2014 Edition

A BAMN Publication

A GUIDE TO CALF MILK REPLACERS
Types, Use, and Quality

Introduction

This guide is published by the Bovine Alliance on Management and Nutrition (BAMN), which is comprised of representatives from the American Association of Bovine Practitioners (AABP), the American Dairy Science Association (ADSA), the American Feed Industry Association (AFIA), and the U.S. Department of Agriculture (USDA). The purpose of this guide is to provide dairy producers with information about how to evaluate calf milk replacers for a particular calf-raising system.

Today's high-quality calf milk replacers—when correctly matched with specific calf-rearing systems—provide several benefits to dairy producers and calf raisers, including improved biosecurity, calf performance, and economics. In the last 15 years, the formulation of milk replacers has changed significantly. Many of today's products are the result of extensive research and, when fed properly, will allow calf growth and performance equal to that attainable with whole milk.
However, the price, ingredients, and nutritional quality of milk replacers vary significantly. It is important, therefore, that calf raisers make informed decisions on which replacer to use in order to maximize calf performance and economic benefit.

Formulation of Milk Replacers

Modern milk replacers can be classified by protein source, protein/fat levels, and the medication or additives in the replacer. Protein levels in calf milk replacers range from 18 to 30% and fat levels from 10 to 28%. Generally, when milk replacer is fed, each calf receives about 1.5 lb of high-protein formula (>22%) daily. Fat sources for calves should be highly digestible and preserved with an antioxidant to prevent rancidity. Calf growth is regulated by the daily intake of protein and energy; therefore, feeding level has the biggest impact on performance. Calf growth, as it relates to milk replacers depends on many factors: the amount of milk replacer fed, replacer protein levels and protein/energy ratios, and protein source interactions. Some conditions, such as cold weather, require feeding at high energy levels, and the metabolizable energy content of milk replacers is primarily determined by fat and carbohydrate levels in the replacers.

Quality Evaluation

Dry powder

Color: Powder should be cream colored to light tan and free of lumps and foreign material. If powder is orange to orange/brown in color and has a burned or caramelized smell, it may have undergone Maillard Browning (nonenzymatic browning) because of excessive heat during storage. If the product has "browned," there will be some loss of nutrient quality and 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 the manufacturer's recommended rate of powder to water and water temperature. Mix until all powder is in solution or suspension without clumps on the surface or at the bottom of the container. Ingredients in suspension but not soluble will settle out of the solution (form a sediment at the bottom of the container) if allowed 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, causing a tangy taste that should not be confused with the "off" lactic acid taste found in sour milk.

Rennet coagulation (clotting of milk replacer) is no longer considered an accurate measure of milk replacer quality. Most of today's milk-replacers contain whey protein (lactalbumin protein) but whey protein will not clot when mixed with rennet.

Milk Replacer Labels and Ingredients Used In Calf Milk Replacers

The following information provides some criteria for choosing and evaluating a milk replacer. The product label provides information about the type of ingredients and medications in the replacer and point to its intended use. If you have questions about the inclusion levels of a product's ingredients, contact the manufacturer's technical services.

Crude protein
Provides essential amino acids for tissue synthesis. Content should be evaluated as to the amount and source of protein (protein sources vary in their bioavailability).

Crude fat
Provides essential fatty acids and is a concentrated energy source (2.25 times the energy of carbohydrates). Smaller frame-sized calves and those raised in cold environments have higher energy requirements.

Crude fiber
Crude-fiber content in milk replacers has been used as a measure of product quality. This measure is no longer considered a valid criterion for evaluating milk replacers. Crude-fiber levels above 0.15% indicate the presence of plant protein; however, levels below 0.15% do not necessarily mean the absence of plant protein. The ingredient list should be reviewed to determine protein sources.

CALF MILK REPLACER
NONMEDICATED

GUARANTEED ANALYSIS

Crude protein, not less than	26.0%
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 D_3, 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 skim milk, dried milk protein, lecithin, calcium carbonate, dicalcium phosphate, DL-methionine, L-lysine, vitamin A supplement, vitamin D supplement, vitamin E supplement, niacin supplement, calcium pantothenate, thiamine mononitrate, choline chloride, vitamin B_{12} supplement, riboflavin supplement, folic acid, manganese sulfate, magnesium oxide, ferrous sulfate, zinc sulfate, copper sulfate, cobalt sulfate, ethylenediamine dihydriodide, 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

Vitamins
Vitamin A, D, and E are necessary for normal growth and health.

Ingredients
Ingredients should be listed in descending order based on the inclusion level in the formula. However, this type of listing is not required; therefore, using the order of ingredients listed for evaluation might result in erroneous conclusions.

