Introduction

This guide is published by the Bovine Alliance on Management and Nutrition (BAMN) which is comprised of representatives from American Association of Bovine Practitioners (AABP), American Dairy Science Association (ADSA), American Feed Industry Association (AFIA) and United States Department of Agriculture (USDA). The purpose of this publication is to provide the dairy industry with information relative to calf milk replacers.

Today's high quality calf milk replacers, when correctly matched to the specific calf rearing systems, provide several benefits to the dairy producer and calf raiser. These benefits include improved biosecurity, calf performance and economics. Within the last 15 years, there have been significant changes in the formulation of milk replacers. Many of today’s products are the result of extensive research. When fed properly, high quality milk replacers will allow calf growth and performance equal or even greater than that attainable with whole milk.

The purpose of this guide is to explain how to evaluate a calf milk replacer for a particular calf raising system. Keep in mind that choosing and using a calf milk replacer is only one part of successful calf rearing.

Significant price differences in milk replacers occur for a variety of reasons including types of ingredients, manufacturing technology and, nutritional quality. It is important that calf raisers understand these differences and make informed decisions in order to maximize both calf performance and economic benefit.

Classification of Milk Replacer Types

Modern milk replacers can be classified by protein source, protein/fat levels and inclusion of medication or additives.

Protein/Fat Levels

Protein and fat levels are both important to consider when choosing a milk replacer. Protein levels in calf milk replacers range from 18% to 30% and fat levels from 10% to 28%, with 18% to 22% being the most common fat levels. Generally, higher protein (greater than 22%) formulas are products fed at 1.5 lb. per head daily or greater. Because fat is the most concentrated energy source, the fat content of milk replacer will be responsible for most of the difference in energy levels. Fat sources should be highly digestible to the young calf and preserved with an antioxidant to prevent rancidity. Calf growth and performance is related to a large number of factors; and differing protein levels, protein/energy ratios, and protein sources interact. Growth is regulated by daily intake of protein and energy; therefore, different feeding levels will also affect performance. Some conditions, such as cold weather, require feeding a higher energy level. Metabolizable energy (ME) content of milk replacers is primarily determined by the fat and carbohydrate levels.

<table>
<thead>
<tr>
<th>Protein Sources</th>
<th>Protein Sources are generally classified as either all milk or a portion coming from alternative proteins.</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Milk Protein</td>
<td>Alternative Protein</td>
</tr>
<tr>
<td>Dried Whey Protein Concentrate</td>
<td>Soy Protein Isolate</td>
</tr>
<tr>
<td>Dried Whey</td>
<td>Protein Modified Soy Flour</td>
</tr>
<tr>
<td>Dried Whey Product</td>
<td>Soy Protein Concentrate</td>
</tr>
<tr>
<td>Skim Milk</td>
<td>Soy Flour</td>
</tr>
<tr>
<td>Casein</td>
<td>Animal Plasma</td>
</tr>
<tr>
<td>Sodium or Calcium Caseniate</td>
<td>Wheat gluten or isolate</td>
</tr>
</tbody>
</table>
Milk Replacer Labels and Ingredients Used In Calf Milk Replacers*

The following information provides some criteria to use in choosing and evaluating a milk replacer. The feed tag provides information about types of ingredients and medication which can indicate the intended use of the milk replacer.

Crude Protein
Protein provides essential amino acids for tissue synthesis in animals. Protein content should be evaluated as to amount, source (protein sources vary in their bioavailability to the animal) and presence of nutritional factors.

Crude Fat
Provides a concentrated energy source (2.25 times the energy of carbohydrates) and provides essential fatty acids. Calves raised in a cold environment have a higher requirement for energy.

Crude Fiber
Crude fiber content in milk replacers has been used in the past as a measure of product quality. This is no longer valid criteria to use in evaluating milk replacers. Crude fiber levels above 0.15% indicate presence of a plant protein source, but levels below 0.15% do not necessarily mean the absence of plant protein. The ingredient list should be reviewed to determine the protein sources.

