

Impact of three times vs. twice a day milk replacer feeding on calf performance, likelihood to reach lactation and future milk production in a commercial dairy herd

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Introduction

- Most dairy calves in US are fed twice a day
- Calves nurse 8-12 times/day for the first 7 days of life
- Calves nurse 4 times a day at 1 month of age
- Abomasitis/ulcers observed in 15-25% of neonatal calves examined at WVDL
- Feeding frequency (≥ 3 times/day) may reduce risk of abomasitis/ulcers in neonatal calves¹

¹Ahmed AF et al. J Dairy Sci 2002. 85: 1502–1508







Study Design

- Calves weighed with a scale shortly after birth
- Calves fed a commercial colostrum replacement product made from bovine colostrum that contained 150g of IgG within 6 hrs of birth
- Blood sample drawn from each calf at 1-3 days of age. Serum tested for bovine IgG by single radial immunodiffussion
- Calves raised outside in individual calf hutches until they were weaned and moved to group pens at 50-55 days of age

Study Design

- Calves fed a full potential milk replacer (MR) diet (28% protein, 20% fat)
- Calves were randomly assigned to either a 2x or 3x feeding regime
- All the calves fed at 08:00 and 21:00 hours
- > 3x calves fed at 14:30 hrs
- ▶ 815g of MR (days 1–7)
- ▶ 1135g of MR (days 8-42)
- ▶ 565g of MR (days 43–49)
- Calves offered free choice calf starter (20% CP) beginning at 3 days of age

Measurements/Statistics

- Calf starter intake measured daily until calves reached 50 days of age
- Hip height and body weight measured weekly by same individual
- Data (birth weight, serum IgG, hip height, weight gain, feed efficiency, calf starter intake, ME305 milk yield and AFC) were evaluated using analysis of variance and co-variance using a G.L.M. procedure (NCSS-2007, Kaysville, Utah)
- Likelihood of calves being weaned, entering lactation and calculation of RR were analyzed using 2-way contingency table analysis (JavaStat)

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ltem	2x Feeding	3x Feeding	P value
Number of Calves	35	35	1.000
Birth weight, kg	40.1	39.8	0.7385
lgG mg/mL	11.2	12.2	0.3459

ltem	2x Feeding	3x Feeding	P value
Calf starter intake, DM (1–21 days), kg	0.56	0.44	0.3682
Calf starter intake, DM (1–42 days), kg	3.3	3.9	0.3448
Calf starter intake, DM (43-49 days), kg	3.8	4.8	0.0122

ltem	2x Feeding	3x Feeding	P value
BW Gain (1–21 days), kg	12.5	14.9	0.0003
BW Gain (1–42 days), kg	25.1	29.8	0.0001
Hip height gain (1–21 days), cm	4.3	5.2	0.0027
Hip height gain (1–42 days), cm	8.6	10.3	0.0027
Feed efficiency Gain/DM intake, 1–21 days	0.57	0.68	0.0002
Feed efficiency Gain/DM intake, 1–21 days	0.52	0.61	0.0001

ltem	2x Feeding	3x Feeding	P value
Number weaned	32	34	0.3070
Number lactating	28	34	0.0250
Age first calving, days	734	718	0.2278
ME305, milk production, kg	13053	13568	0.2217

Conclusions

- Calves fed 3 times a day had improved growth (hip height and weight gain) than calves fed twice a day
- Calves fed 3 times a day had better feed efficiency than calves fed twice a day
- Calves fed 3 times a day consumed more calf starter than calves fed twice a day during the pre-weaning process
- Calves fed 3 times a day were more likely to enter lactation than calves fed twice a day (RR 1.21)
- NNT: For every six calves fed 3 times a day, one additional heifer entered lactation

Colostrum: Age at First Calving

ltem	2x Feeding AFC	3x Feeding AFC	P Value
Low lgG < 10.0 mg/mL	747	700	0.01
High IgG \geq 10.0 mg/mL	723	731	0.536

