

RECENT CALF MILK REPLACER RESEARCH UPDATE

Mike Fowler
Director of Nutritional Services
Land O'Lakes, Inc.
Animal Milk Products Division
Fort Dodge, Iowa 50501

Introduction

The first calf milk replacer in the United States was developed and introduced in 1951 to dairy producers. Since the original calf milk replacer, there have been many nutritional advances in calf milk replacers and calf raising programs. During the last ten years, there has been less and less research information concerning the young calf occurring in scientific literature. Those researchers who consider themselves as primarily working in the area of calf nutrition and health are also fewer in number. For these reasons, this paper will present mainly primary source information rather than review information, in order to add to the scientific information base. This paper will discuss the key nutritional principles as it relates to milk replacer feeding and composition along with some of the newer calf milk replacer areas. The application of the information presented shall be limited to the herd replacement and dairy beef calf.

Objectives of Calf Raising Program

Problems in raising healthy calves are apparent since an estimated 15% to 20% of the dairy calves born in the United States die representing millions of dollars of loss to the dairy industry yearly. Objectives of a good calf raising program are presented in Table 1.

Table 1. Objectives of Calf Raising Program

- Keep them alive and healthy
- Keep mortality to less than 5%
- Replacement heifers--big enough to breed at 14-16 months of age
- Do it economically

Three key and interwoven areas of utmost importance in raising calves are nutrition, health and management. In the area of calf nutrition, the two key items are calf milk replacer and calf starter. During the milk replacer feeding phase, approximately 50% of the nutrients are provided by calf starter. Thus it is important that a high quality, palatable calf starter be fed free choice beginning at 4 days of age along with free-choice water. During the first 6 weeks of life, 75% of calf weight gain can be attributed to calf starter intake.

Reason for Milk Replacer Development -- High Quality Nutrition and Economics

Calf milk replacers were developed to provide high quality nutrition and an economic alternative to whole, marketable milk for the dairyman; thus, allowing the dairyman to sell more marketable milk. Over the years, the relative cost of calf milk replacer in reconstituted solution has been approximately 50%, the value that whole milk could be sold for on the

market. (Example: Whole milk value--\$12 per 100 pounds; reconstituted liquid milk replacer solution--\$6 per 100 pounds.) The additional income to dairymen by feeding calf milk replacer instead of whole milk to a calf has been approximately \$15 to \$25 per calf depending on the relative prices and the amount of whole milk being fed per calf (Table 2). Research over the years has documented that the feeding of a high quality calf milk replacer will provide similar performance (weight gain and health performance) to whole milk feeding.

Table 2. Additional Income Per Calf By Feeding Calf Milk Replacer (Example)

Value of Milk Consumed -- 400 pounds x \$12.00 per cwt	=	\$48.00
Cost of Calf Milk Replacer -- 40 pounds x \$.80 per pound	=	<u>\$32.00</u>
Added Income Per Calf		\$16.00

Milk Replacer Nutrition -- 4 Days to Weaning

A high quality calf milk replacer should be fed from 4 days of age to weaning following a good colostrum feeding and management program the first 3 days of life. Characteristics of a high quality calf milk replacer are presented in Table 3.

Table 3. Characteristics of a High Quality Calf Milk Replacer

- Will substitute for whole milk and provide similar calf performance and health
- Is researched and formulated for optimum performance
- Contains high quality ingredients
- Mixes and stays in solution
- Provides an economic return to the dairyman or calf raiser

Design of Milk Replacer Research Trials and Evaluation

Well designed calf research trials to evaluate various aspects of calf milk replacer nutrition should include the following items. Trials should be designed so that only calf milk replacer is fed in a full feeding situation without calf starter. Feeding of a calf starter can cover up differences in calf performance due to nutritional treatments. A proven statistical design involving a minimum of 18 calves per treatment with calves being allotted to treatment based on initial body weight, location within the building, and initial gamma globulin level. Several well designed research trials are needed before drawing conclusions relative to a given subject.

Protein Level Research

The National Research Council's recommended nutrient content for calf milk replacer is 22% crude protein (1). This recommendation has been published in the 1989 NRC, as well as previous editions beginning with the 1971 edition.

