



Minnesota Dairy Team

*Educating the dairy industry on
today's and tomorrow's dairy technologies.*

Calf Starters

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This presentation will center on basic principles, concepts and management practices when feeding calf starter to dairy calves. The presentation will also cover research studies conducted at the Southern Research and Outreach Center (SROC) in Waseca, MN on various calf starter physical forms, formulations and feeding programs to provide the opportunity for rumen development and growth of the young calf.

Calves tell us that all starters are not created equal

Variables that contribute to differences in calf starter intake:

- Milk feeding programs
- Water intake
- Calf starter formulation and physical form
- Calf genetics, gender, birth weight
- Calf housing, management and environmental conditions

There are a number of variables that contribute to differences in calf starter intake as all starters are not the same. The milk feeding program affects calf starter intake based on the amount being fed and the percentage of protein and fat in the milk replacer. Water is an essential nutrient for the calf and its availability affects starter intake. Other factors include the formulations and physical form of the starter, the birth weight of the calf, the genetic makeup of the calf and even the gender has an effect on intake. And finally, the housing, management and environment the calf is exposed to has a large impact on how well the calf consumes the starter offered.

Energy and crude protein requirements of calves (from birth to weaning)

Calf ADG, <u>lbs/day</u>	ME, <u>Mcal/day</u>	DMI <u>lbs/day</u>	CP <u>g/day</u>	CP <u>% of DM</u>
0.45	2.4	1.2	94	18.0
0.90	2.9	1.4	150	23.4
1.32	3.5	1.7	207	26.6
1.76	4.1	2.0	253	27.5
2.20	4.8	2.4	307	28.7

(adapted from Van Amburgh, 2006)

Rations need to be balanced to meet the needs of the calf and to reach targeted growth goals. This table shows the energy and crude protein requirements of dairy calves from birth to weaning based on various daily gain goals. Ideally, from birth through weaning, a reasonable average daily gain target is 1.76 lbs per day with a dry matter intake of 2 lbs per day.

WATER

The Essential Nutrient for Calves



- **Rumen development**
 - bacteria require an aqueous environment
 - milk or milk replacer bypasses rumen via esophageal groove
- **Promote intake of dry feed**

As was mentioned previously, water has an important influence on the intake level of calf starter. Water goes directly into the rumen and creates an aqueous environment needed by rumen bacteria. Whereas, milk or milk replacer goes directly to the abomasum since the rumen of the calf has not been developed yet.

Physical Factors Contributing to a Palatable High Quality Calf Starter:

- Physical form can affect palatability and intake
- Usually coarse textured, pelleted or a rolled meal
- Pellet too hard or too soft will affect intake
- Calves do not like finely ground mixtures



Another key variable that contributes to differences in calf starter intake is the physical form which can affect palatability and intake. Most calf starters are either coarse textured, pelleted or in a rolled meal form. If using pellets that are too hard or too soft, it will affect intake by the calf. Also, calves do not like starters that are finely ground mixtures.

Calf Starters

- Not dusty, moldy, or have an “off flavor”
- Have a minimum level of fiber provided by inclusions of roughage byproducts
- Molasses or molasses-based products help palatability and intake
 - should be 5-8% of the mixture



Calf starters should not be dusty, moldy or have an “off flavor”. Any of these characteristics can affect intake. Moldy starter can also affect the health of the calf. Calf starter should have a minimum level of fiber provided by inclusions of roughage byproducts. Calf starters that include molasses or molasses-based products help palatability and intake, and should be around 5-8% of the mixture.

The Housing System can affect Intake

Housing systems:

- SROC work (Chester-Jones and Ziegler, 1993) fed dairy herd calves born from November to March 1991 and 1992 assigned to polydome vs wooden hutches outside (av max and min temps were 32°, 13°; 35° and 20° F for years 1 and 2), or inside raised stalls in a controlled environment (55° F).
- Calves were fed a 16.5% CP CS (48% cracked corn, 13% SBM, 32% oats, 5% molasses, and 2% vitamin/minerals), Calves fed pooled waste whole milk at 1 gallon.
- Calves inside had 12.7% lower DMI, similar total gain but used their feed 10.7% more efficiently than outside calves.
- Housing did not affect health in the first winter but 43% more calves were treated inside vs outside the 2nd year.

Housing is another variable that affects calf starter intake. Research conducted at SROC back in the early 1990's using different housing systems demonstrated both intake differences and calf health affects. Calves were assigned to polydomes and wooden hutches outside or to stalls inside in a controlled environment of 55 F. The study took place over a two year period during the colder months from November thru March 1991 and 1992. Results of the study showed that calves inside had 12.7% lower dry matter intake but similar gain as those kept outside. However, the calves housed inside used their feed 10.7% more efficiently. Housing did not affect health in the first winter but in the second winter, 43% more calves were treated inside than outside.