Final Thoughts

- Dairy calves fed 3 or more meals a day are healthier than calves fed twice a day
- Labor costs do not increase much because there are fewer sick calves to treat
- Feeding calves three or more meals a day can overcome some of the harmful effects of calves not receiving an adequate volume of high quality colostrum within 2 hrs of birth
- > Benchmark is \geq 80% calves have a serum total solids of \geq 5.5 g/dL
- Dairy profitability: Milk production/cow, culling rate (longevity in the herd), number of replacement heifers raised

Newborn Calf Diseases and Health Management



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Neonatal Calf Concepts

- Little gastric acid production first 5-7 days
- Gastric acid production important protection against enteric (bacterial) disease
- Immature ("fetal") gut first 7-14 days of life
- Adaptive immunity: Limited first 2-3 weeks
- Colostrum provides protection against K99 *E. coli,* rotavirus, coronavirus and Salmonella for the first 7-10 days of life
- Median age for rotavirus, coronavirus and Cryptosporidium parvum scours is 10 days

Neonatal Calf Concepts

- Newborn calf contains 2.8% of its body weight as fat
- Judge quality of a commercial oral electrolyte solution by how quickly calves return to full feed after they break with diarrhea
- Don't focus on 24 hour mortality
- Goal ≥ 90% return to full feed within 48-96 hours of developing diarrhea

Industry Standards

- Separate calf from dam within 10-15 minutes of birth
- Colostrum (quality, quantity, timing)
- Brix refractometer: Colostrum Quality
- Minimize FPT ($80\% \ge 5.5 \text{ g/dL}$)
- Calves kept dry and comfortable
- Minimize cold and heat stress
- Minimum 4-6 inches of a dry bedding pack

Industry Standards

- Feed 1.5-2.5 gallons of milk or equivalent (1.5-2.5 lbs) milk replacer/hd/day
- Consistent diet (less than 1% variation in TS between feedings)
- Adequate space (30 square feet) (spatial density)
- 10-15 % calf pens empty (temporal density)
- Calf Scour Vaccines

Efficacy Calf Scour Vaccines

Agent	Frequency %	Protection Infection	Protection Scours	Age of Onset	Incubation Days
K99 <i>E. coli</i>	≤ 5 %	YES	YES	1 – 4	0.5 – 1
Attaching and Effacing <i>E.</i> <i>coli</i>	5-10%	NO	NO	3 - 14	1 – 3
Rotavirus	40 - 50%	NO	YES (50– 60%)	5 – 17	1 – 3
Coronavirus	20 - 30%	NO	YES (40– 50%)	5 - 21	1 – 3
<i>Cryptosporidi um parvum</i>	40 - 65%	NO	NO	5 - 14	4 - 8
<i>Salmonella</i> spp.	5 -10%	NO	NO	\geq 7 days	1 – 3

Human Cost of Scours

Numbe r Calves Born/ Week	Scours Prevalen ce %	Scours Duratio n Days	Weanin g Age Weeks	# Calves Requiring Electrolyt es Each Day	% Calves Requiring Electrolyte S Each Day	% Calves Requiring Electrolyte S Each Day ≤ 21days
10	5%	4	8	2	2.5%	6.7%
10	10%	4	8	4	5.0%	13.3%
10	15%	4	8	6	7.5%	20.0%
10	20%	4	8	8	10%	26.7%
10	25%	4	8	10	12.5%	33.3%
10	30%	4	8	12	15%	40.0%
10	40%	4	8	16	20%	53.3%
10	50%	4	8	20	25%	66.7%
10	60%	4	8	24	30%	80.0%

Calf Scours: Current Status

- 20-25% of U.S. dairy calves develop diarrhea that requires oral electrolyte therapy before the calf reaches 21 days of age
- Industry Standards
 - Lower Mortality (Salmonella*)
 - Reduce severity and duration of diarrhea
 - Roughly 50% of the time no effect on morbidity!!
- Why?
- Not controlling pathogen load in calf rearing environment

