


## Choosing the Right Liquid Feed for Your Calves

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## Why Feed Liquid Diet?


- Big picture question
- Could we feed a newborn calf a diet of only starter and hay for the first few weeks of life?




## Why Feed Liquid Diet?

- Simple answer:
  - No! Calves need milk!
- More complex answer:
  - Abomasum ready for nutrient digestion
  - Rumen not developed for digestion and absorption
  - Calves won't be eating much solid feed anyway!





## Voluntary Starter Intake

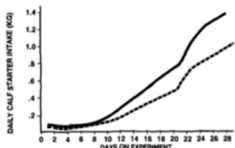
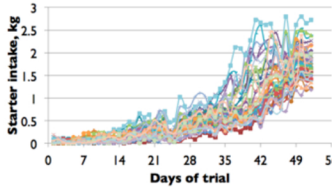




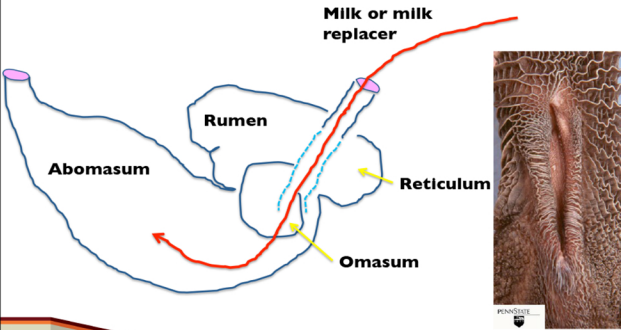
Figure 4. Daily calf starter intake for 335 calves averaging less than (●●●) or equal to or greater than (—) 272 g daily gain. Kerz et al., 1984


Yohe et al., 2015

- Low intake for first 2-3 weeks of life



## Reticular Groove Closure

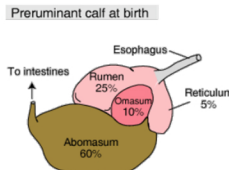




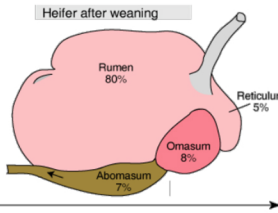
## Importance of Liquid Diet

- Preweaned calf:
  - Main source of energy and protein
  - Rumen underdeveloped

Preruminant calf at birth




Heifer after weaning

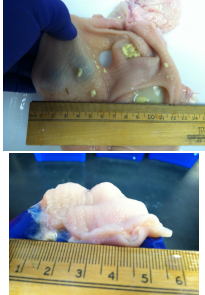


### Undeveloped Rumen

- 1 day old calf rumen



rumen + reticulum + omasum!



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### Undeveloped Rumen

- There's a reason we call it "starter"



Fig. 1. Milk only. Penn State Extension  
Fig. 2. Milk and hay. Penn State Extension  
Fig. 3. Milk and grain. Penn State Extension

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### Liquid Feed Options

- Milk
  - Saleable
  - Nonsaleable/waste (pasteurized)
  - Acidified
- Milk replacer (**MR**)
  - Many formulations (protein:fat, ingredients)
  - Acidified

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### Saleable Milk

- High quality milk that is considered good enough for human consumption
- Taken straight from bulk tank



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### Saleable Milk

Milk	DM%	Fat%	Prot%	Lactose	Ash%
Holstein	12.5	3.6	3.0	5.0	.7
Jersey	14.5	5.0	3.8	5.0	.7

Compare whole milk on a powder basis?

Liquid feed	DM %	Fat%	Protein %
Holstein	100	28.8	24
Jersey	100	34.5	26.2

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### Saleable Milk

- Pros:
  - Highly nutritious (24-27% protein, 28-36% fat DM)
  - Should not be limited in supply
  - "Lactocrine hypothesis"
- Cons:
  - Takes away from producer's milk sales

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### Lactocrine Hypothesis

- Milk-borne factors that may influence development and function of tissues via epigenetic factors

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### Nonsaleable/Waste Milk

- Can include:
  - Nonsaleable transition milk
  - Nonsaleable/waste milk from cows treated with drugs that have withdrawal periods
- Lost economic opportunity for dairy farmers
- Potential for negating loss via feeding to calves

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### Nonsaleable/Waste Milk

- Pros:
  - Typically a good source of nutrition
  - Economically a good choice
  - Also fits lactocrine hypothesis
- Cons:
  - Nutritional variability
  - Variable supply
  - Should have system for pasteurization (expensive)
  - Potential large pathogen load
  - Big question regarding antibiotic resistance?

