CALF MILK REPLACER GUIDE

Developed by Rob Costello, Technical Specialist

MilkSpecialties Global
Animal Nutrition
Providing Science Based Solutions

Contents

Why Feed Milk Replacer

Most dairy calves raised in the United States are fed milk replacer during the liquid feeding period prior to weaning. Economics, convenience and biosecurity are among the major factors that make milk replacer feeding desirable to calf growers.

Economics. It is typically less expensive to feed milk replacer to dairy calves than it is to feed saleable whole milk. Milk replacers are made from byproducts of the milk manufacturing industry. Whey, the major protein source for milk replacers, is a byproduct of cheese manufacturing and is usually much cheaper than other milk protein sources such as casein and skim milk. The use of high quality, lower cost ingredients makes milk replacer a more economic choice than whole milk.

Convenience. Milk replacers offer a variety of choices when it comes to ingredients and nutrient levels. This provides more flexibility and makes it easier for each farm to meet its management needs. Additives such as vitamins, probiotics and medications can easily be supplied through milk replacer. Adding them by hand can be a challenge in whole milk feeding systems. In addition, protein and fat levels in milk replacers can be selected to enhance calf growth objectives and to respond to climatic conditions.

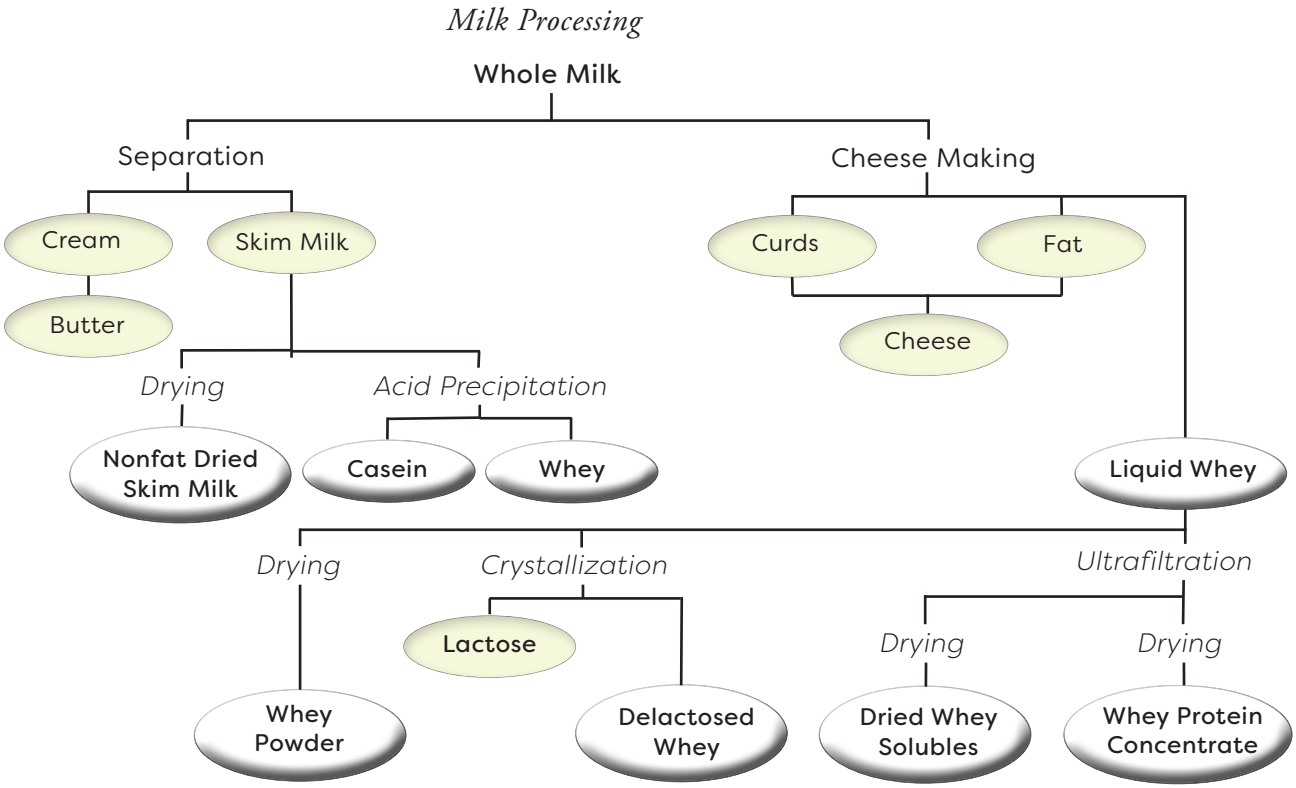
Biosecurity. Calves are especially vulnerable to disease. Disease organisms such as Johne's, Bovine Viral Diarrhea, Bovine Leukosis Virus, pasteurella, salmonella, E. coli and mycoplasma can be transmitted from the cow to her calf through unpasteurized milk. Biosecurity and disease prevention issues are major reasons for the popularity and use of milk replacers.

1 Milk Replacer Ingredients

Proteins

The recommendation for milk replacer protein level is 20 to 28 percent. Higher protein levels usually coincide with higher milk replacer feeding rates designed to increase calf growth. Proteins are typically the most expensive milk replacer ingredients, with many different protein sources being formulated into milk replacers. Those that are the most appropriate for manufacturing milk replacers for dairy replacement and dairy beef calves are described in this section.

Milk Proteins are typically more digestible than non-milk proteins and provide a desirable amino acid profile for calf growth. Many different milk products are used in manufacturing milk replacers. These include whey, whey protein concentrate, whey solubles, delactosed whey, skim milk, and casein. Whey products are utilized as principal protein sources in milk replacers. The diagram below shows how milk protein ingredients are obtained from whole milk.



Whey & Skim Milk Proteins. In the early days of calf milk replacers, skim milk was the primary protein source used. Over the years, use of skim milk in human nutrition such as in sports and fitness drinks has increased. These alternative uses of skim milk proteins have decreased its availability for use in milk replacers. This competition has also increased the price of skim milk relative to whey proteins. As a result, whey proteins are now the major protein sources for milk replacers.

Research into the nutritional value of whey and skim milk proteins and their impact on calf growth demonstrate that the nutritive value of whey proteins is equal to that of skim milk. It can even be argued that whey proteins are superior to the proteins in skim milk.

1 Whey and whey protein concentrate contain lactalbumin protein while skim milk contains a combination of casein-lactalbumin protein. Studies comparing the Protein Efficiency Ratio (PER)[1] of milk proteins show whey proteins to be a superior form of digestible protein:

Protein Efficiency Ratio (PER) of Milk By-products*

Whey	3.0
Whey Protein Concentrate	3.0
Lactalbumin	2.8
Skim Milk	2.8
Casein	2.8

* Based on published studies by the New Zealand Dairy Board. (1984)

[1] Protein Efficiency Ratio (PER) is the gain in weight of growing animals per gram of protein eaten.

2 Researchers at the Pennsylvania State University (Terosky et al, 1997)[1] looked at four dietary ratios of dried skim milk and whey protein concentrate as primary protein sources in calf milk replacers. The four test diets were expressed as ratios of dried skim milk to whey protein concentrate, 100:0, 67:33, 33:67 and 0:100.

Comparison of Milk Protein Sources in Calves Up to 8 Weeks of Age[1]

Skim	WPC	Dig[2]	BV[3]
100	0	82.5	67.7
67	33	82.5	70.2
33	67	83.8	67.5
0	100	84.0	72.3

[1] 1997 J Dairy Sci. 80:2977-2983
[2] Apparent Digestibility of the protein source
[3] Biological Value: proportion of absorbed protein retained in the body

Although no significant differences were noted in health or growth parameter, the researchers found that the apparent digestibility (Dig) and biological value (BV) differed among diets.

