Colostrum Management Strategies

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Colostrum Overview

Key Elements of Today’s Lecture

• What is the purpose of colostrum?
• Key Factors for managing colostrum
  ◦ Quality
  ◦ Quantity
  ◦ Quickness
• How do we FIX the problems?
• New Research
Define the Problem Areas

WHAT ARE THE ON-FARM SOLUTIONS?
Important 4’s

- 4 hours after delivery of the calf the quality and concentration of colostrum is rapidly decreasing.
- Feed 4 liters of quality colostrum in order to achieve adequate passive transfer
- Within 4 hours the gut wall of the calf is already closing. Feed first 4 liters within 4 hours of birth.
Important 4’s

- 4 weeks for the calf’s immune system to develop
- Mammary development is determined largely during this same 4 weeks
- Feed costs and medical costs are highest for the first 4 weeks of the calf’s life
Feeding Colostrum

*****QUALITY*****

- Average colostrum quality is 45-50mg Ig/ml
- What impacts quality?
  - Nutritional status of the cow
  - Vaccination status of the cow
  - Environmental stress and contamination
  - Collection, treatment, storage and feeding of the colostrum
What is the Purpose of Colostrum?

- Immune System
- Minerals
- Vitamins
- Nutrients
- Warmth
Contents of Colostrum

- Immunoglobulins
  - IgG (G1/G2) average 41 mg/ml
  - IgM average 4.3 mg/ml
  - IgA average 1.7 mg/ml

- Leukocytes (macrophages)
- Oligosaccharides
- Trypsin Inhibitors
Ig Molecules in the intestines

Transported through the intestinal enterocytes

Into blood vessels
## Contents of Colostrum

<table>
<thead>
<tr>
<th></th>
<th>Colostrum</th>
<th>Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>14.9%</td>
<td>4.0%</td>
</tr>
<tr>
<td>Fat</td>
<td>6.7%</td>
<td>4.0%</td>
</tr>
<tr>
<td>Lactose</td>
<td>2.5%</td>
<td>5.0%</td>
</tr>
<tr>
<td>Total Solids</td>
<td>27.6%</td>
<td>12.9%</td>
</tr>
<tr>
<td>Vit A</td>
<td>240ug/ml</td>
<td>34ug/ml</td>
</tr>
<tr>
<td>Vit E</td>
<td>80ug/ml</td>
<td>15ug/ml</td>
</tr>
<tr>
<td>Vit B$_{12}$</td>
<td>4.9ug/ml</td>
<td>0.6ug/ml</td>
</tr>
</tbody>
</table>
Contents of Colostrum

- Minerals
  - Ca, K
  - P, Zn
  - Mg, Na
  - Fe, Cu, Mn
  - Fe, Cu, Mn??
How do we FIX colostrum quality?
Contamination During Colostrum Harvest

(Stewart et al. JDS. 2005. 88)
Iowa State University Study 2011

- 800 samples from 67 dairies in 12 States
- Average bacteria 550,000 cfu/ml recommended level is <100,000 cfu

- Samples taken at various steps in the management of colostrum showed other interesting findings
Iowa State University Study 2011

- Colostrum moved too many times
  - Average transfer 2.5 times
  - 42% transferred colostrum >3 times before feeding

- Held at room temperature too long
  - 54% samples held for >60 minutes before storage or feeding

- Refrigerated for too long
  - Refrigerated samples 10X more bacteria than average samples fresh from cow
How often do producers feed contaminated colostrum?

- **Goal:**
  - total plate count (TPC) < 100,000 cfu/ml
  - total coliform count < 10,000 cfu/ml
  
  (McGuirk and Collins. 2004. VCNA Food Animal Practice)

- **Wisconsin field investigation data:**
  - 82% of samples had TPC > 100,000 cfu/ml
  
  (Poulsen et al. Proc. ACVIM. 2002. #52)
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

"Estamos alimentando estiercol 'cargado de grasa' a nuestras becerras"
Infected Gland or Fecal Contamination

- *Escherichia coli*
- *Salmonella* spp.
- *Mycoplasma* spp.
- *Mycobacterium avium subsp. paratuberculosis* (MAP)
- *Mycobacterium tuberculosis*
- Bovine Leukosis Virus
- *Listeria monocytogenes*
- *Campylobacter jejuni*
- *Staphylococcus aureus*
- *(M. bovis)*
- *(Brucella abortus)*

(Fontaine et al., Am. J. Epidem. 1980. 111:247
Acosta-Martinez et al., AJVR. 1980. 41:1143)
Why does it matter if there are Bacteria and viruses in the Colostrum?