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### Milk Replacer

- Manufactured to replace whole milk using multitude of different ingredients
- Typically marketed as:
  - %Protein:%Fat
  - Dry matter basis
  - 20:20, 22:20, 26:20, 27:10

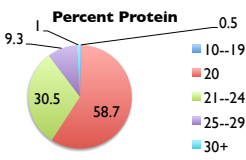


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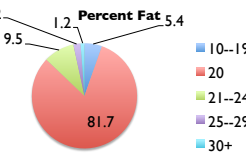
### Popular Milk Replacers

- Most popular form of liquid feed for calves
- 2014 NAHMS data: % of operations that fed MR

**Percent Protein**



**Percent Fat**



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### Reading Milk Replacer Tag

- Important considerations:
  - Order of ingredients does not equal amount
  - Protein source(s)
  - Fat source(s)
  - \*Medicated or nonmedicated?



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### Protein sources for liquid feeds (BAMN, 2014 Publication)

Acceptable milk ingredients	Acceptable nonmilk ingredients	Not acceptable
Dried whey protein concentrate	Soy protein isolate	Meat solutions
Dried skim milk	Protein modified soy flour	Fish protein concentrate
Casein	Soy protein concentrate	Wheat flour
Dried whey	Hydrolyzed soy protein modified	Soy flour
Dried whey product	Animal plasma	Egg products
	Wheat gluten or isolate	

Protein is the most expensive ingredient in liquid feed for calves

Digestibility

### Milk Replacer

- Pros:
  - Many different nutrient and ingredient options
  - Consistent product
  - Potentially fits lactocrine hypothesis as well
- Cons:
  - Ingredient digestibility variable
  - Can be costly depending on what type and competing markets for ingredients

### Milk Replacer Considerations

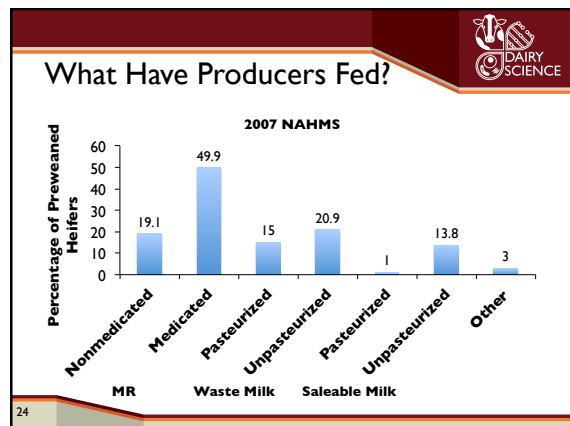
- New FDA Regulations effective 1/1/17
  - Veterinary Feed Directive (VFD) required for “medically important” drugs
  - Does not affect other feed additives:
    - Ionophores (Lasalocid, Monensin)
    - Coccidiostats (Decoquinat)
  - Main antibiotics in MR that will be affected:
    - Chloretetracycline
    - Oxytetracycline
    - Oxytetracycline & Neomycin

### Acidified Milk/Milk Replacer

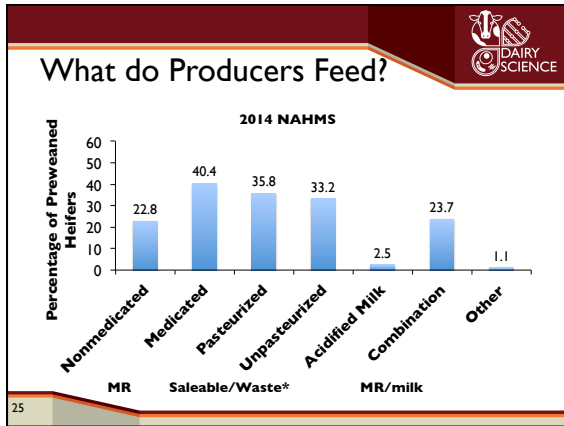
- Effective means of preserving milk/MR without needing refrigeration
- Use of acid (e.g. citric, propionic) to preserve milk by preventing microbial growth
  - pH 4.5-5 suggested
- Helpful Penn State info regarding acidified MR
  - <http://extension.psu.edu/animals/dairy/news/2014/feeding-acidified-milk-to-calves>