Apparent digestibility and biological value of the all whey protein concentrate diets were 84.0 and 72.3 and were higher than any of the diets containing skim milk. Values for the all skim milk diet were 82.5 and 67.7, respectively.

Animal Plasma Proteins are unique proteins which are often referred to as *functional proteins*. These functional proteins contain biologically active albumin and globulin proteins. Immunoglobulins such as IgG are important antibodies that circulate in plasma. The globulin proteins, growth factors, hormones and immune cells in animal plasma make it functionally more like colostrum and fresh suckled milk than an all-milk protein milk replacer.

Characteristics...
Animal plasma is highly soluble with an amino acid profile and nutritive value comparable to nonfat dried (skim) milk and casein.

In the Digestive Tract...
As well as being an excellent source of nutrition for young calves, animal plasma has additional beneficial effects in the digestive tract. During the first two weeks of life, the calf secretes a portion of the immunoglobulins it absorbed from colostrum back into its digestive tract. The more IgG absorbed, the more IgG secreted. This recycling of immunoglobulins helps protect the calf against pathogens. Providing animal plasma in milk replacer increases immunoglobulins levels in the digestive tract, providing an ongoing source after recycling has stopped.

Research with both young calves and baby pigs demonstrates that feeding animal plasma to young animals has a direct effect on the integrity and function of the small intestine. Animal plasma may directly affect antigen growth and attachment in the small intestine, affecting intestinal growth and improving its barrier function.

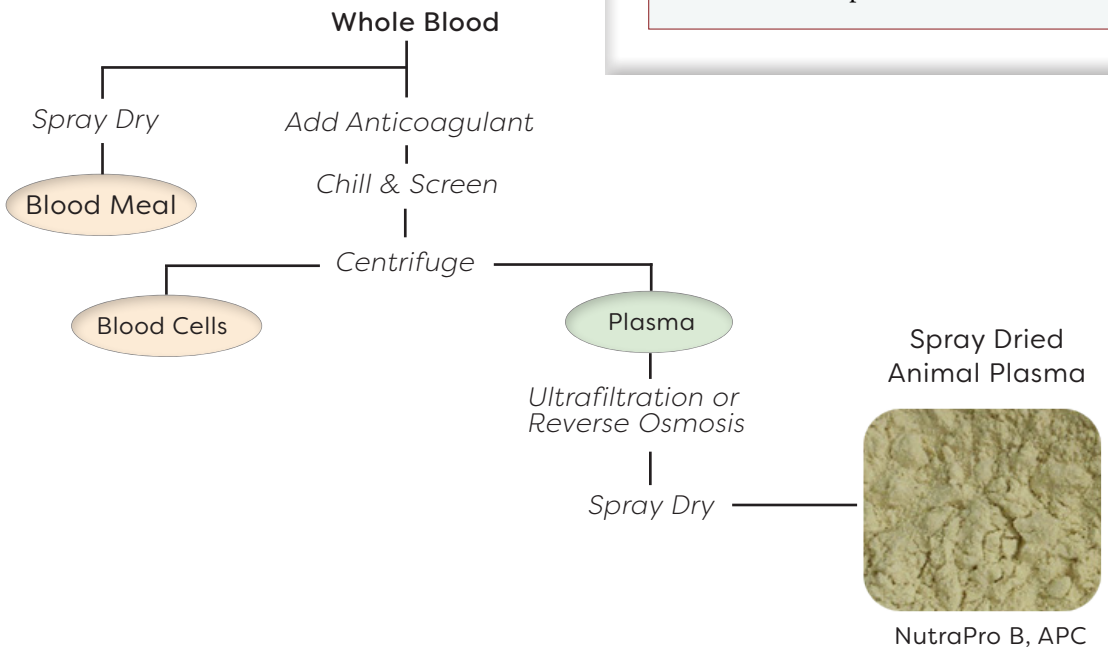
Calf Performance

There have been at least 30 research trials conducted to evaluate the effects of animal plasma on the growth and performance of baby calves. In these trials, plasma ***always*** performed as well as or better than all-milk protein milk replacers.

Improvements include:

- √ fewer, shorter scour episodes
- √ reduced medical costs
- √ better gain
- √ More starter intake
- √ Lower cost than all-milk protein milk replacers

Animal Plasma Processing



Hydrolyzed Wheat Gluten Protein is ideally suited for incorporation into calf milk replacers. It is low in fiber and ash and contains a much higher percentage of protein compared to whey protein concentrate (>80% vs. 34% protein).

Digestibility of hydrolyzed wheat gluten is very high -- about 95% for dry matter, organic matter and crude protein. Research on veal and dairy replacement calves has shown hydrolyzed wheat gluten to be a valuable ingredient in calf milk replacer, providing similar performance to all milk protein formulas.

Hydrolyzed wheat gluten is manufactured from wheat flour by separating the gluten protein from wheat starch. This protein is enzymatically hydrolyzed into small, soluble protein and peptides (similar to the size of whey proteins) before drying.

Whereas wheat flour is an inferior protein source for calf milk replacer, hydrolyzed wheat gluten provides a high quality, economical protein source that contains no anti-nutritional factors.

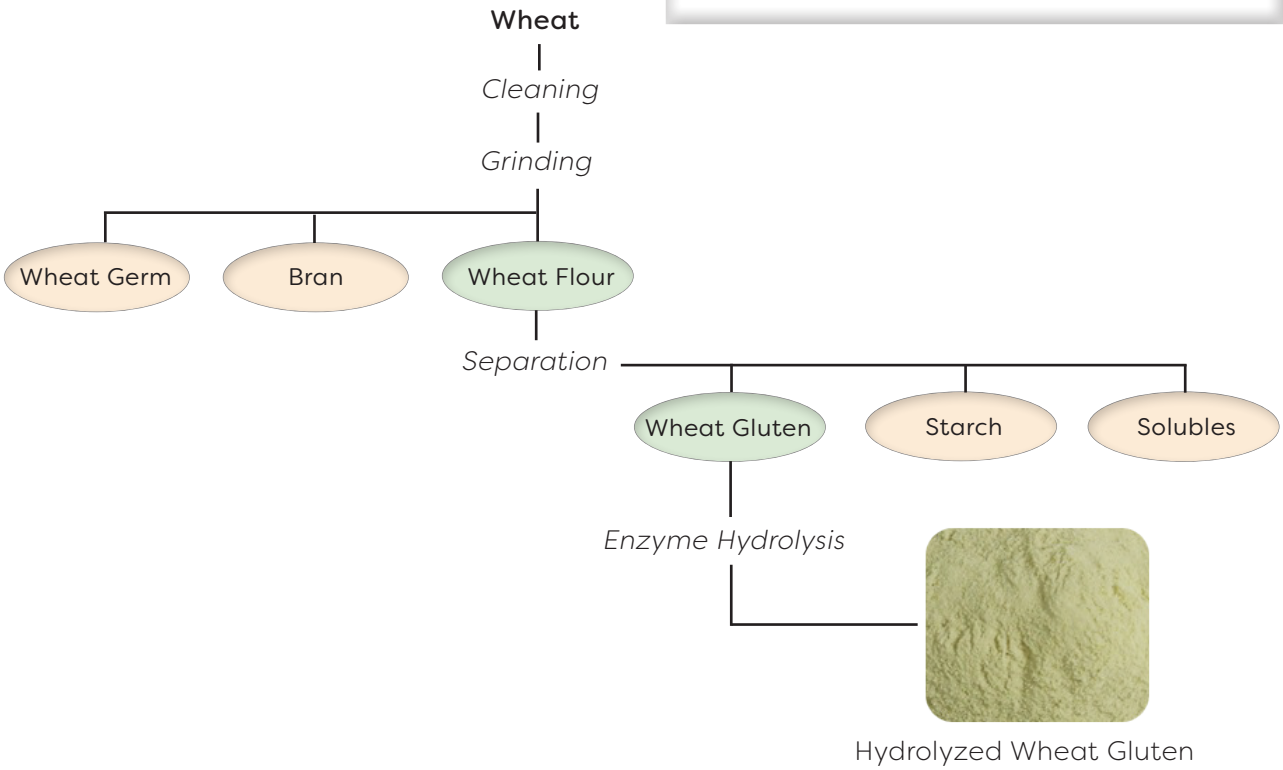
Hydrolyzed wheat gluten is typically included as a complement to animal plasma protein in calf milk replacer, providing greater economic advantage, and works well in high protein formulations.

