Calf Notes.com

Calf Note #136 – Colostrum proteins – more than just IgG

Introduction

Colostrum, defined as the secretions from the mammary gland in the first 24 hours after the cow gives birth, is more than just a source of IgG, IgM and IgA. Colostrum contains much greater amounts of nutrients – fat, protein, vitamins and minerals than normal milk. These nutrients are important to the calf to establish homeostasis, to maintain body temperature, and to establish important body functions right after birth.

There are several proteins found in relatively large concentration in colostrum. What functions do these proteins have and how much can be found in colostrum from a typical cow? How do these proteins vary in colostrum and what effect does this have on the nutritional quality of colostrum to the calf? These questions were the reason for some interesting research.

The research

French researchers (Levieux and Ollier, 1999) reported the results of a study wherein colostrum and transition milk from 60 Holstein cows was collected and analyzed for various protein components.

These researchers collected colostrum from cows from parturition until day 8 (16 milkings) and measured the samples for various protein fractions. They also recorded volume of colostrum to calculate total production of each protein fraction.

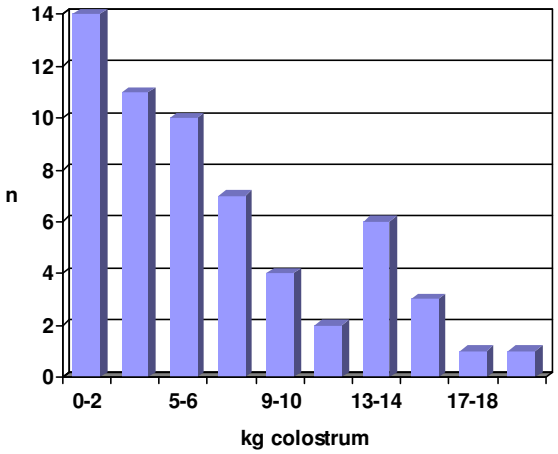

Figure 1. Number of cows producing various amounts of colostrum. Adapted from Levieux and Ollier, 1999.

First lactation heifers (n = 26) produced an average of 3.3 kg of colostrum in their first milking, which averaged 49 g/L of IgG. The total yield of IgG was 167 grams. If we assume that calves should be fed 4 L (or 4 kg) of first milking colostrum with at least 50 g/L in the first 24 hours, these heifers did not produce enough IgG in their first milking. Older cows (2-4 lactations, n = 26) in the study produced 8.1 kg of first-milking colostrum which contained 65 g/L of IgG; so, the production of total IgG was 448 grams.

If we look at Figure 1, there were 25 cows (42%) that produced 4 kg or less of colostrum – the minimum that we'd like to feed to a newborn calf in the first 24 hours. A number of cows produced more than 10 kg of colostrum (n = 13); some of this may have been of lower IgG concentration due to dilution effects.

As has been reported by several researchers, heifers produced less colostrum than did older cows (Figure 2) and the amount of colostrum / milk increased until about the fifth (cows) or 11th (heifers) milking.

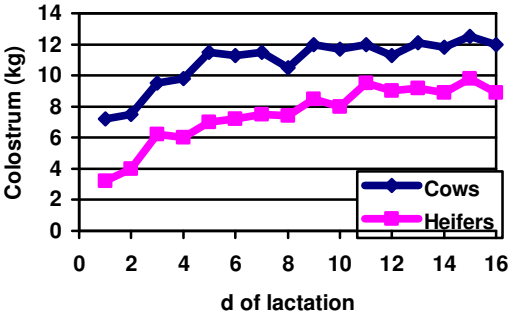

Figure 2. Production of colostrum (kg) by heifers and older cows during the first 16 milkings. Adapted from Levieux and Ollier, 1999.

The researchers also measured the content of α-lactalbumin, β-lactoglobulin and bovine serum albumin (BSA) in colostrum. These proteins could be in colostrum to provide proteins that are important to the animal either as a source of nutrition or to provide some important immune components.

Bovine α-lactalbumin acts as the coenzyme in the biosynthesis of lactose in the mammary gland. In addition, α-lactalbumin has been reported to improve immunity and reduce risk of some cancers in humans. It is also an excellent source of branched chain amino acids. Lactalbumin may serve a primarily "nutritional" role in colostrum – as a source of amino acids for the calf.

