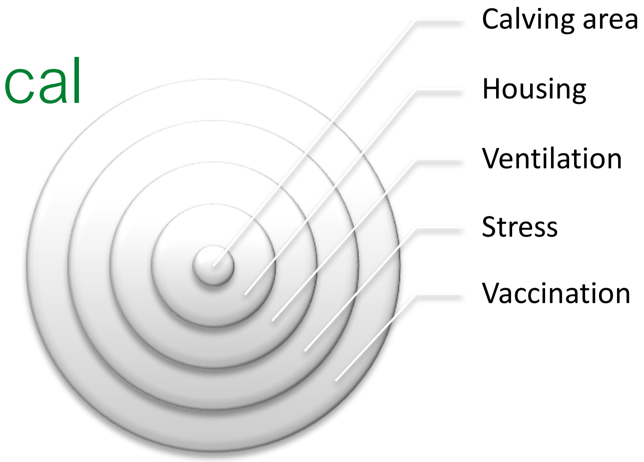
# Heifer Health Events are Critical



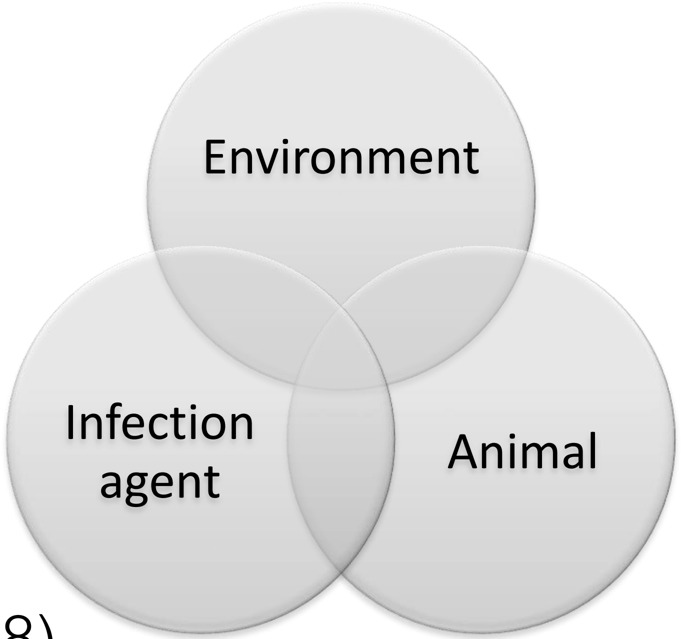

10 March  2021
Biomin GmbH
Zanetta Chodorowska TSM Ruminant

Euroopa Maaelu Arengu Põllumajandusfond: Euroopa investeeringud maapiirkondadesse

# Calves disease control- Key principles

- Removing the source of infection from the calf's environment
- Remove the calf from contaminated environment
- Increase immunity
- Reduce stress

Redstits and Acres Can.Vet.Med 1980




- Calves left with dam for >1hour was a majority factor of Cryptosporidium diarrhea ( Prev Vet Mad 2007; 82:12-28)

# Neonatal calves- disease prevention

Focuse on management.

The vast majority of disease and health problem stem from management.

There is no magic powder to overcome poor colostrum program or poor hygiene.

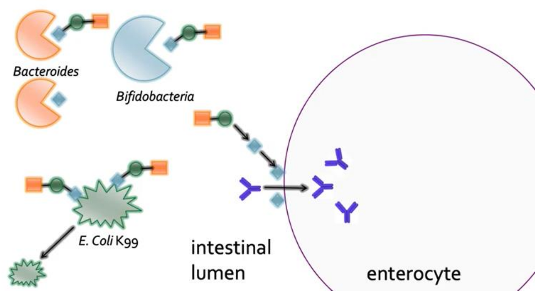
In calves we have diarhea coused by roto virus or cryptosporidia and respiratory disease we have the same disease we had  for 50-100 years.

We still have the same menagment problems we had before.

# Facts and consideration on early calves feeding

- Colostrum related issues
- Time/temperature important
- Bacteria is large problem
- May be an upper limit to IgG uptake
- Other proteins are denatured
- Feeding strategy
- Rumen microbial establishment

**Colostrum Oligosaccharides**




## What's in colostrum?

| | | |
|---|---|---|
| Immunoglobulins | >100:1 | immune function |
| Lactoferrin | >15:1 | local immunity effect in gut |
| IGF-I | 80:1 | |
| IGF-II | 20:1 | |
| Epidermal growth factor | 2:1 | |
| Insulin | 100:1 | local gut effects |
| Interleukines | > 100:1 | |
| Relaxin | 19:1 | reproductive development |
| Prolactin | | little data |
| TGFα and TGFβ | > 100:1 | |
| Leptin | | hypotahlamic pituitary axis |
| Leucocytes | | immune function |

Slide Courtesy of Dr. VanAmburgh

# Facts on calf morbidity and mortality

1. We still have a preweaned heifer calf mortality rate 6-7%
2. Only 40% of farms can supplay their own replacement heifers
3. The majority disease remain diarhea 60% pneumonia 24% and septicemia
4. Poor colostrum management 30-40% of Failure

| | 1991 | 1996 | 2002 | 2007 | 2014 |
|---|---|---|---|---|---|
| Pre-weaned calf mortality | 8,4% | 10,8% | 10,5% | 7,8% | 6,4% |
| % of deaths caused by diarrhea | 52,2% | 60,5% | 62,1% | 56,5% | 56,4 |
| % of death caused by pneumonia | 21,3% | 24,5% | 21,3% | 22,5% | 24,0 |
| Weaned calf mortality | 2,2% | 2,4% | 2,8% | 1,8% | 1,9% |

2014 estimates are preliminary Dr Jason Lombard

# Colostrum Nutrient Composition /Immunoglobulins -
## Immunosuppressed animals -

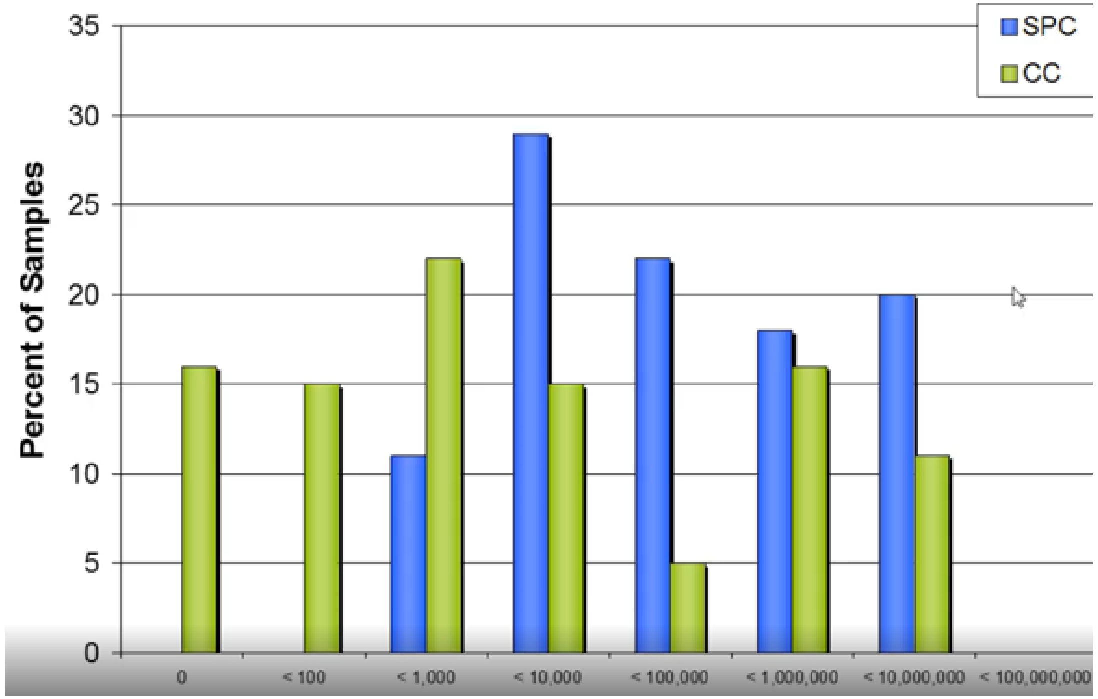
| Item (%) | Mean | Min | Max |
| --- | --- | --- | --- |
| Fat | 6.70 | 2.0 | 26.5 |
| Protein | 14.92 | 7.1 | 22.6 |
| Lactose | 2.49 | 1.2 | 5.2 |
| Total solids | 27.64 | 18.3 | 43.3 |
| Ash | 0.05 | 0.02 | 0.07 |

Avoid dam-to-calf disease transfer through manure, meals by providing a clean, dry calving environment.


