Replacement Report

Calf Starter Research
Protein Sources for Calf Starters

A reduced version of this paper was also in Hoard's Dairyman, January 2007 issue

We recently reviewed much of the literature from the last 15 years on protein concentrations for calf starters. There are nine controlled research trials from four different labs that agree remarkably well and suggest that feeding an 18% protein starter is correct for calves fed conventional milk and milk replacer programs and for calves fed high protein, high feeding rate milk replacer programs (Akey, 2007). These results also agree with NRC (2001) dairy calf sub-model which uses a different approach to determining the nutrient requirements of calves. However, our review did not cover the various sources of protein that are available to use in calf starters. Also, with newer models, such as the NRC (2001) dairy calf sub-model or the CNCPS (2003), one can now start to evaluate starter formulations for protein fractions other than crude protein. The use of various protein sources offers the chance to consider the effects of digestible protein, rumen undegradable protein, metabolizable protein, or amino acids on growth. Metabolizable protein is a function of the rumen undegradability of the protein, the protein's digestion, and also how well the rumen degraded protein fraction is captured as microbial protein. Here, we will review some of what has been published over the last 20 or so years comparing different sources of protein for calf starters.

Several studies have compared concentrations of rumen undegraded protein for starters. Swartz et al. (1991), Holtshausen and Cruywagen (2000), and Abdelgadir et al. (1996a) observed no differences in gains of calves when fed diets with different rumen undegradable protein concentrations. Abdelgadir et al. (1996b) observed improved performance when rumen undegradable protein sources were fed. Maiga et al. (1994) observed better gains when calves were fed extruded soybean meal (more rumen undegraded protein) vs. soybean meal. Abdelgadir et al. (1996b) observed improved performance when calves were fed starters where protein and corn sources were formulated to have similar rates of ruminal degradation in one report, however, they saw similar gains regardless of corn and protein degradation rates in another report (Abdelgadir et al., 1996a). Bunting et al. (1996) found improved gains from rumen undegradable protein sources during hot but not cold weather. McCoy et al. (2003) observed trends for slower gains when rumen undegradable protein sources were fed. Fiems et al. (1987) observed no difference in calf performance when formaldehyde-treated soybean meal (more rumen undegraded protein) replaced soybean meal. Warner (1984) reviewed research prior to 1984 and reported no advantage to using rumen undegradable protein sources in calf starters. These trials show mixed results to increasing the rumen undegradable protein concentration of a starter with a greater number of trials reporting no benefits to increasing rumen undegradable protein.

Quigley et al. (1985) estimated that the proportion of rumen undegraded protein and microbial protein escaping the rumen of calves two weeks after weaning was similar to the proportions in mature cows. So, the rumen of calves can develop rather quickly. Vazquez-Anon et al. (1993) and Holtshausen and Cruywagen (2000) observed that the rumen degradability of protein sources increased with age post-weaning, suggesting rumen degradation is less in the pre-weaned calf but increasing with age and rumen development. The lack of complete development of the rumen and its microbial population in pre-weaned calves may explain why there are no conclusive benefits to formulating starters with greater rumen undegradable protein sources.

A few studies have compared sources of protein used in starters. Fiems et al. (1985) observed numerically lower gains when rapeseed (canola) meal replaced soybean meal. Intake of the rapeseed meal diets was less than that of the soybean meal diets and the low intake (poor

palatability) of the rapeseed meal diets may be been responsible for the slower gains. Sharma et al. (1986) observed poorer gains and digestibility of diets when rapeseed meal or extruded or pelleted whole cottonseed replaced soybean meal. However, they observed similar performance in calves fed unprocessed whole cottonseed, unprocessed whole sunflower seed, and soybean meal-based diets. Fiems et al. (1986) observed poorer digestibility, gains, and efficiency of gain when cottonseed meal replaced soybean meal in the starters. Replacing soybean meal with corn gluten feed resulted in lower efficiency of gains, greater intakes, and similar gains compared to diets with soybean meal. Replacing soybean meal with urea (approximately half of the protein in the diets from urea) supported slower calf gains and poorer efficiency (Fiems et al., 1987).

Corn and soybean meal are commonly used ingredients in calf feeds and are competitively priced ingredients in most years for much of the US. This combination offers a good balance of amino acids, is free of many anti-nutritional factors, is low in fiber, and is consistently digestible (as reviewed by Chiba, 2001, for pigs). Soybean meal was the base protein in many of the calf trials discussed above and calves fed the soybean meal-based diets performed about as well or better than calves fed diets using other sources of protein. However, in many of the published trials, the comparison of one protein source to the other resulted in rumen undegradable protein concentrations or amino acid profiles of the diets not being equal. When variables are unequal, it becomes hard to properly interpret the results.

We designed a research trial to determine if we can improve the growth rates of calves by increasing the rumen undegraded protein concentration of a starter while not altering the amino acid profile of the diet (Akey, 2007). In the trial we used either all soybean meal as the protein supplement in one treatment and heated soybean meal (Soyplus®) and soybean meal as the protein supplements in the other treatment. In the trial by Vazquez-Anon et al. (1993), the estimated the rumen undegraded protein concentration of the soybean meal to change from 58% at two weeks post-weaning to 31% by eight weeks post-weaning. They also estimated the estimated the rumen undegraded protein concentration of Soyplus® to change from 71% at two weeks post-weaning to 51% by eight weeks post-weaning. Thus, the protection of Soyplus® from rumen degradation is considerably greater than that of soybean meal and one reason for using Soyplus®. It was also used because it allowed the two treatments to have very similar amino acid profiles. Both treatments were 18% CP (as-fed basis). In our trial, 48 calves were weaned at four weeks of age and performance was monitored to 8 weeks of age in individual pens and out to 12 weeks of age in group pens of six calves per pen. There were no differences between treatments for gain, starter intake, efficiency, hip width change, or other performance measurements.

