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Calf Note #155 – Day 2

Introduction

Calf nutrition and management seems to be divided into two distinct periods – namely, the first day of life and everything after. We all know of the importance of Day 1 – the all important period when newborn calves can absorb immunoglobulins into the bloodstream without digestion. This is the time when colostrum feeding (or use of colostrum supplements/replacers) is essential to provide the calf with passive immunity and critical nutrients for survival.

But, after the first 24 hours of life, most producers move newborns – now 24 to 36 hours of age, into the "normal" housing and management of the calf raising operation. Of course, the "babies" may get special treatment – teaching them to drink from the nipple or bucket, vaccinations, etc. But, for the most part, we assume that this young animal can be fed and managed other, older calves.

So, here's the question - is the day-old calf able to digest, absorb and utilize nutrients like animals several weeks older? Is its immune system equally competent to fight pathogens as calves much older? The short answers are no and no. The objective of this Calf Note is to explain some of the differences and propose that we might consider a different approach to managing "Day 2" calves. We'll consider differences in three areas – gut flora (bacteria), digestion and metabolism and immunity.

Bacterial flora. When the calf is first born, the digestive tract is sterile. During the first 24 hours or so of life, bacteria take up residence in the tract, colonizing from "both ends" (mouth and anus) and eventually, large numbers of bacteria can be found throughout the tract.

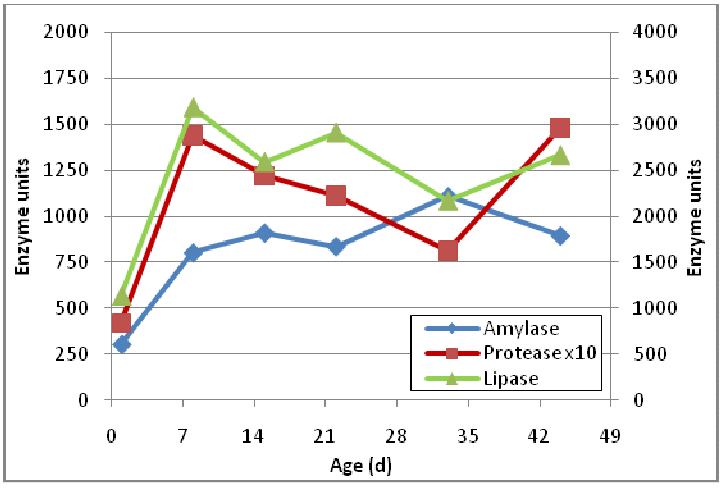

Figure 1. Activity of pancreatic enzymes in milk-fed calves. From Huber et al., 1961.

By 24 hours of life, there is a considerable population in the tract, but many of these bacteria are "transient" – i.e., they become established in the gut because they were inoculated via feed or the environment. They are not normally found (at least in measurable concentrations) in the gut of older calves. Much work was done to understand the changes in

bacterial populations in the rumens of newborn calves (Anderson et al., 1987; Bryant et al., 1958). Similar changes likely occur in the intestine of young calves; however, data are less available.

Digestion and metabolism. The enzymes and gastrointestinal secretions that calves use to digest their feed do not turn on "magically" at 24 hours of age. Many or most of them gradually increase over time. As an example, Huber et al. (1961) measured enzyme activity in milk-fed calves from 1 to 44 days of age. Mean activity of enzymes in the pancreas are in Figure 1. As you can see, activity of all enzymes (lipase, protease and amylase) were lower at day 1 than other days, and then increased by day 8. Thereafter, activities don't change dramatically. Similar data have been reported by other researchers (Ternouth and Buttle, 1973; Ternouth et al., 1976; Sissons, 1981). Generally, activities of many (but not all) enzymes tend to increase with time. Changes in enzyme activity are also affected by diet, amount of solid feed consumed (and subsequent rumen development) and age. But, the data appear clear that most enzymes are less active in the first few days of life. Thus, we shouldn't assume that calves are ready to digest the same type of diet on day 2 that they will be on day 20.

Immunity. Absorption of immunoglobulins is complete by 24 hours of age. The process of intestinal maturation (called intestinal closure) that terminates by the end of the first day. Many other components of the immune system are still depressed by day 2 – levels of complement decline in the first couple of days. Other aspects of the calf's immune response are less well developed and require time to fully mature. Rossi et al. (1981) and many others have documented the immaturity of the neonatal immune system. It can take several weeks for the calf's immune system to fully mature. Until then, it relies on the passive immunity provided by colostrum.

A dietary approach

So, if a calf on day 2 is still not "normally developed" (at least compared to a calf at 14-21 days of age), how do we manage calves to accommodate differences in their metabolism? Are current methods of feeding and management appropriate for day 2 calves? The short answer is that we don't know for sure. Few studies have evaluated differences between calves at 2-3 days of age and those at 14-21 or so. We generally assume that digestive development changes gradually and development at day 2 isn't much different from day 1.

Another approach is to look at how Nature approaches day 2 and try to learn how our nutrition and management could adapt to improve calf performance.