The most expensive portion of a milk replacer is protein because of traditionally high costs of milk protein. A comprehensive study was undertaken to determine the optimum level of protein in calf milk replacer (2). Calves received calf milk replacer containing 18%, 20%, 22%, 24%, 26% or 30% all-milk protein with 16% fat for a 4-week trial period. No calf starter or hay was fed. As the protein level increased, a significant trend toward increased average

daily gain was apparent (Table 4).

Table 4. Protein Level in Calf Milk Replacers						
	Protein Level %					
	<u>18%</u>	<u>20%</u>	<u>22%</u>	<u>24%</u>	<u>26%</u>	<u>30%</u>
Average Daily Gain (lbs.)	.90 ^a	.95 ^{ab}	1.06 ^{ac}	1.08 ^{bc}	1.10 ^c	1.21 ^c
^{a,b,c} — Significant (P < .05).						

A numerical break in calf performance was evident between the 20% and 22% protein formulas indicating 22% protein in calf milk replacer optimizes calf performance. If protein levels less than 22% are used, a higher daily feeding rate is needed to meet the calves daily protein requirement.

Fat Level Research

Typically, calf milk replacers will contain from 10% to 20% fat. Results of a study to evaluate the influence of fat level in calf milk replacer on calf performance and health are shown in Table 5 (3). Calves received 22% all milk protein calf milk replacer containing various levels of added fat for a 4-week trial period. No calf starter or hay was fed.

Table 5. Effect of Fat Levels In Calf Milk Replacer On Calf Performance And Calf Health						
	Fat Level					
	<u>0%</u>	<u>5%</u>	<u>10%</u>	<u>15%</u>	<u>20%</u>	<u>25%</u>
Average Daily Gain, lbs.*	1.07	1.17	1.17	1.13	1.25	1.33
Feed Conversion (Feed/lb. gain)	1.92 ^a	1.56 ^{ab}	1.56 ^{ab}	1.58 ^{ab}	1.43 ^b	1.36 ^b
Scour Score**	1.76 ^a	1.54 ^{ab}	1.45 ^{bc}	1.39 ^{bc}	1.23 ^c	1.23 ^c
* Not significant (P > .10)						
** Lower scour score indicates less severity						
^{a,b,c} — (P < .05)						

There was no significant improvement in weight gain. When fat was included in a milk replacer above the 10% level, feed conversion tended to be positively effected and scour score tended to be reduced with increasing fat levels.

Fiber Level Research

The fiber level guarantee on a milk replacer tag is indicative of the use of alternative proteins (e.g. soy proteins) which contain different levels of crude fiber (with the exception of soy protein isolate) depending on their processing. Fiber guarantee is used by some people as a determination of milk replacer quality. While this appears to be a convenient measure, it is not

a good indicator of quality for the following reasons:

- 1) Fiber will only indicate the use of soy proteins and other plant proteins, not other protein sources which may be poorly utilized by the calf (e.g. meat or blood proteins).
- 2) The fiber analysis method is not completely accurate.
- 3) Soy protein isolate contains no fiber, therefore, fiber content is not a totally valid method of determining alternative protein usage.
- 4) There are new alternative protein sources being utilized which are optimal quality protein sources. These sources can raise the fiber level of a calf milk replacer but still provide good calf performance and health.

Table 6 shows a summary of five trials in which a milk replacer containing modified soy protein (Glymaxene) was compared to milk replacers containing all milk protein sources or a soy flour source (3). Four-week calf weight gains were not significantly different when calves were fed milk replacer containing milk or modified soy protein (Glymaxene). Scour days were significantly reduced when the modified soy protein (Glymaxene) was fed compared to the other 2 protein sources.

	<u>All Milk</u>	<u>Soy Flour</u>	<u>Modified Soy Protein (Glymaxene)</u>
No. of Calves	75	75	75
A.D.G., lbs.	.93 ^a	.64 ^b	.85 ^a
Weight Gain (lbs./28 days)	26.2 ^a	17.9 ^b	23.8 ^a
Calf Health Measurements			
Scour Score (28 days)	1.37 ^a	1.31 ^a	1.21 ^b
Scour Days (Per 28 days)	9.9 ^a	8.4 ^a	5.6 ^b

^{a,b} — (P < .01)

Antibiotics

Scours and respiratory infections are the most common problems associated with calves. Recent market research shows that over 75% of dairy producers report calf scours as a common problem. Results of a recent Land O'Lakes calf milk research trial evaluating the addition of antibiotics to a calf milk replacer are shown in Table 7.