**Nutrient composition, as-fed, of commercial calf
starter used in SROC studies 2004-2006**

(Ionophore at 30-60 g/ton)

Nutrient	Std texturized	Nutrient	Std texturized
CP%	18 or 22	TM & Salt, %	0.56
UIP, % of CP	0.32	Ca, %	0.92
NDF, %	13.85	P, %	0.59
ADF, %	3.22	Mg, %	0.32
Fat, %	3.22	K, %	1.29
NE_L, Mcals/lb	0.74	S, %	0.36
NE_G, Mcals/lb	0.55	Vitamin A, IU/lb	10,150
NFC, %	56.53	Vitamin D, IU/lb	2,540

In studies conducted from 2004-2006 at SROC a standard texturized commercial calf starter was used which consisted of 18 or 22% crude protein, 13.85% neutral detergent fiber, 3.22% acid detergent fiber as well as 3.22% fat. The non-fiber carbohydrate (NFC) value of this starter was 56.53%.

Calf Starter Intake Benchmarks at SROC

Pre-weaning 1-42 days

- Days 1-14 1.7 lbs (range 0.8 to 2.6 lbs)
- Days 15-28 12.0 lbs (range 8.8 to 15.8 lbs)
- Days 29-42 29.7 lbs (range 24.6 to 34.2 lbs)
- Total, Days 1-42 43.5 lbs (range 34.6 to 51.6 lbs)**

Post weaning 43-56 days

Total, Days 43-56 62.2 lbs (range 55.9 to 67.2 lbs)

Using benchmarks is a good way to set realistic and achievable goals and determine if a particular management practice or program is successful. The calf starter intake benchmark at SROC during the 42 day pre-weaning phase is 43.5 lbs, with a range of 34.6 to 51.6 lbs. Post weaning intake from day 43 to day 56 is 62.2 lbs, ranging from 55.9 to 67.2 lbs. The slide also points out the intake and ranges by two week intervals during the pre-weaning phase. This can provide a measurement of how the calves are doing to see if targets are being met.

Weaning Criteria Recommendations

Use Calendar or Feed intake? Calendar at SROC

- ◆ **Large breeds:**
Starter consumption > 1.5 lbs/day for 2-3 consecutive days
- ◆ **Jersey's:**
Starter consumption > 1 lb/day for 2-3 consecutive days
- ◆ **Half feeding rates of milk replacer encourage starter consumption, increases rapidly after weaning**

What criteria should be used to determine when to wean a dairy calf? Should it be based on how much room there is available in post-weaning pens? Should it be based on age of the calf or the amount of feed the calf is consuming? At SROC, calves are weaned based on the age of the calf, mainly because of housing facilities and calves arriving twice per week from the three cooperating dairies that supply calves to SROC. General recommendation for large breeds, including Holsteins, is to wean when the calf is consuming more than 1.5 lbs per day of calf starter for at least 2-3 consecutive days. For the Jersey breed, the calf should be consuming more than 1 lb of starter for 2-3 consecutive days. As the calf gets close to the time of weaning, feeding a half rate of milk replacer will encourage starter consumption, which will increase rapidly after weaning.

Focus of SROC Calf Studies 2004-2007

Calf Starter programs –

- **Levels of molasses in complete texturized starters**
- **Different physical form of starters with/without intake enhancing supplements**
- **Corn sources for calf starters – (steam flaked, whole, roasted)**

Management programs --

- **Use of calf blankets in the winter of 2004-2005**
- **Group vs. Individual transitional management in the nursery**

Calf Starter studies at SROC during the period of 2004-2007 focused on two programs, the calf starters and the management of the calves. Calf Starter programs included: levels of molasses in complete texturized starters, different physical form of starters with and without intake enhancing supplements, and corn sources for the starters such as steam flaked, whole or roasted corn. Management programs evaluated included the use of calf blankets in the winter of 2004-2005 and management of calves in the nursery in preparation for the calf transitioning to its next housing facility.

Calf Starter Options

Using *texturized* or *pelleted* calf starters *with or without* flavor intake enhancing ingredients

56 day study with 114 two day-old Holstein dairy heifer calves were put on trial using five different intake enhancing flavor sources.

Treatments were:

- 1) texturized control (TCS)
 - 2) pelleted control (PCS)
 - 3) pelleted control with chocolate flavor (PCSS)
 - 4) pelleted control with whey flavor (PCSW)
 - 5) pelleted control with sweet start flavor (PCSS)
- Calf starters at 18% CP were offered free choice throughout the study.
 - All calves were fed a medicated 20:20 milk replacer in two equal feedings at 9.9 ounces (as-fed) plus 67.3 fluid ounces of water for 35 days, then once a day from day 36 to 42.
 - Fresh water was available at all times.

Studies were conducted at SROC looking at calf starter options. The following slides will cover results of some of those studies. First, a 56 day study was conducted with 114 two day-old Holstein calves using texturized or pelleted starters with or without flavor enhancing ingredients offered free choice. The pelleted options included a pelleted control, with chocolate flavor, with whey flavor, and with sweet start flavor. All calves were fed a medicated 20:20 milk replacer in two equal feedings at 9.9 ounces as fed, plus 67.3 fluid ounces of water for 35 days, then once a day from day 36 to 42. Fresh water was always available.