6.8kg/head >70% of a good quality

Survey of 55 colostrum samples from PA farms
Kahoe et al., 2007

# Colostrum bacteria distribution
# Effect of heat treatment

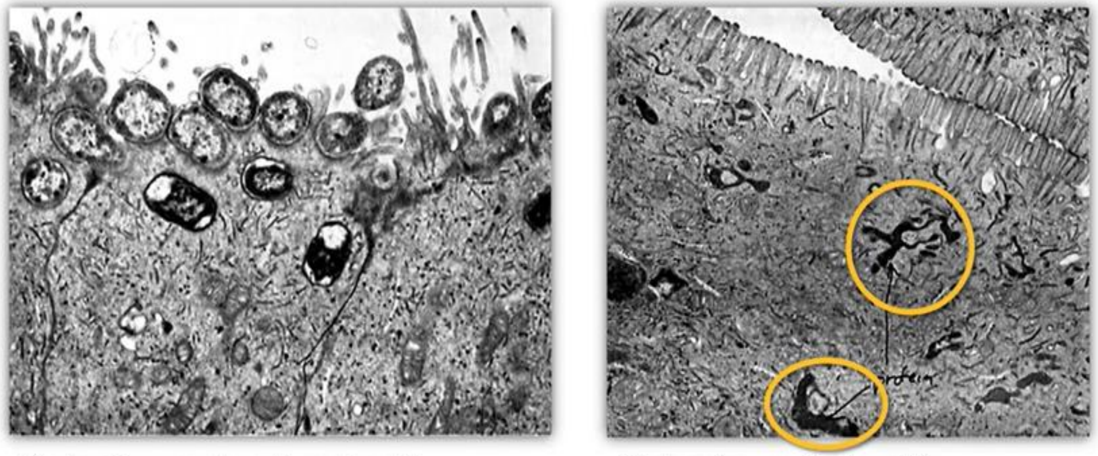



(Bacteria count CFU/ml)

SPC = standard plate count
CC = coliform count; Houser et al., 2008

**E. Coli entering intestine epithelial cell**
**Destruction of microvilli**

Dark areas represent absorbed Ig

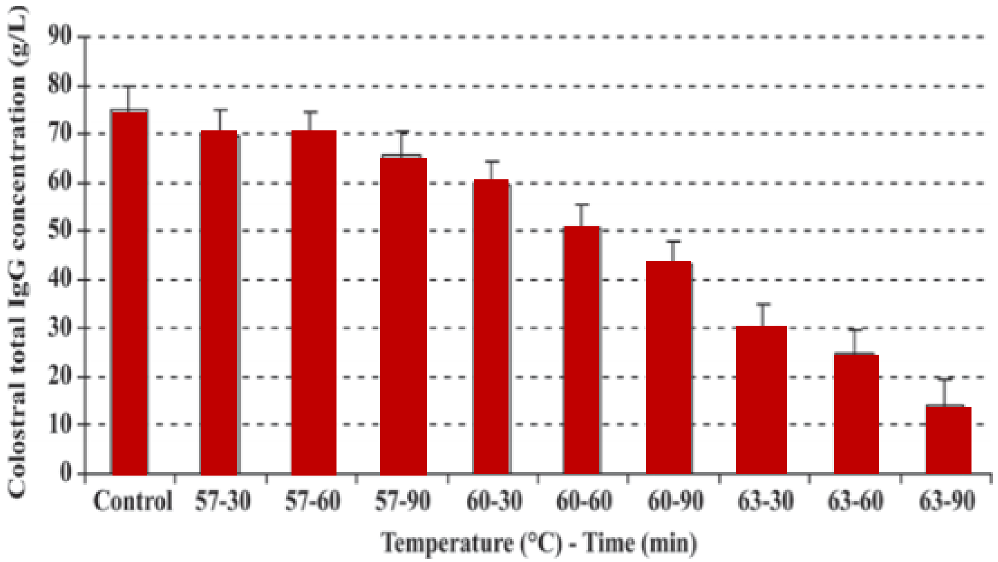


**Colostrum deprived calf** **Colostrum fed calf**

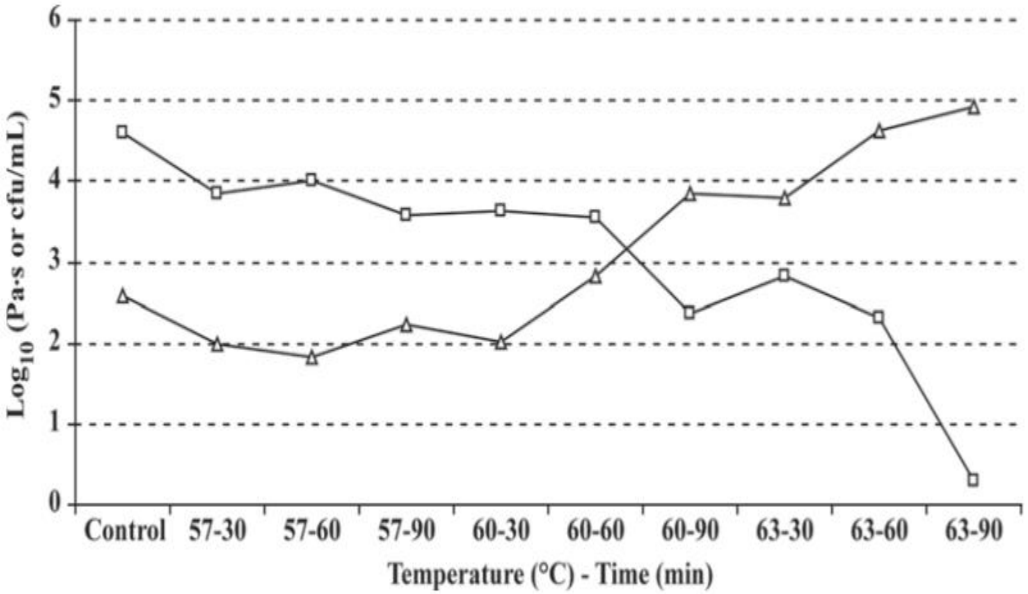
Slide Courtesy of Dr. James

# Effect of heat treatment of Colostrum
# Total immunoglobulin concentration

Changes in total IgG concentration in bovine colostrum

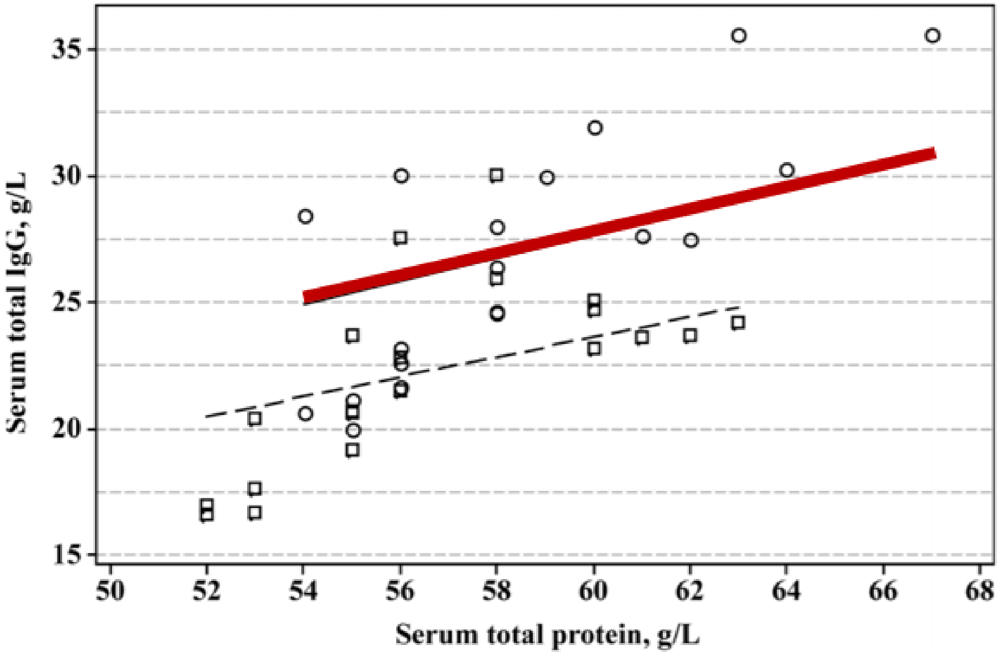



Changes in viscosity (Δ) and standard plate count (□) in bovine colostrum

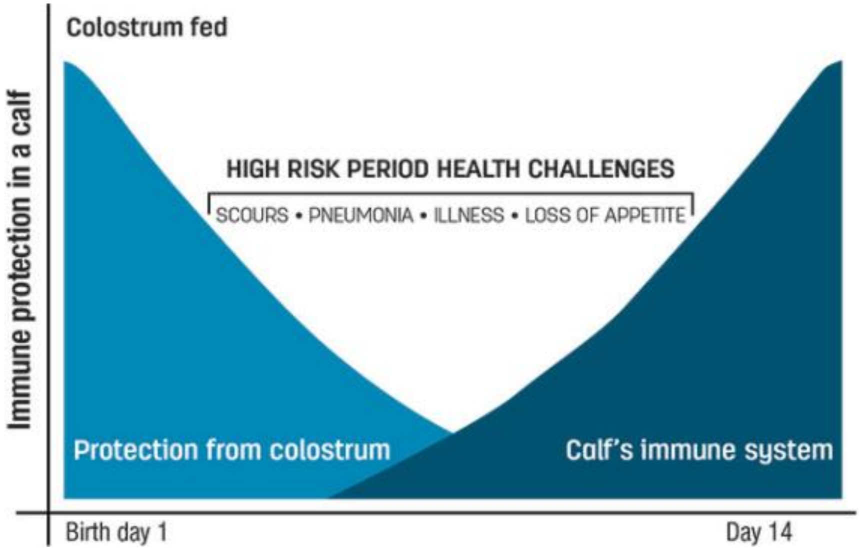



J. A. Elizondo-Salazar ,
Journal of Dairy Science Vol. 93 No. 3, 2010

# Feeding heat treated colostrum




heifers calves receiving unheated (□) or heat-treated (o)




