

Introduction

- Milk - nature's perfect food
- Mammary gland has a unique function - transfers food from parent to offspring
- Roles of lactation
 - Warmth - Hypothermia
 - Nutrition - Starvation
 - Antibodies - Disease
 - Physical Protection - Predators
 - Learned Skills - Various Hazards

Mammary Gland Anatomy

- Composed of 4 glands
- Separated into two halves
 - Medial suspensory ligament
- Fore and rear quarters of each half have separate ducts
 - Rear quarters 60% of milk
- Seven tissues support the udder
 - Medial suspensory ligament
 - Lateral suspensory ligament

Mammary Gland Anatomy

- Teat
 - Pronunciation
 - correct: 'tEt - \E\ as ea in easy
 - incorrect: 'tit - \i\ as i in hit
 - Sphincter muscle
 - Streak canal (keratin) – 0.25 – 0.5"
- Gland cistern
- Ducts - plumbing

Secretory Tissue

- Secretory (alveolar) cells
 - produce milk
- Alveolus - single layer of alveolar cells
- Several alveoli in a group form a lobule
- Myoepithelial cells - cover alveolus
 - oxytocin causes myoepithelial cells to contract, ejecting milk from the lumen

Milk Flow

- Alveolar cells secrete milk into lumen of the alveolus
- Lumen empties into terminal ducts
- Terminal ducts empty to secondary ducts
- Secondary ducts empty to primary ducts
- Primary ducts empty to gland cistern
- Gland cistern empties into teat cistern

Mammary Gland Development

- Development in embryonic bovine starts at 32 d
- Birth to puberty
 - isometric growth – 0 to 3 mo
 - allometric growth – 3 to 9 mo
- Puberty
 - Estrogen – duct growth
 - Progesterone – aveolar growth

Mammary Gland Development

- Pregnancy - exponential growth
 - estrogen, progesterone, placental lactogen
- Early Lactation
 - 10 d after parturition – 65% more DNA
 - Prolactin, growth hormone, cortisol
- Declining Lactation - cell # decrease
- Dry Period - gland involutes

Endocrine Control

- Mammary Growth
 - estrogen, progesterone, prolactin, growth hormone, and placental lactogen
- Lactogenesis - alveolar cells acquire ability to secrete milk
 - prolactin, glucocorticoids, estrogen, and progesterone (inhibits)

Endocrine Control


- Lactation
 - prolactin, GH, glucocorticoids, insulin, and thyroid and parathyroid hormones
 - Homeorhesis - a shift in nutrient partitioning
 - Change from tissue deposition to tissue mobilization
- Blood - carries nutrients to udder
 - blood:milk = 400:1 - 500:1

Factors Affecting Secretion

- Milking frequency
 - 3x vs 2x milking – +15%
 - Interval > 14 h decreases >2%
 - 1x last 3 mo of lactation – -38% last 3 mo
 - 1x entire lactation – -40 to 50%
 - 13x/week – -5 to 11%
 - Cessation of milk 36 h after last milking

Factors Affecting Secretion

- Age
 - 30% increase in production from 1st to 5th lactation
 - 1st lactation peak 15% of 3rd lactation
 - 2nd lactation peak 6% of 3rd lactation
- Climate
 - Optimal temp = 40 to 70°F
 - Humidity = 60 to 80% if temp < 70°F



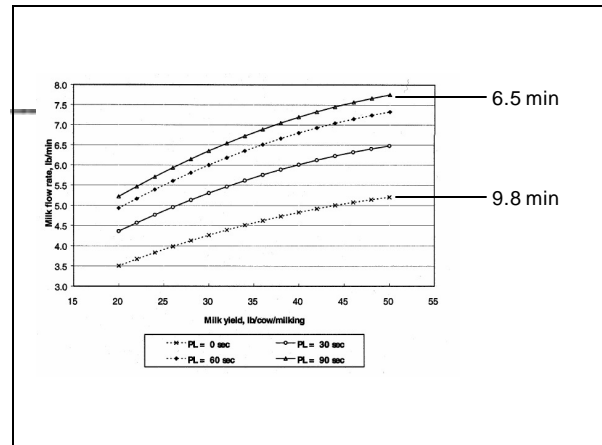
Milking Routine

Effect of Cow Prep on Milk Flow and Parlor Throughput

- Milk Letdown
 - Oxytocin
 - Prep Time
 - 10 – 20 sec
- Prep-Lag Time
 - 60 sec

Steady-state throughput for a Double-20 (cows/hour)