Calf Starter Options

*Using texturized or pelleted calf starters
with or without flavor intake enhancing ingredients*

Average Calf Performance over 56 days

	-----Treatment-----				
	<u>TCS</u>	<u>PCS</u>	<u>PCSS</u>	<u>PCSW</u>	<u>PCSS</u>
Final Hip Ht, in	35.7	35.3	35.9	35.5	35.0
Final BW, lb	177.5	168.1	170.0	165.3	154.1
Total Gain, lb	87.1	79.4	79.5	77.7	64.5
ADG, lb	1.56	1.42	1.42	1.39	1.15
Milk Repl, lb	47.3	47.3	47.2	47.1	47.0
Calf Starter, lb	114.9	114.1	109.6	108.2	90.5

This table shows the average calf performance over the 56 day study period with the five treatments. Data was collected for final hip height, final body weight, total gain and average daily gain, and average lbs/calf of milk replacer and calf starter consumed.

Calf Starter Options

Using *texturized* or *pelleted* calf starters
with or without flavor intake enhancing ingredients

Results –

- Calves fed texturized starter had 11.4% greater pre-weaning gains.
- Calves fed sweet start flavored pellets tended to have the lowest pre-weaning starter intake which was reflected in poorer calf performance.
- Starter intake similar for all calves across diets during first 28 days.
- Post weaning DMI and ADG from day 43-56 were lowest for calves fed PCSS.
- Gain/lb of feed was highest for calves fed TCS.
- Feeding a texturized 18% CP calf starter continues to be the preferred program when compared to complete pelleted starter diets.
- The addition of flavors to pelleted calf starters did not improve calf performance and in the case of PCSS was detrimental to calf growth.

Results of the study showed the following:

Calf Starter Options

Using texturized calf starters with varying molasses content

- Range used 5 to 12%
- Penn State work compared 5 vs 12% molasses in CS for 42 days when fed a 20:20 MR program at 10% birth weight; weaned at 28 days;
- Calves fed 12% < CS intake and gains but > rumen development; 12% molasses not recommended

A study at Penn State University compared texturized calf starters with a molasses content of 5% vs 12% over a period of 42 days. A 20:20 milk replacer was fed at a rate of 10% birth weight. Calves were weaned at 28 days. Results of this study showed that calves fed a 12% molasses content starter had less intake and gains but more rumen development. The conclusion of the study is that a 12% rate of molasses in the calf starter is not recommended.

Calf Starter Options

Using texturized calf starters with varying molasses content

A 56 day study with 79 Holstein heifer calves were put on trial using three differing levels of molasses in calf starter.

Treatments were:

- 1) 240 lbs molasses per ton of calf starter (12%)
 - 2) 180 lbs/ton (9%)
 - 3) 120 lbs/ton (6%)
- All calves fed a 20:20 medicated MR on trial days 1-35 at a rate of 1.25 lbs/hd/day in two equal feedings and 0.625 lbs/hd/day from days 36-42.
 - All calves fed texturized calf starter free choice through day 56 of the trial.
 - Calf starters were similar in nutrient content containing approximately 18% crude protein, 10% ADF, 2.7 Mcals ME/kg, 1.2% Ca, 0.6% P.
 - Fresh water was available at all times.

In a 56 day molasses study at SROC with 79 Holstein heifer calves, a comparison was made using a 6%, 9% and 12% molasses content texturized calf starter fed free choice. All calf starters contained approximately 18% crude protein and 10% acid detergent fiber. A 20:20 medicated milk replacer was used from day 1 to day 35 at 1.25 lb/day in two equal feedings and then from day 36-42, they were fed at 0.625 lb/day. Fresh water was available at all times.

Calf Starter Options

Using texturized calf starters with varying molasses content

Average Calf Performance over 56 days

	-----Treatment-----		
	<u>12 %</u>	<u>9 %</u>	<u>6 %</u>
Final Hip Ht, in	34.41	34.70	34.63
Final BW, lb	168.0	173.4	173.9
Total Gain, lb	78.75	83.80	85.89
ADG, lb	1.41	1.50	1.53
Milk Repl, DM, lb	44.5	44.6	44.7
Calf Starter, DMI, lb	103.2	111.6	108.5
DMI/gain, lb	1.89	1.87	1.79

Results of the study indicated calves fed a calf starter containing 6% molasses had 8.3% greater average daily gain and 5.3% greater gain per lb of feed than calves fed a starter containing 12% molasses. The calves fed the starter with 9% molasses had similar performance to the calves fed 6% molasses.

Calf Starter Options

Using texturized calf starters with varying molasses content

Results –

- Dry matter intake of milk replacer and calf starter were not different between the three molasses treatments over the 56 days.
- Calves fed starter with 12% molasses had 9.1% and 6.4% lower total gains than those fed the 9% and 6% molasses levels, respectively.
- This was partially attributed to less calf starter intake by calves fed 12% vs. those fed 9% and 6% levels.
- Feed was utilized more efficiently by calves fed the 6% treatment compared to those fed the 9% molasses treatment.
- Under conditions of this study, there were no benefits of increasing molasses levels in the calf starter above a 6% inclusion rate.

