The Effect of Continuous Low-level Feeding of Aureomycin on Dairy Cows
CE **Polan**, GA McLaren, AH Rakes… - 1962 - West Virginia University, Agricultural …

The effect of continuous feeding of chlortetracycline on lactating dairy cows.
CE **Polan** - 1960 - West Virginia University

Biohydrogenation of unsaturated fatty acids by rumen microorganisms.
CE **Polan** - 1963 - North Carolina State College.

ROLE OF BACTERIA IN RUMINANT NUTRITION

1

Probiotics and the health of newborn calves?

Bob James
Dept. of Dairy Science

The newborn calf

- Calf is sterile at birth
- Early microbial colonization - rather haphazard?
- Risk of colibacillosis? Early colonization by E. coli.
- Can dosing calf with “good”bacteria” colonize intestine and prevent establishment of E. coli.

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3

Probiotic product from Salem, VA?

- Lactobacilli grown on wheat bran
- Dose calf with priobiotic in shipped in calves housed at Vet Science
- Challenge with enteropathogenic strain of E. coli.

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Problems with probiotics –
according to W. E. C. Moore – VPI Anerobe Lab

- Most intestinal organisms are anaerobes not aerobes
- Microflora is a mixed culture of organisms.
- Liklihood of single species or few species to successfully populate is nill
- Intestine is rapidly populated by organisms at birth.

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Source of meaningful probiotic?

- Source of organisms for probiotic?
  - Older milk-fed calf?
- Duodenal cannulated
- Collect and mix with whey solution
  - Intestinal fluid is of low palatability.

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Influence of "probiotic" on resistance to enteropathogenic E. coli challenge
James et al, 1976

- Calves entered our facility @~ 3 hour of age
- Colostrum fed @ ~ 5 hours of age
  - No E.coli challenge
  - E. coli challenge @ 12 hours
  - E. coli challenge @ 24 hours
  - All with or without "probiotic" inoculum of 200 ml of duodenal fluid from milk-fed calf.
    - Whey solution as carrier

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Results

- Calves receiving probiotic inoculum had less diarrhea and higher ADG for 1st 14 days.

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Serum gamma globulin – g/100 ml @ 24 h

Inoculum	O	12 h challenge	24 h challenge	Means
No inoculum	1.1	0.94	1.68	1.24
Inoculum	.5	0.49	.59	.53
Means	.80	.72	1.14	.89

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Follow up study

James et al., (1978)

- Three Treatments
  - Colostrum @ 2.5 hours of age
  - Colostrum and inoculum (200 ml duodenal fluid) concurrently @ 2.3 hours of age
  - Inoculum followed three h later by colostrum @ 5.6 hours of age
  - No E. coli challenge

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Mean total protein and gamma globulin (g/dl) @ 24 hours of age.

Treatment	Total serum protein	Gamma globulin
No inoculum	5.97+/-0.94	1.05+/-.36
Colostrum and inoculum concurrent	6.07+/-0.64	1.08+/-.41
Delayed colostrum	5.22+/-.59	.76+/-.31

Delayed colostrum calves had lower protein and gamma globulin

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Cause of apparent depression in Ig absorption?

- Live bacteria?
- Cell walls of bacteria (endotoxins)?
- Carrier for the inoculum – dried whey?

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Intensive study

James et al, (1981)

- Utilized “gut loops” in newborn calves ~ 8.6 hours at beginning of treatments
- Constructed beginning 1.8 M anterior to ileocecal junction
- Each calf received all treatments
- Incubated for 4 hours
- Inject loops with ^{125}I – gamma globulin in electrolyte solution incubated for 75 min.

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Treatments

- Live bacteria – .3ml duodenal fluid – 9 ml anaerobic rumen fluid glucose cellobiose broth (RGC). **Anaerobic culture**
- Autoclaved culture
- Sterile RGC broth

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Treatment means for uptake, bacterial no. in tissue and inoculum

Uptake of gamma globulin[a]			Bacterial growth in tissue[b]		
Live bacteria	Sterile broth	Autoclaved bacteria	Live bacteria	Sterile broth	Autoclaved bacteria
2.09 +/- 1.15	3.18 +/- 1.50	3.56 +/- 1.49	**594+/- 316**	86 +/- 82	220

[a] milligrams gamma globulin internalized/g tissue
[b] Bacteria ($X10^6$)
Uptake reduced only with live bacteria culture – ($P<.05$)
organisms significantly related to uptake

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Three Q’s of colostrum management

- Quickness – feed as soon as possible with a goal of less than 6 hours
- Quantity – 4 liters in 1st 12 hours
- Quality - >50g/liter
- Not colostrum again!