Prep-Lag, sec	Milk Yield (lb/cow/milking)		
	30	35	40
0	109	103	98
10	114	108	102
20	117	111	106
30	119	113	108
40	120	115	110
60	121	116	111
90	118	113	109




Ideal Prep Routine

- Minimize water use
- Use a sanitizer (i.e. prep-dip)
- Assure complete pre-dip coverage of teat surfaces
- Allow pre-dip 30 seconds contact time
- Remove all dirt from teat surfaces

Ideal Prep Routine

- Provide a minimum let down stimulus (teat massage, fore-stripping, teat drying) of 10 to 20 sec
- Provide a prep-lag time of 60 seconds
- Minimize machine-on time
- Minimize variation between milkers
- Not slow down milking



Milk Composition

Breed Statistics

	lb milk/yr	% fat	% protein	% of US cows
Holstein	24,755	3.67	3.18	93
Jersey	17,680	4.56	3.70	5.6
Brown Swiss	20,972	3.98	3.42	0.8
Guernsey	15,143	4.48	3.46	0.3
Aryshire	16,864	3.87	3.31	0.3

Milk Composition

- Remember that dairies are paid for the amount of fat, protein, and other solids
- Breeds have similar milk lactose %, milk protein varies by 0.5% and milk fat by 1%
 - Fat is always higher than protein in a healthy cow
- Milk fat depression is most common problem

Milk Fat Depression (MFD)

- High grain diets (high NFC)
 - Lower milk fat and slightly lower protein
- Small particle size ration
- RUP – variable results
- Fat – too much can decrease fat and protein

Milk Fat Depression (MFD)

- Results in significant economic loss
- Causes
 - High grain diets
 - Short particle length of fiber
 - High fat diets
- High grain diets (high NFC)
 - Lower milk fat and slightly higher protein
 - Lack of acetate for fat synthesis
 - Acetate:Propionate ratio ↓

Milk Fat Depression (MFD)

- Small particle size of fiber
 - Decreases rumination
 - Decreases forage digestion
 - Acetate:Propionate ratio ↓
- High fat diets
 - Polyunsaturated fatty acids (PUFA) and partially hydrogenated vegetable oils (PHVO)
 - Trans-18:1 inhibits fat production in the mammary gland

Milk Fat Depression (MFD)

- High fat diets (cont)
 - PUFA & high forage ↑ trans-11 in milk and no MFD
 - PUFA & high concentrate ↑ trans-10 in milk and caused MFD
 - trans-10, 18:1 and/or trans-10,cis-12,18:2 cause MFD
 - exacerbated by high concentrate:low forage

Mastitis

Definitions

- Mastitis – inflammation of mammary gland
 - Microorganisms (bacteria) invade udder, multiply, and produce toxins
- Clinical mastitis – visible signs of disease
 - Mild signs - flakes or clots
 - Severe signs – abnormal secretion, hot, swollen; fever, inappetance, death

Definitions

- Subclinical mastitis – no visible signs
 - Somatic cell count (SCC) elevated
 - Culturing of milk will detect bacteria
 - Greatest financial loss
 - For every clinical case, 15 – 40 subclinical cases

Annual Loss Due to Mastitis

Source	Loss/cow	%
Reduced yield	121.00	66.0
Discarded milk	10.45	5.7
Replacement cost	41.73	22.6
Extra labor	1.14	0.1
Treatment	7.36	0.1
Vet	2.72	1.5
Total	184.40	100.0

Estimated Annual Losses

- \$184 per cow
- \$18,400 per 100 cow herd
- \$1.7 billion is US

Somatic Cell Count (SCC)

- SCC is the # of leukocytes or white blood cells per ml of milk
- Normal milk <200,000 cells/ml
- Leukocytes enter gland in response to injury (infection)
- Elevated SCC indicative of mammary gland infection

Contagious (Subclinical) Mastitis

- Greatest financial loss (70% of losses)
- Caused by:
 - *Strep. agalactiae*
 - *Staph. aureus*
 - *Mycoplasmaspp.*
- Primary source
 - udders of infected cows
 - *Mycoplasmaspp.* – udders and respiratory