The 56 day study also showed that dry matter intake of milk replacer and calf starter were not different between the three molasses treatments. However, calves fed the 12% molasses starter had 9.1% lower total gains than those fed the 9% molasses level and 6.4% lower total gain than those fed the 6% molasses treatment., partially attributed to less intake. Feed efficiency was better for the 6% molasses starter compared to the 9% treatment. Under conditions of this study at SROC, there was no benefit seen to increasing the molasses content of calf starter above 6%.

Calf Starter Options

Using texturized calf starters with differing processed corn vs. a pelleted starter

A 56 day study with 125 Holstein heifer calves

- All starters were medicated with 1.3 oz. Rumensin per ton.
- Calf starters were offered free choice throughout the trial.

Treatments were:

- 1) steam flaked corn, pellet and oats (SFCPWO)
 - 2) whole corn and pellet (WC)
 - 3) whole corn pellet and oats (WCPWO)
 - 4) roasted corn, pellet and oats (RCPWO)
 - 5) complete pellet (CPEL)
- All calves were fed a 20:20 medicated milk replacer on trial days 1-35 at a rate of 1.25 lbs/hd/day in two equal feedings and 0.625 lbs/hd/day from days 36-42.
 - Calves were weaned at day 42
 - Fresh water was available at all times.

Another calf starter trial at SROC involved 125 Holstein heifer calves over a 56 day period using texturized starters with differing processed corn vs a pelleted starter. All starters contained 1.3 oz of Rumensin per ton. All calves were fed a 20:20 medicated milk replacer from day 1-35 at 1.25 lbs/hd/day in two equal feedings and 0.625 lbs/hd/day from days 36-42, then weaned. Fresh water was available at all times. There were five treatments in the trial as follows: steam flaked corn, pellet and oats; whole corn and pellet; whole corn pellet and oats; roasted corn, pellet and oats; and complete pellet.

Calf Starter Options

*Using texturized calf starters with differing processed corn
vs. a pelleted starter*

Average Calf Performance over 56 days

	-----Treatment-----				
	<u>SFCPWO</u>	<u>WC</u>	<u>WCPWO</u>	<u>RCPWO</u>	<u>CPEL</u>
Final Hip Ht, in	35.3	35.6	35.2	35.6	35.4
Final BW, lb	159.0	163.9	158.1	166.3	156.0
Total Gain, lb	70.0	76.2	71.7	77.8	66.6
ADG, lb	1.25	1.36	1.28	1.39	1.19
DM Feed/gain, lb	1.22	1.24	1.20	1.24	1.29
Total DMI, lb	86.6	95.3	87.3	97.6	87.2
Health cost, \$	2.88	3.85	2.34	2.44	1.74

Results of this study showed: Calves fed a complete pelleted calf starter had lower gains and poorer feed conversion compared to calves fed texturized diets but had a tendency for less scouring days and treatment cost per calf. Calves fed the whole corn/pellet diet and the roasted corn/pellet/oats diet tended to have slightly higher intake and gain than calves fed the steam flaked corn/pellet/oats diet and the whole corn pellet/oats texturized diet. Analysis of all starters showed variations across starters especially in fiber content, neutral detergent fiber and acid detergent fiber, crude protein and starch composition. The variations in feed analyses may have affected calf performance as much, if not more, than physical form.

Calf Starter Options

Pre- and post weaning performance and health of calves fed texturized calf starters with different processed corn or on a different milk replacer feeding schedule

- 108 2-4 day-old calves assigned to one of 4 treatments to evaluate their effect on pre- (42 d) and post weaning (d 43-56) calf performance and health.
- Calves were housed in individual pens in a naturally ventilated barn.
- All calves fed a 20% fat, 20% protein all-milk protein medicated milk replacer (MR) with 19.7% CP (DM basis) calf starters (CS) fed free choice with access to fresh water.

A calf starter trial at SROC involving 108 two to four day old calves evaluated pre- and post weaning performance and health using texturized calf starters with different processed corn or were on a different milk replacer feeding schedule. Four treatments were used and all calves were fed a 20:20 all-milk protein medicated milk replacer with 19.7% CP calf starters fed free choice and with access to fresh water.

Calf Starter Options

Pre- and post weaning performance and health of calves fed texturized calf starters with different processed corn or on a different milk replacer feeding schedule

Treatments:

- 1) Texturized calf starter based on steam flaked corn, pellet and oats
- 2) CS based on whole corn and pellet
- 3) CS based on roasted corn, pellet and oats

These 3 groups fed an all-milk protein, medicated MR (20%CP:20% fat) at 0.57 kg powder/day in 3.98 L water (12.5% solids) divided into 2 equal feedings for 35 days. From d 35 to 42 (weaning), calves were fed once daily (0.285 kg powder in 1.99 L water).

- 4) CS as in Treatment 3 but fed a different Milk Replacer feeding schedule

This group fed MR at the same rate as above for 14 days then switched to 1x daily feeding (.57 kg) powder/day in 3.98 L water) from day 15 to 35 followed by the same schedule as above 3 groups for days 35 to 42.

Fresh water was available at all times.