When using wheat protein in calf milk replacers, amino acids should be properly balanced, particularly l-lysine. This optimizes calf growth and also adds further cost savings when using hydrolyzed wheat gluten.

Hydrolyzed Wheat Gluten Characteristics

- √ Neutral color and taste
- √ Very low ash
- √ No anti-nutritional factors
- √ Soluble/dispersible, no sediment
- √ 83-87% protein
- √ Typical use rate: 5% (replaces 20% of total protein)

Wheat Processing



Soy Protein can provide an economic alternative to milk proteins. The popularity of soy proteins stems from their widespread availability, relatively low cost and generally favorable amino acid profile. These vegetable proteins can be substituted for a portion of the milk proteins in milk replacers, providing acceptable calf growth and performance.

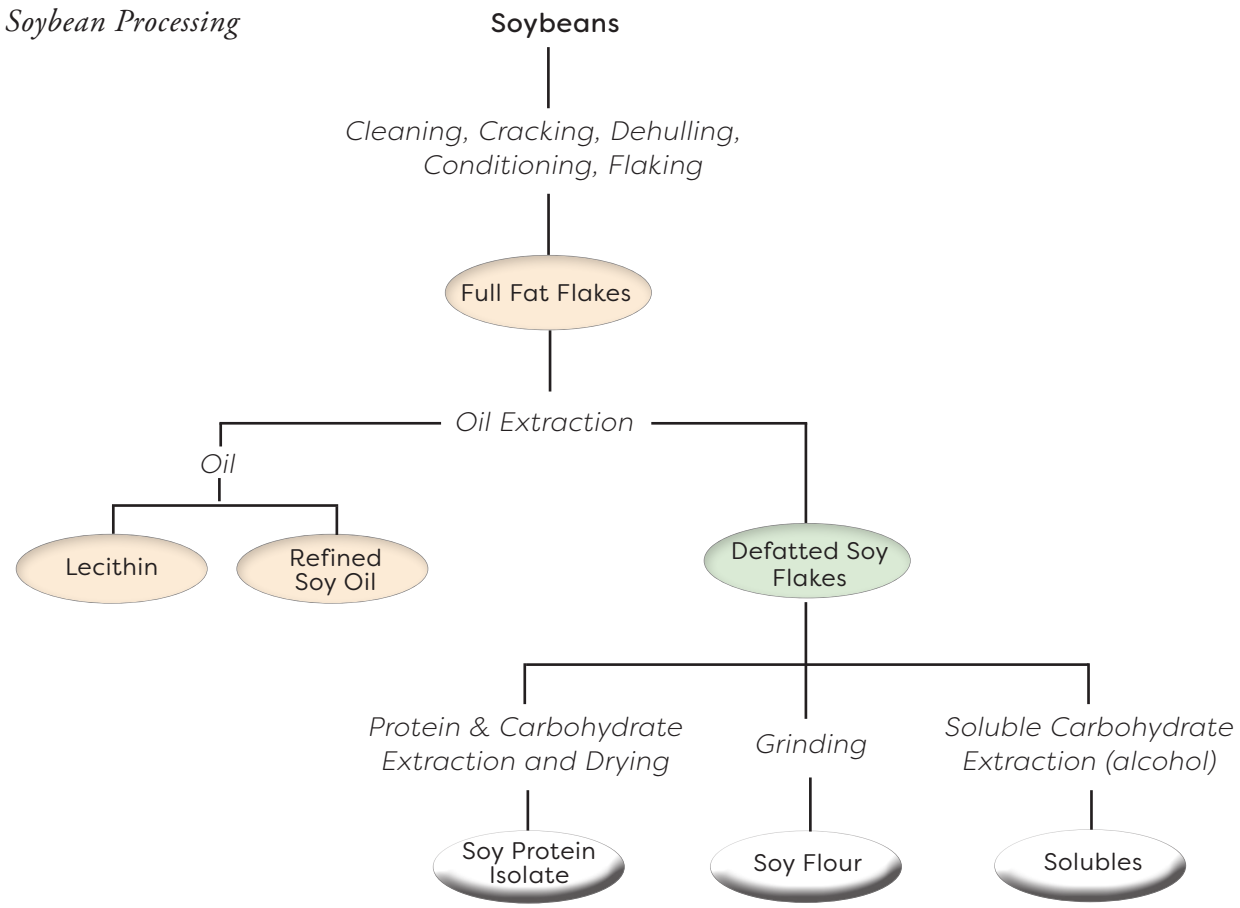
Soy flour contains anti-nutritional factors such as antigens, enzyme inhibitors and phytic acid. These factors cause allergic reactions and inflammation in the digestive tract, reduce protein digestion and can impair mineral absorption. Additional processing of soy flour to produce soy protein concentrate and soy protein isolate reduces anti-nutritional factors and the potential for harmful effects on calf health and performance.

An abundance of calf research repeatedly shows significant reductions in calf performance and gut health if toxins naturally found in soy are fed. Only proven soy sources that have adequately removed the anti-nutritional factors should be used in calf milk replacer formulas.

Milk replacers containing **soy protein concentrate** or **soy protein isolate** can be fed to calves once colostrum feeding is completed. Including animal plasma can help improve soy performance in the first weeks of life.

Milk replacers containing **soy flour** can be fed after the calf is three weeks of age and better able to cope with the anti-nutritional factors.

Soy proteins should be avoided when raising calves on an intensive milk replacer feeding program. Soy proteins are typically substituted for 50% of milk replacer protein.



Energy

The primary sources of energy in milk replacers are *fats* and *carbohydrates*. A unit of fat provides about twice the energy as a unit of carbohydrate. Calf milk replacers are typically formulated with anywhere from 15 to 24% fat. High fat milk replacers provide more energy and are often used in colder climates while lower fat formulas are sometimes used in hot climates and in formulations designed for intensive milk replacer feeding that support higher rates of gain.

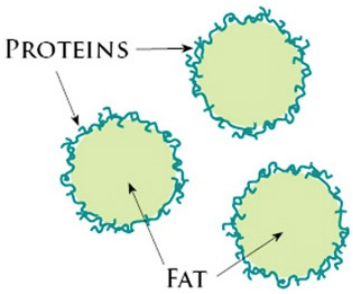
Fats and oils provide a concentrated energy source for animal feeds. Lard and tallow are the major fats used in manufacturing calf milk replacers. Vegetable oils such as coconut and palm oil can be incorporated into milk replacers with excellent results.

Fat Digestibilities In Calves

Fat Source	Digestibility %
Milk Fat (in whole milk)	95-97
Lard, Tallow	87-96
Coconut Oil	92-96
Palm Oil	92-96

Adapted from Davis & Drackley, 1998

By itself, fat is not soluble in water. Milk Specialties combines the fat with proteins and emulsifiers and homogenizes the mix, forming very small evenly dispersed particles that readily dissolve in water.



