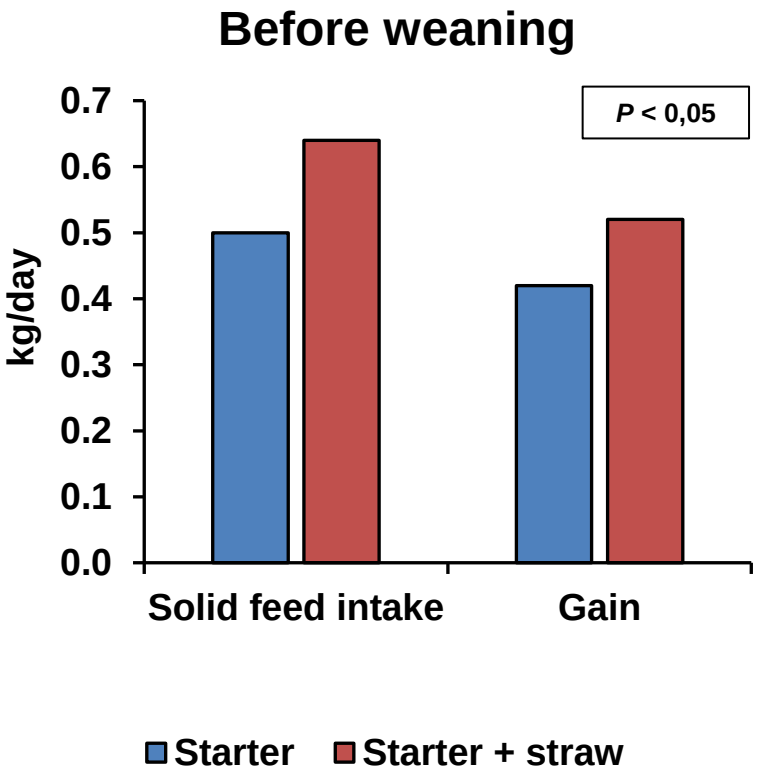
Impact on effects of rearing

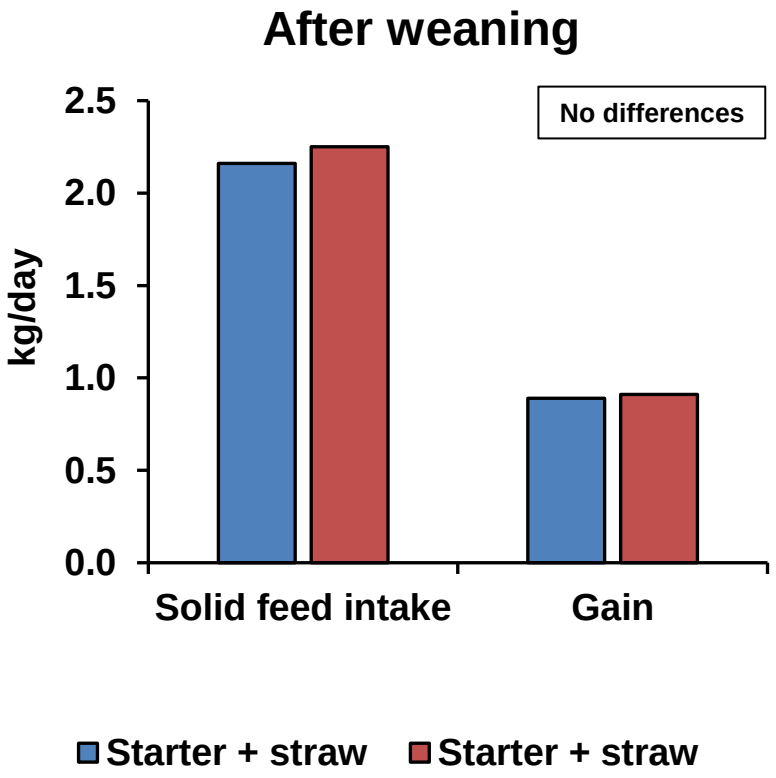




Gelsinger et al. (2020)

Impact on effects of rearing

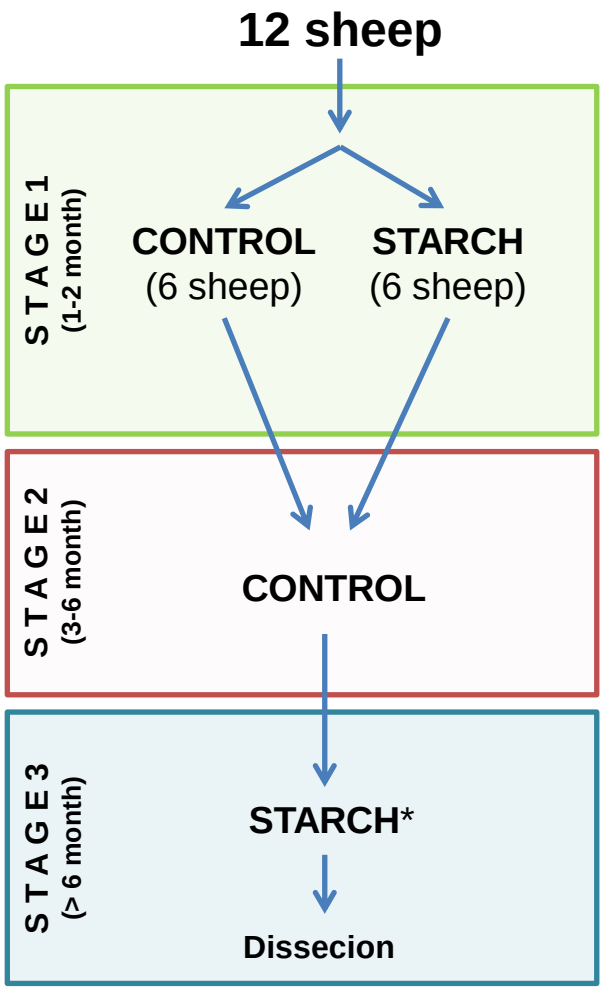




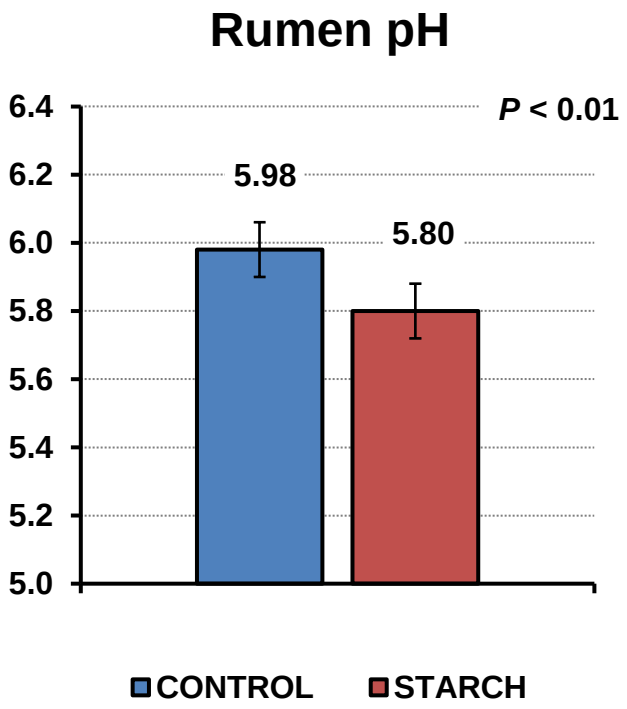
Chopped oat straw (≈ 2 cm)