- The four treatments were: 1) Texturized calf starter based on steam flaked corn, pellet and oats; 2) Calf starter based on whole corn and pellet; 3) Calf starter based on roasted corn, pellet and oats. These three groups fed medicated MR at 0.57 kg powder/day in 3.98 L water (12.5% solids) divided into 2 equal feedings for 35 days. From d 35 to 42 (weaning), calves were fed once daily (0.285 kg powder in 1.99 L water).
- 4) Calf starter same as in Treatment 3 but fed at the same rate as above for 14 days, then switched to 1x daily feeding (.57 kg) powder/day in 3.98 L water) from day 15 to 35, then followed by the same schedule as first 3 groups for days 35 to 42 (fed once daily at 0.285 kg powder in 1.99 L water).

Calf Starter Options

Pre- and post weaning performance and health of calves fed texturized calf starters with different processed corn or on a different milk replacer feeding schedule

Overall 56 d calf performance:

- There were no overall performance differences.
- Daily DMI, daily gain, and feed/gain averaged 1.24, 0.66 and 1.95 kg, respectively.

Health parameters:

- Calves on treatment 4 fed 1x/day from day 15-35 had the lowest fecal scores from day 1-42.
- No differences in pre-weaning scouring days (fecal score ≥ 3) and overall treatments costs averaging 1.97 and \$1.65/calf, respectively.

Conclusion:

- Using steam- flaked, whole or roasted corn based calf starters did not affect calf performance or health.
- Feeding MR 1x vs. 2x daily from 15-35 days did not affect calf growth.

Results of this study indicated there were no overall performance differences amongst all calves over the 56 day period. Whether using a calf starter based on steam flaked, whole or roasted corn did not affect calf performance or health. It was also concluded that feeding milk replacer one time or two times daily from day 15-35 did not affect calf growth.

Calf Starter and Milk Replacer Options

Parameter	Control	Modified	Intensive
	20:20 non-acidified	28:16	28:16
MR rate, lb/day	1.25	1.5	2.25
Solids, %	13.88	16.67	16.67
Calf starter, CP %	18	22	22
Initial BW, lb	90.64	89.54	88.66
Initial HH, in	31.8	31.78	31.81
Serum Protein, g/dl	5.0	4.9	4.98
Final BW, lb	169.84	179.08	188.76
BW change vs Initial	187%	200%	213%
Final HH, in	35.91	35.91 (-2%)	36.65
Milk DM, lb	46.86 (-43.3%)	55.44 (-23%)	82.72
Calf Starter, DM lb, 56 d total	103.4 (+19.8%)	108.46 (+23.6%)	82.94
Total DM, lb	150.26	163.9	165.66
ADG, day 1-56, lb	(-18.7%)	1.61 (-8.8%)	1.76
Total Gain, lb	79.2	89.54	100.1

There has been a lot of interest in using an intensive milk replacer feeding program for dairy heifer calves. A number of calf raisers have been doing it for some time. A study was set up at SROC to evaluate calf performance comparing three programs over a 56 day period: 1) a control using a 20:20 non-acidified milk replacer fed at a rate of 1.25 lbs/day with an 18% crude protein calf starter; 2) a modified treatment using a 28:16 milk replacer fed at 1.5 lbs/day with a 22% crude protein calf starter, and 3) an intensive treatment using a 28:16 milk replacer fed at 2.25 lbs/day with a 22% calf starter. Results of the study showed a body weight change over the 56 day period of 187% with the control; 200% with the modified; and 213% with the intensive program. Calves on the control program consumed 43.3% less milk replacer but 19.8% more calf starter than the intensive program calves. Calves on the modified intensive program consumed 23% less milk replacer but 23.6% more calf starter than the intensive program calves. Average daily gain compared to the intensive program was 18.7% less with the control and 8.8% less for the modified intensive program. Although the study shows an advantage in using an intensive program, or a modified intensive program compared to the control program in body weight gain to 56 days, calf raisers must determine how each of these choices fit into their overall calf raiser goals and the costs associated with each of the program choices.

Performance of 105 dairy heifer calves fed control diets across 7 research projects from 1 to 56 days The <u>range</u> of 56 day calf performance when fed standard control diets: • 1.53 to 1.72 lbs/day • gain/feed from 0.49 to 0.56 lbs gain /lb DM	Parameter	Ave. 4 trials '04 to '05	July '05 to Sept '05	Dec '04 to Feb '05	Dec '05 to Feb '06
	No.calves/group	24	25	20	36
	Initial serum protein (g/dl)	5.25	5.41	4.7	5.48
	MR, Protein:fat %	20:20 med	20:20 non-med	20:20 med	24:20 med
	MR, lbs/d, 1-35 d	1.25	1.25	1.5	1.25
	MR, lbs/d, 36-42 d	0.625	0.625	0.75	0.625
	MR DM, lb, 1-42 d	46.59	47.16	54.42	45.91
	Calf starter % CP	18	18	20	18
	Calf starter, lb DM,1-42d	48.75	38.36	52.01	58.17
	Calf starter, lb DM,43-56d	67.53	57.83	68.46	65.65
	Initial Hip Height, in	31.59	31.59	31.93	31.98
	Final Hip Height, in,1-56d	35.53	35.22	36.12	36.04
	Hip Height gain, in,1-56d	3.94	3.63	4.19	4.06
	Initial BW, lb	89.17	88.29	91.88	92.62
	BW at 56 days	179.38	162.28	183.88	182.07
	BW gain, % of initial	201	184	200	197
	Total DM lb, 1-56 d	162.87	143.35	174.88	174.85
	Gain, total lb, 1-56 d	90.21	73.99	92	89.35
	ADG, lb, 1-56 d	1.61	1.32	1.64	1.6
	Gain/feed, DM lb, 1-56 d	0.55	0.52	0.53	0.51