These protein encapsulated fats (PEFs) assure that ingredients are evenly dispersed throughout the product enhancing digestibility and absorption.

Carbohydrates also supply energy in milk replacers. Lactose is the major carbohydrate and is a natural component of whey and whey protein concentrate with about one half the energy value of fat. A typical milk replacer contains about 40-45% lactose, making it a major energy source for the calf.

Lactase is the primary enzyme produced by the young calf for digesting carbohydrates (lactose). Enzymes such as amylase and maltase for digesting starches are low at birth, but increase in number and activity as the calf grows. Feeding starches to calves should be avoided until they are older and can produce the enzymes necessary for digesting starch.

Carbohydrates in Milk Replacers
For Young Calves

Acceptable:	Lactose, Dextrose, Galactose
Unacceptable:	Starch, Sucrose (table sugar)

Changing the Fat Percentage. As fat is added to the formula, an equal amount of carbohydrates is removed to create space for the additional fat. Since proteins and minerals are not changed in this process, the amount of carbohydrates must decrease. The opposite occurs when removing fat from the formula. Since fat has about twice the energy of carbohydrates, the actual energy change in the milk replacer is about 1/2 of the energy value of the fat that's being added (or removed). Changing the fat percentage by 10% changes total energy in the milk replacer by about 5%.

Vitamins & Minerals

Vitamins play an important role in metabolism and are involved in enzyme systems. The young calf has limited storage of vitamins, making it dependent on dietary sources of these essential nutrients. Minerals are important for the structural development of the calf. They are an important part of body fluids, playing a critical role in maintaining acid-base balance and nerve transmission. Milk Specialties milk replacers are reinforced with the following vitamins and minerals.

Vitamins

Vitamin A	helps protect the body from infections by maintaining mucous membranes and is necessary for normal vision
Vitamin D	required for calcium metabolism, bone and tooth formation
Vitamin E	involved in immune system function and acts as an antioxidant to maintain cell integrity
Vitamin B_{12}	an integral part of several enzymes used to metabolize energy
Thiamine *(B_1)*	necessary for normal energy metabolism and supports nerve and brain function
Vitamin C *(ascorbic acid)*	an antioxidant that also functions in tissue repair and connective tissue synthesis and is an essential nutrient of calves 3 weeks of age or younger
Biotin	acts as a cofactor for many enzymes and is involved in both carbon dioxide fixation and decarboxylation
Choline	involved in the transmission of nerve impulses and plays a major role in fat metabolism
Folic Acid	used in the synthesis of amino acids and the production of nucleic acids for DNA synthesis; improves red blood cell formation and oxygen carrying capacity of the blood
Pyridoxine *(B_2)*	functions in several enzyme systems associated with protein metabolism
Vitamin K	required for the synthesis of many proteins and blood clotting factors that prevent hemorrhage
Riboflavin	a constituent of several enzyme systems associated with metabolism
Niacin	plays a critical role in carbohydrate, lipid and amino acid metabolism and essential for mitochondrial respiration
Pantothenic Acid	a constituent of coenzyme A and is essential for metabolic reactions such as fatty acid oxidation, amino acid catabolism and acetylcholine synthesis

Minerals

Calcium	important in bone and skeletal formation, muscle contraction, heart and nerve function and blood clotting
Chlorine	vital for maintaining acid-base balance and is an integral component of gastric secretions
Cobalt	an essential component of vitamin B_{12} which cannot be synthesized by rumen organisms without dietary cobalt
Copper	necessary along with iron for hemoglobin formation, is an integral part of many enzymes and is important for bone, collagen and elastin formation
Iodine	an essential component of hemoglobin and oxygen transport throughout the body
Magnesium	often is low in whole milk; important to enzymes involved in energy metabolism and is a normal constituent of bone
Manganese	a component of enzyme systems and is essential for normal bone formation
Phosphorous	a major component of bones and teeth; involved in appetite and almost all energy transactions in the body
Potassium	involved in acid-base regulation, water balance, nerve function, muscle contraction and transport of oxygen and carbon dioxide
Selenium	closely linked to vitamin E function and is involved in protein synthesis, muscle development and growth. Milk Specialties' milk replacers provide the organic form, selenium yeast, for improved selenium retention by the calf
Sulfur	an important component of several amino acids, cartilage and the B-vitamins thiamine and biotin
Zinc	plays an important role in enzyme systems involved in energy and protein metabolism

Vitamin & Mineral Supplementation. Whole milk fails to meet the basic vitamin and mineral requirements of the young calf and is deficient in vitamins D_3, E, six essential trace minerals and six essential B vitamins. Even colostrum, which is rich in vitamin A, is a poor source of vitamins D and E and is deficient in several essential vitamins and minerals, including iron.

Milk replacers are made from milk ingredients and are fortified with these important micronutrients to assure calves receive the complete nutrition they need for optimum health and growth.

Research shows that fetal mineral reserves are highly variable and calves may have less than 25% of the tissue reserves of their dam. Milk feeding cannot replenish these reserves, which can deplete quickly if the calf gets sick. Micronutrient requirements increase during illness and also increase when a calf grows at full potential. Research shows a link between pre-weaning performance and future milk production.

Medications

Certain medications can be added to calf milk replacers during manufacturing. Antibiotic medications include two levels of the antibiotic combination of Oxytetracyline and Neomycin Sulfate to provide broad spectrum antibacterial activity. Two other medications, Deccox and Bovatec are non-antibiotic medications that provide protection against coccidia.

Antibiotic Medications

Oxytetracycline & Neomycin Sulfate (Oxy/Neo)

- an antibiotic combination that provides broad spectrum antibacterial activity. *Use of more than one product containing neomycin or failure to follow withdrawal times may result in illegal drug residue.*

Treatment Level (10 mg/lb of bodyweight daily)

The drug inclusion level depends on the milk replacer feeding rate. 1600g Oxytetracycline & 1600g Neomycin Sulfate per ton of finished milk replacer correlate to a feeding rate of 1.25 lb of milk replacer powder per calf per day (10 oz per feeding twice daily). To provide 10 mg/lb of body weight daily, different milk replacer feeding rates require different drug inclusion levels.

This antibiotic combination can be fed to calves up to 250 lb for treatment of bacterial enteritis caused by *E. coli* susceptible to Oxytetracycline; treatment and control of colibacillosis (bacterial enteritis) caused by *E. coli* susceptible to Neomycin; treatment and control of bacterial pneumonia (shipping fever complex) caused by *P. multocida* susceptible to Oxytetracycline. This inclusion level provides 1.0g Neomycin Sulfate and 1.0g Oxytetracycline per pound of finished milk replacer.

Feed continuously for 7-14 days. If symptoms persist after using for 2-3 days, consult a veterinarian. Continue treatment for 24 to 48 hours beyond remission of disease symptoms. A withdrawal period has not been established for use in pre-ruminating calves. Do not use in calves to be processed for veal. A milk discard time has not been established for use in lactating dairy cattle. Do not use in female dairy cattle 20 months of age of older. Withdraw 5 days before slaughter.

VFD Requirement:

Beginning January 1, 2017, to purchase and use any medically important antibiotic, including Oxytetracycline & Neomycin Sulfate, requires a Veterinary Feed Directive (VFD) or a prescription from a licensed veterinarian. This includes manufactured feeds containing the medication.

Anticoccidial Medications

Deccox, 45g/ton (to provide 22.7 g per 100 lb body weight daily)

- for the prevention of coccidiosis in ruminating and pre-ruminating calves, including veal calves, and cattle caused by *Eimeria bovis* and *Eimeria zuernii.* Deccox is a coccidiostat that stops coccidial growth. Deccox is known to inhibit the activity of the cell's mitochondria. Total oocyst reduction with Deccox is 98%.