# Impact on heating time and Colostrum absorption

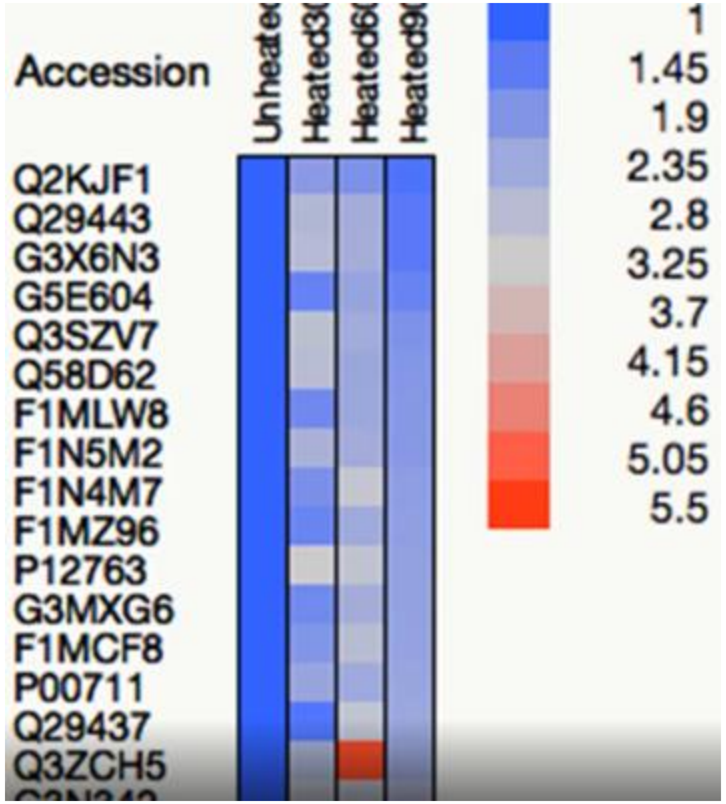
Effect of different heating times of high-, medium-, and low-quality colostrum on immunoglobulin G absorption in dairy calves  D. J. Saldana 2019

| | Unheated | | | Heated 30 min | | | Heated 60 min | | | *P*-value[1] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Low | Medium | High | Low | Medium | High | Low | Medium | High | Q | M | Q × M | SEM |
| Total protein, g/dL | 5.3[b] | 5.6[b] | 6.1[a] | 5.3[b] | 5.6[b] | 6.3[a] | 5.2[b] | 5.7[b] | 6.1[a] | <0.01 | 0.7 | 0.8 | 0.1 |
| IgG, mg/mL | 19.4 | 18.2 | 21.4 | 13.3 | 22.1 | 25.7 | 21.6 | 26.3 | 27.2 | 0.02 | 0.06 | 0.3 | 3.1 |
| AEA,[2] % | 37.3 | 26.2 | 20.8 | 32.6 | 39.6 | 25.4 | 47.3 | 48.5 | 28.9 | <0.01 | 0.01 | 0.2 | 5.1 |
| Hematocrit, % | 28.5 | 30.3 | 32.2 | 31.5 | 31.8 | 27.0 | 31.4 | 31.2 | 30.0 | 0.52 | 0.79 | 0.06 | 1.4 |

[a,b]Values within a heat time with different superscripts are different ($P < 0.05$) after accounting for multiple comparison by Tukey's adjustment factor.

[1]Q = colostrum quality (high, medium, or low); M = heat treatment minutes (0, 30, or 60).

[2]Apparent efficiency of absorption, calculated as AEA = [(birth weight × 0.091 × serum IgG)/total IgG fed] × 100.




The majority of proteins effected by heat treatment were involved in immunity, enzyme function

# Milk replacer fed 2x or 4x per day calves weaned at 42 days

| Item | Treatment | | | | SEM | Contrast, P-value | | |
|---|---|---|---|---|---|---|---|---|
| | 20:20 2X | 20:20 4X | 26:18 2X | 26:18 4X | | MR | 2X v. 4X | Interaction |
| BirthBW,kg | 42.7 | 40.6 | 41.1 | 41.3 | 1.6 | 0.79 | 0.57 | 0.49 |
| d 42 BW, kg | 67.9 | 68.4 | 70.8 | 70.8 | 1.9 | 0.15 | 0.88 | 0.87 |
| d 56 BW, kg | 78.6 | 82.1 | 86.0 | 83.5 | 2.7 | 0.11 | 0.85 | 0.24 |
| ADG, kg/d | | | | | | | | |
| d 1 to 42 | 0.63 | 0.64 | 0.70 | 0.77 | 0.05 | 0.06 | 0.40 | 0.51 |
| d 1 to 56 | 0.66 | 0.72 | 0.79 | 0.81 | 0.05 | <0.05 | 0.48 | 0.63 |
| Gain:Feed | | | | | | | | |
| d 1 to 42 | 0.57 | 0.55 | 0.60 | 0.62 | 0.03 | 0.11 | 0.91 | 0.58 |
| d 1 to 56 | 0.50 | 0.48 | 0.55 | 0.55 | 0.03 | <0.05 | 0.78 | 0.76 |

20:20 MR 20% CP, 20% fat, fed at 1,5% of BW
26:18 MR 26% CP, 18% fat, fed at 2% of BW
18% CP starter and water offered free choice , 12 calves per treatment

Kmicikewycz et al 2013

# Meta analysis of calf growth and milk yield

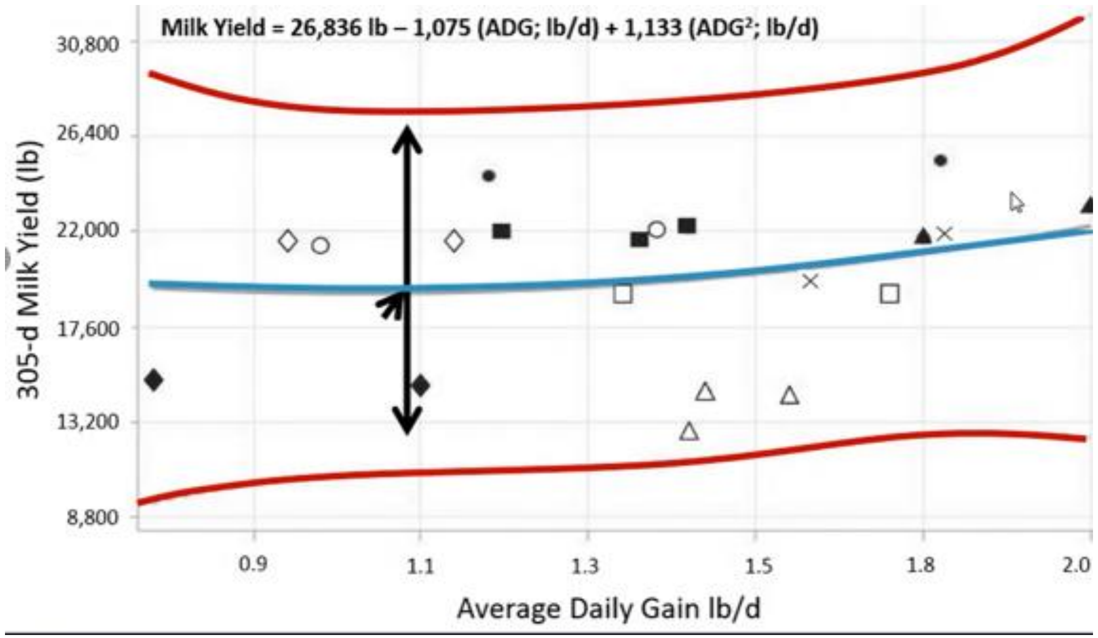
## Studies compering preweaning calf nutrition and future milk production of the same animals

WM whole milk , MR milk replacer, Na not available, DIM days in milk

| Study | N | ADG of control kg | ADG of treatment kg | Milk yield of control kg | Milk respond kg | Estimated ME , Mcal/d above control | Source of nutrient |
|---|---|---|---|---|---|---|---|
| Foldager and Krohn (1994) | 30 | na | na | na | 1,405 | na | WM |
| Bar-Peled et al. (1997) | 20 | 0.56 | 0.85 | 9,171 | 453 | 0.290 | WM/MR |
| Foldager et al. (1997) | 20 | 0.60 | 0.90 | 7,716 | 519 | 0.266 | WM |
| Ballard et al. (2005), at 200 DIM | 14 | 0.44 | 0.73 | 6,100 | 700 | 0.200 | MR |
| Shamay et al. (2005) | 20 | 0.59 | 0.88 | 10,784 | 981 | 0.270 | WM/MR |
| Drackley et al. (2007) block 1 | 10 | 0.52 | 0.75 | 9,245 | 1,332 | 0.410 | MR |
| Drackley et al. (2007) block 2 | 14 | 0.56 | 0.79 | 12,962 | 718 | 0.540 | MR |
| Raeth-Knight et al. (2009) | 26 | 0.56 | 0.79 | 12,962 | 718 | 0.540 | MR |
| Terré et al. (2009) | 30 | 0.80 | 0.90 | 9,888 | 624 | 0.200 | MR |
| Morrison et al (2009) | 38 | 0.34 | 0.50 | 6,862 | 0 | 0.160 | MR |
| Moallem et al ( 2010) | 23 | 0.73 | 0.80 | 9,150 | 732 | 0.074 | WM/MR |
| Soberon et al (2012) | 400 | 0.32 | 0.70 | 10,605 | 552 | 0.450 | MR |

# Meta –analysis of ADG and 1st lactation milk production/ preweaning ADG

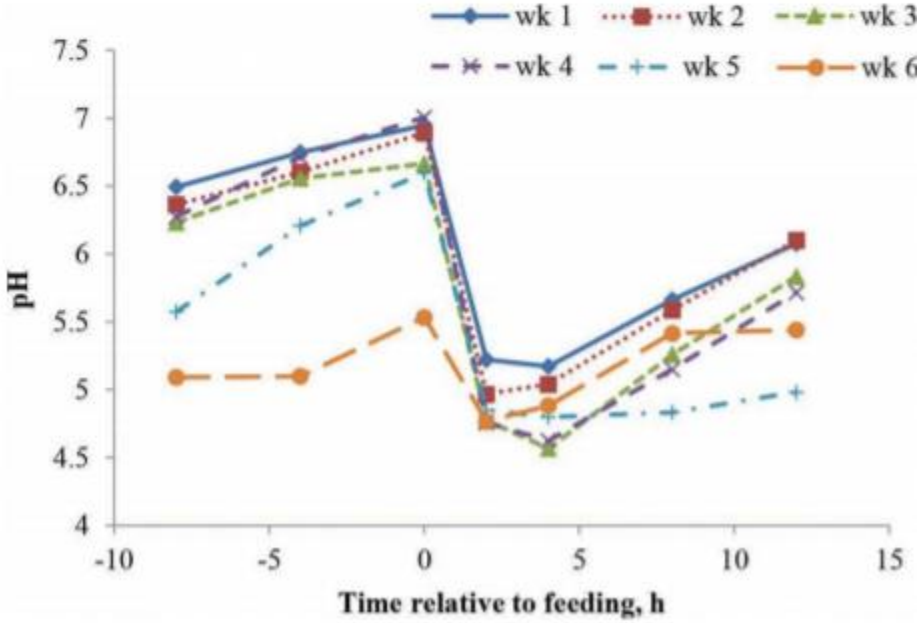
- 100g/d gain during pre-weaning yield 150kg milk
- 19.6% accounted for by increased of milk intake
- 80.4% accounted for by increased grain intake
- Calf starter intake is the component of primary importance