Castells et al. (2015)

Long term effect



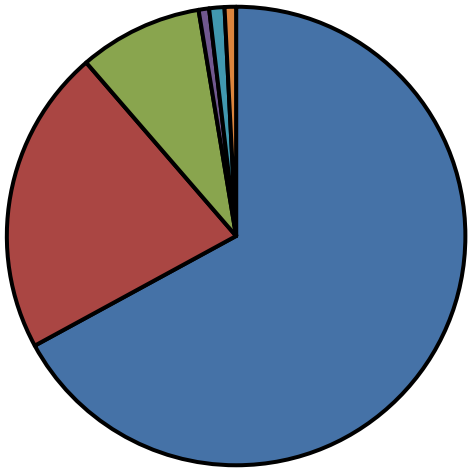
*Diet with high inclusion of grain



Jamrogiewicz et al. (unpublished)

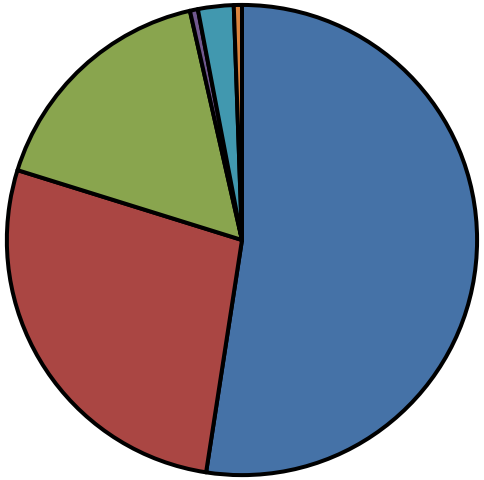
Objętościowe vs. treściwe

SIANO



Suma kwasów 131 mmol/l
pH = XXX

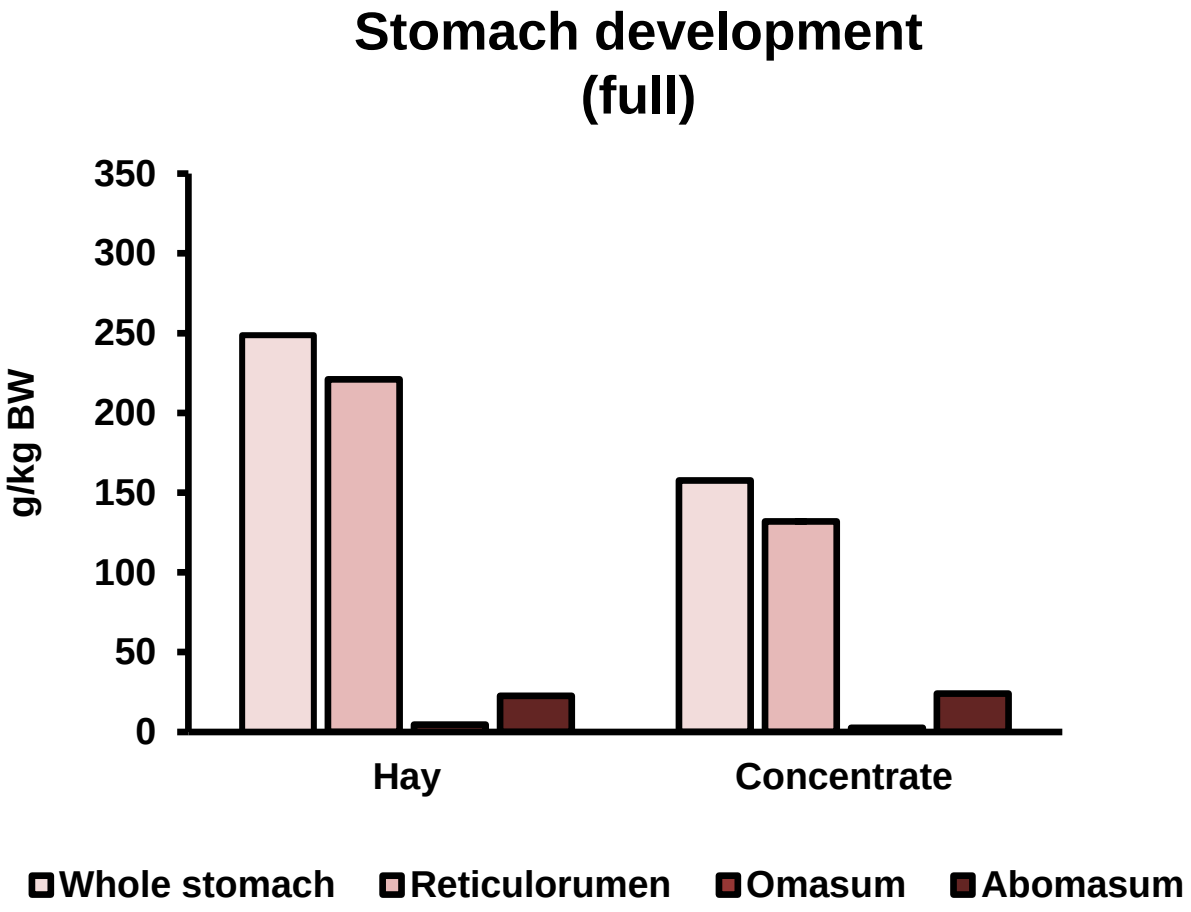
TREŚCIWE



Suma kwasów 142 mmol/l
pH = XXX

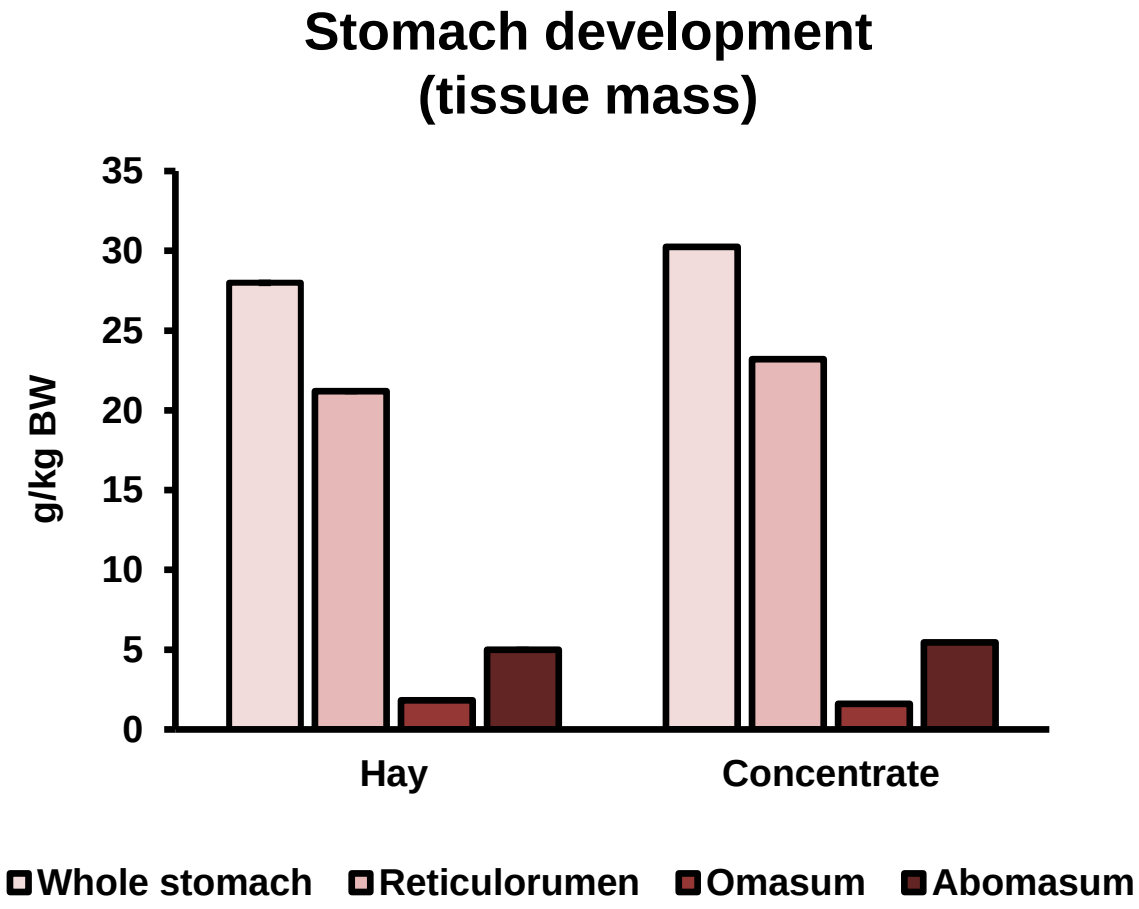
Jamrogiewicz et al. (unpublished)

Forage vs. concentrate