Bovatec, 90g/ton (to provide 1 mg per 100 lb body weight daily)

- for control of coccidiosis caused by *Eimeria bovis* and *Eimeria zuernii*. Bovatec is also a coccidiostat. As an ionophore, Bovatec disrupts cell membrane function causing cations such as K^+, Na^+, Ca^+ and Mg^+ to be transported into the coccidial cell. These cations draw water into the cell, causing the coccidia to burst and die. Bovatec should not be fed to horses or dogs. Total oocyst reduction with Bovatec is 96%.

Deccox vs. Bovatec

Deccox (decoquinate) is a coccidiostat that stops the growth of coccidia, but does not actually kill coccidia. It works by inhibiting the activity of mitochondria inside the cell. This causes a disruption in energy production within the cell. Deccox provides the widest range of action of all the anticoccidial agents. Research has shown the total oocyst reduction with Deccox to be 98%.

Bovatec (lasalocid) is also a coccidiostat that kills coccidia. It is an ionophore that moves potassium, sodium, calcium and magnesium into the cell causing the cell to swell and burst. Bovatec works primarily on a single developmental stage of coccidia, providing a more narrow range of action than Deccox. Research has shown the total oocyst reduction with Bovatec to be 96%.

Conclusion: research studies evaluating the performance of both anticoccidial agents under the same conditions report similar levels of coccidia control.

The amount of anticoccidial product the calf needs is based on its body size. The amount included in the milk replacer is set for a 100 pound calf and is based on the feeding rate stated on the milk replacer tag. As the calf grows, the amount of medication it needs increases. So unless the volume of milk replacer consumed increases and keeps pace with calf growth, the amount of anticoccidial agent consumed will soon fall below the effective dose.

There is a simple way to deal with this issue. In addition to milk replacer, the calf begins to consume more and more starter feed as it grows. To assure the correct amount of drug is consumed for adequate control of coccidia, the same anticoccidial agent that is in the milk replacer should also be added to the starter feed. With the same product in both feed sources, the calf is assured of receiving adequate protection.

Other Additives

The following additives can be included in Milk Specialties milk replacer during manufacturing.

Organic Minerals	mineral chelates that enhance mineral absorption and improve bioavailability. Research with organic trace minerals shows improvements in production characteristics such as feed efficiency, growth, breeding, body composition and hoof integrity. Calf research shows better retention of minerals during stress and improved response to vaccines when organic minerals are fed.
MOS	yeast fraction of *Saccharomyces cerevisiae* rich in mannan-oligosaccharides (MOS) and B-glucans. MOS products bind major pathogens, reducing their ability to attach and grow in the gut. They help improve gain and feed efficiency and improve the immune response. Milk Specialties provides several MOS options.
DFM	live organisms that provide health benefits to the calf. Direct-fed microbials (DFM), stimulate a healthy gut environment by preventing bacterial pathogens from colonizing the intestine, by helping increase digestive capacity and improving immune function. Lactic acid bacteria grow in large numbers in the intestine where they promote the growth of beneficial bacteria, help maintain the integrity of the intestinal lining and support overall digestive function. Bacillus are hardy bacteria that have antimicrobial and antidiarrheal effects. They stimulate the immune system and help prevent intestinal inflammation. Milk Specialties provides several DFM options.
Essential Oils	plant extracts known for their antimicrobial activities. Certain essential oils have been shown to stimulate or enhance appetite.
Essential Fatty Acids	a blend of essential fatty acids to support the calf's immune system and promote weight gain, structural growth and feed efficiency
ClariFly	a larvicide that prevents adult house flies, stable flies, face flies, and horn flies from developing in and emerging from the manure of treated calves
Vitamin E	an antioxidant that helps protect cells and improve both cellular and humoral immune responses. Vitamin E supplementation of calves has been shown to increase dry matter intake and growth rate. Calves fed 125 or 250 IU/day of vitamin E gained significantly more body weight compared to nonsupplemented calves.

2 Milk Replacer Tags

CALVITA®
22/20 AM BOV
MEDICATED
All Milk Protein - Calf Milk Replacer
Dairy Herd and Dairy Beef Calf Milk Replacer
For the control of coccidiosis caused by *Eimeria bovis* and *Eimeria zuernii* in replacement calves.

ACTIVE DRUG INGREDIENT
Lasalocid (as lasalocid sodium) . . . . . 72.6 g/ton
WARNING: Withdrawal period has not been established for lasalocid in pre-ruminant calves. Do not use in calves to be processed for veal.
CAUTION: The safety of lasalocid in unapproved species has not been established. Do not allow horses or other equines access to feeds containing lasalocid as ingestion may be fatal.

GUARANTEED ANALYSIS

Crude Protein, not less than	22.00%
Crude Fat, not more than	20.00%
Crude Fiber, not more than	0.15%
Calcium, not less than	0.75%
Calcium, not more than	1.25%
Phosphorus, not less than	0.70%
Vitamin A, not less than	30,000 IU/lb
Vitamin D_3, not less than	10,000 IU/lb
Vitamin E, not less than	125 IU/lb

INGREDIENTS
Dried Whey, Dried Whey Protein Concentrate, Dried Whey Product, Animal and Vegetable Fat (Preserved with BHA and BHT), Dried Skimmed Milk, Lecithin, Dicalcium Phosphate, Calcium Carbonate, L-Lysine Monohydrochloride, DL - Methonine , Vitamin A Supplement, Vitamin D_3 Supplement, Vitamin E Supplement, Ascorbic Acid, Magnesium Oxide, Zinc Sulfate, Ferrous Sulfate, Niacin Supplement, Manganese Sulfate, Calcium Pantothenate, Vitamin B_{12} Supplement, Thiamine Mononitrate, Riboflavin Supplement, Biotin, Copper Sulfate, Pyridoxine Hydrochloride, Ethylenediamine Dihydrodiodide, Folic Acid, Choline Chloride, Cobalt Sulate, Selenium Yeast, Sodium Silico Aluminate, Mono and Diglycerides of Edible Fats or Oils, Artifical Flavor.

SEE FEEDING DIRECTIONS ON REVERSE SIDE
NET WEIGHT 50 LB (22.68 KG)
This product was made in a feed manufacturing facility that does not handle or store products containing animal proteins prohibited in ruminant feed.

Manufactured by:
MILK SPECIALTIES GLOBAL
800-323-4274
Eden Prairie, MN 55344
www.milkspecialtiesglobal.com
MADE IN THE U.S.A.
485823

Medicated
This indicates the product contains a medication and provides a statement about its use.

Active Drug Ingredients
Lists the name of the drug and its inclusion level in the milk replacer.
Warning & Caution Statements provide information about withdrawal periods and use limitations.

Guaranteed Analysis
Crude Protein
Protein provides the building blocks for tissue growth. The amount of protein provided is listed as a percentage. 20-22% is standard. 24% and above may indicate a milk replacer designed for a higher, more intensive feeding rate.

Crude Fat
Fat serves as an energy source in milk replacer. It also supplies essential fatty acids. Only high quality animal fats and/or vegetable oils should be present. 20% is standard. A lower level may indicate a milk replacer designed for higher, more intensive feeding rates. Higher fat levels are sometimes used when providing a little more energy is desirable.

Crude Fiber
Fiber is an indicator of protein quality. Milk, plasma, hydrolyzed wheat or soy protein isolate proteins result in 0.15% fiber or less. Fiber levels of 0.50% or more indicate the presence of lower quality proteins such as soy protein concentrate or soy flour.