- May interfere with absorption of Immunoglobulins (IgG)
- Causes illness in calves
- Can spread disease that will remain endemic in the herd
Can bacteria in colostrum interfere with passive transfer of immunoglobulins?

- Uptake of globulin protein across the gut was reduced when bacteria were present
  
  (James et al., J.D.S. 1981.64; Staley and Bush, J.D.S. 1985. 68)

- Proposed Mechanisms?
  - Antigen-antibody complex may form in gut lumen
  - Damage to villus epithelial cells might reduce permeability
  - Enhanced replacement of permeable cells by cells incapable of macromolecular uptake (nonspecific pinocytosis)
  - Nonspecific pinocytosis of bacteria could block absorption of Ig molecules (limited pinocytosis)

  (Corley et al. J.D.S. 1977. 60)
Ig Molecules in the intestines

Transported through the intestinal enterocytes

Into blood vessels
Do bacteria interfere with passive transfer of IgG?

- High bacteria counts in colostrum were associated with...
  - Higher fecal consistency scores (more diarrhea)
  - Lower acquisition of passive transfer of IgG
    (Poulsen et al. Proc. ACVIM. 2002. #52)

- Calves fed pasteurized colostrum have higher AEA % IgG
  (Johnson et al., 2007; Donahue et al., 2008; Elizondo-Salazar & Heinrichs, 2009)

- High bacteria count colostrum was associated with lower serum IgG concentrations (> 1000 calves from 12 MN dairy herds) (Godden, 2010, unpublished).
How to Measure Quality

Colostrometer

Figure 1

Figure 2

Bacterial Cultures

Brix Refractometer
Methods to Reduce Pathogens in Colostrum

- Avoid pathogen contamination of colostrum:
  - Identify infected cows? (MAP, TB, Brucellosis)
  - Don’t let calf suckle dam
  - Udder prep
  - Don’t pool raw colostrum

- Reduce other sources of contamination:
  - Sanitation of milking, storage & feeding equipment
Methods to Reduce Pathogens in Colostrum

- Prevent bacterial proliferation in stored colostrum:
  - Feed (< 1-2 hrs), refrigerate (< 48 hrs) or freeze ASAP
  - Use of preservatives … Potassium Sorbate

- Remove Bacteria from the Process:
  - Colostrum replacers (feed 150 - 200 g IgG, efficacy tested)
    - Expensive
    - Do not contain all the components of natural colostrum
  - Pasteurize colostrum
    - Retains nearly all of the components nature intended
    - Economical way to use colostrum on the dairy
Comparing Management Methods to control bacteria growth

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Day 1</th>
<th>Day 3</th>
<th>Day 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerated</td>
<td>1,920</td>
<td>9,600</td>
<td>110,000</td>
</tr>
<tr>
<td>Frozen</td>
<td>2,460</td>
<td>16,880</td>
<td>11,860</td>
</tr>
<tr>
<td>Ascorbic Acid</td>
<td>2,220</td>
<td>10,600</td>
<td>110,000</td>
</tr>
<tr>
<td>Pasteurized</td>
<td>112</td>
<td>554</td>
<td>1,260</td>
</tr>
</tbody>
</table>

* Daw & Devalaar, Dordt College Research, Sioux Center, IA  2012
Tips for handling colostrum

- Use single serve containers for all steps of colostrum handling
  - Cools more quickly for better quality
  - Ensures the right amount per calf
  - Avoid cleaning issues

- Feed the correct amount to the calf based on its weight.
Perfect Udder® Colostrum Management System

- Special Material allows for rapid heating and cooling
- Perfect for clean storage
- Pasteurize in the bag
- Feed Directly from the bag with a nipple or Esophageal tube
- Avoid dirty bottles and eliminate cleaning labor
Potassium Sorbate Preservative
Colostrum Replacers and Supplements
Pasteurization (Heat Treatment) of Colostrum
Pasteurizing Colostrum

- Batch pasteurize: 60 °C x 60 min
  - No viscosity changes
  - No change in colostrum IgG (mg/ml)
  - Significantly reduce or eliminate *M. paratuberculosis*, *Salmonella*, *Mycoplasma bovis*, *E. coli*, *Listeria*

What about 30 Min.?

- Heat treatment of colostrum at 60°C for 30 min reduced colostrum bacteria concentration yet maintained colostral IgG concentration and viscosity at similar levels to the control treatment.