This is a performance summary of the control groups only for 7 research projects completed at SROC from 2004, when the new facilities opened, until February 2006. The length of the projects were 56 days, pre-weaning from day 1 to 42, then post-weaning from day 43 to 56. The summary is divided into time periods and shows the milk replacer and calf starter programs, initial and final hip heights, initial and final body weights, total dry matter consumed, average daily gain, and gain per lb of feed for the 56 day period. Note the data in the bottom row – no difference in gain per lb of dry matter consumed. However, there was a difference in average daily gain of about 0.3 lb/day less for the non-medicated milk replacer group. This group also consumed less calf starter, had shorter final hip height and less body weight gain at 56 days.

Protein Sources and Levels

- Early SROC work (Miller et al., 1986) indicated increasing protein from 13.1, to 15.1 to 17.2% in calf starter fed to bull calves enhanced ADG and feed efficiency.

- **Compared:**
 - SBM
 - 2/3 SBM:1/3 Urea
 - Urea in 68.4% rolled corn, 20% alfalfa hay based starter

No performance differences tendency for decrease in ADG as Urea increased.

Do the protein sources in calf starters influence calf performance? Research back in 1986 by Miller at SROC indicated that by increasing protein from 13.1% to 15.1% to 17.2% in calf starter fed to bull calves enhanced average daily gain and feed efficiency. The protein sources used were soybean meal, a mixture of 2/3 soybean meal and 1/3 urea, and incorporating urea into a mix of 68.4% rolled corn and a 20% alfalfa hay based starter. The study also showed no performance differences for decrease in average daily gain as the urea percentage increased.

Protein Sources and Levels

Also at SROC, Miller et al., (1986) compared alternative protein sources in 15.2% CP Calf Starter for calves from 94 to 400 lbs BW.

	<u>Ave Daily Gain</u>
• Urea	1.72
• Soybean Meal	1.96
• Formaldehyde treated SBM	1.88
• Dried Distillers Grain	1.71
• Meat Meal	1.88

Dry matter intake averaged 2.4% of body weight vs 3% today at SROC.

In addition to the work done to evaluate performance by increasing protein percentage in calf starter, Miller also compared alternative protein sources using a standard 15.2% crude protein calf starter for calves from 94 to 400 lbs body weight. The protein sources and average daily gains for the study were as follows: urea-1.72, soybean meal-1.96, formaldehyde treated with soybean meal-1.88, dried distillers grain-1.71, and meat meal-1.88 lb/day. Dry matter intake for all calves averaged 2.4% of body weight. In research conducted recently at SROC the dry matter intake is at 3% of body weight.

Protein Sources and Levels

Other information:

- Drackley (2000) fed a 18:20 vs 22:20 milk replacer with 18 or 22% CP calf starter. Results showed daily gain was greater for 22:20 milk replacer. The 22% calf starter resulted in greater feed efficiency but not in gain.
- Akayezu et al, (1994) fed a 15%, 16.8%, 19.6% or 22.4% CP (dry matter basis) calf starter from 4 to 56 days plus whole milk fed at 8% of birth weight daily. Results showed the maximum growth was with the 19.6% CP starter.
- Abdelgadir et al. (1996) fed a 17% CP calf starter with soybean meal and roasted soybeans (280°F vs 295°F) and 30%, 45%, or 52% RUP with raw or roasted corn. Results showed the higher temperature roasted beans with roasted corn was the best combination. Using protein and energy sources of similar rumen-undegradable protein (RUP) is recommended.

In continuing to look at protein sources for calf starters, other studies around the country include: 1) an 18:20 vs 22:20 milk replacer with 18 or 22% CP calf starter. Results showed daily gain was greater for 22:20 milk replacer. The 22% calf starter resulted in greater feed efficiency but not in gain. 2) a 15%, 16.8%, 19.6% or 22.4% CP (dry matter basis) calf starter from 4 to 56 days plus whole milk fed at 8% of birth weight daily. Results showed the maximum growth was with the 19.6% CP starter. 3) a 17% CP calf starter with soybean meal and roasted soybeans (280°F vs 295°F) and 30%, 45%, or 52% rumen-undegradable protein (RUP) with raw or roasted corn. Results showed the higher temperature roasted beans with roasted corn was the best combination. Using protein and energy sources of similar RUP is recommended.

Role of Forage



← Coarse + 7.5% Hay

Hay of consistent particle size

CP - 23.08% ADF - 6.47%

Coarse + 15% Hay →

Hay of consistent particle size

CP - 22.60% ADF - 7.43%



The next few slides will look at incorporating forage fiber in the diet for pre-weaned calves. The photos in this slide show hay particles mixed in the calf starter, one at 7.5% hay and the other at 15% hay.

Hay or no Hay?