CALF MILK REPLACER
NON-MEDICATED

GUARANTEED ANALYSIS

Crude Protein, not less than 22.0%
Crude Fat, not less than 20.0%
Crude Fiber, not more than 0.15%
Calcium (min) 0.75%
Calcium (max) 1.25%
Phosphorus (min) 0.7%

Vitamin A, not less than 20,000 IU/lb
Vitamin D₃, not less than 5,000 IU/lb
Vitamin E, not less than 100 IU/lb

INGREDIENTS
Dried Whey, Dried Whey Product, Dried Whey Protein Concentrate, Animal and Vegetable Fat (Preserved with BHA), Dried Skimmed Milk, Dried Milk Protein, Lecithin, Calcium Carbonate, Dicalcium Phosphate, DL-Methionine, L-Lysine, Vitamin A Supplement, Vitamin D₃ Supplement, Vitamin E Supplement, Niacin Supplement, Calcium Pantothenate, Thiamine Mononitrate, Choline Chloride, Vitamin B₁₂ Supplement, Riboflavin Supplement, Folic Acid, Manganese Sulfate, Magnesium Oxide, Copper Sulfate, Zinc Sulfate, Copper Sulfate, Cobalt Sulfate, Ethylenediamine Dihydroiodide, Sodium Selenite, Polyoxyethylene Glycol (400), Mono and Dioleates, Silicon Dioxide, Artificial Flavor.

Manufactured For
Dairytown Company
Your Town, State
50 lb. (22.7 Kg) NET WEIGHT

Common Milk Replacer Ingredients

Animal Fat and Vegetable Oil -
Fats and oils obtained by removing lipid portion of animal and vegetable tissue.

Animal Plasma -
A concentrated source of protein obtained by removing the red and white blood cells from fresh whole blood. The resulting plasma is dried (78% protein).

Casein (Dried Milk Protein) -
Primary protein in skimmed milk. Concentrated by coagulating milk (85% protein).

Dried Skimmed Milk -
The fat in milk is removed. The remaining protein, lactose and minerals are dried (34% protein).

Dried Whey -
Liquid drained from cheese during processing and then dried. Contains lactalbumin proteins and is high in lactose (12% protein).

Beware of the use of collective terms in milk replacer ingredient listings. These terms include many different products:

Animal Protein Products -
This collective term covers ingredients containing protein that originate from animal sources. A partial listing, but not all inclusive, is: casein, fish meal, meat and bone meal, dried skimmed milk, dried whey and dried animal blood.

Plant Protein Products -
This collective term covers ingredients that originate from plant products that contain protein. A partial listing, but not all inclusive, is: cottonseed meal, soy protein concentrate, soybean meal, brewers yeast, soy flour and active dry yeast.

Protein Modified Soy Flour -
A soy flour specially processed to increase digestibility and decrease antigenicity (50% protein).

Soy Flour -
Finely ground soybean meal (50% protein).

Soy Protein Concentrate (SPC) -
Protein portion of soybeans concentrated by removal of soluble carbohydrates. Contains fiber (66% protein).

Soy Protein Isolate -
Isolated protein of soybean with carbohydrate fraction removed. Water soluble and fiber free (86% protein).
Quality Evaluation

Dry Powder

COLOR  Cream to light tan, free of lumps and foreign material. If powder is orange to orange-brown in color and has a burned or caramelized smell, the product may have Maillard Browning (non-enzymatic browning) as a result of excessive heat during storage. If the product has “browned”, there will be some loss of nutrient quality and product palatability.

ODOR  Powder should have a bland to pleasant odor. If odor is characterized as smelling like paint, grass, clay or gasoline, the fat portion of the product may be rancid.

