Replacement Report

Milk Replacer Research
Alternatives to milk proteins

Are there alternatives to milk proteins for calf milk replacers (MR)? Most of the research suggests that there are not and that average daily gain or other calf performance with be sacrificed if alternative proteins are substituted for part of the milk protein. Here we will review most of the research with alternative proteins for calf MR.

Before reviewing the controlled research, consider the economics of performance. When using equal cost per lb of gain as a benchmark, feeding an alternative protein MR and sacrificing 10% calf gain means that an alternative protein MR must be approximately $0.14/lb less expensive than an all milk protein MR that costs $1.30/lb. If an alternative protein MR is fed and 30% of calf gain is lost, that alternative protein MR must be approximately $0.43/lb less expensive than an all milk protein MR that costs $1.30/lb. Most alternative protein MR will not be more than $0.20/lb less expensive than a somewhat similar all milk protein product. The point here is that performance cannot be sacrificed or else what little money saved on MR costs can be lost with poor performance.

Soy proteins

There are four major types of soy proteins: 1) soy flour, 2) soy flour modified with alcohol and particle sizing, 3) soy protein concentrate, and 4) soy protein isolate. Soy proteins contain several known types of antinutritional factors, yet they are the most popular alternative protein in the US calf MR market. Figure 1 shows Akey research evaluating different amounts of soy proteins replacing milk protein. With each 15% replacement of protein, gain was lost with each of three types of soy protein. Soy flour was the worst choice, while soy concentrate and isolate reduced gains similarly. We have also evaluated modified soy flour and observed a 25% reduction in daily gain when 50% of the milk protein was replaced with it in a 20% protein, 20% fat MR fed at 1 lb/calf/day. A 30% reduction in daily gain resulted when 30% of the milk protein was replaced with modified soy flour in a 26% protein, 17% fat MR fed at 1.5 lb/calf/day. However, feeding 10% milk protein replacement with soy concentrate did not reduce daily gain or other performance measures in a 20% protein, 20% fat MR fed at 1 lb/calf/day. Thus, the only successful use of a soy protein replacement of milk protein has been at a very low concentration, unlike the majority of the US MR using approximately 50% replacement of milk protein with soy.

Hydrolyzed wheat gluten protein

Hydrolyzed wheat gluten (HWG) is becoming a popular ingredient for MR. Two studies with calves growing at average to below average rates of gain showed little disadvantage to replacing half of the milk protein with HWG (Table 1; Terui et al., 1996; Davis and Drackley, 1998). However, research with fast growing calves has shown reductions in gain ranging from 12 to 27% when 15 to 50% milk protein was replaced with HWG (Akey; Provimi; Hayes et al., 2007).

Plasma protein

Both bovine and porcine plasma have been evaluated in MR. In studies where the calves fed the control all milk protein MR were gaining between 0.08 and 0.3 lb/day, calves fed MR with 16 to 27% plasma protein gained at statistically similar rates of gain (88 to 200% the rate of control calves; Table 2; Morrill et al., 1995; Quigley and Bernard, 1996; Quigley et al., 2002; Quigley and Wolfe, 2003). These data have to be viewed with caution since the rates of gain were so low.

Egg protein

Egg protein has a very high biological value, however, it does contain a couple of known antinutritional factors. Various studies evaluating egg proteins are shown in Table 3 (Quigley, 2002; Tochette et al., 2003) and Figure 2 (Akey). The responses have been quite variable and are likely associated with variability in quality of egg relative to supply source and the amount (maximum of 15%) of milk protein replaced with egg.

Meat hydrolysates

Hydrolysates of various meat sources have been proposed for MR. We are only aware of one calf study evaluating a meat source. In that study from our unit, replacing 15% of the milk protein with bovine collagen resulted in a 22% loss of daily gain.

Summary

The research with plant (soy and wheat) proteins has not shown a favorable response to replacing large amounts of milk protein. The only research to not reduce gain in calves growing at average to fast rates was when only 10% of the milk protein was replaced with soy protein concentrate. Plasma protein replacing approximately 25% of the milk protein has potential; however, all the published research was in calves growing very slowly (0.08 to 0.32 lb/day). Egg protein appears to be variable in quality and poses some risk to use and if a high quality source is used it should be limited to less than 15% of the protein in a MR.