McMartin et al. JDSci. 2006.9:2110
Godden et al., JDSci. 2006.89:3476

Elizondo-Slazaar, etal J. Dairy Sci. 92 :4565–4571
Bacterial counts were significantly reduced in heat-treated colostrum

Effect of feeding pasteurized colostrum on colostrum characteristics and passive transfer in calves
(Johnson et al., J.D.Sci. 2007. 90)
Pasteurization did not affect Colostrum IgG Levels

![Graph showing comparison of Colostral IgG (mg/ml) between Heat Treated and Fresh Treatment Groups. The Heat Treated group has a value of 67.27 mg/ml, while the Fresh group has a value of 72.56 mg/ml.]
Serum IgG levels were significantly higher in calves fed heat-treated colostrum.

<table>
<thead>
<tr>
<th>Time after colostrum feeding (hrs)</th>
<th>Serum IgG concentration (mg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Raw: 0.4, Heat-treated: 0.3</td>
</tr>
<tr>
<td>24</td>
<td>Raw: 17.5, Heat-treated: 22.3</td>
</tr>
</tbody>
</table>
Efficiency of IgG absorption was significantly higher for calves fed heat-treated colostrum.
• **Conclusions from pilot study** (Johnson et al., JDS 2007. 90)
  ◦ Feeding pasteurized colostrum resulted in:
    • No effect on IgG levels in colostrum
    • Reduced bacterial exposure through colostrum
    • Improved passive transfer of IgG in calves

• **Summer 2007 – initiate large field study feeding pasteurized vs raw colostrum:**
  ◦ > 1100 calves enrolled from 6 herds
  ◦ Calves fed pasteurized colostrum had:
    • Improved IgG levels
    • No effect on preweaning health, growth
  ◦ **Adulthood – in progress:**
    • Risk for MAP infection, longevity, production
DT30G Milk & Colostrum Pasteurizer

- Dairy Tech, Inc.
- 115 Liter capacity
- For 10-60 calves
- Batch Pasteurizer
- 110vac/220vac
- Auto-Controls
- Delay Start
- Plug & Play
- Milk or Colostrum
DT10G Pasteurizer

- Dairy Tech, Inc.
- DT10G Platinum
- 4-38 Liters
- 5-18 calves
- Colostrum or milk
- 220vac & cold water
- Fully automated
Feeding Colostrum

**QUANTITY**

- **How much to feed**
  - 10% of body weight of quality colostrum
  - Goal is >10g/L serum IgG
  - 90lb (41kg) needs 1gal (3.8L)

- **How often to feed**
  - 4 liters in one feeding …or…
  - Multiple smaller feedings … which is better?
Feeding Colostrum

***QUICKNESS***

- When to Feed

Within 1-2 hours of birth
Feed with the Nipple?
or Feed with the Esophageal Tube Feeder?
Colostrum Reheating

- Rapidly thaws frozen colostrum while protecting the Ig molecules
- Increase thaw times by 4X
- Can be used with Perfect Udder bags or standard bottles
Overview of Colostrum Management

- The industry has an opportunity to improve calf health/future productivity through colostrum management

- Principles:
  - Quality: $> 50$ g/L IgG
  - Quantity: 10% BWt
  - Quickness: 1-2 hrs (6 max.)
  - Cleanliness: TPC $< 100,000$ cfu/ml
  - Monitoring quality with proper tools.
Brucellosis: Colostrum Research

Laboratorio de Análisis Clínicos y Patología Veterinaria de La Laguna.
Dr Jesus Quintero Cedeño and Dra. Alma Luna
What is the effect of pasteurization on *Brucella sp.*?

Dr Quintero reports in early data that up to 40% of cows positive for Brucellosis will shed it in colostrum. Pasteurization at 60°C for 60 minutes successfully removes *Brucella* bacteria.
Gracias por su tiempo y de la hospitalidad
Heat treatment of colostrum on commercial dairy farms decreases colostrum microbial counts while maintaining colostrum immunoglobulin G concentrations

Effects of Feeding Heat-Treated Colostrum on Passive Transfer of Immune and Nutritional Parameters in Neonatal Dairy Calves

- Higher serum total protein and IgG concentrations
- Greater apparent efficiency of IgG absorption
  - 35.6% vs 26.1%
- No effect on serum concentrations of IgA, IgM, vitamin A, vitamin E, cholesterol, β-carotene or vitamin E:cholesterol ratio, or on serum bovine viral diarrhea virus type I serum neutralization titers.
- No difference between treatment groups when examining calf plasma total leukocyte counts, neutrophil counts, lymphocyte counts