### Acidified Milk/Milk Replacer

- Pros:
  - Nutritionally good option
  - Effective method for short term preservation
- Cons:
  - Must use acid, which may be dangerous
    - FDA approved citric, propionic acid, but not formic!
  - Increased management to safely use







### Future Implications?

- MR still probably most used liquid feed
  - Medicated continue to decline
- An increase in usage of pasteurized waste milk
  - As long as no restrictions are imposed
- Automatic calf feeders adapting to different liquid feed sources

### Cost Comparison of Milk Replacer vs Whole Milk

	Whole Milk	Milk Replacer
<b>WHOLE MILK INPUT</b>		
Milkbox milk price (value of milk sold, \$/cwt)	10.40	from milk check
Total solids content of milk (%)	12.5	if not on milk check, enter 12.5
True protein content of milk (%)	3.2	from milk check
Fat content of milk (%)	3.5	from milk check
Weight of whole milk to feed calves (lb/d)	12.0	enter the weight of liquid; 1 gal = 8.6 lb
<b>MILK REPLACER INPUT</b>		
Cost of milk replacer per bag (\$)	60	
Weight of milk replacer bag (lb)	50	
Dry matter content of milk replacer (%)	86.5	may range from 96 to 98
Crude protein content of milk replacer (%)	20	from milk replacer feed tag
Fat content of milk replacer (%)	20	from milk replacer feed tag
Weight of milk replacer fed to calves (lb/d)	1.5	weight of powder, not liquid
<b>OUTPUT</b>		
	Whole Milk	Milk Replacer
Crude protein (% dry matter)	27.1	20.7
Fat (% dry matter)	28.0	20.7
Cost per pound of dry matter	\$1.31	\$1.24
Cost per 50 lb of dry matter	\$66	\$62
Dry matter fed per calf (lb/d)	1.50	1.45
Crude protein fed per calf (lb/d), DM basis	0.41	0.30
Fat fed per calf (lb/d), DM basis	0.42	0.30
Cost per calf per day (\$/calf/d)	\$1.97	\$1.80

<http://extension.psu.edu/animals/dairy/nutrition/calves/feeding/spreadsheet-to-compare-cost-of-milk-and-milk-replacer/view>

### What Does This Mean?

- This scenario:
  - \$0.17 more per calf per day to feed whole milk
  - Assuming 8 week weaning = \$9.52 per calf
- Is it worth it to pay that extra amount per calf?

### Maybe So

- Study fed differing amounts of pasteurized whole milk at 26.7% CP and 31.7% fat (Rosenberger et al., 2017)

Fed @ 12% solids	Prewearing ADG g/d (lb/d)
5.7 L/d (~13 lb/d)	580 g/d (1.28 lb/d)
8.3 L/d (~19 lb/d)	650 g/d (1.43 lb/d)
9.4 L/d (~21 lb/d)	880 g/d (1.94 lb/d)

- Decreased preweaning starter intake
  - 300 g/d @ 5.7 L/d milk vs. 50 g/d @ 9.4 L/d milk

### More to Consider

- 2016 meta-analysis (Gelsinger et al., 2016):
  - 500-900 g/d (1.1-1.98 lb/d) preweaning ADG linked with enhanced first lactation performance
- Included milk/MR and starter intake
  - Calves consuming  $\geq 100$  g of starter (on DM basis) expected to produce 127 kg (280 lb) more milk vs. calves consuming no starter preweaning
- Suggested synergistic effects of milk/MR + starter