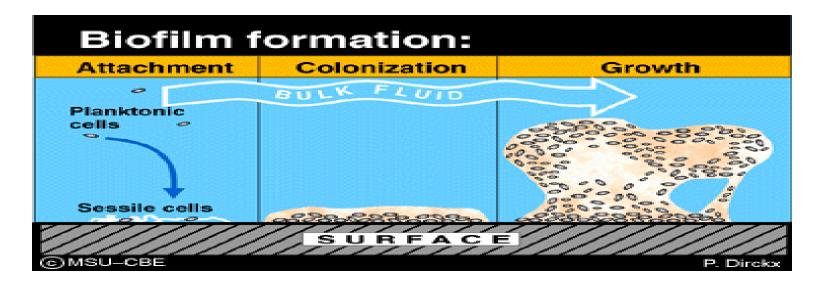
Environmental Sources of Rotavirus and Coronavirus

Location	Coronavirus Ct ()	Rotavirus Ct ()
Calf #1: Back	Positive (32.7)	Positive (38.9)
Calf #1: Belly	Positive (30.4)	Positive (32.1)
Calf #1: Nasal	Positive (17.9)	Negative
Calf# 1: Rectal	Positive (26.0)	Positive (28.9)
Calf #2: Belly	Positive (25.3)	Positive (30.9)
Calf #2: Nasal	Positive (17.0)	Negative
Calf# 2: Rectal	Positive (27.2)	Positive (30.1)
Nipple	Positive (33.9)	Negative
Feed Trough: Calf Starter	Positive (33.6)	Positive (38.0)
Drinker	Positive (28.4)	Negative
Wall: Corner	Positive (25.6)	Positive (27.6)
Floor: Bedding Pack	Suspect	Positive (34.8)

1993

- E. coli 0157:H7 outbreak in Washington State and California changed the food processing industry forever
- "It looks clean" no longer acceptable
- Validate and Verify: Facilities are clean, sanitary and free of food borne pathogens
- Concept: If you control your variables (air, water, equipment, environment and minimize crosscontamination); you reduce the risk of product contamination with pathogens
- Calf Raising Facilities: Same Concepts as Food and Beverage Industry

BIOFILM: Bacterial Habitat



- Planktonic free floating/swimming bacteria in an aquatic environment – 10%
- Sessile static organisms attached to surfaces, usually associated with a biofilm – 90-99%

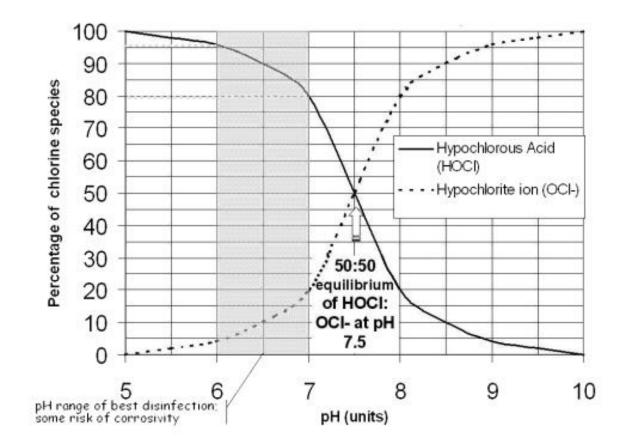
Cleaning and Disinfection

- Clean (cannot disinfect filth!!)
- Soak with hot water (≥ 140 °F) that contains a chlorinated alkaline detergent
- Wash (No high pressure washers!!). Low pressure foam cleaning
- Rinse (acid pH 2-3)
- Dry
- Disinfect (2 applications in heavily contaminated environments)
- Occupy

ATP Meter



Household Bleach: Effect of pH on Biocidal Activity



More Bleach is Not Always Better

Bleach Dilution (City of Madison)	Water (pH)	Free Chlorine Concentratio n ppm	Percent Hypochlorou s Acid	Percent Hypochlorite Ion
Tap Water	7.68	2.0	45	55
1:500	7.83	100	30	70
1:250	8.33	200	10	90
1:100	8.73	500	5	95
1:50	9.24	1000	3	97
1:25	9.57	2000	2	98
1:10	11.0	5000	.03	99.97

Cryptosporidium parvum

- Both rotavirus and C. parvum can persist for several weeks/months in the environment
- C. parvum oocysts have a high affinity (stick) for rubber and plastic
- Fomites (inanimate objects) are very important means of transmission
- People's hands and feet
- Water implicated in some outbreaks (surface water or shallow wells)
- Resistant to many commercial disinfectants