Contagious Mastitis

- Method of spread
 - primarily at milking (cloths, hands, units)
- Indicators
 - no clinical signs of disease (i.e. abnormal milk), except *Mycoplasma spp.*
 - elevated somatic cell count (SCC)
 - >500,000 cells/ml
 - bacterial culturing

Contagious Mastitis

- Control
 - prevent spread at milking
 - segregate and milked last or with a separate milking unit
 - eliminate infectious cows
- Goals
 - eradicate *Strep. agalactiae*
 - reduce *Staph. aureus* to less than 5% of cows in the herd

Controlling Contagious Mastitis

- Staph - cure rate low
- Strep - responds well to antibiotic therapy
- *Mycoplasma* - cure rate low
- Prevention
 - clean, dry teats
 - minimize liner slips
 - use effective teat dip
 - maintain milking system

Controlling Contagious Mastitis

- Eliminate infections
 - treat all quarters at dry off
 - cull chronically infected cows
- Steps to follow
 - teat dip – predips and postdips effective
 - dry cow treat
 - proper milking procedure and functional equipment
 - cull chronic cows

Environmental (Clinical) Mastitis

- Caused by coliforms
 - *E. coli*
 - *Klebsiella spp.*
- Caused by environmental streptococci
 - *Strep. spp.* (*uberis*, *bovis*, *dysgalactiae*)
 - *Enterococcus Spp.*
- Primary source
 - environment of the cow

Environmental Mastitis

- Indicator of problem
 - high rate of clinical mastitis, usually in early lactation
 - SCC may be low, <300,000 cells/ml
- Risk
 - Higher during dry period – 1st 2 weeks and last 2 weeks
 - During lactation – early highest risk

Environmental Mastitis

- Control
 - reduce # of bacteria to which teat end is exposed
 - improve cleanliness of surroundings especially in late dry period and at calving
 - improve milking prep
- Goal
 - reduce clinical mastitis to less than 3% of the milking cows per month

Environmental Mastitis

- Duration of infections
 - Coliforms
 - More than 50% <10 days
 - Nearly 70% < 30 days
 - Can become chronic – 1.5% > 100 days
 - Strep
 - Longer than coliforms
 - 60% < 30 days
 - 18% chronic - >100 days
 - 40% eliminated spontaneously

Controlling Environmental Mastitis

- Prevention is the key
 - reduce # of bacteria to which teat end is exposed
 - highest infection rates: first 2 wks and last two wks of dry period
- Environment
 - clean and dry
- Bedding
 - inorganic - low nutrients and moisture

Controlling Environmental Mastitis

- Teat dipping (1% iodine, 0.5% chlorhexidine)
 - pre milking teat dip
 - reduces environmental mastitis by 50%
 - post milking teat dip
 - exerts some control over environmental streps
 - barrier dips effective against coliforms
- Dry cow therapy
 - treat all quarters at drying off
 - effective against strep, not coliform
- Proper milking procedure

Infection Prevalence

Bulk tank SCC/ml	% infected quarters	% production loss
200,000	6	0
500,000	16	6
1,000,000	32	18
1,500,000	48	29

Production Losses

SCC score	SCC/ml	Production Loss (lbs)	
		1 st Lact	2 nd + Lact
0	12,500	-	-
1	25,000	-	-
2	50,000	-	-
3	100,000	200	400
4	200,000	400	800
5	400,000	600	1,200
6	800,000	800	1,600
7	1,600,000	1,000	2,000

Bulk Tank SCC and SCC Score Comparison

Cow	Tank SCC	SCC Score
1	4,000,000	8.3
2	3,000,000	7.9
3	1,500,000	6.9
4	400,000	5.0
5	250,000	4.3
6	200,000	4.0
7	150,000	3.6
8	100,000	3.0
9	75,000	2.6
10	50,000	2.0
Avg	973,000	4.8

Impact of Culling Cows on SCC

Cow	Cow SCC	SCC Reduction	Tank SCC
			973,000
1	4,000,000	337,000	636,000
2	3,000,000	296,000	340,000
3	1,500,000	165,000	175,000
4	400,000	38,000	138,000

Cow 1 produces 41% of cells in tank
 Cows 1 and 2 produce 72% of cells
 Cows 1, 2, and 3 produce 87% of cells