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Add another letter to the list?

- "C" for cleanliness

VirginiaTech Invent the Future

Microbial risks associated with feeding colostrum

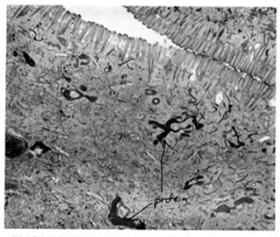
VirginiaTech Invent the Future

Review Ig absorption in the calf

Ig Absorption

- Large MW macromolecules absorbed from Jejunum and proximal ileum
- 1st 2 – 24 hours of life
- Variable efficiency
- Little selectivity in uptake
- Some selectivity in transfer through serosal side

Calf epithelium ~ 24 hours



Corley et al. 1977

VirginiaTech Invent the Future

Cessation of Ig absorption

- Cessation termed closure
- Differs by species
- In the calf
  - Not as diet dependent
  - Very variable onset – 6 – 24 hours
  - Precipitous decline in absorptive efficiency

VirginiaTech Invent the Future

Closure - One step process where uptake and transfer ceases

- Theories
  - Development of gastric and enzymatic function
  - Reduction in permeability of villus epithelial cells
  - Replacement by generation of cells incapable of pinocytocis

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Replacement by generation of cells incapable of absorption.

- Micropinocytotic IgG transfer by newborn calf enterocytes
  - Existence of a receptor mediated transport system?
  - Relationship between apoptosis in cessation of Ig transfer

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Apoptosis and IgG absorption in goats

Castro-Alonso et al. (2008)

- 10 new born kids
- Fed colostrum – 2,000 mg IgG/kg body weight – 2X @ 2 and 14 h
- Sacrificed - birth – 60 d of age.
- Assessed for apoptotic cells and stained for IgG.

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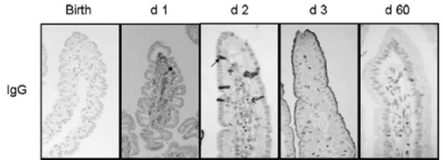
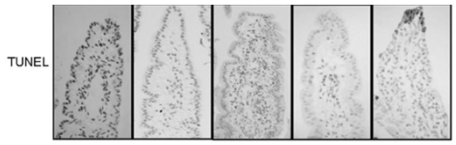
IgG staining in duodenum of goat kids harvested at …..



Birth - no IgG immunoreactivity
Day 1 – IgG internalized
Day 2 + IgG was bound to enterocytes but minimal internalization
Day 60 – No staining for IgG

24

Terminal deoxynucleotidyl transferase nick end labeling (TUNEL) – identifies apoptotic cells



Birth – TUNEL staining at center of villus
Day 1 – staining is significantly reduced after day 1
Day 60 – only cells at villus terminus are staining

Conclusions

- Relationship of IgG absorption with apoptosis in the intestine?
- Apoptosis is influenced by composition of colonizing intestinal bacteria in pigs (Willing and Van Kessel, 2007)
- How to delay apoptosis?

Feeding heat-treated colostrum or unheated colostrum with two different bacterial concentrations to neonatal calves - Elizonda-Salazar and Heinrichs, 2009

- Treatments
  - Colostrum frozen - low bacteria
  - Colostrum pasteurized – 60°C / 30 min. then frozen
  - Colostrum stored at 20°C for 24 h then frozen
  - First feeding 3.8 liters / 68g IgG/liter - 1.5 – 2 h after birth with esophageal feeder.

IgG (g/L) and SPC of colostrum Serum protein and IgG @24 h

Item	Low bacteria	High bacteria	Heat – treated
IgG (g/L)	69.55	69.55	66.17
SPC x10^3/ml	9.332	40.738	.645
Serum protein @ 24h (g/L)	57	56.2	62.5
IgG @ 24 h (g/L)	20.2	20.1	26.7
AEA of IgG @ 24 h (%)	35.4	32.4	43.9

Heat treating improved AEA and IgG at 24 h.
High bacteria load was relatively low / less than 100,000 goal (McGuirk)

Role for microbial colonization and Ig absorption?

- Rate of intestinal cell production in the crypts
- Migration of cells up the villus and desquamation from the tips influenced by microbial colonization?
- Microbes may occupy binding sites on the apical plasma membrane.

