A Replacement Report

Milk Replacer Research
Soluble Wheat Gluten Protein for Milk Replacers

Interest in soluble, hydrolyzed wheat gluten protein (WP) in calf milk replacers increased in 2005 because of the rising price of milk proteins. Various vegetable proteins are lower cost sources of protein than milk protein, however, many contain anti-nutritional factors such as antigens and poorly digested carbohydrate fractions. Unlike various soy proteins, WP appears to have no anti-nutritional factors. However, there is limited published research in calves to substantiate using WP in calf milk replacers.

French research (Branco-Pardal et al., 1995 using calves 8+ weeks old; Toullec and Formal, 1998 using calves 12+ weeks old) in veal calves, older than herd replacement calves fed milk replacers, has shown that the amino acids in WP are about 95% as digestible as the amino acids in milk protein. Research of this type in young calves is not available. Also, the amino acid profile is less favorable for WP than for skim milk or whey proteins. The profile of WP is high in several of the non-essential amino acids. However, two essential amino acids, lysine and methionine, that are limiting to growth and low in WP vs. milk proteins can be supplemented with synthetic sources in a cost-effective manner.

French research (Ortigues-Marty et. al., 2003) in veal calves reported similar gains of calves fed either an all milk protein milk replacer or one with 50% of the milk protein replaced with WP from 29 to 83 days. These veal calves were not introduced to the test milk replacer until 29 days of age, missing much of the time that herd replacement calves are fed milk replacer.

Kansas State University (Terui et al., 1996) reported similar performance of calves fed milk replacers with 0, 30%, or 50% of the milk protein replaced with WP. The calves only gained 0.5 lb daily from 0 to 42 days when they were weaned which is approximately 40% slower than is typical.

The University of Illinois and Milk Specialties Co. (Davis and Drackley, 1998) reported that calves fed a milk replacer with 50% of the protein from WP grew at 95% the rate of calves fed an all milk protein milk replacer from 0 to 42 days. Gains from 0 to 14 days were 17% slower for calves fed the milk replacer with WP vs. all milk protein.

In 1999, we fed calves from multiple sources, initially about 5 days old a 20% protein, 20% fat milk replacer at 1.0 lb daily and weaned them at 42 days. When we replaced 15% of the milk protein with WP and balanced the diets for limiting amino acids, calves grew 14% slower from 0 to 42 days. Starter intake and gain to feed efficiency from 0 to 42 days were also reduced with the inclusion of WP in the milk replacer.

In 2005, we fed calves from one dairy that were initially 3 and 4 days old a 26% protein, 17% fat milk replacer at 1.5 lb daily and weaned them at 42 days. Three milk replacers were fed that contained 0, 17.5%, or 35% of the protein WP replacing milk protein and balanced for limiting amino acids. Calves fed the milk replacer with 17.5% of the protein from WP gained 12% slower and calves fed the milk replacer with 35% of the protein from WP gained 21% slower than calves fed the milk replacer with 0% WP from 0 to 42 days. Gain and gain to feed efficiency declined linearly and starter intake tended to decline linearly with increasing concentration of WP from 0-42 days. Reductions in calf gain from inclusion of WP were more severe in the first 14 days than during days 15 to 42.

In 2005, Provimi (in The Netherlands) fed calves a 22% protein, 18% fat milk replacer at 12% of body weight (approximately 1.6 lb of MR powder daily) and weaned them after 49 days. These calves were 17 days old when the trial began. The three test milk replacers fed were balanced for limiting amino acids when 0, 30, or 50% of the milk protein was replaced with wheat protein. Calves fed the milk replacer with 30% protein from WP gained 11% slower and calves fed the milk replacer with 50% protein from WP gained 26% slower than calves fed the milk replacer with 0% WP from 0 to 49 days. Reductions in calf gain from inclusion of 50% of the protein from WP were more severe in the first 14 days of the trial than during days 15 to 49.

Data through weaning from the five non-veal trials are summarized in Table 1. When calf gains were below normal (less than 0.6 lb/day from 0 to 42 days) in the trial at Kansas State University, WP did not affect gain. In the University of Illinois / MS trial, WP had a small negative effect of gain when calf gains were average (approximately 0.9 lb/day). In our two trials and the Provimi trial, when calf gains were high (1.2 to 1.9 lb/day from 0 to 42 or 49 days), WP reduced calf gain much more than in the other trials. Additionally, gain decreased as the concentration of WP increased in the 2005 trials where two concentrations of WP were tested.

The inclusion of WP in the milk replacers reduced calf gains in all of the trials during days 0 to 14 (Table 2). So when protein and amino acids are most important to the calf, during the first 2 to 3 weeks of age, WP appears inadequate compared to milk proteins. In our 2005 trial shown in Table 3, daily gains for calves fed the milk replacers with WP were lower for all of the 7-day periods. As previously mentioned, WP appears to contain no anti-nutritional factors. Thus, the burden to the fast growing calf may be to metabolize a diet with an imbalance of amino acids created from the large amounts of non-essential amino acids in WP relative to milk protein.