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Crude Fiber, not more than	0.15%
Calcium, not less than	0.75%
Calcium, not more than	1.25%
Phosphorus, not less than	0.70%
Vitamin A, not less than	30,000 IU/lb
Vitamin D_3, not less than	10,000 IU/lb
Vitamin E, not less than	125 IU/lb

INGREDIENTS

Dried Whey, Dried Whey Protein Concentrate, Dried Whey Product, Animal and Vegetable Fat (Preserved with BHA and BHT), Dried Skimmed Milk, Lecithin, Dicalcium Phosphate, Calcium Carbonate, L-Lysine Monohydrochloride, DL - Methonine , Vitamin A Supplement, Vitamin D_3 Supplement, Vitamin E Supplement, Ascorbic Acid, Magnesium Oxide, Zinc Sulfate, Ferrous Sulfate, Niacin Supplement, Manganese Sulfate, Calcium Pantothenate, Vitamin B_{12} Supplement, Thiamine Mononitrate, Riboflavin Supplement, Biotin, Copper Sulfate, Pyridoxine Hydrochloride, Ethylenediamine Dihydrodiodide, Folic Acid, Choline Chloride, Cobalt Sulate, Selenium Yeast, Sodium Silico Aluminate, Mono and Diglycerides of Edible Fats or Oils, Artifical Flavor.

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Guaranteed Analysis (cont'd)

Minerals

Calcium is critical for skeletal development, blood clotting, and heart, muscle and nerve function. Phosphorus is found mainly in complex with calcium and is also involved in energy transformation. Typical supplementation is between a 1:1 and 2:1 calcium to phosphorus.

Vitamins

Vitamins A, D and E are essential for metabolism, growth, immune function, cell integrity and overall health of the calf. Vitamin A and D levels are typically set at 30,000 and 10,000 IU /lb, respectively. Vitamin E, on the other hand can be adjusted. Supplementing 125 to 250 IU/ day of vitamin E is related to increased body weight gain.

Ingredients

This list includes all ingredients used in the manufacture of the milk replacer. Careful inspection of this list is required to understand more about the quality of the product inside the bag. Major ingredients are typically listed first while vitamins, minerals and flavorings are listed last.

Feeding Instructions

Not all milk replacers are designed to be fed at the same rate. The Feeding Instructions provide the appropriate mixing and feeding instructions for the milk replacer.

3 Mixing & Feeding Milk Replacer

When it comes to mixing and feeding milk replacer to calves, there are a surprising number of issues than can arise, either from a mixing, feeding or animal performance standpoint. How milk replacer powder is measured, how it is mixed with water, as well as the amount and temperature at feeding time affect both the milk replacer and the calf.

Measuring. The only way to accurately measure milk replacer powder is to weigh it. That means using a scale. There are a variety of scales available from hanging to floor scales to fit any farm situation.

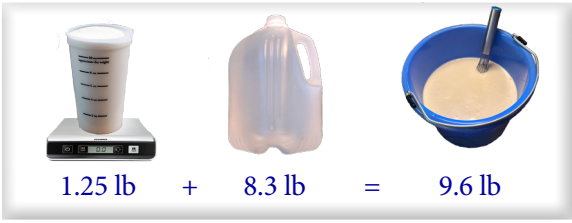
A cup or scoop is often included in the bag of milk replacer. This cup measures volume, not weight. Lines on the cup try to bridge the gap between weight and volume, but they only approximate the actual weight of the powder.

The density of milk replacer powder, or how much fits in a cup, can change a bit over time. Environmental and storage conditions can both have an effect. Who is doing the scooping and how they fill the cup affects the amount of powder being used. So it's worth repeating: ***the only way to accurately measure milk replacer powder is to weight it.***

Mixing. The mix rate listed on most milk replacer tags is 10 ounces of powder added to two quarts of water, or 1.25 pounds per gallon of water. When you add milk replacer powder to water, you'll notice the powder displaces some of the water and you end up with more liquid than what you started with. Adding 10 ounces of powder to 2 quarts of water results in almost 2.2 quarts of total mixed solution. When feeding with two quart bottles, fill the bottle all the way to the rim with milk replacer solution to get the right amount to the calf.

Solids. The concentration of powder in the milk replacer solution is referred to as the percent solids. With the standard mix rate, solids is 13%. Whole milk is about 12.5% solids.

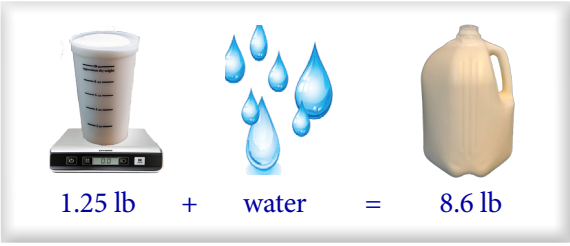
Calculating solids is easy to do and can be very helpful when evaluating a farm's feeding program. Adding 1.25 pounds of milk replacer powder to one gallon of water (which weighs about 8.3 pounds)



To determine the percentage of the solution that is milk replacer, divide the weight of the powder by the weight of the solution. Multiply the result by 100 to convert to a percentage:

$$(1.25 \text{ lb} \div 9.6 \text{ lb}) \times 100 = 13.0\%$$

There is another way to mix milk replacer powder with water. In this case, take the measured amount of powder, 1.25 pounds, and mix that with enough water to make a final mix of one gallon of solution. A gallon of milk weighs about 8.6 pounds.



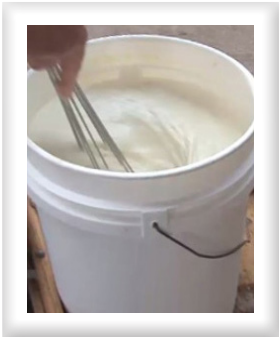
Divide the weight of the powder by the weight of the gallon of solution. Multiply by 100 to turn it into a percentage. In this case, solids is 14.5%. Mixing this way results in a more concentrated solution.

$$(1.25 \text{ lb} \div 8.6 \text{ lb}) \times 100 = 14.5\%$$

Although the upper solids limit is about 18%, some farms experience calf health issues above 15% solids. Staying between 13 and 15% minimizes problems. The higher the solids level, the more important it is to ensure calves have access to clean water at all times. As solids level increases, calves put more water into their digestive tract to dilute the solution. Without access to additional water, calves will move more water from their bloodstream into their digestive tract which can ultimately lead to dehydration and/or diarrhea.

Mixing & Mixing Equipment. When mixing milk replacer, it's best to add the powder to the water, not the other way around. If you add the powder first, you may find that some of it sticks to the bottom of the bucket when you begin mixing, especially around the bottom edge, which can be pretty hard to get to.

When mixing by hand, using a wire whisk is an excellent way to ensure complete mixing. Whisks are designed for this function and come in many sizes.

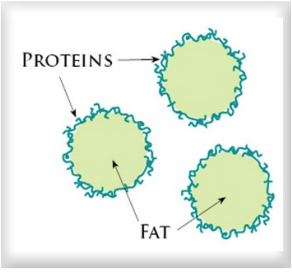


Some farms like to add power to the mixing process. A simple approach is to use a variable speed drill with a paint mixer attachment. This can work well, especially when mixing in 5 gallon buckets, but power tools in the hands of a young inexperienced calf feeder can lead to injuries. Power mixers can be a good choice when mixing larger batches of milk replacer. Mixers can be stationary or portable like the one shown below.

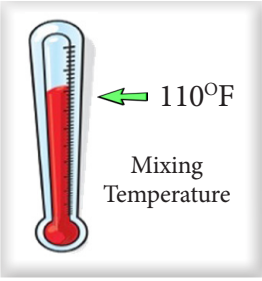
One technique that has been gaining popularity is the automatic calf feeder. This is a computerized system, primarily for group housed calves that automates the processes of measuring, mixing and feeding milk replacer. Routine calibration should be performed to ensure water and milk replacer powder are are mixed and offered consistently at every feeding.