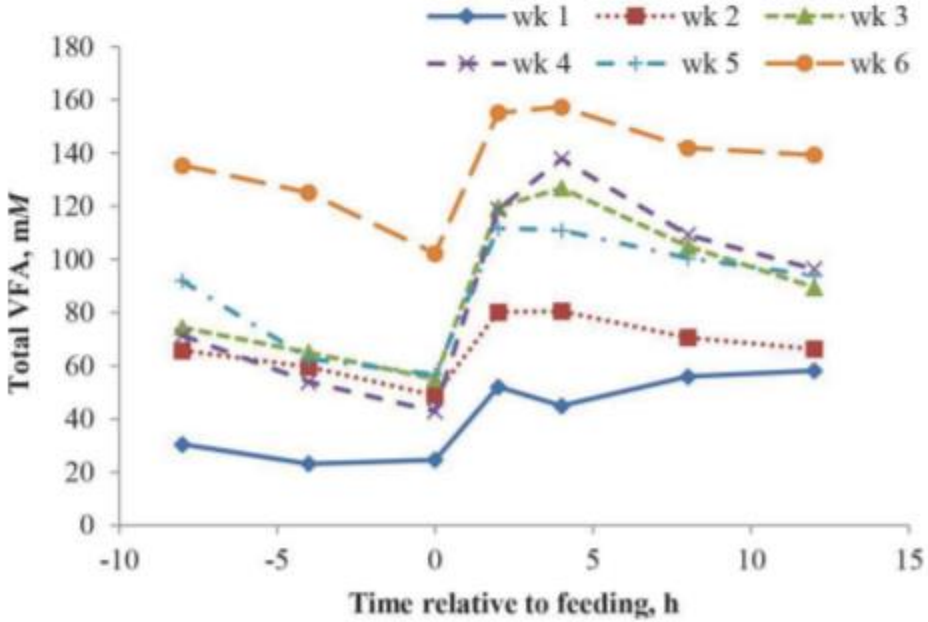



Gelsinger et al., 2016

# Starter intake in the early live

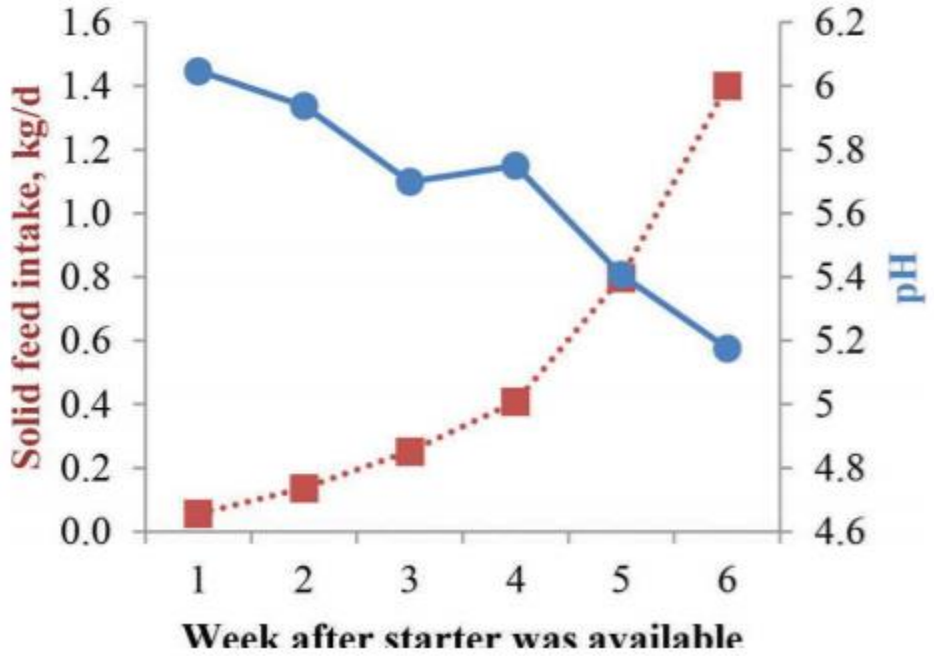
rumen pH variation at −8, −4, 0, 2, 4, 8, and 12 h relative to feeding from 1 to 6 wk after starter was available with 5% straw short cut >1 cm




SUAREZ-MENA ET AL 2016

# Solid feed intake and the rumen pH




solid feed intake and rumen pH from 1 to 6 wk after starter was available for calves fed starter containing 5% straw

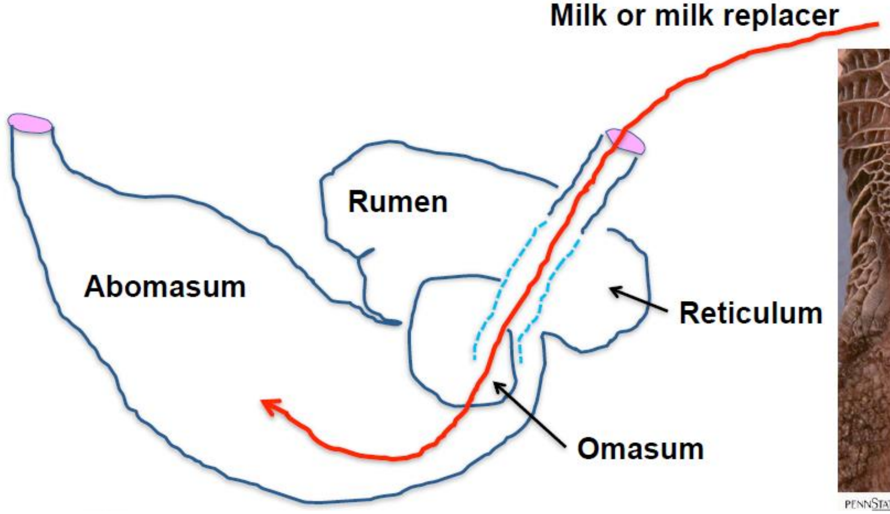
- Adaptation of the rumen pH.
- Adaptation of the liver to low rumen pH.
- Low rumen pH affect gen expression of the rumen epithelium and liver.
- Developing rumen adapts to increase acidotic pressure from calve starter fermentation.



F. X. Suarez-Mena et al., 2016

# Milk v. solid feed intake in young calf

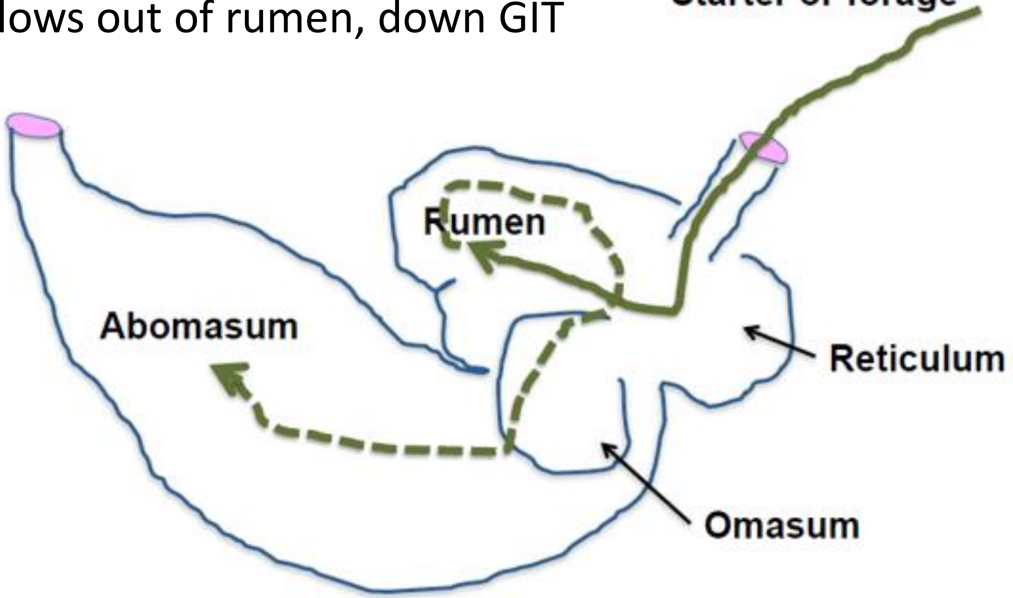
**When milk is ingested, here's what happens**





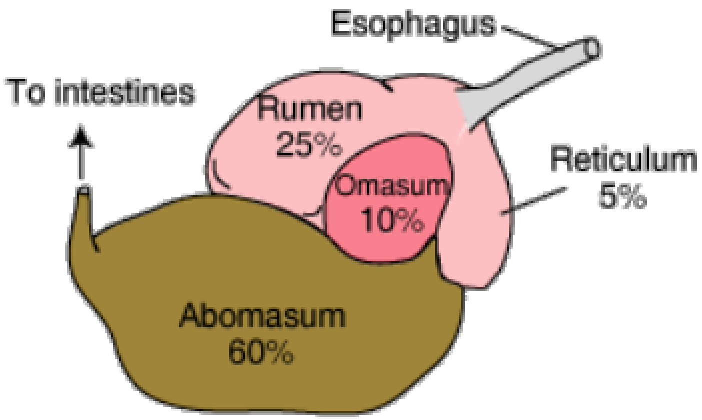
**When starter or forage is ingested, here's what happens**

VFA absorbed in rumen by papillae.
Microbial protein and other digesta flows out of rumen, down GIT