Should access to hay be limited during pre-weaning?

Intake of dry feed and early consumption of feed promote growth of rumen epithelium – starter grain is fermented in the rumen to create volatile fatty acids, which equals energy. The volatile fatty acids need water and starter.

Hay = scratch factor to keep rumen papillae from forming keratin layers that reduce absorption.

An example would be to wait to feed hay until 6-7 weeks of age. This would be after weaning at 4 to 5 weeks of age.

(Adapted from Quigley, 1996)

Should hay be offered to pre-weaned calves and if so, how much and when? Intake of dry feed and early consumption of feed promote growth of rumen epithelium – starter grain is fermented in the rumen to create volatile fatty acids, which equals energy. The volatile fatty acids need water and starter. Hay offers a scratch factor to keep rumen papillae from forming keratin layers that reduce absorption. One good strategy would be to wait to feed hay until 6-7 weeks of age. This would be after weaning at 4 to 5 weeks of age.

Rumens of 6-Week-Old Calves



Milk, Grain, Hay



Milk and Grain



Milk

An important goal during pre-weaning is to make sure the rumen develops properly. Note the photos in the slide comparing rumen development where the calf was fed milk, starter and hay; another calf was fed milk and starter only; and another calf was fed milk only. Again, young calf needs to consume an adequate amount of calf starter to promote growth of rumen epithelium.

Incorporation of fiber sources

SROC study on bull calves weaned at 28 days

- fed 80% corn and 17.6% soybean meal diets from 5-7 days up to 300-400 lbs
- compared 0, 15 or 30% chopped alfalfa hay (to replace some corn and soybean meal).

Results –

The starter with 15% hay gained 3.7% and 8% greater than calves fed 30% or no hay from 95 to 300 lb.

A few years ago, a study was conducted at SROC on bull calves weaned at 28 days. They were fed 80% corn and 17.6% soybean meal diets from 5-7 days up to 300-400 lbs. A comparison was made of incorporating 0, 15% or 30% chopped alfalfa hay into the diet to replace an amount of corn and soybean meal. Results showed that the calves on the starter with 15% hay gained 3.7% and 8% greater than calves fed 30% or no hay respectively, from body weight average of 95 lb up to 300 lb.

Incorporation of fiber sources

Minnesota work with a 20:20 milk replacer program plus:

- **17.4% crude protein, 35.1% neutral detergent fiber complete pelleted calf starter**
- **with 0, 12.5 or 25% alfalfa leaf meal (26% CP, 47% NDF)**

Results:

- **Increasing the alfalfa meal percentage decreased feed efficiency and tended to decrease calf starter intake but there were no gain differences.**
- **Gains were much lower than current SROC research work taking place.**

More work was done in Minnesota on incorporating fiber sources into the diet of pre-weaned calves using a 20:20 milk replacer program plus: 17.4% crude protein, 35.1% neutral detergent fiber complete pelleted calf starter with 0, 12.5 or 25% alfalfa leaf meal (26% CP, 47% NDF). Results showed that increasing the % alfalfa meal decreased feed efficiency and tended to decrease calf starter intake. However, there were no gain differences.

Incorporation of fiber sources

Iowa State work (Cloverdale et al, 2004)

- fed commercial CS (22.65% CP, 19.04% NDF, 4.22% fat
- 31.85% finely cracked vs 32% coarse steam flaked corn;
- oats, molasses, protein pellet)
- with 7.5% or 15% bromegrass hay chopped to 8-19 mm particle size.
- 20:20 milk replacer fed at 10% body weight
- calves were weaned based on intake level

At Iowa State University, researchers fed a 22.65% crude protein commercial calf starter comparing a starter containing 31.85% finely cracked corn to one containing 32% coarse steam flaked corn. The starters also contained oats, molasses and a protein pellet. These starters were compared with a 7.5% or 15% bromegrass hay chopped to 8-19 mm particle size. Calves were weaned based on intake level.

Incorporation of fiber sources

Iowa State work (Cloverdale et al, 2004) -- continued

Results of study 1:

- Calf starter intake constant at 2-24 days = 0.55 lb/day
- 25-47 days = 0.77 lb/day
- 48-50 days = 1 lb/day
- Calves fed the coarse diet had a greater ADG and feed per lb of gain
- Calves fed the starter that included the 7.5% hay did better.
- Ruminant Volatile Fatty Acids (VFA) were greater for the coarse diet

Results of Study 2 (same diets as Study 1 but fed free choice)

- No performance or VFA differences
- Pre-weaning starter intake averaged 1.41 lbs and ADG was 1.19 lb/day

Authors suggested “forages of consistent particle size are beneficial for both rumen development and calf performance and have the potential to be economically viable”.

Results of the Iowa State research were divided into two parts: **Study 1:** Calf starter intake was constant at 2-24 days = 0.55 lb/day; at 25-47 days = 0.77 lb/day; at 48-50 days = 1 lb/day. Calves fed the coarse diet had a greater ADG and feed per lb of gain. Calves fed the starter that included the 7.5% hay did better. Ruminant Volatile Fatty Acids (VFA) were greater for the coarse diet. **Study 2:** (where the diets were the same as in study 1 but fed free choice) No performance or VFA differences. Pre-weaning starter intake averaged 1.41 lbs and ADG was 1.19 lb/day. Therefore, it was suggested that “forages of consistent particle size are beneficial for both rumen development and calf performance and have the potential to be economically viable”.