CT Values for Cryptosporidium parvum

Chemical	Concentration (ppm)	Contact time
Chlorine dioxide	78	1 minute
Hydrogen Peroxide (6%)	60,000	4 minutes
Peracetic acid	3,500	5 minutes
Ammonia (5%)	50,000	18 hours
Formalin (10%)	100,000	18 hours
Benzlkonium chloride (1%)	10,000	Not Effective
Chlorhexidine (2%)	20,000	Not Effective
Chlorophenols (5%)	50,000	Not Effective
Isopropanol (70%)	700,000	Not Effective
Sodium Hydroxide	200	Not Effective
Sodium Hypochlorite (6%) Bleach	60,000	Not Effective

OVERVIEW:

- What's Chlorine Dioxide (CIO₂)?
- Biocidal Benefits
- Chemistry & Safety
- Livestock Applications
- Dosing Rates & Efficiency
- Corrosion

PHYSICAL CHARACTERISTICS:

- CIO₂ Solutions Are Yellow To Greenish-Yellow And Smell Like Chlorine
- Boiling Point: 51.8 °F
- Store concentrated CIO₂ product in a household refrigerator
- Highly Soluble Gas That Does Not React With Water
- Very Stable When Dissolved In Water
- Potent Oxidizing Agent

OXIDIZER COMPARISION:

MATERIAL *** Activity Affected by pH	ORP (mVolts)	OXIDATION CAPACITY
Ozone (0 ³)	2.07	2 Electrons
Peroxycetic Acid (PAA)***	1.88	2 Electrons
Hydrogen Peroxide (H ₂ O ₂)***	1.76	2 Electrons
Hypochlorous Acid (HOCl)***	1.49	2 Electrons
Chlorine (Cl ₂)***	1.36	2 Electrons
Hypobromous Acid (HOBr)***	1.33	2 Electrons
Chlorine Dioxide (ClO ₂) Lq.	0.95	5 Electrons

CIO₂ BIOCIDAL EFFICACY:

- Eliminates Planktonic AND Sessile Bacteria
- Migrate Into and Destroys Biofilm Habitat
- Low CT (concentration and time) Values
- Biocidal Against Following Agents: Mycoplasma, gram positive and gram negative bacteria, algae, yeast, enveloped viruses, chlamydia, non-enveloped viruses, fungal spores, FMD, parvovirus, acid-fast bacteria, bacterial spores and protozoan cysts

QUICK KILL AGAINST YOUR WORST CALF SCOUR ENEMIES:

- Coccidian oocysts
- Cryptosporidium oocysts
- Giardia cysts
- Bacterial Spores
- Yeast & Mold Spores
- Salmonella
- E. coli
- Rotavirus and Coronavirus
- LOW CT VALUES!

Livestock: Applications

- Drinking Water:(Residual CIO₂ concentration 0.5–0.8 ppm)
 - Remove: Biofilms, Bacteria, Viruses, Giardia, Cryptosporidia
 - Remove: Iron, Manganese, Sulfites and Hydrogen Sulfide
- Sanitize Calf Feeding Equipment (50 ppm ClO₂)
 - ≻1-2 minutes contact time
 - > Bottles/Nipples, Buckets, Pasteurizers, Mixing Equipment, Etc.
- Misting Livestock Present (100 ppm ClO₂)
 - \geq 30 seconds contact time
 - Locations: Maternity Pens, Calf Pens, Bedding Packs, Calf's Feet, Legs, Brisket and Belly
- Environmental Disinfecting (250 ppm ClO₂)
 - > 5-10 minutes contact time
 - Locations: Maternity Pens, Calf Pens, Calf Barns, Calf Transporters, Automated Calf Feeders, Livestock Trailers
- Environmental Fogging (500 ppm ClO₂)
 - \geq 20 minutes contact time
 - Locations: Calf Barns, Livestock Trailers

Summary

- Traditional methods will fail to control scours diarrhea 50% of the time
- Traditional methods will reduce mortality, severity and duration of diarrhea
- Pull potential vs. conventional feeding will reduce duration and severity of diarrhea
- Must focus on pathogen reduction in calf rearing environment
- Monitor water quality

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Questions?

