Calf Note 167 – Testing the lactocrine hypothesis in newborn calves

Introduction

Feeding colostrum is important for all newborn calves. High quality first-milking colostrum contains large amounts of immunoglobulins required to provide passive immunity to the newborn. Feeding enough colostrum to provide 150-200 grams of IgG in the first 24 hours of life should be standard practice for all calf raisers.

However, recent research suggests that other parts of colostrum – specifically growth factors and hormones – may play an essential role in growth and development of the newborn. This is called the "lactocrine hypothesis".

The lactocrine hypothesis "*describes the effect of milk-borne factors, including colostrum in this definition, on the epigenetic development of specific tissues or physiological functions…"* (Soberon et al., 2012). Put another way, the lactocrine hypothesis proposes that some factors in colostrum and milk may permanently affect future calf performance such as growth, efficiency or even future milk production.

Researchers using newborn piglets have reported a role for some proteins in colostrum and milk, including a hormone called relaxin (Bartol et al., 2008; Bagell et al., 2009), which may be involved in development of the reproductive organs in piglets. For example, Chen et al. (2011) allowed some newborn piglets to nurse the mother *ad libitum* while other piglets were fed a colostrum/milk replacer without or with added relaxin for two days. At the end of the two day period, piglets nursing from the sow had greater indices of uterine development than piglets nursing replacer. Adding relaxin to the replacer improved some, but not all, indices of uterine development.

Researchers at the University of Berne in Switzerland and the University of Hannover in Germany have evaluated the role of protein in colostrum on intestinal growth, metabolism and development of digestive processes in calves fed adequate or inadequate amounts of colostrum (for example, see Rauprich et al., 2000; Hammon and Blum, 2002 and many others). Many of these studies report that feeding maternal colostrum increased the rate and extent of gastrointestinal development compared to calves fed formulas without colostrum proteins.

Taken together, these data suggest that hormones and growth factors in colostrum and milk (i.e., lactocrine factors) may have long-lasting effects on growth and development of the newborn.

How might these "lactocrine factors" affect future production in newborn dairy calves? Well, the answer to this question is still not clear, but may be related to expression of genes that are involved in weight gain, utilization of nutrients, reproductive or mammary development. Thus, it may be

necessary or important that a calf be exposed to these factors at the right times and in the right amounts to ensure the calf may be able to express its full genetic potential.

The role of colostrum

Colostrum is that logical source for lactocrine factors for the newborn. First-milking colostrum contains large amounts of protein, including immunoglobulins (IgG, IgM, and IgA) and other proteins such as growth factors (IGF-1, IGF-2 and many others), hormones (insulin, growth hormone, etc.), and other peptides. These proteins are often found in amounts far greater than can be found in normal milk. Indeed, some growth factors (e.g., IGF-1) are specifically "activated" (in the case of IGF-1, separated from binding proteins) right around parturition. Thus, it's logical that these proteins might play a critical role in establishing a baseline for future calf performance.

Is there a dataset that specifically evaluates this lactocrine hypothesis? That is, are there studies that compare milk production in calves fed with or without maternal colostrum, then grown, allowed to calve and produce milk? Well, indeed there is such a dataset. The study is an excellent evaluation of the hypothesis that colostrum proteins and growth factors can permanently affect an animals ability to make milk after calving.

The research

The study by Pithua et al. (2010) utilized 497 heifer calves from 12 dairies in Minnesota and Wisconsin. Calves were born on farms involved with Johne's control programs and the study was originally intended to evaluate the use of colostrum replacers in Johne's control. However, for the purposes of this Calf Note, we'll focus on the consumption of colostral proteins and the effect of lactocrine factors on future production.

Calves were assigned to receive either 4-6 L of maternal colostrum (including all lactocrine factors contained in colostrum) or 1 dose of a commercial colostrum replacer by 1 hour after birth. Farms that fed an additional dose of colostrum at 12 hours also fed a colostrum supplement at about 12 hours of age to calves fed the replacer. All calves were separated from the dam within 60 minutes of birth and were fed their respective treatments to ensure that calves fed the commercial products did not consume maternal colostrum. After the first 24 hours of life, calves were housed, managed and raised according to the normal management of the farm. They all were fed commercial milk replacer, calf starter and water prior to weaning at 56 days of age. Calves were bred and calved according to normal protocols on the farm and milk production was monitored to about 54 months of age.