Jamrogiewicz et al. (unpublished)

Forage vs. concentrate

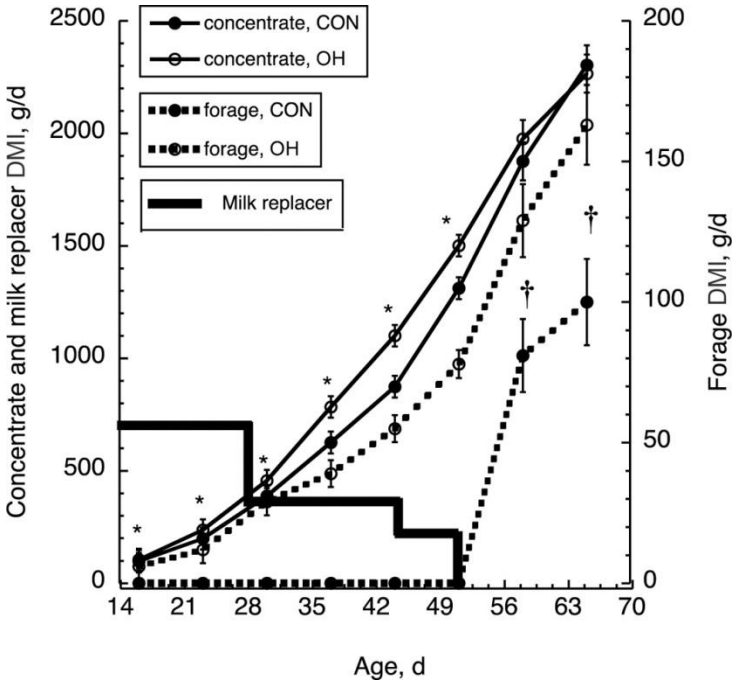


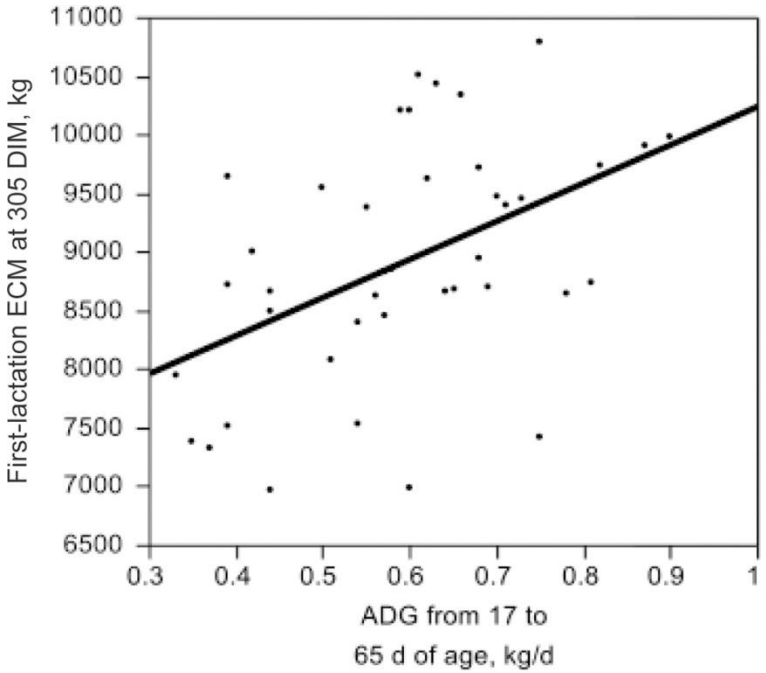
Jamrogiewicz et al. (unpublished)

Forage vs. concentrate

Jamrogiewicz et al. (unpublished)

Long term effect





Lack of effect on milk yield in first lactation but positive effect between daily gains in first weeks of life and future milk yield

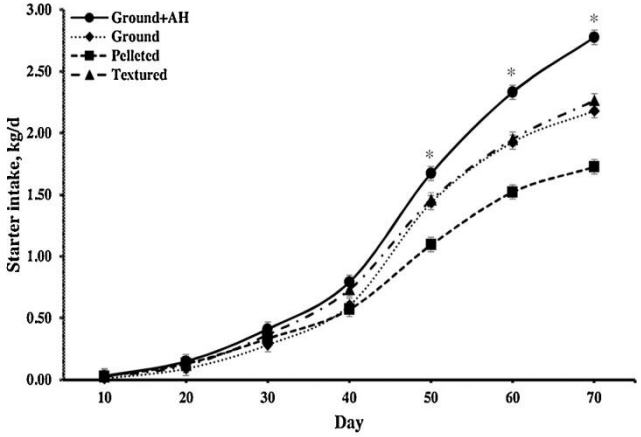
Castells et al. (2015)