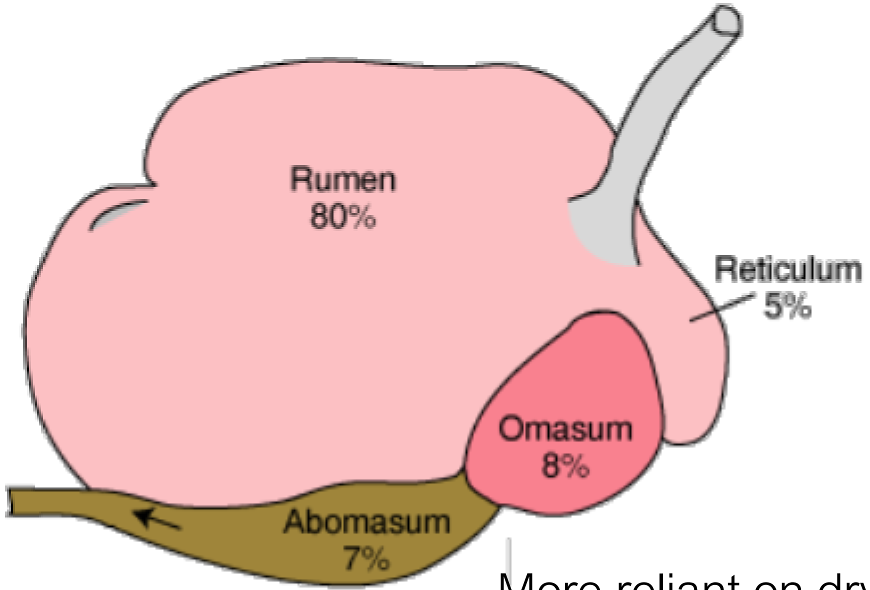


# Digesting track, proportional changes with age

Non-ruminant metabolism ---------- Ruminant metabolism



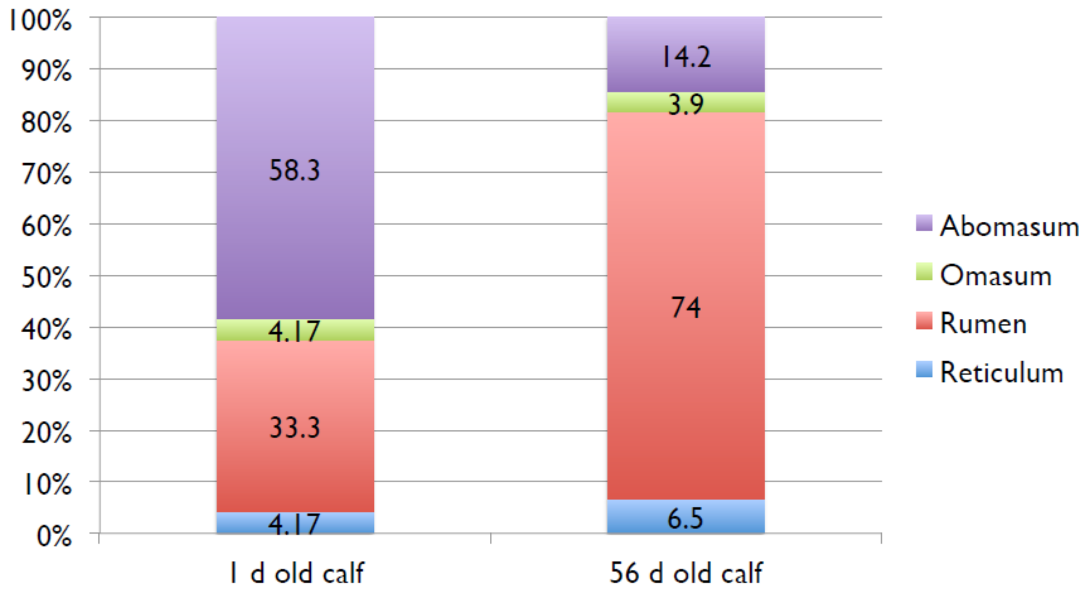

More reliant on milk/milk replacer than dry feed



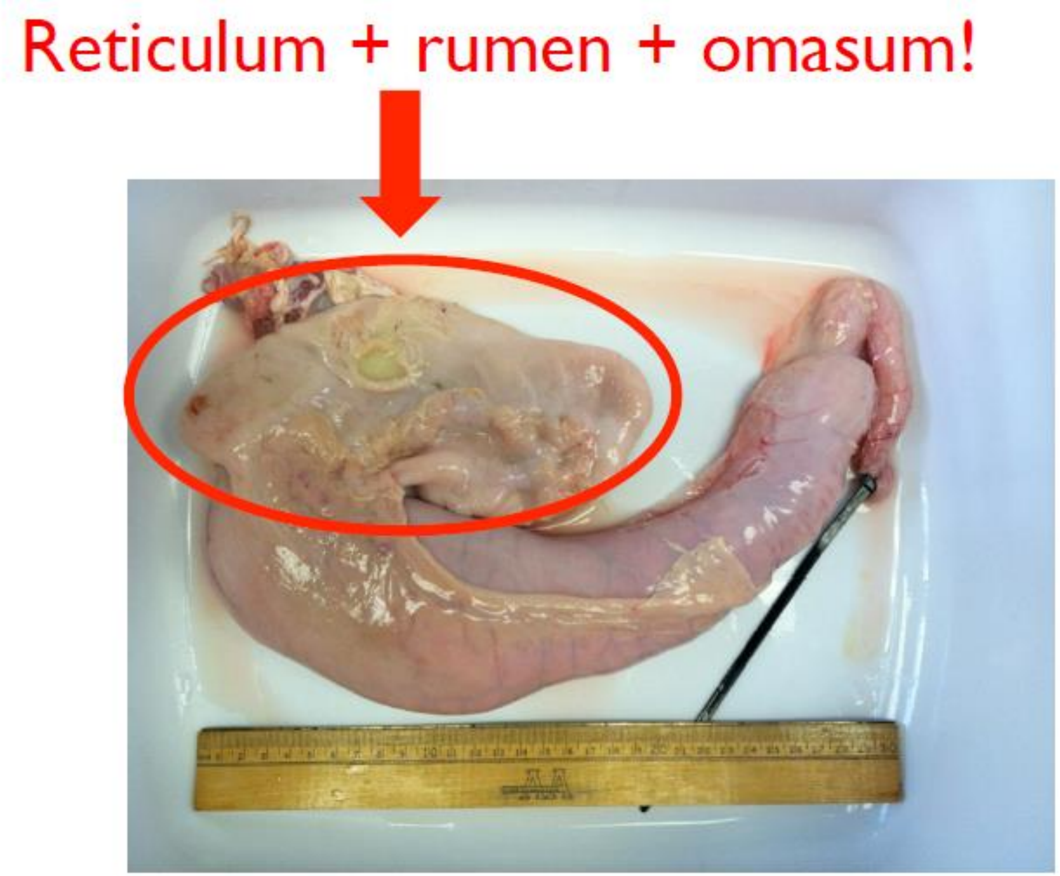

More reliant on dry feed

# The ruminant stomach
# Age when dry feed is introduced

Stomach proportions change with age




By delaying the offering of starter for 11 days:
Potentially miss out on
about 1kg of starter consumption



# Ruminant stomach size changes with age

1 day old calf stomach
inside changes too
Papillae are present but
they are tiny

**5 cm grid**

56 d old calf stomach



**5 cm grid**

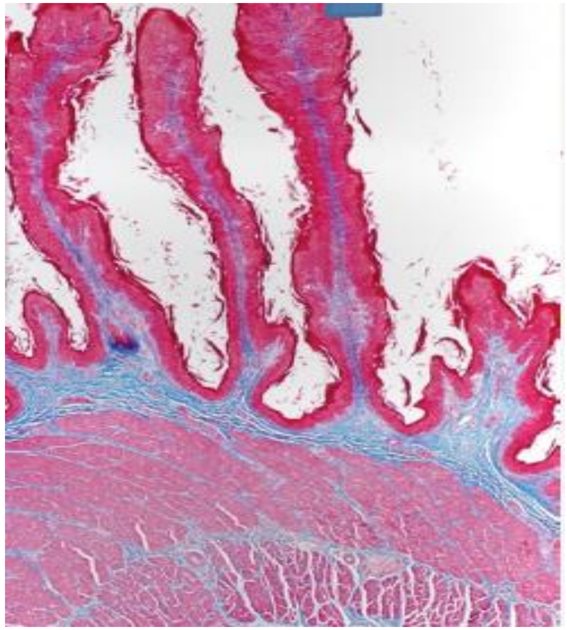
# Questions for us to consider

What do papillae do?

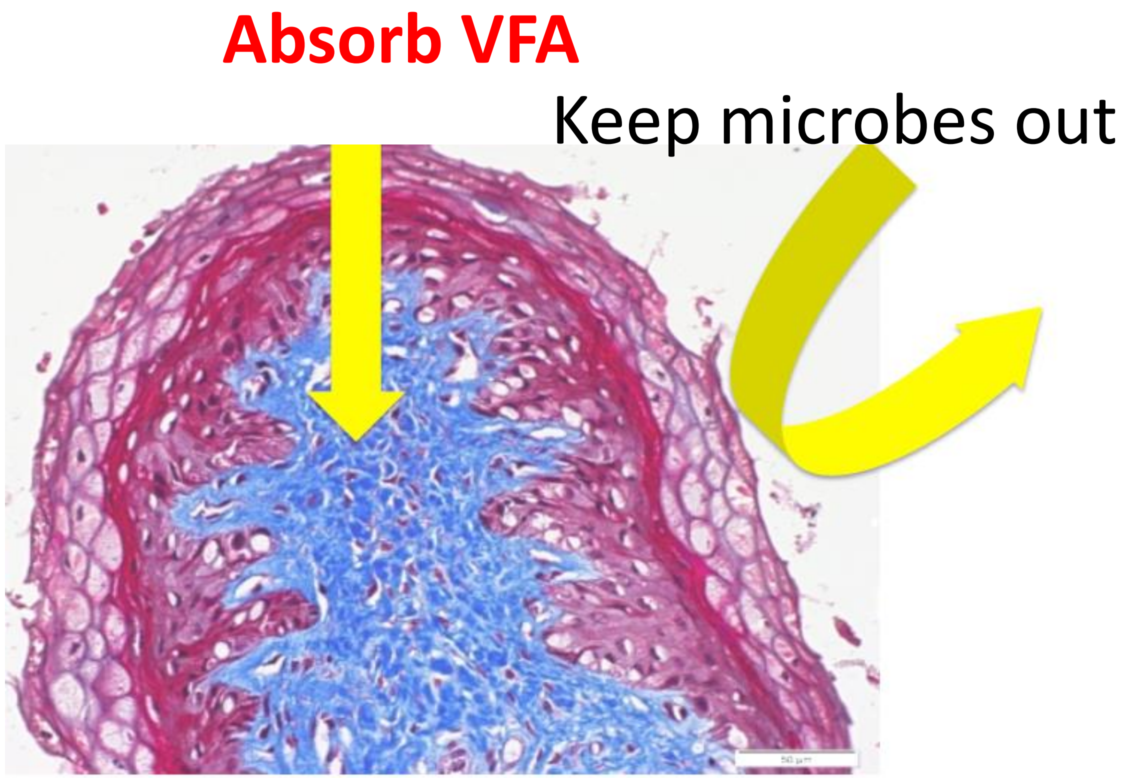
What drives papillae growth?