### Do I Need to Feed Whole Milk?

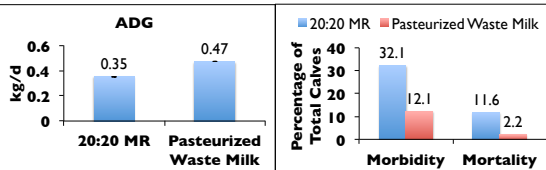
- Not necessarily
- What are some comparable options?
  - Pasteurized nonsaleable/waste milk
  - Enhanced/accelerated MR



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### Pasteurized Waste Milk vs. MR

- Calves given:
  - Pasteurized waste milk (n=223)
  - MR 20:20 (n=215)



(Godden et al., 2005)

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### Other Findings from Study

- Saved \$0.69/calf/day (\$34 from birth to weaning)
  - Savings from not purchasing MR and less treatments
- Important to note:
  - Didn't analyze pasteurized whole milk for nutrients
  - Estimated 25.6% crude protein and 29.6% crude fat

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### Can We Rely on Waste Milk?

- It's an interesting question
- Too much is a sign of questionable herd health
- Is it actually safe to feed?
  - Bacteria still shown to be present
  - Antibiotic residue still present as well

H. Littier MS Thesis

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### What about Milk Replacer?

- Cornell study (Soberon et al., 2012) found feeding elevated amounts of MR (4.5-5.3 Mcal of ME/d of 28:15 or 28:20) lead to:
  - high ADG preweaning (approx. 1.6 lb/d)
  - Increased first lactation milk production
    - Each additional 2.2 lb of ADG preweaning lead to an increase of 2,138 lb in first lactation milk production
- How much 20:20 MR would be needed to reach that ADG? Would it be lean or fat growth?

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### What About Acidified Milk/MR?

- Recent study (Todd et al., 2017) compared ad libitum access to acidified MR vs. restricted MR feeding (6 L/d)
  - MR used for both treatments = 24:18
- Increased preweaning ADG for acidified (1.3 lb/d vs 0.948 lb/d)
  - when checked at 8 mo. of age no difference in BW or ADG
- Also, no differences in morbidity or mortality

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## More on Acidified Milk/MR

- Decent alternative option if necessary
- Safety hazard handling acids
  - No formic acid!
  - Must be careful to keep pH in acceptable range (4.5-5)
- Acid should only be added to cooled milk (68-75°F)
  - Temp above 75°F may start to cause curdling
- Feeding of acidified MR at ambient temperature
  - Ideally liquid feed should be at or close to body temp

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## Combining Liquid Feeds

- Potentially the most useful way to effectively and efficiently use your resources
- System where pasteurized waste milk can be used and if not enough then a combination of whole milk/MR can be used
- Use of milk balancer products

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## Other Important Factors

- Enhanced nutrition preweaning (whole milk or MR)
  - Increased mammary gland development
  - Lactocrine hypothesis
  - Decreased rumen development
    - Can potentially be mitigated via stepdown weaning
- Management important for any feeding regimen

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## Main Takeaways

- Many good options for liquid diets to feed calves
  - Stay away from unpasteurized waste milk!
- Pasteurized waste milk a decent option
  - At the moment unaffected by VFD
- Feeding as close to whole milk with lower fat best option
  - MR with high protein (25-28%) and low to mid fat (10-20% depending on season) with digestible nutrients good option

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## Benchmarks to Consider

- Preweaned calves:
  - ADG > 650 g/d (1.43 lb/d)
  - <10% treated for respiratory disease
  - <15% treated for scouring
- Method for helping to achieve benchmarks:
  - ≥ 8 L/d (approx. 8.5 quarts) milk or MR fed daily @ 12-12.5% solids
    - With protein (25-28%) and fat (10-20%) depending on season

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## Useful Tools

- Penn State Extension website
  - spreadsheet to assess costs of whole milk vs MR options
    - <http://extension.psu.edu/animals/dairy/nutrition/calves/feeding/spreadsheet-to-compare-cost-of-milk-and-milk-replacer/view>
- Calfnotes.com (Dr. Jim Quigley of Provimi NA)

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Thanks!

- Questions?



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