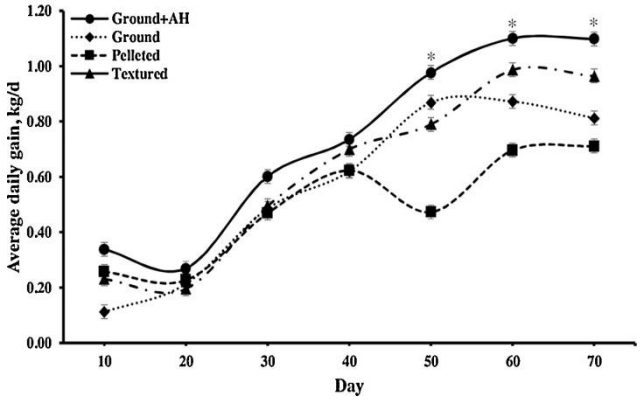
The presented scope of the negative impact of high intake of concentrates by calves comes from typically experimental systems and there are no statistical studies in this area

In the studies, animals often received only a starter based on concentrate and could not consume the bedding

4. Prevention of subacute ruminal acidosis in calves

Forage in the diet





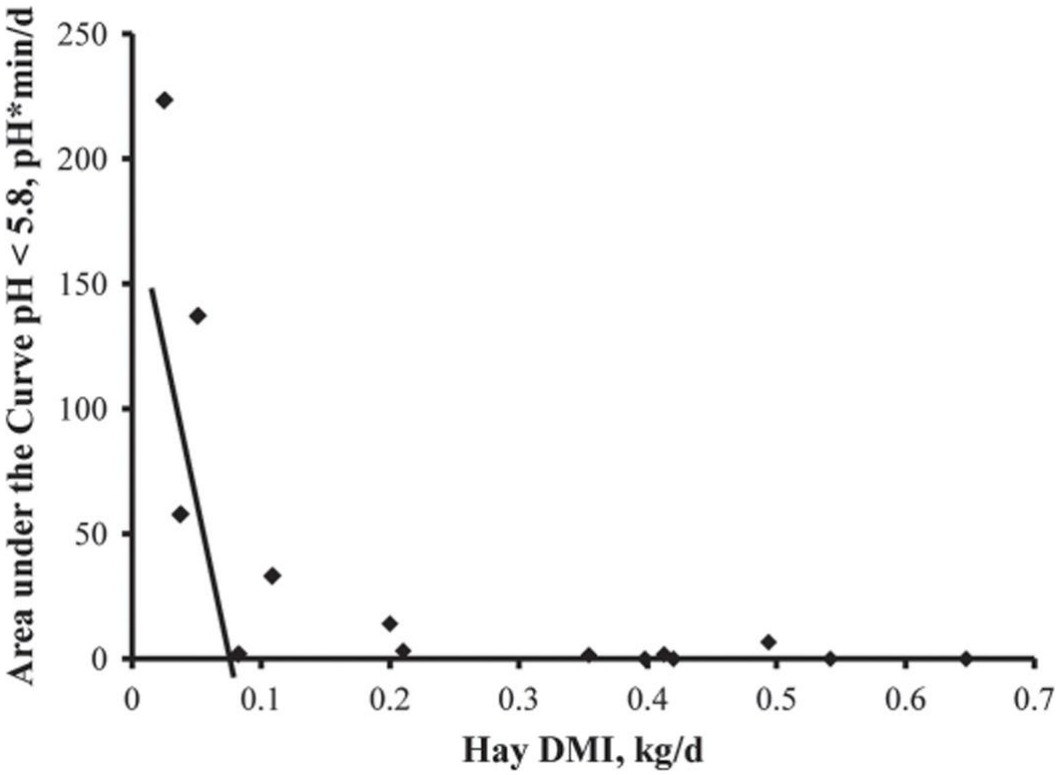
Ground **„Muesli”**

Pellet **Ground + chopped hay**

Chopped hay = 10% chopped lucerne (≈ 2 cm) in starter feed

Pazoki et al. (2017)

Forage in the diet



It is enought for the calf to consume 80 g of hay/day to limit time of low rumen pH

Laarman and Oba (2011)

Forage – how to feed?

Starter

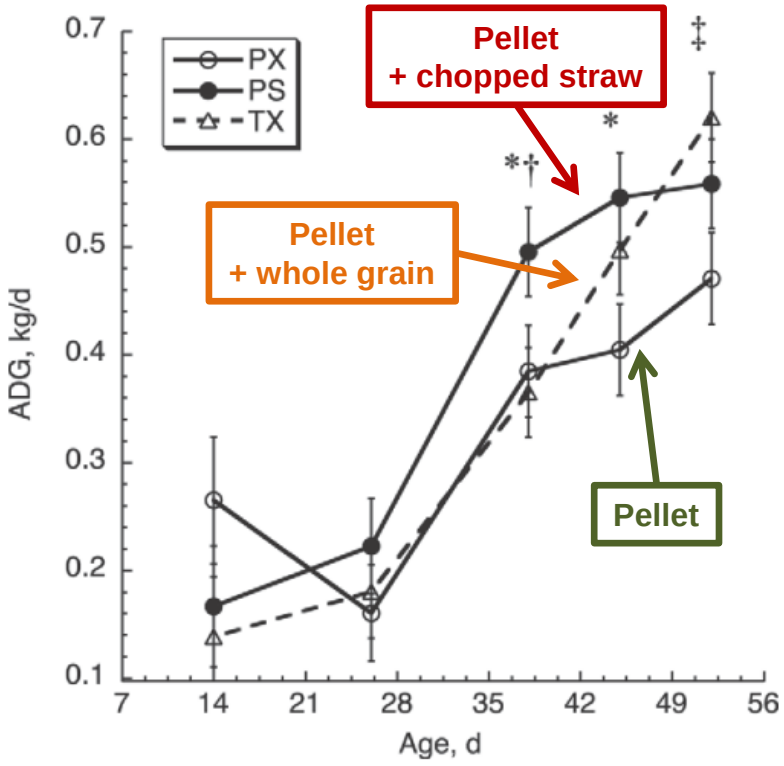
+

Hay/straw (chopped)