Reconstituted Liquid

MIXING  The product should go into solution easily. Milk replacer should be mixed at manufacturer's recommended water temperature. Mix until all powder is in solution or suspension without clumps of undissolved powder on the surface of the solution or at the bottom of the pail. Ingredients that are in suspension but are not soluble will settle out of solution (form a sediment at the bottom of the container) to stand without agitation. This sediment layer will be more apparent as the fiber content and/or level of added minerals and/or medication increases. In some feeding situations (automatic feeders, nipple bottles, etc.), milk replacers containing significant amounts of insoluble components may not be acceptable. Care should be taken not to over mix. If agitation is continued after product is in solution, excessive foaming can occur or the fat portion of the product may separate and form a greasy layer on the surface.

COLOR  Cream to light tan.

ODOR  Pleasant with no “off” odors noted.

FLAVOR  Milky with no “off” flavors. Some milk replacers are supplemented with organic acids. These milk replacers will have a “tangy” (sweet tart) taste. This should not be confused with the “off” lactic acid taste found in sour milk.

Clotting or lack of clotting with rennet of milk replacers as a measure of product quality is no longer an indication of quality with today's formulations of calf milk replacers. Most milk replacer formulas have replaced skim milk or casein protein with whey protein (lactalbumin protein). Both are excellent sources of protein but whey protein will not “clot” when mixed with rennet.

Commonly Used Milk Replacer Medications

Medication in milk replacers can provide significant benefits in calf health and performance. However, use of medication may require a withdrawal period prior to slaughter. Five medications, listed in the table below, are approved for use in milk replacers. (g/ton refer to grams per ton of dry powder.)

<table>
<thead>
<tr>
<th>Medication</th>
<th>Use Level</th>
<th>Statement</th>
<th>Withdrawal Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlortetracycline</td>
<td>20 g/ton (to provide 0.1 mg per pound body weight daily)</td>
<td>Increased rate of weight gain and improved feed efficiency</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>2000 g/ton (to provide 10 mg per pound body weight daily)</td>
<td>Treatment of bacterial enteritis caused by E. coli susceptible to chlortetracycline. Treat for not more than 5 days.</td>
<td>10 days before slaughter</td>
</tr>
<tr>
<td>Oxytetracycline</td>
<td>10 to 20 g/ton (to provide 0.05-0.1 mg per pound body weight daily)</td>
<td>Increased rate of weight gain and improved feed efficiency</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>2000 g/ton (to provide 10 mg per pound body weight daily)</td>
<td>Treatment of bacterial enteritis caused by E. coli susceptible to oxytetracycline. Feed continuously for 7 to 14 days.</td>
<td>5 days before slaughter</td>
</tr>
<tr>
<td>Oxytetracycline/Neomycin</td>
<td>8 mg/gallon Oxytetracycline and 100 mg/gallon Neomycin to 200 mg/gallon Oxytetracycline and 200 mg/gallon Neomycin or 40 mg/gallon Oxytetracycline and 200 mg/gallon Neomycin to 400 mg/gallon Neomycin.</td>
<td>Aid in the prevention of bacterial enteritis (scours).</td>
<td>30 days before slaughter</td>
</tr>
<tr>
<td>Decoquinate</td>
<td>12.9 to 90.8 g/ton (to provide 22.7 mg decoquinate per 100 lbs. body weight daily).</td>
<td>For the prevention of coccidiosis in ruminating and non-ruminating calves and cattle caused by <em>Eimeria bovis</em> and <em>Eimeria zuernii</em></td>
<td>None</td>
</tr>
<tr>
<td>Lasalocid</td>
<td>60 to 90 g/ton (to provide 1 mg lasalocid per 2.2 pounds of body weight daily)</td>
<td>For control of coccidiosis caused by <em>Eimeria bovis</em> and <em>Eimeria zuernii</em> in replacement calves.</td>
<td>None</td>
</tr>
</tbody>
</table>
Matching Calf Milk Replacers to Calf Rearing Systems

In choosing a milk replacer, the requirements (protein source, vitamin supplementation, medication, ease of mixing, etc.) of a particular calf rearing situation must be evaluated. Many “quality” problems associated with milk replacers actually result from choosing the wrong type of milk replacer for a particular situation. Suitability of various protein sources is listed below.