In another trial we compared formulating starters with different amounts of protein and sources of protein to alter the rumen degradable protein intake and metabolizable protein intake based on the CNCPS (2003) model equations (Akey, 2007). The control starter (A) contained all soybean meal protein and was 18% protein. One treatment starter (B) was also 18% protein but used a blend of soybean meal, fish meal, corn gluten meal, and blood meal to increase the metabolizable protein concentration by approximately 15%. This treatment (B) contained a lower concentration of rumen degraded protein than the control treatment. The other treatment starter (C) contained the same concentration of metabolizable protein as starter B and the same rumen degraded protein as starter A, resulting in a starter with 21% crude protein. In this trial, 48 calves were weaned at four weeks of age and performance was monitored to 8 weeks of age in individual pens. There were no differences among the three treatments for gain, starter intake, efficiency, hip width change, or other performance measurements.

Considering the controlled research, it appears difficult to improve on the protein provided from an 18% protein starter formulated with mostly corn and using soybean meal as the protein source. Sources of rumen undegraded protein appear to have little value for starters. Also, there appears

to be no advantage to feed starters that contain more than 18% CP, even when the starters are formulated to be equal in rumen degradable and metabolizable protein.

Literature Cited

Abdelgadir, I. E. O., J. L. Morrill, and J. J. Higgins. 1996a. Ruminal availabilities of protein and starch: effects on growth and ruminal and plasma metabolites of dairy calves. Journal of Dairy Science 79: 283-290.

Abdelgadir, I. E. O., J. L. Morrill, and J. J. Higgins. 1996b. Effect of roasted soybeans and corn on performance and ruminal and blood metabolites of dairy calves. Journal of Dairy Science 79: 465-474.

Akey. 2007. Protein concentrations for starters fed to transported neonatal calves. Prof. Anim. Sci. 23:123-134.

Bunting, L. D., J. M. Fernandez, R. J. Fornea, T. W. White, M. A. Froetschel, J. D. Stone, and K. Ingawa. 1996. Seasonal effects of supplemental fat or undegradable protein on growth and metabolism of Holstein calves. Journal of Dairy Science 79: 1611-1620.

Chiba, L. I. 2001. Swine Nutrition, 2nd Edition. pp. 803-837. Edited by Lewis, A. J., and L. L. Southern. CRC Press, Boca Roton, FL.

CNCPS version 5.0. Fox, D. G., T. P. Tylutki, L. O. Tedeschi, M. E. Van Amburgh, L. E. Chase, A. N. Pell, T. R. Overon, and J. B. Russell. 2003. The net carbohydrate and protein system for evaluating herd nutrition and nutrient excretion. http://www.cncps.cornell.edu/downloads.htm

Fiems, L. O., C. V. Bouchque, B. G. Cottyn, and F. X. Bysse. 1985. Evaluation of rapeseed meal with low and high glucosinolates as a protein source in calf starters. Livestock Production Science 12: 131-143.

Fiems, L. O., C. V. Bouchque, B. G. Cottyn, and F. X. Bysse. 1986. Cottonseed meal and maize gluten feed versus soybean meal as protein supplements in calf starters. Archives of Animal Nutrition 36: 731-740.

Fiems, L. O., C. V. Bouchque, B. G. Cottyn, and F. X. Bysse. 1987. Effect of formaldehyde-treated soya bean meal and urea in starters on nitrogen quality, degradability in sacco, sheep digestibility and calf performance. Animal and Feed Science Technology 16: 287-295.

Holtshausen, L., and C. W. Crywagen. 2000. The effect of age on in sacco estimates of rumen dry matter and crude protein degradability in real calves. South African Journal of Animal Science, 30 212-219.

Maiga, H. A., D. J. Schingoethe, F. C. Ludens, W. L. Tucker, and D. P. Casper. 1994. Response of calves to diets that varied in amounts of ruminally degradable carbohydrate and protein. Journal of Dairy Science 77: 278-283.

McCoy, G. C., L. D. Ruppert, and M. F. Hutjens. 2003. Feeding an extruded cottonseed-soybean-based calf starter. http://trail.outreach.uiuc.edu/dairynet/paperdisplay.cfm? Content ID = 269

NRC. 2001. Nutrient Requirements of Dairy Cattle, 7th rev. ed. Washington, D.C.: National Academy Press.

Quigley, III, J. D. C. G. Schwab, and E. E. Hylton. 1985. Development of rumen function in calves: nature of protein reaching the abomasum. Journal of Dairy Science 68: 694-702.

Scharma, H. R., B. White, and J. R. Ingalls. 1986. Utilization of whole rape (canola) seed and sunflower seeds as sources of energy and protein in calf starter diets. Animal Feed Science and Technology 15: 101-112.

Swartz, L. A., A. J. Heinrichs, G. A. Varga, and L. D. Muller. 1991. Effects of varying dietary undegradable protein on dry matter intake, growth, and carcass composition of Holstein calves. Journal of Dairy Science 74: 3884-3890.

Vazquez-Anon, M., A. J. Heinrichs, J. M. Aldrich, and G. A. Varga. 1993. Effect of post-weaning age on rate of in site protein disappearance in calves weaned at 5 weeks of age. Journal of Dairy Science 76: 2749-2757.

Warner, R. G. 1984. The impact of protein solubility in dairy calf starters. In Proceedings of the Cornell Nutrition Conference for Feed Manufacturers. Rochester, NY. pp. 42-45.