Medication
Medicated milk replacers should not be used as a substitute for good management and sanitization. Choosing to feed medicated or nonmedicated milk replacer and which medication to use should be based on the health status and stress level (shipping, poor weather, less than optimum housing, low birth weight, etc.) of animals. Withdrawal periods, when applicable, should be followed according to the manufacturer's recommendations. Current regulation does not require a veterinarian's involvement but FDA will likely require this in the near future via the Veterinarian Feed Directive (VFD).

Common Milk Replacer Ingredients

Animal fat and vegetable oil
Fats and oils are obtained by removing the lipid portion of animal and vegetable tissues. Typical animal fats used are edible lard and tallow. Vegetable oils used vary widely. In some products, fats and oils are encapsulated to minimize fat separation in rehydrated milk replacer.

Animal plasma
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 skim milk. Concentrated by coagulating milk (85% protein).

Dried skim milk
After fat is removed from milk, the remaining protein, lactose, and minerals are dried (34% protein).

Dried whey
Produced by draining liquid from cheese and then drying it. Dried whey contains lactalbumin (12% protein) and is high in lactose.

Dried whey product (delactosed whey)
A portion of the lactose in whey is removed, resulting in high levels of protein and minerals (20–26% protein).

Dried whey protein concentrate (WPC)
Protein portion of whey is concentrated through ultrafiltration (34–80% protein).

Lecithin
Emulsifier, aids in dispersal of fat in solution and enhances fat digestion.

L-lysine and DL-methionine
Essential amino acids necessary for calf growth.

Polyoxyethylene glycol (400) mono and dioleates (PEG 400)
Emulsifier, aids in dispersal of fat in solution.

Vitamin and mineral supplements
Many vitamins and minerals are supplemented to provide for normal health, growth and maintenance of calves.

Definitions of soy/wheat ingredients

Soy protein isolate
Isolated soybean protein with carbohydrate fraction removed. Water soluble and fiber free (86% protein).

Protein modified soy flour
Specifically processed to increase digestibility and decrease antigenicity (50% protein).

Soy protein concentrate (SPC)
Soybean protein concentrated by removing soluble carbohydrates. Contains fiber (66% protein).

Soy flour
Finely ground soybean meal (50% protein).

Wheat gluten or isolate
Isolated wheat protein with carbohydrate fraction removed.

Beware of collective terms (e.g., animal protein products, plant protein products) in a milk replacer's ingredients. These terms include many different products:

Animal protein products
A collective term that covers ingredients containing protein originating from animal sources. A partial, but not inclusive, list: casein, fish meal, meat and bone meal, dried skim milk, dried whey, and dried animal blood.

Plant protein products
A collective term that covers ingredients originating from plant products that contain protein. A partial, but not inclusive list: cottonseed meal, soy protein concentrate, soybean meal, brewer's yeast, soy flour, and active dry yeast.

Protein sources

Acceptable—Protein sources from milk or nonmilk sources, and their use in calf milk replacers is well researched.

Not acceptable—Protein sources that have been shown to produce deleterious results when fed to young calves.

Acceptable milk ingredients	**Acceptable nonmilk ingredients**	**Not acceptable**
Dried whey protein concentrate	Soy protein isolate	Meat solubles
Dried skim milk	Protein modified soy flour	Fish protein concentrate
Casein	Soy protein concentrate	Wheat flour
Dried whey	Hydrolyzed soy protein modified	Soy flour
Dried whey product	Animal plasma	Egg products
	Wheat gluten or isolate	

Commonly Used Milk Replacer Medications/Fly Control

FAILURE TO OBSERVE LABEL INSTRUCTIONS PRECISELY
CAN RESULT IN VIOLATIVE TISSUE RESIDUES

Medication in milk replacers may be added to provide benefits to calf health and performance. Using medication, however, may require a withdrawal period before slaughter. The six medications listed in the table below are approved for use in milk replacers (see disclaimer below). (g/ton refers to grams per ton of dry powder.)

