The Nutrients of a Good Calf Milk Replacer

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Milk replacer (MR) formulation has moved beyond crude protein, fat, and crude fiber. These nutrients mean little relative to performance. Today we should be focused on amino acids, fatty acids, feeding rate, and weaning age.

Note how much specific amino acids influence the growth of a calf in Figures 1 and 2. These figures were generated from feeding 240 calves MR and changes in ADG exceeded 25% from different lysine and methionine concentrations. These data with other data have been used to determine the amino acid concentrations required in MR for calves under a month old.

Several economical synthetic amino acids are available (lysine, methionine, and threonine) and are used in MR. The use of these amino acids allow the CP concentration of a MR to support a given ADG to be 2 to 4 percentage points lower than if no synthetic amino acids are used in the MR. This lowers the cost of gain and reduces nitrogen excretion into the environment.

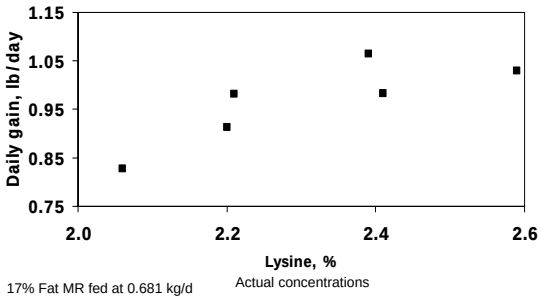
Fatty acids are the components of fat. Calf MR in the US are based on animal fat. Animal fat is low in essential fatty acids, especially linolenic acid (C18:3). Essential fatty acids cannot be synthesized by the animal and have to be included in the diet. Additionally, animal fat is very low in medium and short chain fatty acids that have metabolic functions in the body. The fat in milk has an array of all of these fatty acids that are much more balanced than the fatty acid profile of animal fat. In human nutrition, MR are formulated to specific concentrations of several of these key fatty acid groups, thus human baby formulas have a nutrient composition much more similar to human milk than the typical calf MR does to cow's milk. An approach like human MR are formulated has been taken with the research and formulation of calf MR at Akey. When essential fatty acids and medium chain fatty acids were added to MR based on animal fat only, calf ADG and health were improved (Figure 3). Likewise, when MR based on animal fat were supplemented with butyrate (a short chain fatty acid), ADG was increased (Table 1).

Fat from the MR is a major energy source for calves. The fat concentration and the amount of MR fed influences overall energy intake and ADG. However, if too much energy is consumed from the MR (or milk), starter intake will be reduced for several weeks pre- and post-weaning and reduction in ADG occurs at weaning and it can carry over for several weeks post-weaning (Bar-Peled, 1997; Jasper, 2002). Thus, as more energy is fed to the calf from MR or milk, pre-weaning ADG will increase but at some point this will have a negative impact on post-weaning ADG. Additionally, when post-weaning ADG has been reduced from feeding too much MR or milk, it is a function of both reduced starter intake and reduce digestion of the starter (Terre, 2007). Excess MR or milk intake will reduce rumen development.

Milk does not contain fiber, however, a trace amount of crude fiber can be analyzed in milk. Alternative proteins like soy and wheat protein will analyze with greater concentration of crude fiber than milk. Thus, crude fiber is an indicator of alternatives to milk protein within a MR, albeit a poor indicator. When soy proteins were studied years ago as alternatives for milk protein, they were found to have antinutritional factors (antigens and carbohydrates). The antigens created abnormal intestinal villi important in the absorption of nutrients (absorption was reduced). Additionally, the carbohydrate fractions of soy proteins are hard to digest by the young animal. Today it is fairly well accepted that soy proteins are inferior to milk proteins, especially in traditional 20 and 22% CP MR fed at approximately 1 lb of powder daily. Research from the Akey facility with replacement of milk protein in a 26% CP MR powder fed at 1.5 lb daily with modified (improved) soy proteins (concentrates and flours), hydrolyzed wheat gluten (Figure , and rice protein concentrate reduced ADG of the calf. Much has been made of using plasma protein in MR. However, the research has been with slow growing calves, bringing into question the feasibility of plasma protein to support fast ADG in calves (Table 2). The only MR with alternative proteins that has research data supporting good rates of ADG, comparable with all milk MR, is Akey Infiniti MR. Good rates of gain are achieved when feeding Akey Infiniti because it contains 90% milk protein. Most alternative protein MR marketed contain 50+% alternative proteins.

Summary points:
Focus on amino acids and fatty acids, not CP and fat.
Do not over-feed MR or milk, because it will reduce overall ADG and efficiency of gain.
Most all alternative proteins will not support the same ADG as milk proteins.

Figure 1. Effect of Lysine on ADG



17% Fat MR fed at 0.681 kg/d

Figure 2. Effect of Methionine on ADG

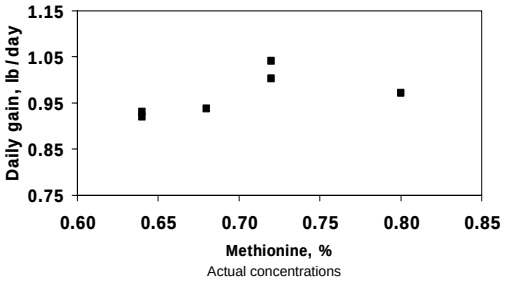
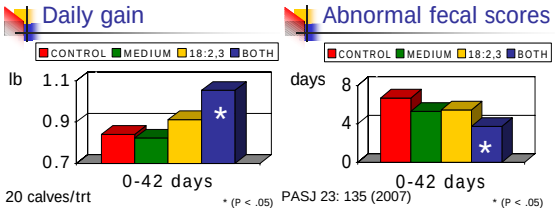


Figure 3. Effect of medium chain, C18:2, and C18:3 fatty acids in a MR on ADG and health



20 calves/trt

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Table 1. Effect of adding butyrate to a MR

0-6 Weeks	Gain, lb/d	Starter intake, lb/d	Scour days
Trial 1			
Control	1.21	0.81	9.0
w/ Butyrate	1.26*	0.88	10.2
Trial 2			
Control	1.06	0.65	8.4
w/ Butyrate	1.12*	0.67	7.2

* Greater than control (P < 0.05).

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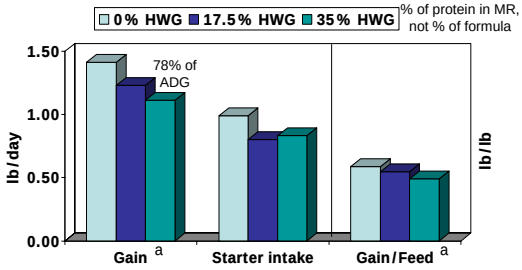
Figure 4. Hydrolyzed wheat gluten in MR



[a] Linear decrease with increase in HWG (P < 0.05)

Table 2. Plasma protein sources for MR

(20% CP, 20% fat MR, ~1.0 lb/day, 0-28 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

References:

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