Does this just happen on its own?

Why are well-developed papillae desirable?



# Papillae functions



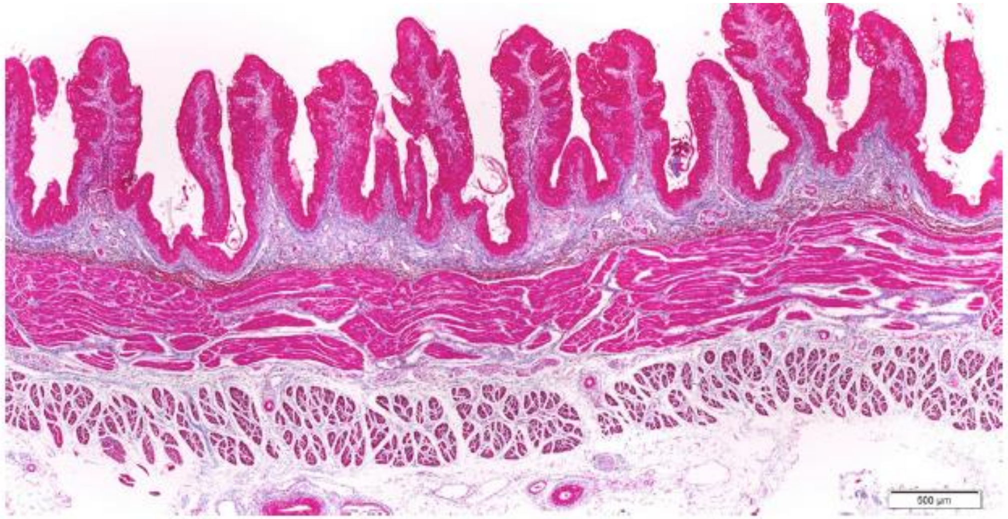

Do papillae simply grow as the calf grows?

So, calf age alone is not the driver of papillae development;

Diet has something to do with this process.

# Developing rumen papillae
# How can we promote their growth?

In adult cattle, absorbed VFA provide the majority of energetic precursors for metabolic processes.

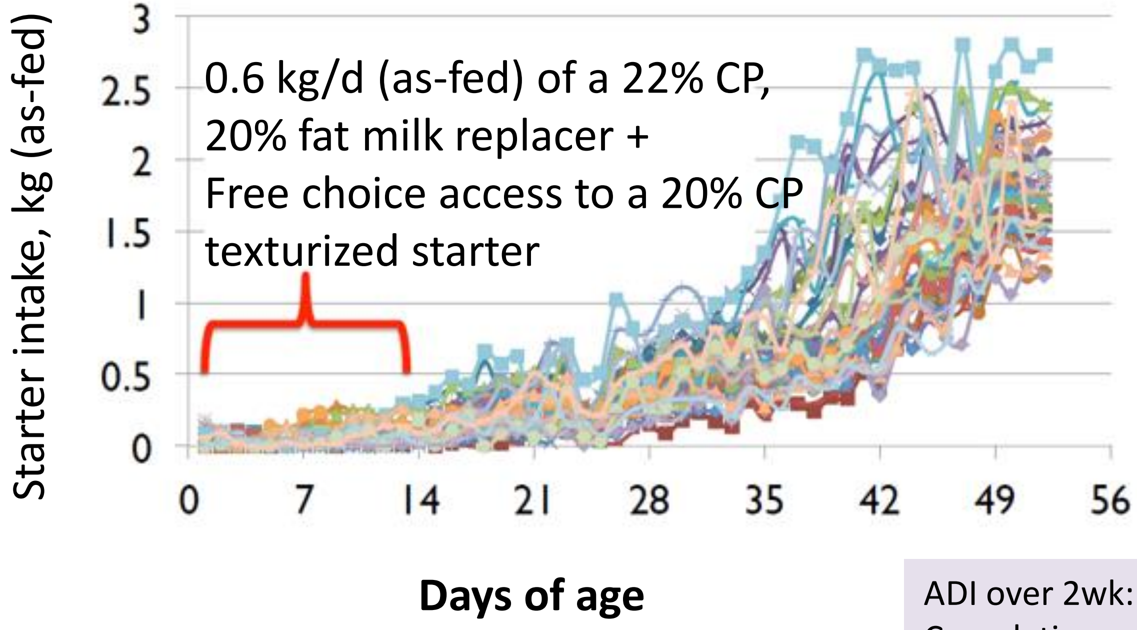



4 steps to developing a rumen:

1. Substrate availability in the rumen
2. Liquid in the rumen
3. Establishment of bacteria in the rumen
4. Absorptive ability of rumen tissue

# Early life voluntary starter intake is low

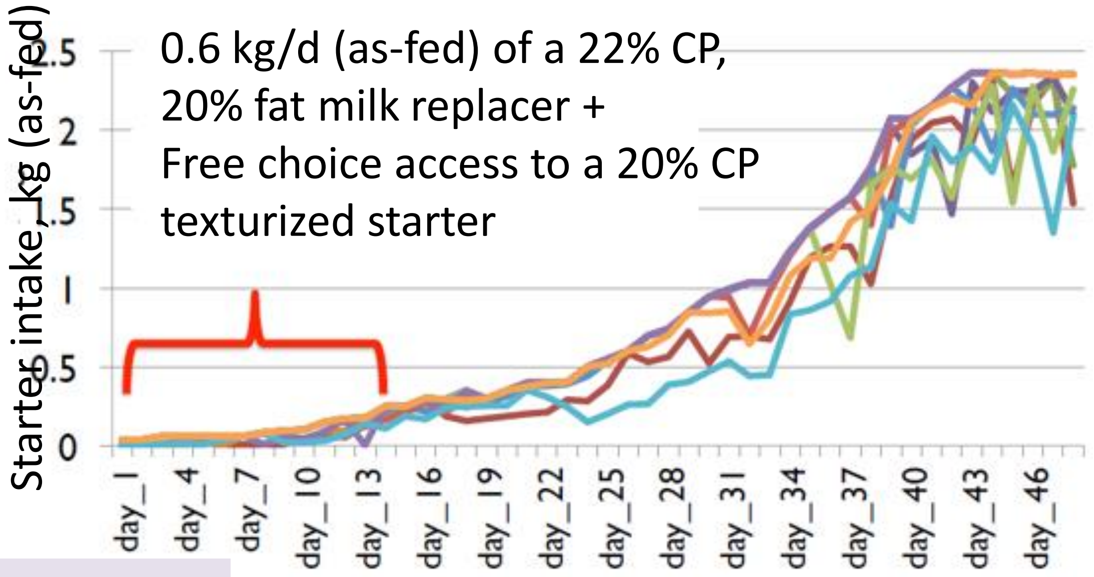
Voluntary starter intake (n = 56)
in Ohio State calf trial 2016




Yohe et al., 2015

ADI over 2wk: 0.08 kg
Cumulative over 2 wk: 1.13 kg
ADI CMR over 2 wk: 0.62kg/d
Cumulative: 8.8 kg

Voluntary starter intake (n =12)
in another Ohio State calf trial




Daniels et al., unpublished

# Avg age (days) when solid feedstuff is introduced

Operation Average Age (d)

Herd Size (number of cows)

| Diet | Very small (fewer than 30) Avg. | Very small Std. error | Small (30–99) Avg. | Small Std. error | Medium (100–499) Avg. | Medium Std. error | Large (500 or more) Avg. | Large Std. error | All operations Avg. | All operations Std. error |
|---|---|---|---|---|---|---|---|---|---|---|
| Starter grain or other concentrates | 17.6 | (3.4) | 10.9 | (0.7) | 8.0 | (0.4) | 6.3 | (0.3) | 10.8 | (0.6) |

Operation Average Age (d)

Herd Size (number of cows)

| Diet | Very small (fewer than 30) Avg. | Very small Std. error | Small (30–99) Avg. | Small Std. error | Medium (100–499) Avg. | Medium Std. error | Large (500 or more) Avg. | Large Std. error | All operations Avg. | All operations Std. error |
|---|---|---|---|---|---|---|---|---|---|---|
| Water | 15.6 | (2.5) | 20.0 | (1.1) | 15.4 | (1.1) | 7.8 | (1.0) | 17.3 | (0.7) |

NAHMS, 2014 Dairy

# Practically, what might this mean for calves near weaning?

Weaning age of calf.