Although this is a very interesting approach to calf feeding and management, these systems are beyond the scope of this discussion.

Solubility is an important aspect of how well milk replacer powder mixes with water. Ingredients such as fat are not soluble in water. To overcome this challenge, Milk Specialties creates a particle that has fat on the inside (the insoluble portion) and proteins (which are very soluble) on the outside. This process, called encapsulation, allows the protein-coated fat to go into solution.

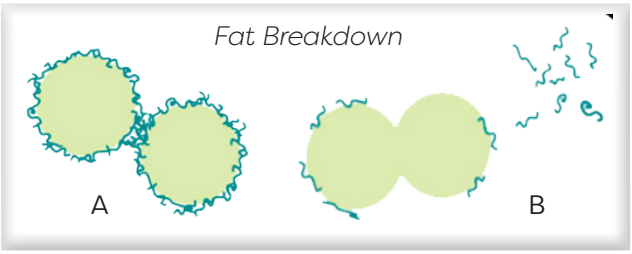


Water temperature also effects how much milk replacer powder will go into solution. Avoid the temptation to measure water temperature with your fingers. It may be quick, but it can be very inaccurate. Cool water feels pretty warm to hands that have been working outside on a cold day. So use an actual thermometer.



The best temperature for mixing milk replacer is 110°F. If the water is too cold, it's more difficult for many milk replacer ingredients to fully mix into solution, and may actually decrease digestibility.

It's also possible to mix in water that's too hot. Mixing in excessively hot water can make the proteins that coat the fat stick to each other, causing fat particles to clump together (see A, below). Another outcome of using water that's too hot is that proteins may migrate away from the fat droplets (B).



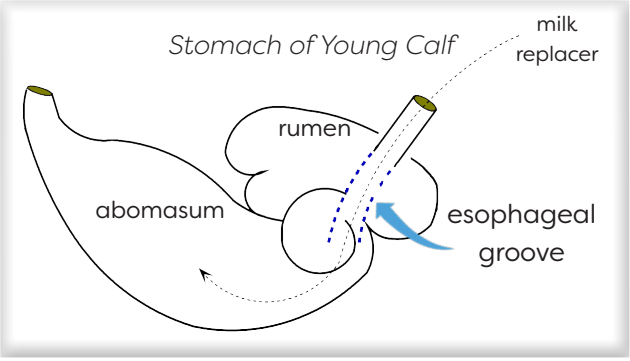
Without their protein coat, these fat droplets are no longer soluble in water. This often results in a greasy film being deposited on mixing and feeding equipment.

Feeding. Milk replacer should be cooled from 110° at mixing down to 102° for feeding, which is right around the calf's body temperature.

Calves are not fond of drinking excessively warm milk replacer and may drink more slowly or may not drink all of it if the temperature is too warm. If the milk replacer is cold, the calf will warm it up to its own body temperature after it's consumed. And that takes energy. Using energy to warm up milk inside the calf means less energy going toward growth and maintaining health. This can become a serious situation for younger calves during cold weather.

Feeding colder milk replacer can slow the rate at which the calf drinks and can reduce its desire to drink. Cold feeding is a technique that's used to slow down and reduce intake in calves that have continuous access to milk replacer to prevent over-eating. So unless that's the objective, milk replacer should be fed at or very close to the calf's body temperature.

Feeding the milk replacer at the proper temperature is also related to closure of the esophageal groove.



The esophageal groove is a muscular fold at the end of the esophagus that closes when stimulated, and funnels milk directly into the abomasum. This prevents it from dropping into the rumen and souring or becoming fermented.

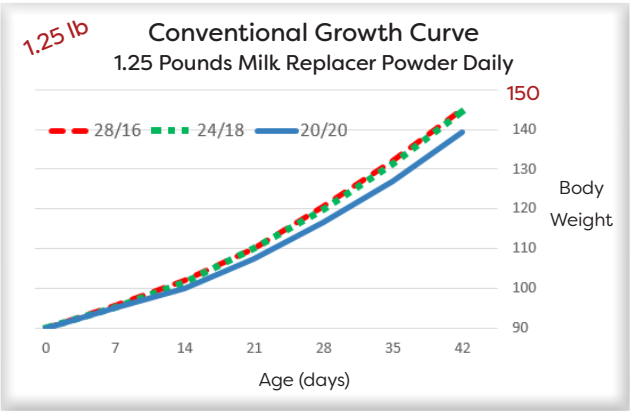
A thermometer is a must-have tool to monitor what's going on and to help develop procedures that ensure milk replacer is fed at the right temperature.

4 Formulation and Feeding Rate

Protein and fat are primary components of any milk replacer. Their percentages, which are listed on the product tag, indicate how the milk replacer is to be fed. In other words, protein and fat levels are related to the feeding rate. Growth and body composition goals are key factors in selecting the appropriate milk replacer.

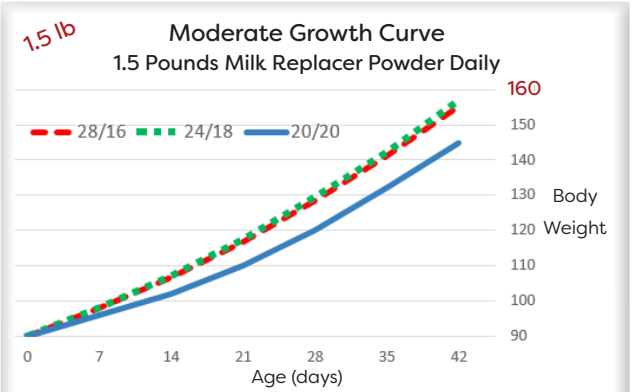
A milk replacer formulated with 20% protein and 20% fat (a 20/20 milk replacer) is generally fed at a rate of 1.25 pounds of powder per day. As the feeding rate increases, the total amount of protein consumed is not enough to convert all that energy to lean gain. The excess energy is converted to body fat rather than structural growth.

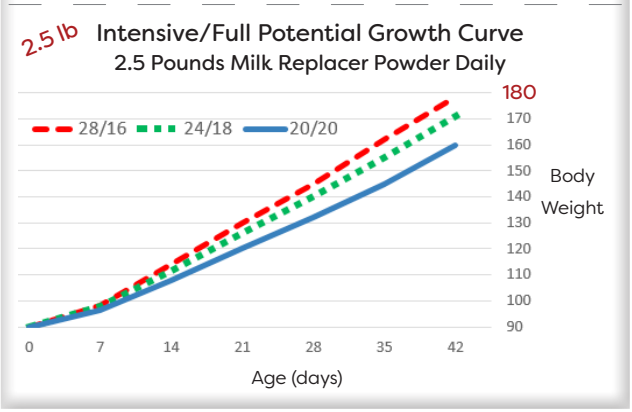
The following graphs compare the growth rates of calves fed three different milk replacer formulations fed at three different feeding rates. In the first example, calves are fed 1.25 pounds of milk replacer powder each day and consume a modest amount of starter feed. Starter quality and access to fresh water have a substantial impact on actual calf growth.



The 24/18 and 28/16 calves, represented by the green and red lines, have almost identical growth curves. The 20/20 calves are not far off -- about 5 pounds less than the higher protein formulas. Considering the cost of additional protein in the formulas, the 20/20 formula is more cost effective when feeding at the 1.25 pound feeding rate.

When feeding 1.5 pounds of powder per day, the 20/20 calves lag behind calves on the other two formulas by over 10 pounds, with the 24/18 formula being the most cost effective. At the 2.5 pound feeding rate, the 28/16 formula provides the best result.