As can be seen from Figure 3, the amount of α-lactalbumin in the first few milkings was higher than in subsequent milkings. But the concentration of α-lactalbumin generally ranged between 2 and 1.5 mg/ml during the first 16 milkings; not a tremendous change in concentration when compared to IgG or other proteins in colostrum and milk. Remember, that the concentration of IgG in colostrum in this study averaged between 49 and 65 mg/ml, about 25 to 30 times the amount of lactalbumin.

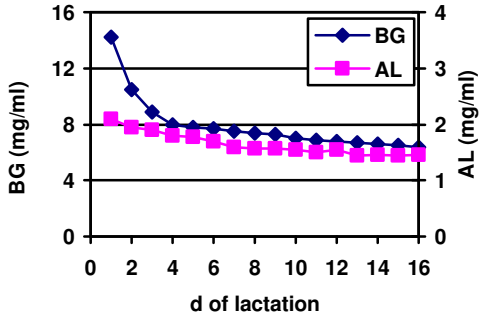

Figure 3. Concentration of β-lactoglobulin (BG) and α-lactalbumin (AL) in colostrum. Adapted from Levieux and Ollier, 1999.

β-lactoglobulin is a normal constituent of milk that comprises 50 to 60% of total whey protein. It binds retinol and may be involved in the transport of retinol. However, it has been suggested that the primary role of β-lactoglobulin as a nutrient source – it is particularly rich in cysteine, an important amino acid.

As can be seen in Figure 3, the amount of β-lactoglobulin in colostrum declined more dramatically than lactalbumin. The authors reported approximately 14 mg/ml of β-lactoglobulin in first milking colostrum; by the 16th milking, the concentration had dropped to less than half the original concentration.

Bovine serum albumin (BSA) is a normal component of blood. It is found in very low concentrations in milk but can also be found in colostrum. The BSA could be in colostrum coincidentally – i.e., bovine serum albumin could be in colostrum simply as a result of "leakage" of BSA from the blood. There is no known role for BSA in colostrum to assist in calf nutrition or

health. Generally, the concentrations of BSA in colostrum were low – about 1.2 mg/ml in the first two milkings, then falling rapidly to about 0.2 mg/ml (Figure 4).

Colostrum protein content is an important source of nutrition. Proteins in colostrum are used for protein synthesis as well as gluconeogenesis (production of glucose) by the newborn calf. In baby calves – particularly in cold weather – gluconeogenesis is a particularly important function. The amount of lactose in colostrum is typically lower than that found in milk, so the energy that calves utilize during the first few days of life will come significantly from colostral fat and protein.

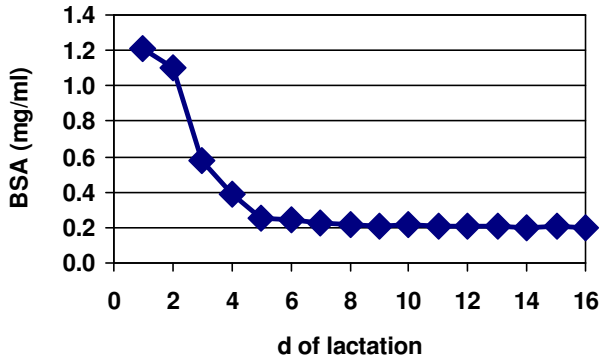

Figure 4. Concentration of bovine serum albumin in colostrum. Adapted from Levieux and Ollier, 1999.

This research shows that there are more proteins in colostrum than just IgG and that the content of these proteins changes over time. First milking colostrum contains large amounts of IgG, as well as α-lactalbumin, β-lactoglobulin and BSA. Other proteins such as lactoferrin, growth factors and hormones are also found in high concentration in colostrum. More research is needed to completely document the role that all of these proteins play in neonatal health and nutrition.

References

Levieux, D. and A. Ollier. 1999. Bovine immunoglobulin G, β-lactoglobulin, α-lactalbumin and serum albumin in colostrum and milk during the early post partum period. J. Dairy Research 66:421-430.

Prosser, C. G., S. J. Eicher, V. C. Farr, and S. R. Davis. 1992. Effect of colostrum intake on alpha-lactalbumin concentrations in serum of calves. Res. Vet. Sci. 53:219-222.

Written by Dr. Jim Quigley (31 August 2008)

Calf Notes.com (http://www.calfnotes.com)