In our trial in 1999 and the Provimi trial in 2005, starter intake was reduced when WP was included in the milk replacer. Note the data from our 2005 trial in Table 3, the same pattern of starter intake was observed. Unlike in the veal calf, the replacement calf must undergo a weaning process and intake of starter feed is critical to maintain performance.

In veal calves, it is common to have a "starter" milk replacer that is fed for 30 days or so, followed in some systems with a "grower" milk replacer then a "finisher" milk replacer or in other systems with just one "grower/finisher" milk replacer. Additionally, milk replacers are fed to veal calves at much higher rates than herd replacement calves. Thus, WP may be successfully used in a milk replacer fed to the older veal calf as appeared successful in the French study (Ortigues-Marty et. al., 2003).

In summary, replacing milk protein with WP has reduced the growth of non-veal calves during the first 14 days or so of life in all published trials. Replacing milk protein with WP has reduced the growth of non-veal calves during the entire 6 to 7 week milk replacer feeding phase in trials where calves were growing at above average rates of gain. This has been true despite formulating the diets with synthetic amino acid sources to correct amino acids that are known to limit growth. Inclusion of WP in the milk replacer, also has reduced the intake of starter feed. If used in calf milk replacers, it is best suited to be fed to calves over one month of age.

Literature cited:

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Table 1. Summary of daily gains until time of weaning in non-veal calf trials using different percentages of hydrolyzed wheat gluten protein replacing milk protein in the milk replacers (MR). It appears the negative impact of wheat protein on calf gain is greater at greater rates of gain.

Source of data	% wheat protein replacing milk protein in MR			
Feeding rate, % CP, days	Body weight gain (lb/day)			
Kansas St. Univ., 1995	0%		30%	50%
1.0 lb of 20% CP milk replacer, 0-42 days	0.57 lb		0.53 lb	0.59 lb
Univ. Illinois/MS, 1998	0%			50%
(not described in reference)	0.95 lb			0.88 lb
Akey, 1999	0%	15%		
1.0 lb of 20% CP milk replacer, 0-42 days	1.22 lb	1.05 lb		
Akey, 2005	0%	17.5%	35%	
1.5 lb of 26% CP milk replacer, 0-42 days	1.41 lb	1.23 lb	1.11 lb	
Provimi, 2005	0%		30%	50%
1.6 lb of 22% CP milk replacer, 0-49 days	1.92 lb		1.69 lb	1.40 lb

Table 2. Summary of daily gains during the first 14 days in non-veal calf trials using different percentages of hydrolyzed wheat gluten protein replacing milk protein in the milk replacers (MR). Wheat protein reduced gain in all trials during the first 14 days.

Source of data Feeding rate, % CP, days	% wheat protein replacing milk protein in MR Body weight gain (lb/day)			
Kansas St. Univ., 1995	0%		30%	50%
1.0 lb of 20% CP milk replacer	0.42 lb		0.35 lb	0.36 lb
Univ. Illinois/MS, 1998	0%			50%
(not described in reference)	0.51 lb			0.42 lb
Akey, 1999	0%	15%		
1.0 lb of 20% CP milk replacer	0.39 lb	0.37 lb		
Akey, 2005	0%	17.5%	35%	
1.5 lb of 26% CP milk replacer	0.76 lb	0.55 lb	0.38 lb	
Provimi, 2005	0%		30%	50%
1.6 lb of 22% CP milk replacer	1.02 lb		0.97 lb	0.19 lb

Table 3. Gain and starter intake by 7-day periods for calves fed three milk replacers with increasing amounts of wheat protein. Gain and starter intake was lower for every period when wheat proteins were included. Source: Akey, 2005.

	Wheat protein replacing milk protein, %		
Measurement / period	0%	17.5%	35.0%
Body weight gain, lb/day			
0 to 7 days	0.57	0.36	0.20
8 to 14 days	0.94	0.74	0.55
15 to 21 days	1.39	1.26	1.01
22 to 28 days	1.91	1.72	1.75
23 to 35 days	2.13	2.01	1.86
36 to 42 days	1.51	1.32	1.28
43 to 49 days	2.14	2.10	2.08
50 to 56 days	2.41	2.27	2.39
Starter intake, lb/day			
0 to 7 days	0.05	0.01	0.02
8 to 14 days	0.26	0.09	0.12
15 to 21 days	0.57	0.40	0.37
22 to 28 days	1.12	0.94	0.97
23 to 35 days	1.73	1.51	1.49
36 to 42 days	2.20	1.86	2.04
43 to 49 days	4.50	4.07	4.24
50 to 56 days	5.92	5.61	5.48