Calves were monitored throughout life for growth, breeding efficiency, survival in the herd and production of milk in the first two lactations. Reasons for culling heifers were recorded and all measurements were compared between the two treatment groups.

The results

A total of 261 calves were fed maternal colostrum and 236 calves were fed the commercial colostrum products. It's important to note that the commercial colostrum replacer and supplement were based on highly fractionated bovine plasma, so these products contained little or none of the lactocrine factors found in maternal colostrum. The colostrum fed in the study was high quality with an average of 77 g of IgG/L. So, the average IgG concentration was much greater than the recommended 150-200 grams of IgG in the first 24 hours.

Though the concentration of various growth factors, peptides or hormones were not measured, it is assumed that there were sufficient amounts of these lactocrine factors in the colostrum, whereas little or no lactocrine factors would be present in the commercial products.

The researchers monitored growth, culling events, milk yield and breeding performance of both groups of calves. Key production parameters are shown in Table 1. The data clearly show that feeding colostrum or colostrum replacer had no effect on milk production, reproduction or survival to 54 months of age. In a previous study, Pithua et al. (2009) reported that calves fed the colostrum replacer were at less risk to become infected with *Mycobacterium paratuberculosis*, the organism responsible for Johne's disease in cattle.

Item	MC	CR	P
No. of calves	261	236	…
Died, 0-54 mo	55	58	NS
Culled, 0-54 mo	81	68	NS
Total left the herd, 0-54	136	126	NS
Age 1st calving, mo	24.4	24.3	NS
Services per conception			
1st Lactation	2.70	2.74	NS
2nd Lactation	2.54	2.36	NS
Days open			
1st Lactation	138	139	NS
2nd Lactation	121	118	NS
Milk production, kg			
1st Lactation	12,232	11,889	NS
2nd Lactation	11,451	11,972	NS
Total Lactations	22,944	22,681	NS

Table 1. Production of cows fed maternal colostrum (MC) containing lactocrine factors or colostrum replacer (CR) without lactocrine factors. From: Pithua et al., 2010.

So, what of the lactocrine hypothesis? In this study, calves fed the colostrum replacer, (which was manufactured using fractionated bovine plasma) produced just as much milk and were just as productive as calves fed 4-6 L of high quality maternal colostrum. Here are some of the potential explanations for the lack of an effect:

The colostrum replacer used in the study provided similar amounts of lactocrine factors. Unlikely. Though the non-Ig proteins of products used in the study were not measured, it's likely that colostrum replacers derived from bovine plasma don't contain the large number of different proteins as found in maternal colostrum. The udder concentrates many blood proteins into higher concentrations than found in serum and manufactures others, so that the profile of proteins in colostrum is very different from that of serum.

Effects of lactocrine factors in colostrum are unimportant or

transient. Results in calves (Hammon and Blum, 2002; Rauprich et al., 2002) and piglets (Bagnell et al., 2009; Bartol et al., 2008) suggest that lactocrine factors play a role in the development of the gastrointestinal and reproductive systems. Some of these changes appear to be permanent, so, while the results of Pithua don't support a role of lactocrine factors in future milk production, it's unlikely that they're unimportant to the animal.

Lactocrine factors in milk replacer allowed replacer-fed calves to "catch up". Calves in the study by Pithua et al. (2009; 2010) were fed commercial milk replacer after colostrum feeding and until weaning at 56 days. It's possible that lactocrine factors which are also found in milk proteins might influence the calf so that calves fed the colostrum replacer received enough "lactocrine signals" from the milk replacer for proper development. All calves produced a lot of milk in their first lactation (average was >12,000 kg or 26,000 lbs), so it's unlikely that the lack of lactocrine signals in calves fed colostrum replacer had a negative effect on these calves.

Summary

Growth factors and hormones in maternal colostrum likely play an important role in the development of the newborn calf. Very interesting research into how these compounds – lactocrine factors – is being conducted in many species of animals and will shed new light on the roles these compounds play. However, some existing research suggests that the effects of these factors, if any, don't permanently affect the ability of calves to survive, grow and become productive on modern dairy farms.

References

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