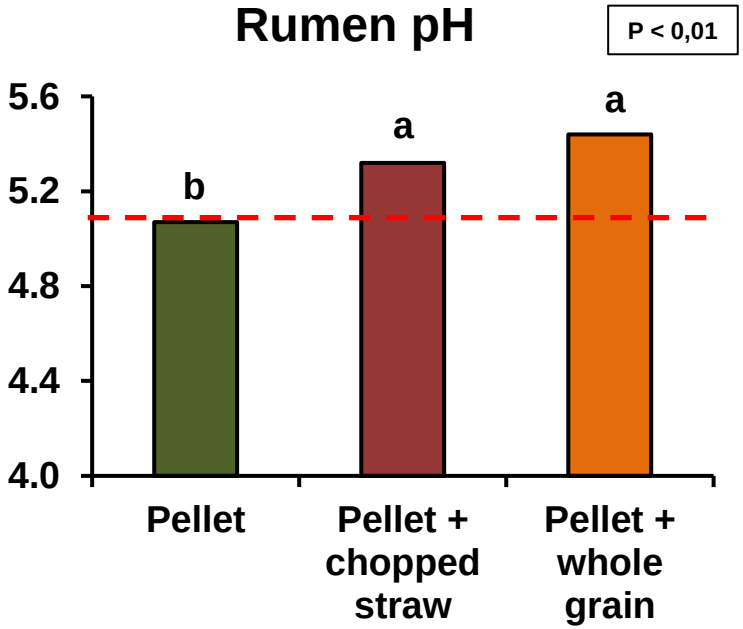
- ✓ Starter + chopped hay (or straw; 2-4 cm)
- ✓ 100-200 g/day (in separate feeder)
- ✓ Or mixed in starter (5-10% in feed)

Pellet – how to feed?

Daily gains



Rumen pH



Pellet + grain = 47% pellet + 29% whole corn + 24% whole oat
Straw = chopped straw 2-4 cm

Terre et al. (2015)

Concentrate – how to fed?

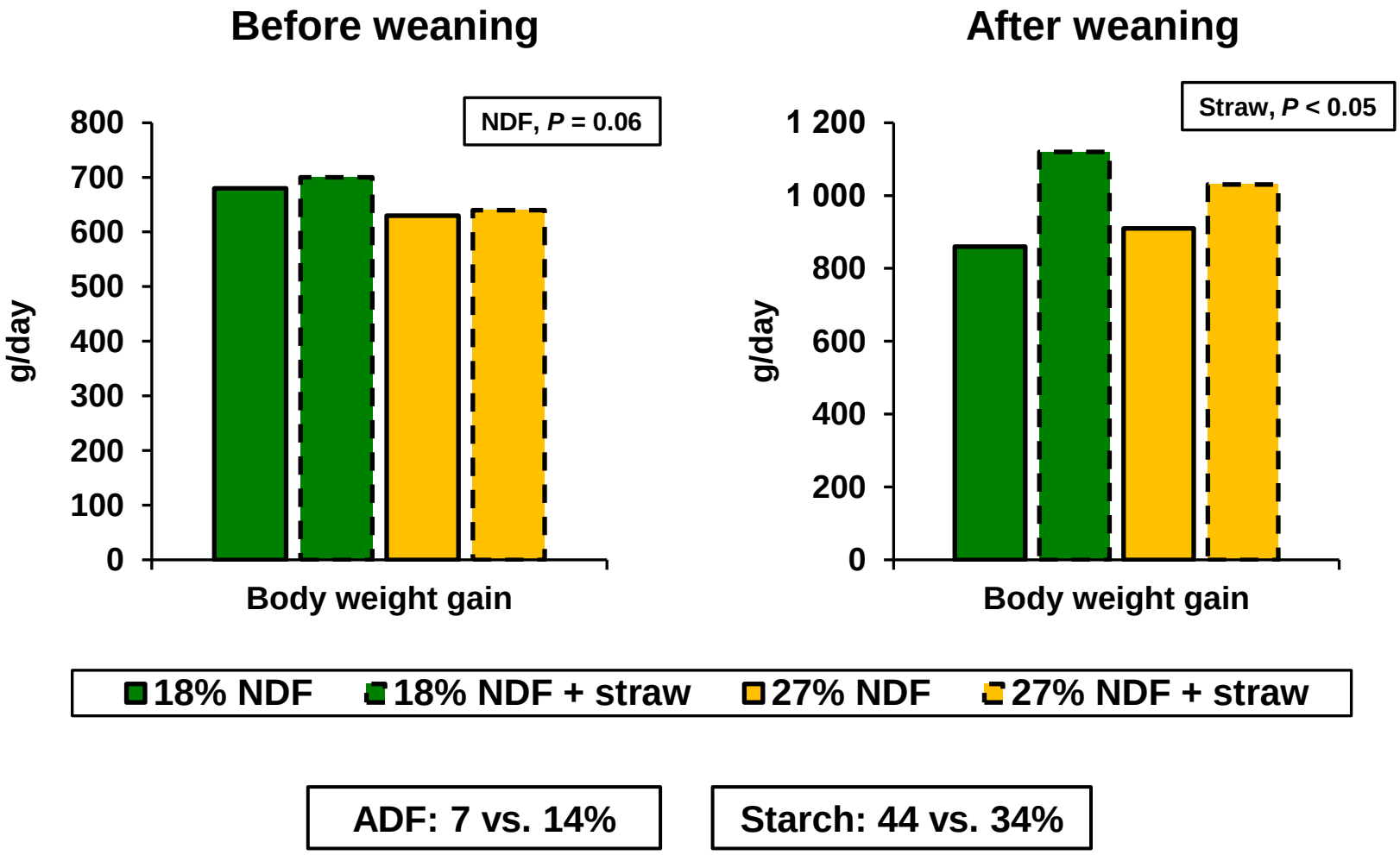
+

Chopped hay or straw (2-4 cm)