If goal is to consume 1kg  of starter (as-fed) per day,

- Calf should have access to at least 3l water/d
- Water in addition to milk or milk replacer

If goal is to consume 2,5kg of starter (as-fed) per day, older heifers

- Calf should have access to at least 7l water/d

# Absorptive ability of rumen tissue

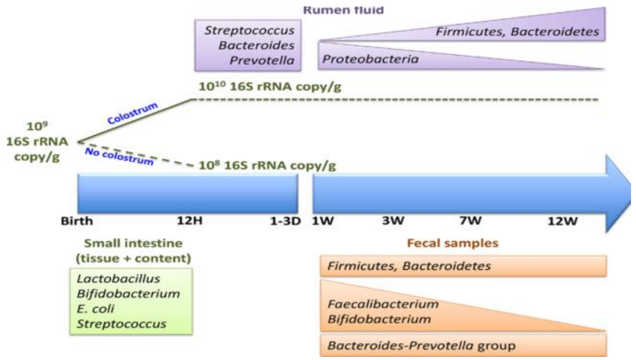
An analogy for importance of rumen papillae development

VFA absorption occurs by 2 mains routes:

– Passive diffusion

– Facilitated transport through membrane receptors

# Rumen microbial establishment




1. Inoculation starts during the birth process
2. In general a microbe can survive in the rumen if it has food
3. There are 2 distinct bacterial microbiomes in the rumen
   1. Rumen content microbiome
   2. Adherent rumen tissue microbiome

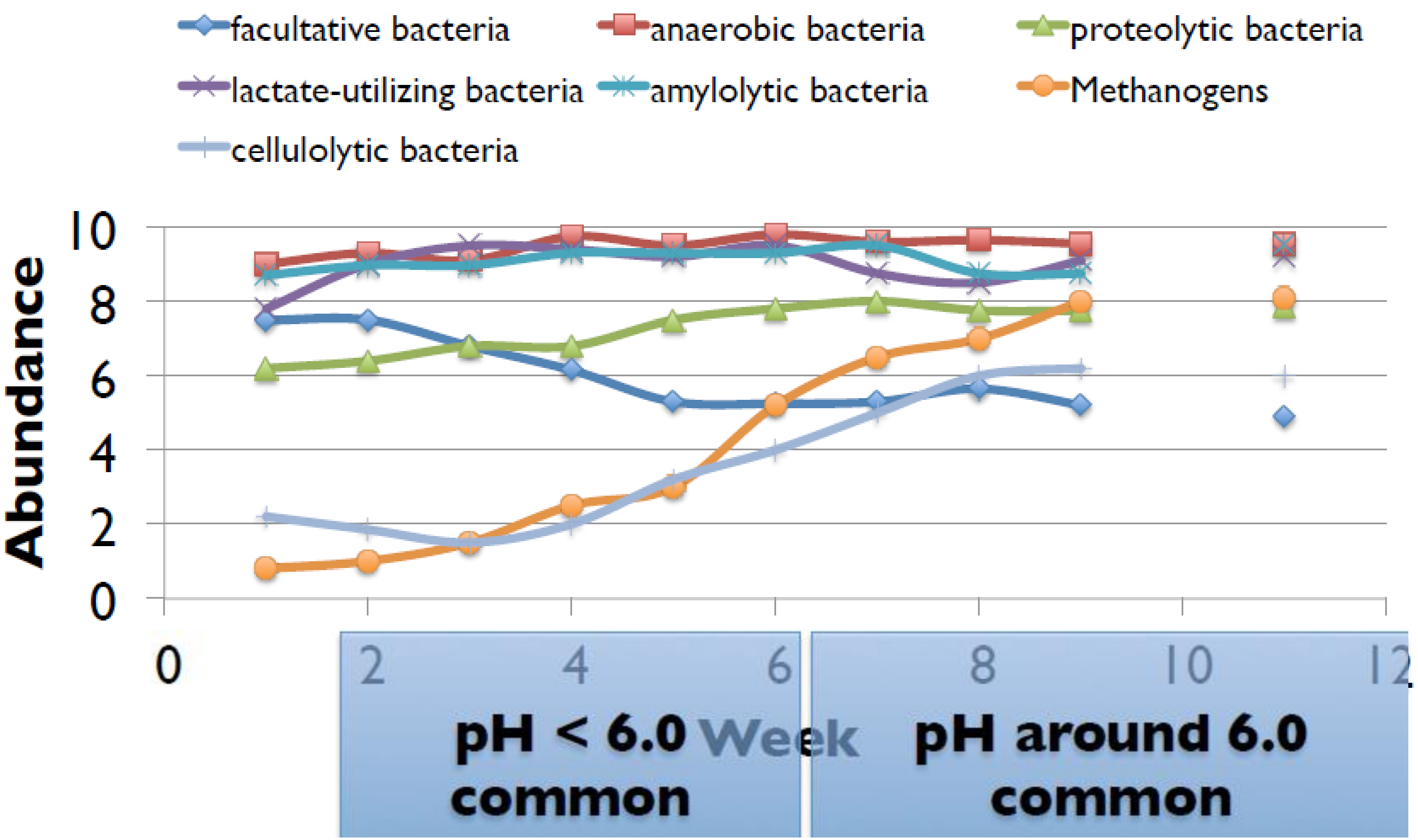
Mature rumen microbe number /ml contents

- **Anaerobic bacteria, $10^{11}$**
- Protozoa, $10^6$
- Fungi, $10^6$
- Methanogens, $10^9$

- In 3 d old dairy calves
  - Facultative bacteria, $10^7$
  - Anaerobic bacteria, $10^9$

Anderson et al., 1987

# Ruminal microbe establishment




Adapted from Anderson et al., 1987

# Cellulose provision to microbes

- When does this make sense?
- When does this not make sense?
- What does the NRC have to say?

*Photo by Mike Dixon.*

"Long hay should not be fed to calves until after weaning." (Dairy NRC, 2001)

*Or at least not until ruminal pH regulates around 6.0,*
*because cellulolytic bacteria don't like rumen pH  under 6*

# Take home points about rumen development

For calves, three growth phases make some physiological sense, assuming

Minimal starter intake before 2 wk of age – Weaned at 8 wk of age

1. Birth to 2 wk of age
   – Non-ruminant phase
2. 3 wk to 8 wk of age
   – Transition phase
3. 8 to 12 wk of age
   – Ruminant phase

Easiest things to address are:

access to starter, water, and forage (when it makes sense)

# How do egg antibodies work?

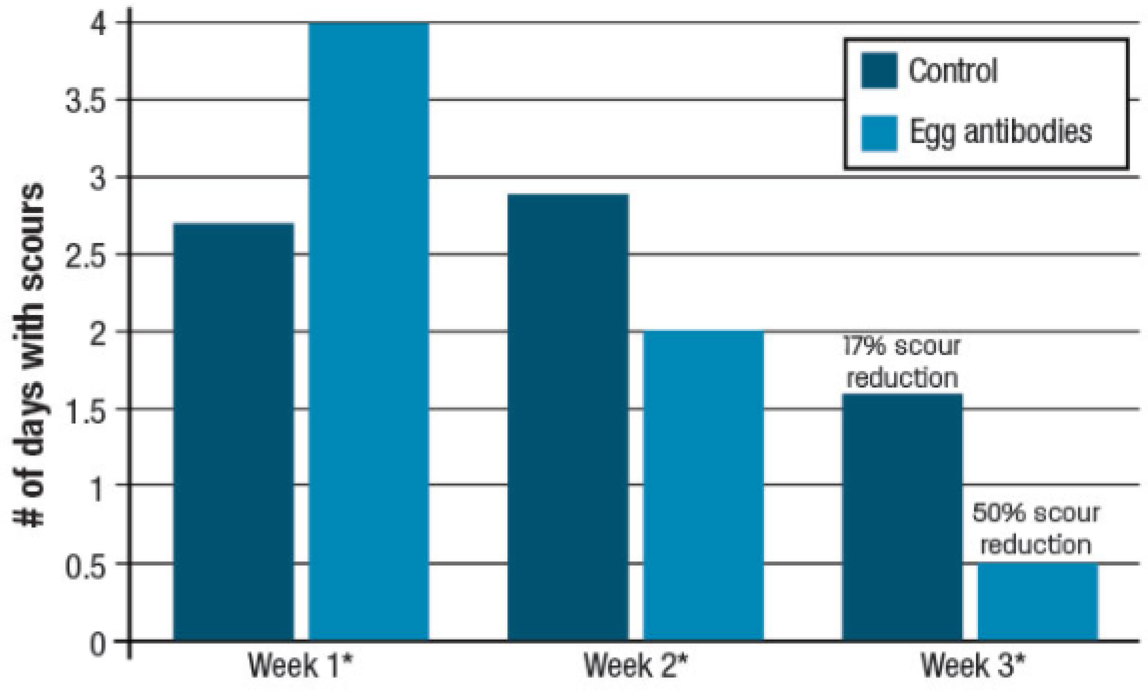
IgYs work in a similar to IgGs (colostral antibodies) in the gut but have a much greater ability per gram to bind to antigens than IgGs do.

IgYs do not cross into the bloodstream and have no effect on passive transfer.

they are not a substitute for an excellent colostrum protocol.

The IgYs bind to, and reduce, the pathogens' ability to attach to the gut lining and are passed in the manure.