Nutrient	Day 1 (Milking 1)	Day 2 (Milking 3)	Day 3 (Milking 5)	Milk
Specific gravity	1.056	1.035	1.033	1.032
Solids, %	23.9	14.1	13.6	12.9
Fat, %	6.7	3.9	4.3	4.0
SNF, %	16.7	9.8	9.5	8.8
Protein, %	14.0	5.1	4.1	3.1
Lactose, %	2.7	4.4	4.7	5.0
Ca, %	0.26	0.15	0.15	0.13
Casein, %	4.8	3.8	2.9	2.5
Ig, g/L	60	24	N/A*	0.09
IgG, g/L	32	15	N/A*	0.06

Table 1. Composition of milk from cows following calving. Adapted from Foley and Otterby, 1978. *N/A = not available.

Table 1 contains the nutrient and immunoglobulin (total Ig and IgG) content of colostrum (first milking after calving) and transition

milk collected on day 2 and day 3. These are compared to normal milk (adapted from Foley and Otterby, 1978).

As we can see, the composition of transition milk (milking 3 and milking 5) varies significantly from both colostrum AND mature milk in terms of solids, nutrition and immunoglobulin content. The content of IgG is still significant. According to Foley and Otterby, the content of IgG is about half that of first-milking colostrum. If we calculate the intake of nutrients and IgG (assume a calf consumes 4 liters of colostrum, transition milk and mature milk), we see that there are still lots of differences between intake of day 2 transition milk, mature milk and colostrum. These figures are in Table 2. Compared to colostrum, day 2 milk contains less solids (-41%), fat (-42%), protein (-74%), casein (-21%), total Ig (-60%) and IgG (-52%). However, compared to colostrum, calves fed day 2 milk will consume more lactose (+63%) due to changes in lactose content of day 2 transition milk compared to colostrum.

Intake, grams	Day 1 (Milking 1)	Day 2 (Milking 3)	Day 3 (Milking 5)	Milk
Solids, %	956	564	544	516
Fat	268	156	172	160
Lactose	108	176	188	200
Protein	560	204	164	124
Casein	192	152	116	100
Ig	240	96	N/A*	<1
IgG	124	60	N/A	<1

Table 2. Intake of nutrients, Ig and IgG in calves fed 4 liters of colostrum, transition milk and mature milk. Adapted from Foley and Otterby, 1978. *Not available.

When we compare intake on day 2 compared to intake of 4 L of mature milk, we see calves fed day 2 milk eat more solids (+9%), protein (+65%), casein (+52%), Ig and IgG. Intake of fat is similar and lactose is slightly lower than when calves drink mature milk.

What are the implications to this information? It appears that calves on day 2 will consume more solids, protein and IgG when they drink transition milk compared to whole milk. Blättler et al. (2001) and Bühler et al. (1998) reported that feeding more colostrum had positive effects on maturation of the intestine, enzyme activity and digestion.

Of particular interest is continued feeding of relatively large amounts of IgG. On day 2, calves fed transition milk still receive over 50 grams of IgG. If we assume that dairy cows provide IgG in their colostrum and milk for a reason, we might conclude that continued feeding of IgG confer continued benefit to calves even though they are not absorbed into the bloodstream. And, indeed, many published papers suggest that continued feeding of IgG and other functional proteins from colostrum. So, many extension publications recommend continued feeding of colostrum for three days after birth:

- http://ag.udel.edu/anfs/faculty/kung/articles/importance_of_colostrum_for_calv.htm
- http://www.uky.edu/Ag/AnimalSciences/dairy/extension/nut00109.pdf
- http://www.farmllc.org/custom3.html
- http://www.rennut.com/articles/pdf/Newborn%20Calf%20Care.pdf

So, if transition milk is available, it's an excellent source of both nutrition and immunity for day 2 calves. Unfortunately, many producers don't have transition milk available. Some sell their transition milk; others move calves from the dairy to a calf ranch on day 1 and may only have access to commercial milk replacer.

One potential solution is to blend first milking colostrum or commercial colostrum replacer into milk replacer. Table 3 contains an example of the calculation for blending a 22/20 commercial milk replacer with a commercial colostrum replacer. I've assumed that the colostrum replacer contains about 50% protein, 25% IgG and 20% fat. The content of replacers can vary, so check the label. As you can see from table 3, it's possible for us to match the solids (DM), protein and IgG content of day 2 transition milk.

		DM		CP		Fat		IgG	
	grams	**%**	**g**	**%**	**g**	**%**	**g**	**%**	**g**
Milk replacer	350	95%	333	22%	77	20%	70	0%	0
Colostrum replacer	250	95%	238	50%	125	20%	50	25%	63
Total	600	95%	570	34%	202	21%	120	11%	63
Day 2 milk			564		204		156		56

Table 3. Blend of commercial milk replacer and colostrum replacer to simulate nutrient composition of day 2 transition milk.

Of course, the use of a colostrum replacer is more expensive than milk replacer. Using liquid colostrum will cost less – however, don't consider colostrum to be cost free or risk free. Stored maternal colostrum can be highly contaminated with bacteria, potentially infecting calves. It's essential that any stored colostrum be properly managed to minize microbial contamination. Also, liquid colostrum isn't free – you invest the time and expertise to manage liquid colostrum. Colostrum replacers, though more expensive, have the advantage of low microbial risk and ease of use.

Summary

We often assume that the immune and digestive systems of calves on days 2 and 3 of life are as mature as calves much older. They are not. This Calf Note documents some of the differences and proposes that the composition of day 2 and day 3 transition milk is a reasonable guide for evaluating the needs of calves during the important second and third day of life. Supplementing the diet with an additional source of proteinand IgG may support digestive and immune development and keep calves growing normally.

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Written by Dr. Jim Quigley (29 January 2011)

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