or

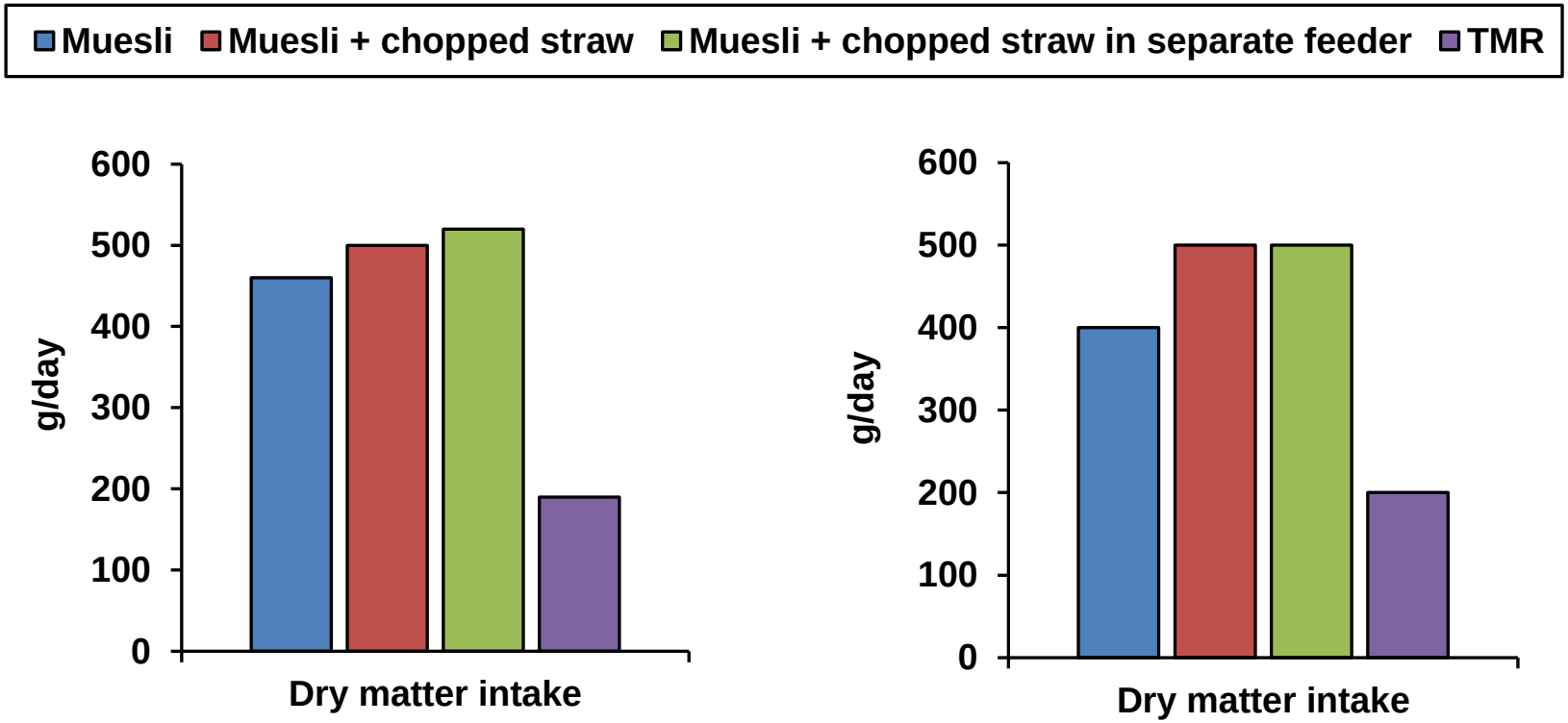
Whole grain (corn, oat)

When start feeding forage?



Terre i wsp. (2013)

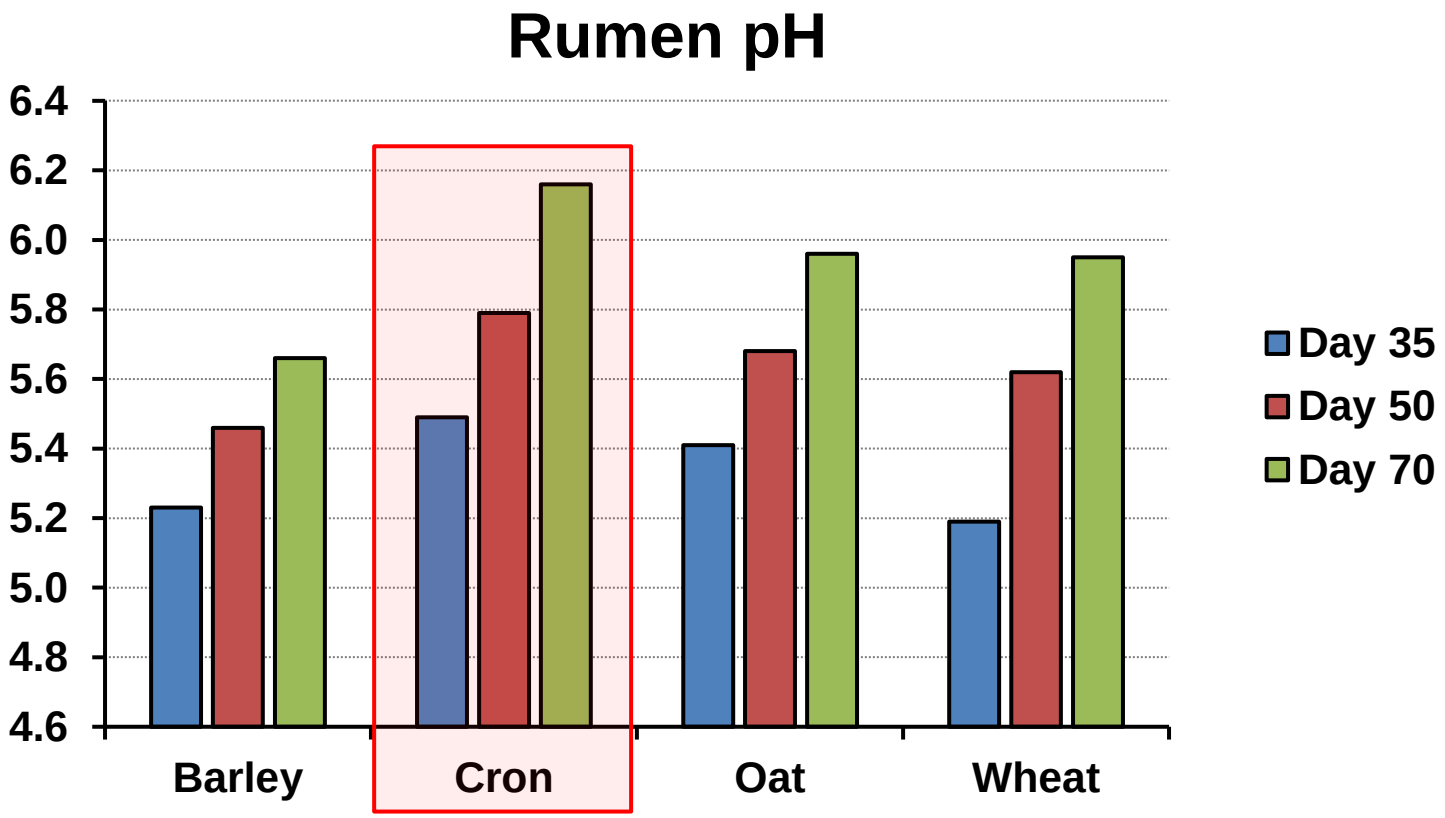
How to fed forages?



1. Refers to weaning period. 2. Hay = 15% dry matter of the diet.
3. Mixing hay with starter incereased eating time.
4. Muesli = pellet + whole corn grain + flaked barley.