Table 7. Effect of Antibiotics In Calf Milk Replacer On Calf Health And Performance

	<u>Non-Medicated</u>	<u>Chlortetracycline</u>	<u>Neomycin-Terramycin</u>
Average Daily Gain, lb.	1.19	1.19	1.15
Fecal Score	1.31 ^b	1.21 ^a	1.13 ^a
Scour Days	7.26 ^b	5.51 ^{ab}	3.56 ^a
Chlortetracycline — 150 grams per ton Neomycin-Terramycin — 250 grams Neomycin Base and 100 grams Terramycin per ton			
^{ab} — Significant (P < .05)			

Antibiotics did not improve daily gain, but scour days were reduced by the addition of antibiotics compared to a non-medicated calf milk replacer.

Alternative Protein Source Research

Approximately 60% of the dairy herd replacement calves in the United States are fed calf milk replacers. Of this number, it is estimated that approximately 65% of the calf milk replacers contain an alternative protein source with the predominant alternative protein source being soy proteins. Milk protein costs have been rising due to increasing demand for milk proteins in human food processing. For this reason, a great deal of research has been focused on alternative proteins which will provide similar performance to milk protein at reduced cost. Much of the research has been conducted regarding the following alternative soy protein sources: (1) soy flour, (2) special processed soy flour, (3) soy protein concentrate, (4) soy protein isolate, (5) modified soy protein (Glymaxene) over the past 20 years. Based on well designed and controlled calf research trials, a classification of protein sources based on calf performance and health is shown in Table 8.

Table 8. Performance Classification Of Different Calf Milk Replacer Protein Sources*

<u>Optimum</u>	<u>Acceptable</u>	<u>Inferior</u>
<ul style="list-style-type: none"> •Glymaxene •Skim Milk Powder •Buttermilk Powder •Dried Whole Whey •Dried Whey Product •Whey Protein Concentrate •Casein 	<ul style="list-style-type: none"> •Soy Protein Concentrate •Soy Protein Isolate •Special Processed Soy Flour 	<ul style="list-style-type: none"> •Unprocessed Soy Flour •Meat Solubles •Fish Protein Concentrate •Distillers Dried Solubles •Brewers Dried Yeast •Oat Flour •Wheat Flour

* Based on calf and health performance in calf research trials

Numerous research trials with calf milk replacers containing high quality alternative protein sources document that these calf milk replacers can be successfully fed to calves from 4 days of age to weaning.

Alternative soy protein sources in calf milk replacers have been successful as a result of 3 major factors. The alternative soy protein sources being used are "specially" processed by a

variety of special techniques. Raw soy protein is not used. Many of the calf milk replacers have 50% or less of the milk proteins being replaced by alternative soy protein sources. Third, 75% of the weight gain of calves during the first 6 weeks of life can be explained by the intake of high quality calf starters.

High quality alternative protein sources used in calf milk replacer can save the calf raiser approximately \$4-6 per calf during the milk replacer feeding period.

Immunoglobulins in Calf Milk Replacers

Land O'Lakes has conducted extensive research regarding the addition of various immunoglobulin sources to calf milk replacers during the milk replacer feeding period. Results from these trials show that naturally present non-specific immunoglobulins have not been effective in milk replacer fed calves. The immunoglobulin research area provides promise in the future to help prevent economically important calf health problems as specific sources of immunoglobulins are developed and researched.

Evaluating Milk Replacer Quality

Criteria to be utilized for evaluating milk replacer quality are shown in Table 9.