Observed scour days when fed egg antibodies vs. control




*Denotes significance at $p<0.05$

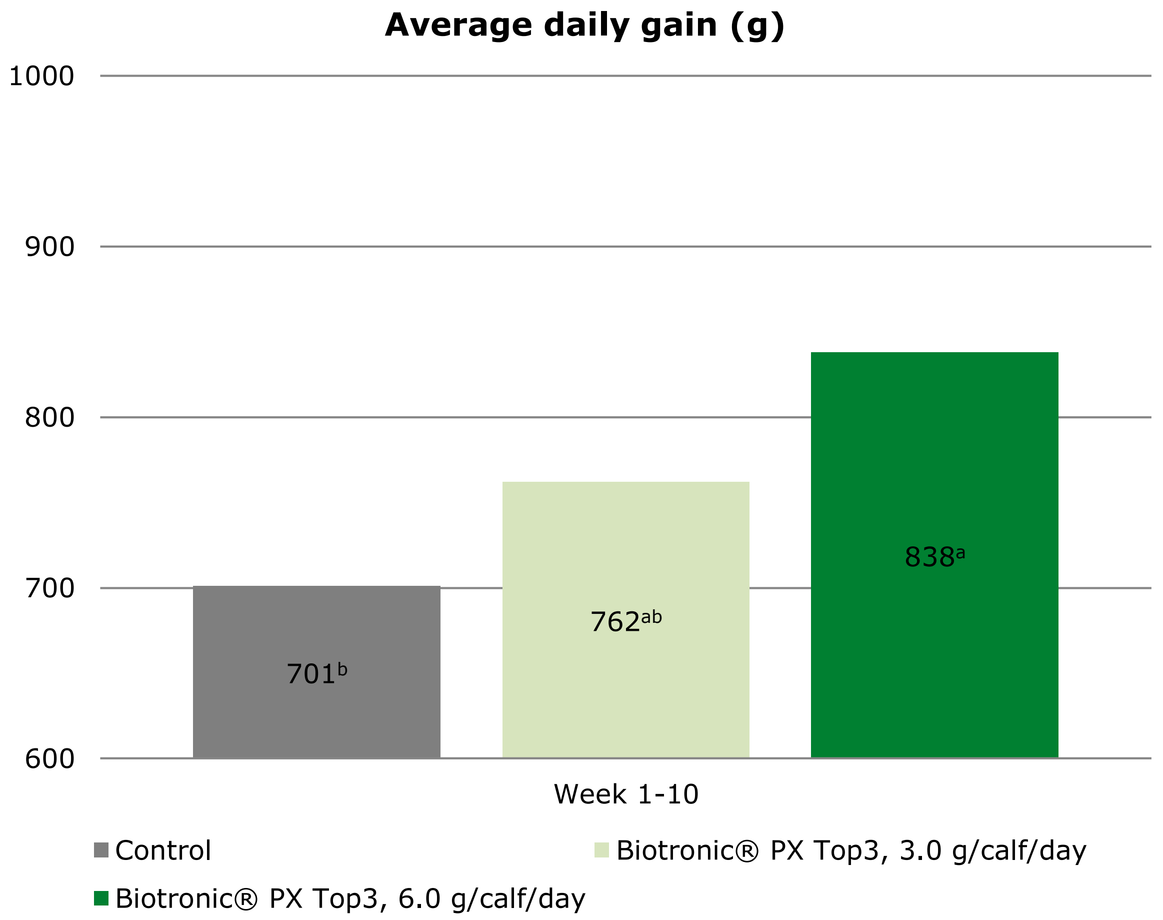
Jackson Matschke for Progressive Dairy Published on 31 July 2020

# PX TOP3 in milk
# Commercial farm, Denmark

Biotronic® PX Top3 in milk replacer of calves

led to…

- increased growth performance
- better faecal consistency → reduced diarrhea symptoms
- reduced coughing scores and nasal discharge → healthier calves



# How Biomin can help ?

Levabon Rumen in calf starter 2.5-5kg/T

85% of the Butyric Acid is absorbed in the rumen wall

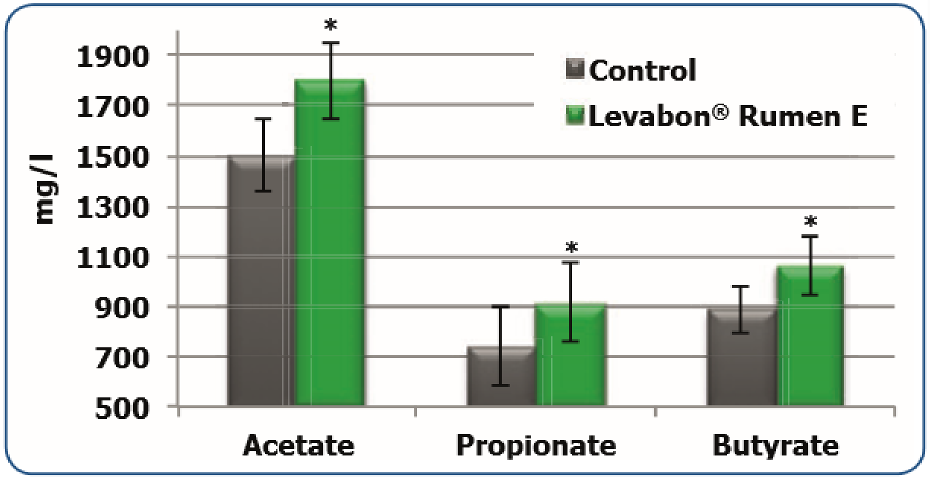
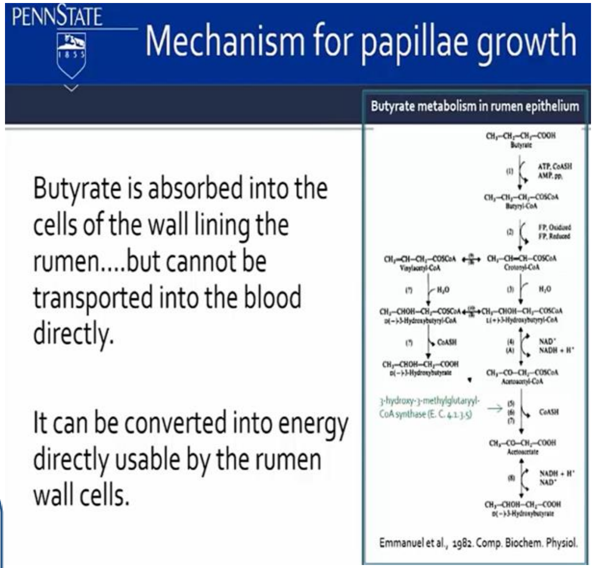
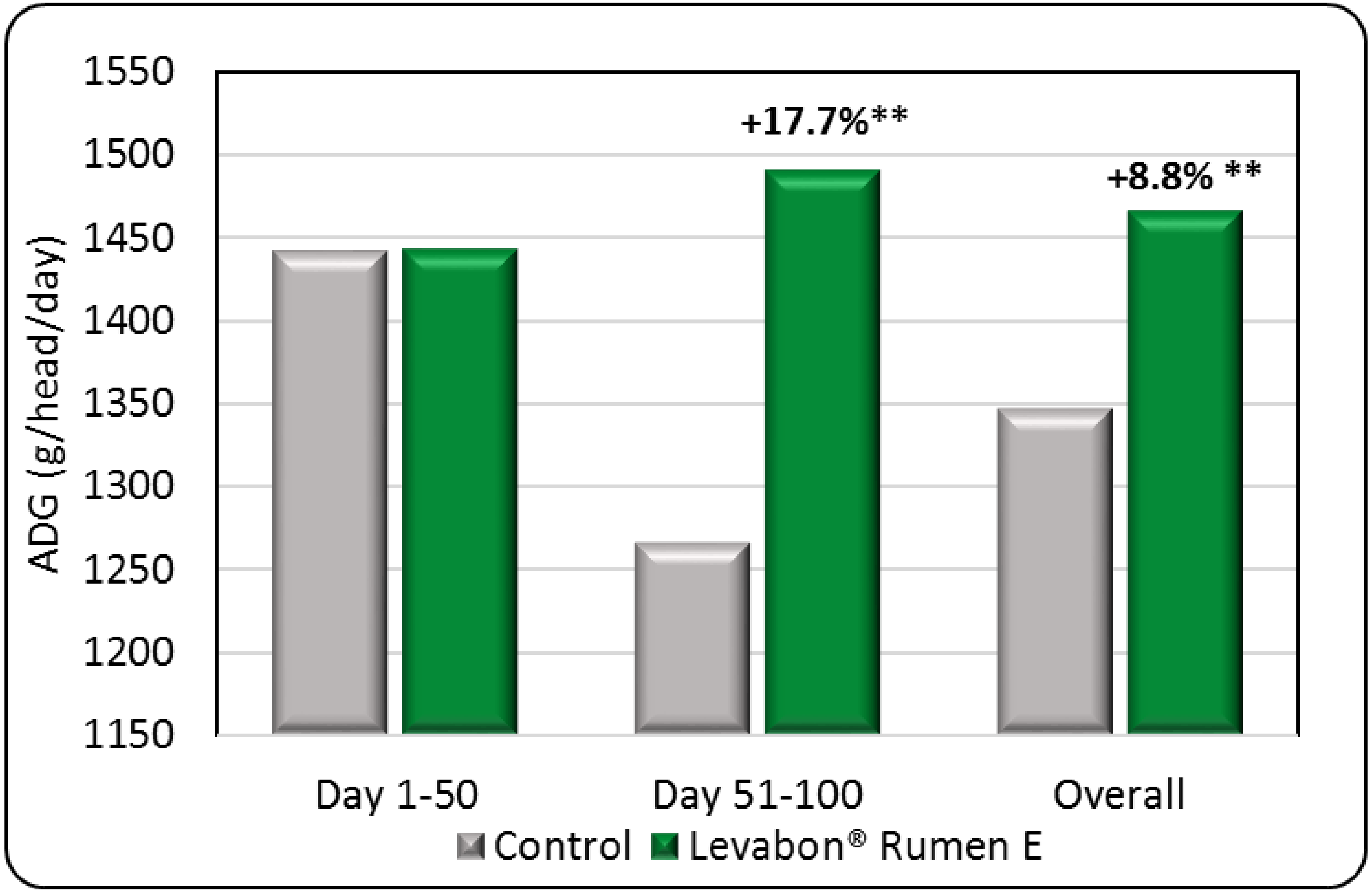




*Figure 2.* *Levabon® Rumen E supplementation increased the three volatile fatty acids (VFAs) acetate, propionate and butyrate significantly (p<0.05) (n=18).*



# Average Daily Weight Gain (ADG)

## Germany, 2012




** highly statistically significant ($P < 0.001$)

**Levabon® effect on weight gain:**

- Similar ADG in first 50 days
- Significant increase in ADG from Day 51 to 100 (high starch diet) +224 g/head/day ($P < 0.001$)
- Significant increase in ADG over whole trial +119 g/head/day ($P < 0.001$)