Overvest et al. (2016)

Ingredient composition of starter

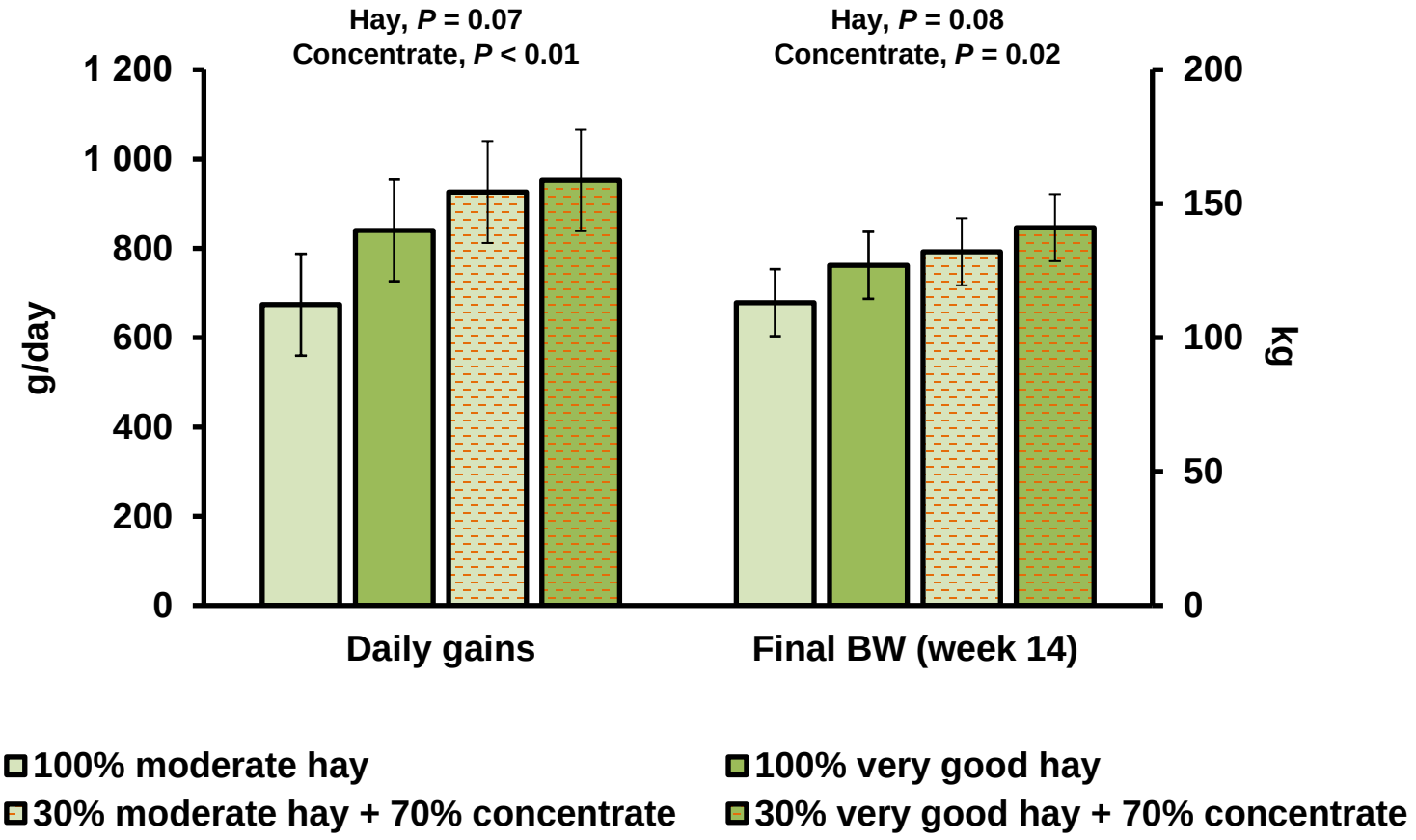


Pelleted starter + chopped hay

Khan et al. (2008)

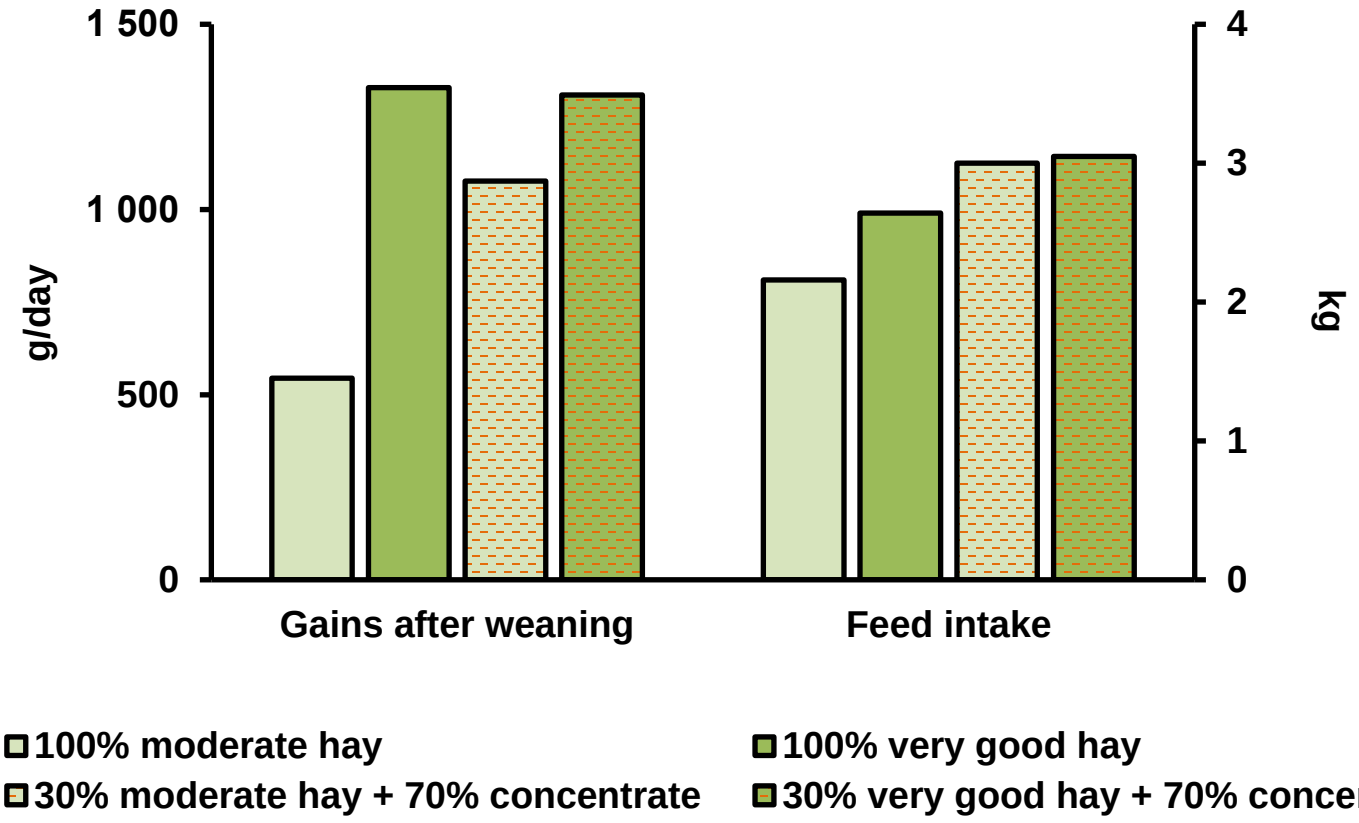
Feeding of ony hay may be a method of limiting subacute ruminal acidosis in calves

Hay in the diet



Terler et al. (2023)

Hay in the diet



Terler et al. (2023)

Why feeding has is not satisfactory?