Table 9. Criteria for Evaluating Milk Replacer Quality
<ul style="list-style-type: none"> • Total Protein Level — Higher better, 22% Optimum • Total Fat Level — Higher better, 20% Ideal • High Quality Protein Sources (based on calf research) — Proper processing important <ul style="list-style-type: none"> -- Milk Proteins -- Alternative Proteins (protein modified soy flour, soy protein concentrate, soy protein isolate, special processed soy flour) • Calf Performance and Health (based on calf research trials) • Mixes Fast and Stays In Solution • Color • Odor • Flavor • Scorch Particle Levels • Microbiological Considerations • Fat Droplet Size • Protein/Fat Separation in Milk Replacer Solution

Many of the above tests are routinely performed by the major milk replacer manufacturers to ensure that dairymen and calf raisers receive high quality calf milk replacers. Many of the criteria used in the past to evaluate quality of milk replacers are of little or no value in today's industry.

Summary

Approximately 60% of the herd replacement calves in the United States receive a calf milk replacer. The original reason why calf milk replacer was developed approximately 40 years ago to provide an economic alternative to dairymen feeding whole milk to calves is still

valid today. Approximate savings of \$15 to \$25 over feeding whole milk per calf can be realized by feeding calf milk replacer today.

A great deal of research by the industry in recent years has focused on developing high quality milk replacers which provide excellent calf performance and health while providing an economic benefit to the dairyman and calf raiser. Primary research has focused on protein levels and alternative protein sources to milk protein since the cost of milk protein continues to rise due to their demand in human foods. Research relative to the major nutrient levels has been well documented over the years.

With the advent of new research breakthroughs in alternative proteins which are well utilized by the calf, fiber level is no longer a good indicator of quality in a calf milk replacer. Criteria for evaluating milk replacer quality based on optimum calf performance and health are presented in this paper.

References

1. *Nutrient Requirements of Dairy Cattle*, Sixth Revised Edition, Update 1989. National Academy Press, Washington, D.C.
2. Barr, G.W., *Developments in Calf Starters and Milk Replacers*. 33rd Kansas Formula Feed Conference, 1978.
3. DeGregorio, R.M., *Nutritional and Immunological Aspects of Feeding the Young Calf*. California Animal Nutrition Conference, 1990.

Sumario

Aproximadamente el 60% de las novillas de reemplazo en los Estados Unidos reciben un sustituto de leche. La idea original que motivó el desarrollo de un sustituto de leche hace aproximadamente 40 años para proporcionar una alternativa económica al productor lechero alimentando con leche íntegra, es válida aún. Ahorros de aproximadamente \$15 a \$25 se pueden obtener hoy día, cuando se ofrece un sustituto de leche.

Mucho interés por parte de la industria, se ha puesto en el desarrollo de sustitutos de leche de alta calidad que promueven un excelente rendimiento y salud de los terneros, con cierto beneficio económico para el lechero y el criador. La investigación principal se ha concentrado en niveles y fuentes alternativas de proteína que sustituyan la proteína láctea, la que aumenta de precio la demanda humana. La investigación sobre los niveles de los mayores nutrientes ha sido bien documentada a través de los años.

Con los nuevos descubrimientos sobre proteínas alternativas bien utilizadas por los terneros, el nivel de fibra ya no es un buen indicador de la calidad de un sustituto de leche. Los criterios para evaluar la calidad de un sustituto, basados en los rendimiento y salud de los terneros, son presentados en este artículo.

Le Sommaire

60% environ des veaux de remplacement de la troupe dans les Etats Unis reçoivent un substitut de lait. Le but original inventé il y a 40 ans était pour développer un substitut de lait pour offrir aux producteurs un alternatif économique a la nourriture avec du lait entier, est encore valide aujourd'hui. On peut gagner \$15-25/veaux avec les substituts de lait.

Les recherches récentes se concernent au développement des substituts de lait lesquels fournent la santé et du bon développement des veaux aussi bien que le profit pour les producteurs. Les recherches principaux se concentrent sur les niveaux et sources alternatifs de la protéine comparé a la protéine de lait puisque le prix continue a monter à cause de leur demande dans la nourriture humaine. La recherche relatif aux niveaux des nourritures principales a été bien documenté depuis des années.

Avec les nouvelles découvertes dans la recherche sur les protéines qui sont bien utilisées par les veaux, le niveau de la fibre n'est pas toujours un bon indicateur de la qualité d'un substitut de lait fondé sur la santé et le développement des veaux.