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Calf Note #70 – Glutamine and soy protein in milk replacers

Introduction. Alternative ingredients have been evaluated extensively in calf milk replacer formulations. In the U.S., there are a number of alternative (i.e., non-milk) ingredients, including specially modified soy flour, soy protein concentrate, wheat isolate, and others. These formulations generally result in lower cost products, although animal performance may be reduced slightly (particularly in calves less than 3 weeks of age) by the inclusion of these products.

The role of soy. Soy proteins are widely used in CMR formulations. Soy protein has an acceptable amino acid profile and is relatively inexpensive compared to most other alternative proteins. Because protein is usually the most expensive component of milk replacer formulas, soy proteins have long been viewed as a potential alternative to more expensive milk proteins (whey, casein) in CMR. There are several sources of soy protein used in milk replacers, which vary depending on the level of processing. Unfortunately, soy proteins also contain compounds that may impair digestibility and reduce animal performance, especially when they are fed to very young animals (< 3 weeks of age). Young calves are particularly sensitive to antigenic compounds in soy and the presence of protease inhibitors may further reduce digestion of soy protein. Soy may be highly processed to soy protein isolate, which contains fewer antigenic compounds than soy flour, but the processing adds cost to the protein. Some researchers have developed methods of chemically treat soy flour to destroy the antigenic factors, and thereby improve digestion and animal performance. For more information on the use of soy proteins in calf milk replacers, see Calf Note # 23.

Why Glutamine? Glutamine is an amino acid that is extremely important as an energy substrate for the intestine. The intestine is one of the most metabolically active tissues in the body and a significant amount of the energy and protein consumed by the animal is used to maintain the integrity and activity of the intestine. In addition, since the intestine has access to the nutrients in the diet before other tissues, it can use these nutrients for energy and growth. Indeed, researchers have shown that glutamine is a preferred energy source for intestinal tissue. Soy proteins generally contain less glutamine than milk proteins and the lack of this important fuel source might be at least partially responsible for reduced animal performance when calves are fed milk replacers containing soy.

Researchers at the University of Illinois reported a study at the 2001 Midwest ASAS/ADSA meetings in Des Moines, Iowa, where they added 1% L-glutamine to milk replacers containing soy protein concentrate (60% of the crude protein was replaced by soy protein) and compared animal performance and intestinal morphology to calves fed a similar milk replacer without glutamine and milk replacer containing all-milk proteins. In this study, calves were fed all CMR at 10% of body weight during days 3 to 10, then 12% of body weight to day 28. At the end of 28 days, five calves per treatment were sacrificed and intestinal morphology was determined. Measurement of intestinal morphology was necessary to determine whether glutamine improved overall intestinal health of the calves.

In the three sections of the intestine (duodenum, jejunum, and ileum), villus height and crypt depth were measured and recorded for each treatment. Results of the study are in the table. Clearly, calves fed diets containing soy protein concentrate grew more slowly during the first 28 days of life (344 g/day versus 282 g/day). Also, the intestinal morphology of the intestine was affected by addition of soy protein concentrate. In the jejunum and ileum, the addition of soy protein reduced villus height by >30% and crypt depth by 27%. Villus height and crypt depth are indicators of intestinal integrity. When the intestine is damaged due to injury (e.g., caused by pathogens such as rotavirus or antigens in some vegetable proteins such as soy), these measurements will be affected.

The addition of glutamine to CMR increased the depth of the crypts (383 vs. 301 µm) in the ileum when added to the soy protein containing milk replacer. However, there was no effect on villus height in the ileum and no effect of glutamine on measures in the jejunum.

Adding glutamine to CMR caused an increase in plasma urea nitrogen, which indicates that the glutamine was deaminated (the nitrogen portion of the amino acid was removed) and the nitrogen was converted to urea, which was then moved into the plasma on its way to being excreted in the urine.

Effects of glutamine in calf milk replacer containing soy protein concentrate on growth and intestinal morphology of calves.

Item	All-Milk	SPC	SPC + Glu	Milk v. Soy	Add Glu
BW gain, g/d	**344**	**281**	**282**	**0.05**	**NS**
Jejunum					
villus height, µm	**713**	**506**	**464**	**0.05**	
crypt depth, µm	**300**	**209**	**229**	**0.05**	
Ileum					
villus height, µm	**532**	**458**	**456**	**0.05**	
crypt depth, µm	**352**	**301**	**383**		**0.05**
Plasma urea N, mg/dl	**5.7**	**4.0**	**6.6**		**0.01**

Milk v. soy = the comparison of all-milk replacer versus soy-containing milk replacers.

Add Glu = the comparison of soy-containing milk replacers without or with the addition of glutamine.

What does this mean to calf growers? Well, the authors concluded that the addition of glutamine did not improve the growth or intestinal morphology of calves fed milk replacers containing soy protein concentrate. The implications here are that the changes caused by the addition of soy protein concentrate cannot be solved easily by the addition of glutamine. Other researchers have shown that the addition of soy protein can cause allergic reactions in the intestine, causing changes in intestinal morphology and reducing growth. On a practical level, addition of soy protein to milk replacers should be limited, particularly when calves are less than 3 weeks of age. Older calves are better able to digest the soy proteins and appear to be less susceptible to allergic reactions. If you feed a milk replacer that contains soy protein, ask the manufacturer if the soy has been chemically treated to reduce the presence of antigens and if the level of soy is low enough to minimize any growth depression. Of course, the best indicator of milk replacer quality is the performance of your calves.

Reference:

Drackley, J. K., K. L. Bailey, K. S. Bartlett, and R. M. Blome. 2001. Supplemental glutamine does not overcome in the growth depression caused by soy protein concentrate in calf milk replacer. J. Dairy Sci. Abstract #54 presented at the Midwestern Section ASAS and Midwest Branch ADSA 2001 Meeting, Des Moines, IA.

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