Physical Form of Calf Starters and Ingredients

Franklin et al. 2003 –

- 22% CP calf starter with Bovatec.
- Calves 1 gal whole milk daily;
- weaned when calves CS intake 1.5 lb/day for 2 days;
- Compared ground(G), pelleted (P) or texturized (T) CS;

Results –

- Ave. days to weaning were 32, 37, and 31 for G, P, and T CS;
- ADG over 42 days were 1.1, 0.97, 1.21 for calves fed G, P, and T CS, respectively.

The physical form of calf starter can influence intake and rumen development of the pre-weaned calf. In a 2003 study by Franklin, calves were fed a 22% starter with Bovatec along with 1 gallon of whole milk daily. Weaning occurred when starter intake was at 1.5 lb/day for two consecutive days. The study compared ground, pelleted and texturized calf starter. In this study, physical form of calf starter had some influence on average days to weaning and on average daily gain over the 42 day period. For the Ground starter, average days to weaning was 32 days with calves having a 1.1 ADG over the 42 day study period; the Pelleted starter showed 37 days to weaning and a 0.97 ADG; and the Texturized starter showed 31 average days to weaning and a 1.21 ADG over 42 days of the study.

Physical Form of Calf Starters and Ingredients

- Beharka et al, 1996 – fed bull calves from 4 days of-age; 17.5% CP; 30% NDF, 12.7% ADF CS with 75% grain mix and 25% chopped alfalfa hay; whole milk fed at 8% birth weight daily; weaning when calves CS intake of 1.2 lb/day for 2 days.
- Unground CS (hay chopped at 0.25 inches (0.64 cm) and grains rolled) vs Ground CS (all milled through 1 mm screen)
- Results showed Ruminal pH was less for the ground starter; Cellolytic bacteria was less for unground starter. The conclusion was that physical form is important for rumen development and calf performance.

A few years ago, Beharka did a study on bull calves starting at 4 days of age. The calf starter was 75% grain mix and 25% chopped alfalfa hay resulting in an analysis of 17.5% CP; 30% NDF, 12.7% ADF. Whole milk was fed at 8% birth weight daily. Weaning took place when calf starter intake was 1.2 lb/day for 2 days. A comparison was made using unground calf starter and hay chopped at 0.25 inches (0.64 cm) and grains rolled vs ground starter that was all milled through 1 mm screen.

Results showed Ruminal pH was less for the ground starter; Cellolytic bacteria was less for unground starter. The conclusion was that physical form is important for rumen development and calf performance.

Physical Form of Calf Starters and Ingredients

- Lesmeister and Heinrichs (2004) fed 33% whole corn (WC) vs, dry rolled corn (DRC) vs roasted corn (RC), or steam flaked corn (SFC) in calf starter (21.14% CP, 75.6% TDN, 17.94% NDF, 7.76% ADF, 0.78 Mcals NE_G /lb);
- Calf starter intake highest for DRC, then WC, RC, and SFC, respectively. No performance differences
- Authors suggested that RC calves had similar growth and rumen development but increased rumen structural growth and butyrate production that suggested better prepared for weaning.

In another study on physical form of calf starters and ingredients, Lesmeister and Heinrichs in 2004 fed 33% whole corn vs, dry rolled corn vs roasted corn, or steam flaked corn in starter. The analysis was 21.14% CP, 75.6% TDN, 17.94% NDF, 7.76% ADF, 0.78 Mcals NE_G /lb.

Results showed that starter intake was highest for the dry rolled corn, then whole corn, followed by roasted corn and steam flaked corn. There was no differences in calf performance across the various forms of corn. The authors suggested from the study calves fed roasted corn had similar growth and rumen development but increased rumen structural growth and butyrate production that suggested they were better prepared for weaning.

Other Options for Calf Starters

- Fat levels
- ionophores
- various vitamins
- yeast cultures
- mannan oligosaccharides
- and other supplements

These have been evaluated and provide opportunities to refine CS formulations above the main ingredients just discussed.

Other options that can be considered for calf starters include: Fat levels, ionophores, various vitamins, yeast cultures, mannan oligosaccharides, and other supplements. These have been evaluated at SROC and provide opportunities to refine calf starter formulations above the main ingredients just discussed.

Summary:

- Calf starters should be relatively simple formulations that promote optimum intake, rumen development and meet target growth goals as economically as possible.
- All starters are not created equal. Remember, there are number of variables that contribute to differences in intake, including the milk feeding programs, physical form and main nutrient inclusion levels that have been emphasized in this presentation.



In summarizing calf starters for dairy replacement heifers, formulations and feeding program need not be complicated. They should be relatively simple formulations that promote optimum intake, rumen development and that meet target growth goals as economically as possible. The bottom line is that all calf starters are not created equal. Remember, there are number of variables that contribute to differences in calf starter intake, including the physical form and main nutrient inclusion levels that have been emphasized in this presentation.