Ingredient (%DM)	Low quality	Moderate quality	High quality
Protein	8	15	22
Fat	1.4	1.8	2.4
Ash	8	8	8
NDF	65	52	45
ADF	40	32	25
ADL	5.0	4.0	2.5
Sugar	8	12	20

A hay that is used has often low quality

Wzmianka o efektach wydłużenia podawania mleka

Wzmianka o dodatkach paszowych

5. Acute ruminal acidosis in calves

Acidosis and reticular groove

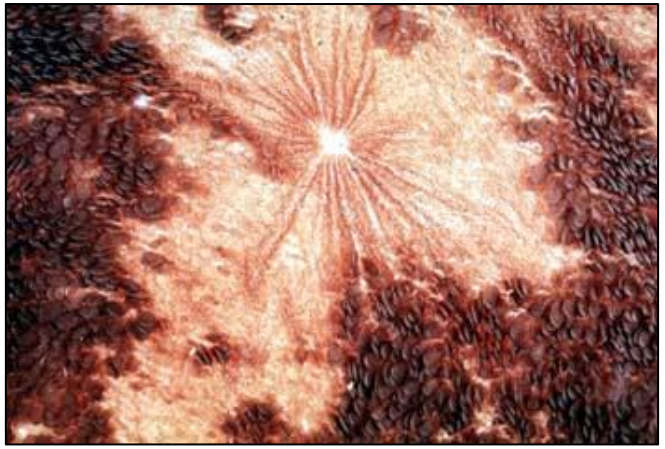
- Milk "bypasses" the rumen via reticular groove and is transproted to the abomasum
- About **3%** of milk „leaks” via reticular groove to the rumen
- In intensively feed beed calves this amount may reach **10-30%**
- In pathological situation **50%** enters the rumen

R**umen drinking**

Acidosis and reticular groove

Rumen drinking – consequences:

- Rumen acidosis
- Inflamation in rumen, omasum and abomasum
- Hyper- and parakeratosis
- Villi atrophy
- Metabolic acidosis
- Negative energy and protein balance
- General weaknesses



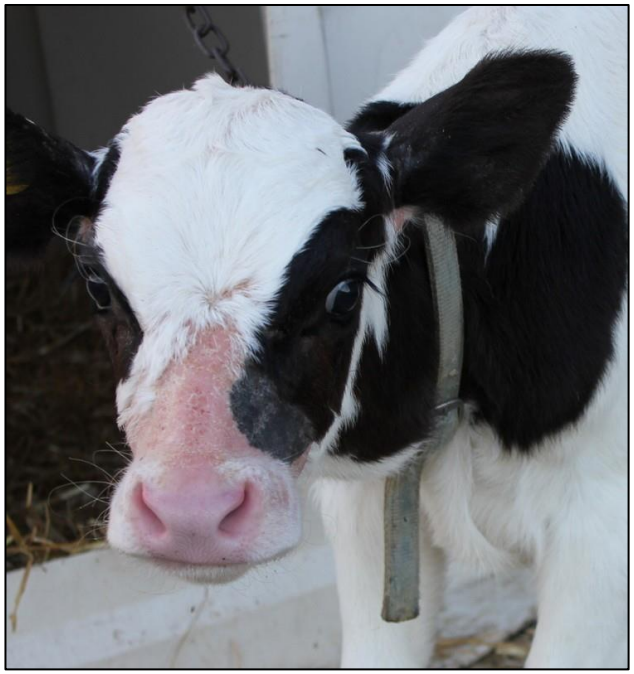
from Gintile (2004)

http://vet.uga.edu/ivcvm/courses/vpat5215/digestive/week02/forestomach/rumen06.htm

Acidosis and reticular groove

Rumen drinking – symptoms:

- Lack of apetite
- Visible symptoms of pain, kicking legs, bent spine
- Dehydration due to diarrhea
- Rumen bloat
- Growth inhibition
- Hair loss
- Clay feces



from Gintile (2004)

https://talk.newagtalk.com/forums/thread-view.asp?tid=563470&DisplayType=flat&setCookie=1

Acidosis and reticular groove

Rumen drinking – causes:

Feeding

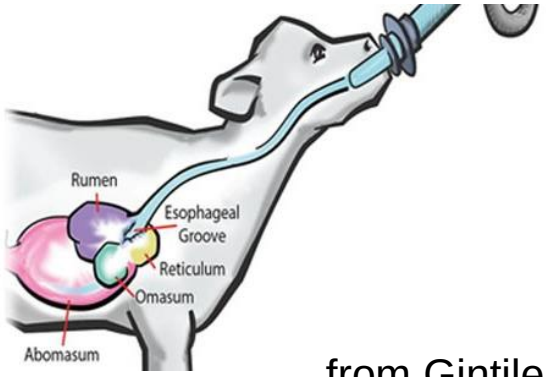
- Irregular feeding
- Low-quality milk replacer
- Cold feed
- Drinking from an open bucket (?)
- Tube feeding (discomfort, pain)

Pathological situations

- Diarrhea
- Body exhaustion

Stress

- Transportation



from Gintile (2004)

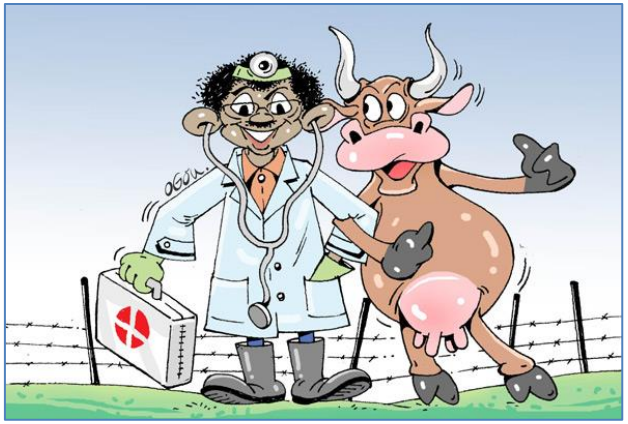
http://www.hubbardfeeds.com/tipsandtools/dairy/dairy-solution-e-newsletter/rumen-drinking

Acute rumen acidosis in calves is not very common

Acidosis and reticular groove

Rumen dringing – treatment:

- Elimination of nutritional mistakes – improvement of milk feeding procedures
- Elimination of stress
- "Learning" how to drink milk correctly
- Early weaning from milk



from Gintile (2004)

6. Summary

Podsumowanie

- Rumen pH in calves calves is generally low
- Under typical practical conditions, calves seem to cope well with this situation as long as they have access to roughage
- Feeding forage during the rearing period effectively prevents very low pH in the rumen and the negative consequences of such a situation
- The use of feed additives does not seem to have any effect on the rumen pH of calves

Podsumowanie

- The possible impact of high intake of concentrate feed on acidosis in the large intestine is unknown
- The long-term effects of feeding calves ad libitum concentrates are unknown
- It seems justified to establish recommendations regarding the optimal concentration of fiber from forage (physically effective fiber) in feed for calves

Thank you