**Acceptable** - Protein sources which are either from milk or are specifically manufactured and processed for use in calf milk replacers. Their use in calf milk replacers is well researched.

**Marginal** - Protein sources which are sometimes used in calf milk replacers but may vary in quality and may not be suitable for the very young calf.

**Not Acceptable** - Protein sources which research has shown to produce deleterious results when fed to young calves.

### Protein Sources

<table>
<thead>
<tr>
<th>Acceptable</th>
<th>Acceptable</th>
<th>Marginal</th>
<th>Not Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dried Whey Protein Concentrate</td>
<td>Soy Protein Isolate</td>
<td>Soy Flour</td>
<td>Meat Solubles</td>
</tr>
<tr>
<td>Dried Skim Milk</td>
<td>Protein Modified Soy Flour</td>
<td></td>
<td>Fish Protein Concentrate</td>
</tr>
<tr>
<td>Casein</td>
<td>Soy Protein Concentrate</td>
<td></td>
<td>Wheat Flour</td>
</tr>
<tr>
<td>Dried Whey</td>
<td>Animal Plasma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dried Whey Product</td>
<td>Wheat gluten or isolate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other alternative protein sources continue to be researched (e.g. egg protein) with mixed results.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Calf Rearing Systems

There are both different calf rearing systems and different climates to consider when matching a milk replacer to a specific set of conditions. The table below provides guidelines for these systems.

<table>
<thead>
<tr>
<th>Calf Rearing System</th>
<th>Recommended Calf Milk Replacer to Use</th>
<th>Recommended Feeding Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>Use milk replacers containing protein sources listed under “acceptable” above. Protein level of the milk replacer should be 20 or 22%</td>
<td>Bucket or nipple bottle. Generally, feed 2 to 3 quarts twice daily for 4 to 6 weeks.</td>
</tr>
<tr>
<td>Intensified or Accelerated</td>
<td>Use milk replacers specifically designed and recommended for this feeding regime. Protein level should be matched to energy intake.</td>
<td>Follow manufacturers recommendations relative to mixing rate, feeding rates and management recommendations.</td>
</tr>
<tr>
<td>Winter Feeding At Low Temperatures</td>
<td>It is preferable to use a higher energy (20% fat) milk replacer when ambient temperatures fall below freezing. In addition, milk replacer quantities fed should be increased 25%-50%.</td>
<td>Bucket or nipple bottle. Feed calves 3 times a day to increase energy intake or feed a greater volume of milk replacer per feeding, but gradually step up volume fed.</td>
</tr>
<tr>
<td>Cold Ad libitum (Self-Serve/ Free Choice / Acidified Feeding)</td>
<td>Use only an acidified milk replacer specifically recommended by the manufacturer. Do not use a product which produces a heavy sediment when reconstituted.</td>
<td>Nipple feed only from a reservoir with a suitable nipple assembly and hose. Keep milk available at all times during the first 3 weeks until the weaning process begins.</td>
</tr>
</tbody>
</table>

All calves should have access to fresh, clean water and fresh, high quality calf starter at all times.

Milk replacer bags should be stored in a clean, dry place not subject to excessive heat. Opened milk replacer bags should be stored in an air tight fashion to prevent exposure to contamination, pests, heat and humidity.

### Summary

Extensive evaluation of the nutritional integrity of a calf milk replacer involves complex chemical and microbiological analyses. This bulletin is a general guide for a rapid evaluation of calf milk replacers and is not meant to replace consultation with a qualified nutritionist. **The single best criterion for evaluating a calf milk replacer is calf performance.** If calf performance is poor, more detailed evaluation of management, calf health and calf milk replacer quality is necessary to determine the reason for poor performance.

For electronic or paper copies of this or other BAMN Publications, Contact:

AFIA Publications
2101 Wilson Blvd., Suite 916
Arlington, Virginia 22201
Fax: 703-524-1921
Phone: 703 524-0810
E-mail: afia@afia.org
Printed in USA


3. An Introduction to Infectious Disease Control on Farms (Biosecurity), 2001. (Spanish version available)

Revised 2008