References:

Davis, C. L., and J. K. Drackley. 1998. The Development, Nutrition, and Management of the Young Calf. pp. 221-222. Iowa State Univ. Press, Ames.

Hayes et al. 2007. J. Dairy Sci. 90 (Suppl. 1):114

Morrill et al., 1995. J. Dairy Sci. 78:902

Quigley and Bernard. 1996. J. Dairy Sci. 79:1811

Quigley et al. 2002. J. Dairy Sci. 85:413

Quigley. 2002. J. Dairy Sci. 86:198

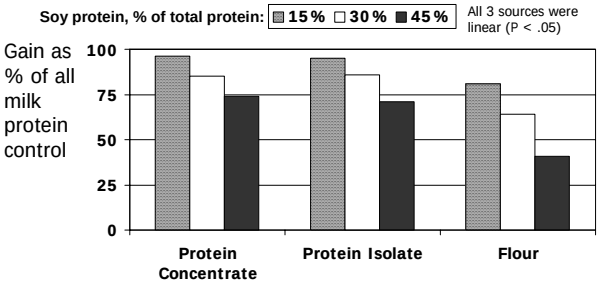
Quigley and Wolfe. 2003. J. Dairy Sci. 86:586

Terui et al. 1996. J. Dairy Sci. 79:1261.

Touchette et al. 2003. J. Dairy Sci. 86:2662

Figure 1. Soy protein sources

(1 lb MR/day, 20% CP, 20% fat, 0-42 days)



(3 different trials, 48 calves per trial)

Table 1. Wheat gluten studies

Source of data	% wheat protein replacing milk protein in the MR			
Feeding rate, % protein, days	Body weight gain, lb/day			
JDS 79:1261	0%		30%	50%
1.0 lb of 20% protein MR, 0-42 days	0.57 lb		0.53 lb	0.59 lb
Davis and Drackley, 1998	0%			50%
(not describe in reference)	0.95 lb			0.88 lb
Akey, 1999	0%	15%		
1.0 lb of 20% protein MR, 0-42 days	1.22 lb	1.05 lb		
Akey, 2005	0%	17.5%	35%	
1.5 lb of 26% protein MR, 0-42 days	1.41 lb	1.23 lb	1.11 lb	
Provimi, 2005	0%		30%	50%
1.6 lb of 22% protein MR, 0-49 days	1.92 lb		1.69 lb	1.40 lb
JDS 90:114	0%			50%
1.25 lb of 20% protein MR, 0-42 days	1.92 lb			1.56 lb

Table 2. Plasma protein studies

(~1 lb MR/day, 20% CP, 20% fat, 0-42 days)

Reference	~Plasma % of CP	Control All whey	Beef Plasma	Pork Plasma
		ADG, lb/day		
JDS 78:902	27	0.157	0.279	0.314
JDS 79:1881	25	0.296	0.220 (P < 0.09)	--
JDS 85:413	20	0.267	0.260	--
JDS 85:413*	16	0.216	0.191	--
JDS 86:586	20	0.083	0.119	0.080

*~22% of CP from soy protein concentrate in each MR treatment

Table 3. Egg protein studies

(~1 lb MR/day, 20% CP, 20% fat)

Egg,% of MR	0	5	10	15	20
Egg,% of CP	0	13	26	39	52
	ADG, lb/day				
JDS 86:198 0-28 days, no starter	0.509	--	0.154 (P < 0.05)	--	0.000 (P < 0.05)
JDS 86:2662 0-42 days, starter fed	0.548	0.595 (P < 0.05)	--	--	--
	0.808	0.621	--	--	--
	1.088	1.039	1.059	0.784 (P < 0.09)	--

Figure 2. Egg protein sources

(1 lb MR/day, 20% CP, 20% fat, 0-42 days)

MR with egg supported 62 to 100% of the daily gain of the MR with 0% egg