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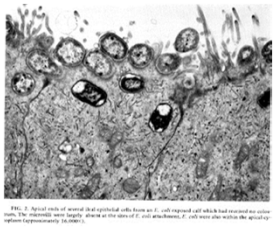
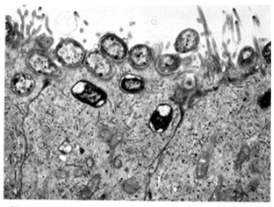
Intestinal microflora and the absorptive surface

- Colostrum deprived calf receiving E. coli O55
- Exfoliation of microvilli
- Intracellular penetration of epithelial cells

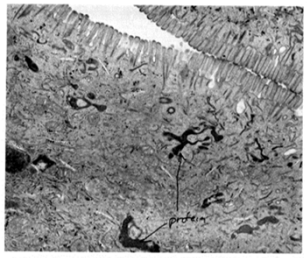


Corley et al. , 1977

30



Colostrum deprived



Colostrum fed calf

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How is colostrum managed on many dairies?

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How is colostrum managed on dairies?

33

Field studies of colostrum quality

- Swan et al., 2007 –
  - 12 Minnesota and Wisconsin dairies
  - Median TPC – 6.15×10^8
  - Varied from $7X\ 10^7$ - $>10^9$
  - 93% of samples over goal of 100,000 TPC
- Poulsen et al., 2002
  - 82% of samples over 100,000 TPC

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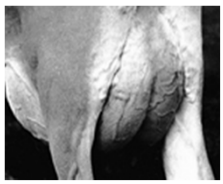
Critical control points for colostrum contamination



udder

Collection bucket

Esophageal feeder

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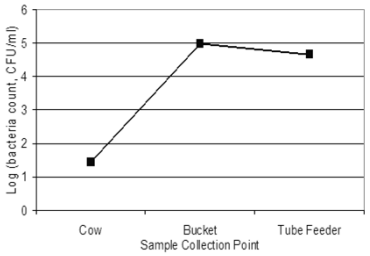
Critical control points

Stewart et al, 2005



Samples from cow, bucket and tube feeder
64% of samples collected within 20 min of harvest were <100,000 TPC

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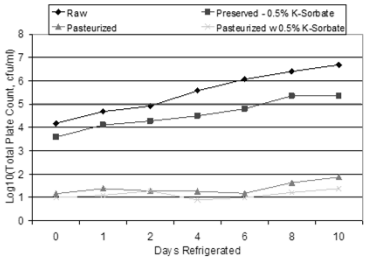
Growth during storage



Goal – 100,000

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Batch pasteurization of colostrum

- 60º – 60 minutes
- Batch pasteurization
- Higher temperatures = cottage cheese

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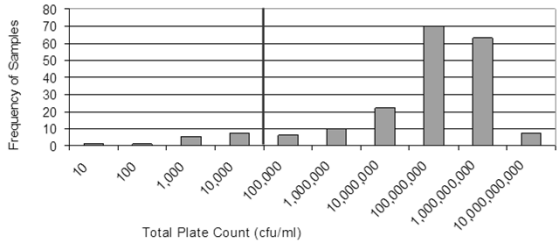
Total Bacteria Counts in Minnesota Colostrum

(Swan et al. 2007. JDSci. 90)

Median TPC = 615 million cfu/ml (73 to 104 billion)

93% of samples > 100,000 cfu/ml TPC

"*We are feeding 'fat-laden' manure*" Rob Trembley, 2006



From - S. Godden

Raw vs. pasteurized colostrum

Johnson et al., 2007

Parameter	Raw	Pasteurized
IgG – mg/ml	72.6	67.3
Total plate count	46,000	872

Colostrum	Serum protein	IgG concentration	AEA %
Raw	5.9 g/dl	18.1 mg/ml	35.6
Pasteurized	6.3g/dl	22.34 mg/ml	26.1

Correct table in proceedings

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Recent UMN Field Study

M. Donahue, S. Godden

- 1,000 calves / 6 herds
  - ½ fed raw and ½ fed heat-treated colostrum
- Colostrum total plate count and serum IgG – negative
- Colostrum IgG concentration – positive effect
- Heat treatment – positive – independent of Total plate count

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30 years later - lots of common sense

Did some “West Virginia” rub off?
I hope so!!!!

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Common Sense and Colostrum

- Clean cows – infection and sanitation
- Don’t pool colostrum
- Milk fresh cows first and process colostrum immediately.
- If refrigerating – cool rapidly in ice bath
- Clean buckets, bottles and esophageal feeders
- If herd size and herd infection status warrants – pasteurize or use replacer
- Avoid use of probiotics for 24 hours

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Thanks, Carl!

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