Medication	Use level	Statement	Withdrawal period
Decoquinate	12.9 to 90.8 g/ton (to provide 22.7 mg decoquinate per 100 lb of body weight daily)	Prevention of coccidiosis in ruminating and nonruminating calves and cattle caused by *Eimeria bovis* and *Eimeria zuernii*	None[1]
Lasalocid	Feed to provide 1 mg lasalocid per 2.2 lb of body weight daily	Control of coccidiosis caused by *Eimeria bovis* and *Eimeria zuernii* in replacement calves	None[1]
Oxytetracycline/neomycin combination for calves (up to 250 lb)	500 to 2,500 g/ton (to provide 10 mg/lb of body weight daily). Feed continuously for 7 to 14 days.	Treatment of bacterial enteritis caused by *Escherichia coli* or bacterial pneumonia (shipping fever complex) caused by *Pasteurella multocida* susceptible to oxytetracycline or treatment and control of colibacillosis (bacterial enteritis) caused by *E. coli* susceptible to neomycin.	5 days before slaughter
	Or		
	10 to 20 g/ton (to provide 0.05–0.1 mg of body weight daily)	Increased rate of weight gain and improved feed efficiency[2]	None[1]
Chlortetracycline	2,000 g/ton (to provide 10 mg/lb of body weight daily)	Treatment of bacterial enteritis caused by *E. coli* susceptible to chlortetracycline. Treat for not more than 5 days.	5 or 10 days before slaughter (depends on manufacturer – follow label directions)
	Or		
	20 g/ton (to provide 0.1 mg/lb of body weight daily)	Increased rate of weight gain and improved feed efficiency[2]	None[1]
Oxytetracycline	2,000 g/ton (to provide 10 mg/lb of body weight daily)	Treatment of bacterial enteritis caused by *E. coli* susceptible to oxytetracycline. Feed continuously for 7 to 14 days.	5 days before slaughter
	Or		
	10 to 20 g/ton (to provide 0.05–0.1 mg/lb of body weight daily)	Increased rate of weight gain and improved feed efficiency[2]	None[1]
Diflubenzuron	9.1 to 22.6 g/ton	To prevent the development of house flies, stable flies, face flies, and horn flies in the manure of treated calves.	Only with medications as listed above, then follow medication withdrawal recommendation.

1. Withdrawal period has not been established in pre-ruminating calves.

2 In December 2013, the U.S. Food and Drug Administration (FDA) released Guidance for Industry #213 which asks drug manufacturers to voluntarily remove all feed efficiency and growth promotion labeling of medically important antibiotics (including oxytetracycline, chlortetracycline, and neomycin) in feed and water. The FDA intends that there be a three-year voluntary period (starting Dec. 2013) for Guidance #213 to be phased in. Once the rules of Guidance #213 are fully implemented after the phase-in period, there will also be a requirement for veterinary oversight (via a Veterinary Feed Directive) for all feed and water uses of medically important antibiotics.

Disclaimer: The feeding levels and withdrawal periods are accurate as of March 2014. Regulations regarding medications in milk replacers are subject to change; therefore, it is wise to periodically check for changes in approved feeding levels and withdrawal periods.

Matching Calf Milk Replacers to Calf Rearing Systems

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

Calf Rearing Systems

Differing calf-rearing systems and climates should be considered when matching a milk replacer to a specific set of conditions. The National Research Council for Dairy Cattle calf model is one resource for determining calves' nutritional needs.

Calf-rearing system	Milk replacer type	General feeding directions
Traditional	Use "acceptable" milk replacers (see previous listing) containing protein sources. Protein level of the milk replacer should be 20 or 22%.	Generally, feed 2 to 3 qt two to three times daily for 6 to 8 weeks.
Intensified, accelerated, or full potential	Use milk replacers specifically designed and recommended for this feeding regime. Protein level should be matched to energy intake.	Follow manufacturer's recommendations relative to mixing rates, feeding rates, and management recommendations.
Winter feeding at low temperatures (always provide deep straw bedding and calf blankets).	It is preferable to use a higher energy (20% or higher fat) milk replacer when ambient temperatures fall below freezing. In addition, milk-replacer quantities fed should be increased 25 to 50%.	Feed calves three times daily to increase energy intake, or feed a greater volume of milk replacer per feeding, but gradually step-up volume fed.
Cold *ad* libitum (self-serve/free choice/acidified feeding)	Use only a nonmedicated, acidified milk replacer specifically recommended by the manufacturer. Do not use a product that produces heavy sediment when reconstituted.	Nipple feed only from a reservoir with regular agitation and a suitable nipple assembly and hose. Keep milk available at all times until the weaning process begins.

Always weigh milk replacer and water for accurate mixing according to manufacturer's recommendation. Feeding temperature of milk replacer and other liquid diets should be 100 to 105°F, unless acidified milk is fed. Refer to specific acidified milk feeding systems for recommended temperatures for those diets.

Beginning the first 1 to 2 days of life, all calves should have access to fresh, clean water and fresh, high-quality calf starter at all times. The starter should be at least 18% protein. Milk-replacer bags should be stored in a clean, dry area not subject to excessive heat. Opened milk-replacer bags should be stored in an air-tight fashion to prevent contamination and exposure to pests, heat, and humidity.

Summary

Extensive evaluation of the nutritional integrity of calf milk replacers involves complex chemical and microbiological analyses. This guide provides strategies for rapidly evaluating calf milk replacers but is not meant to replace consultation with a qualified nutritionist. **Calf performance is the single best criterion for evaluating calf milk replacers.** Recommended performance measures are available from the Dairy Calf and Heifer Association Web site (http://www.calfandheifer.org/?page=goldstandards). If calf performance does not meet the goals of the operation, more detailed evaluation of management, calf health, and calf milk-replacer quality is necessary to determine the reason for poor performance.

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Revised 2014