Match Milk Replacer With Growth Objectives

Growth Objective	Milk Replacer	Feed Rate
Conventional/Standard	20/20, 22/20	1.25 lbs/day
Moderate	24-26/15-20	1.50 lbs/day
Intensive/Full Potential	26-28/15-18	2.0-2.5 lbs/day

5 Cold Weather Feeding Strategies

Winter time can put a lot of stress on calves. Cold temperatures mean extra demands on the calf to stay warm and to grow. But there are a number of adjustments you can make to your calf feeding program to support and protect calves as the temperaure drops.

The calf's heat production remains steady at temperatures between 50° and 78°F. For newborn calves, the lower temperature is closer to 60°F. Below this temperature, the calf uses additional energy to produce heat. Adding other stressors such as wind or precipitation will intensify the calf's response to changing temperatures.

From a physiological standpoint, the young calf is not very well equipped to handle environmental stresses:

Characteristics of the Young Calf

- thin hair coat, can't trap much body heat, poor air insulation layer
- born with precious little body fat, not much energy reserve
- very large surface area relative to body size, difficult to retain body heat
- temperature control mechanisms are not as well developed as mature animals

Cold affects a calf's need for energy**.** During cold weather, the calf needs additional energy to produce heat just to stay warm. A general rule of thumb says "for each degree the temperature drops below 50°F, the calf needs at least 1% more energy".

Additional Energy Required As Temperature Drops

Temperature drops from 50° to 32°F

20-25% more energy

Temperature drops below 10°F

40-50% more energy

Feeding Strategy 1: Feed more milk replacer.
Option A. The easiest way to do this is to feed more at each feeding. If you feed 2 quarts twice a day, adding another pint at each feeding increases the energy the calf consumes by 25%. Feeding another quart at each feeding increases energy by 50%. Choose a level that matches the energy demands in your area.

Option B. The second option is to add another feeding. Adding a third feeding evens out nutrient intake over the course of the day and provides another opportunity for additional feed management. Sufficient water intake is critical for starter intake and calf growth. The water in milk replacer won't get the job done. Making another visit to the calf facility each day helps assure that calves have adequate drinking water especially in climates where water freezes quickly.

Feeding Strategy 2. Use an energy supplement.
Another option to consider is to use a high energy supplement. Milk Energizer is made from the same fat used in calf milk replacers. Adding one to four ounces of Milk Energizer to each calf's milk replacer is a quick, simple and economical way of adjusting energy intake to fit local conditions.

Keep in mind that a high energy supplement is primarily a source of additional fat. If wintertime for you means large adjustments to the calf's energy

intake, you might do better feeding more milk replacer rather than using an energy supplement. Milk replacer provides a balance of protein, carbohydrates and fat to support growth as well as additional energy for the calf.

Feeding Strategy 3. There is another approach to winter feeding that's sometimes used, and that is to increase the concentration of milk replacer powder in water above the normal rate. Keep in mind that the additional powder may not meet the calf's increased demand for energy if the winter temperature drops substantially.

If you choose this option, use caution. Calves don't respond well to rapid changes in milk replacer concentration. As the concentration increases, the calf moves more water from its body into its digestive tract as a way of diluting the solution. If the concentration gets too high, the calf may not be able to pull all of that water back out. This can cause scours, dehydration and other digestive problems.

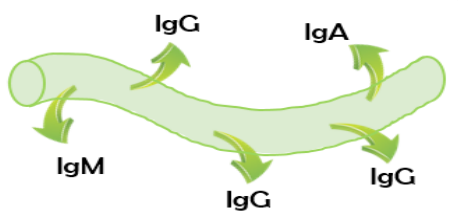
A critical part of feeding a higher concentration of solids is availability of water. Calves will have a greater need for water, so be sure they have access to drinking water. If you are not willing to address the issue of frozen water during wintertime, it's best to steer clear of this option.

Calves are creatures of habit and do best when you are consistent. Rather than trying to match feed intake with daily fluctuations in temperature, calves may be better served by making seasonal adjustments to the feeding program. There may be days when you need to provide a little extra, but large quick swings in intake or types of nutrients should be avoided.

6 Tips For Raising a Healthy Calf

Following good management practices is important for raising a healthy calf. This final chapter provides guidelines for key calf management areas. Feeding high quality colostrum is critical for protecting the calf from disease challenges. A high quality milk replacer feeding program, equipment cleaning and sanitation, access to high quality starter feed and water to promote rumen development and a weaning process that minimizes stress provide the calf with great start in life.

Feeding Colostrum. Colostrum is the first milk produced by the cow after calving. It is high in protein, fat, vitamins, minerals and immunoglobulins (Ig), or antibodies. The protection a young calf has against disease challenges comes from colostrum. Since a calf's ability to absorb immunoglobulins decreases rapidly after birth, it should consume colostrum as soon as possible - within two hours of birth is best.



Immunoglobulins are absorbed intact during the first 12-24 hours after birth. Absorption rate decreaes rapidly.

To provide an adequate level of immunoglobulins and other key nutrients, the calf needs four quarts of colostrum at this first feeding. Use a refractometer or colostrometer to measure colostrum quality. If using a colostrum replacer, provide 150-200g of IgG for adequate protection.

During the first two weeks of life, the calf cycles some of the immunoglobulins it absorbed from colostrum back into its digestive tract. This provides antibodies to help protect the calf from pathogens and support digestive functions. The more immunoglobulins the calf absorbs from colostrum, the more it cycles back into its digestive tract.

Milk Replacer. Begin feeding milk replacer as soon as colostrum feeding has ended. Calves should receive a minimum of 1.25 pounds of milk replacer powder per day. When feeding twice-a-day, calves receive 10 ounces of powder mixed with 2 quarts of water at each feeding.

Increasing milk replacer feeding rate increases rate of gain and decreases the likelihood of calf health issues. At higher milk replacer feeding rates, better gain with less body fat build up can be achieved by increasing milk replacer protein and decreasing fat percentages. When feeding higher levels of milk replacer powder, it's best to feed more reconstituted milk replacer than increasing the concentration of powder in water. Feed more at each feeding or add another feeding each day.

Cleaning and sanitizing feeding equipment is critical to prevent the spread of disease. Bottles, nipples, pails and other equipment used in milk feeding must first be cleaned to remove dirt, manure, milk and other substances. Next, the biofilm, which is made up of fat, protein and carbohydrates must be removed to prevent pathogens from becoming embedded on the equipment. Equipment should be sanitized before use. Good practices include:

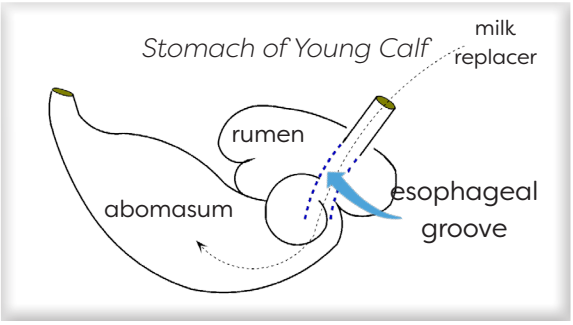
- warm rinse
- hot water soak (≥140°F) in chlorinated detergent
- vigorous wash for 1-2 minutes
- cold water rinse
- second rinse with acid solution
- thorough drying
- sanitize equipment within 2 hours before use

Starter Feed. Offer starter feed to calves each day once calves are drinking milk replacer. Begin by offering small amounts of starter, cleaning out any left over each day to ensure the calf has continual access to fresh starter. The most important components of a good quality starter feed are cereal grains. They provide texture and contain high levels of fermentable carbohydrates, providing a readily available energy source. The end products of grain digestion stimulate rumen papillae growth. Starter protein should be about 19-20%, but may need to be higher to support weight gain with high growth feeding programs.

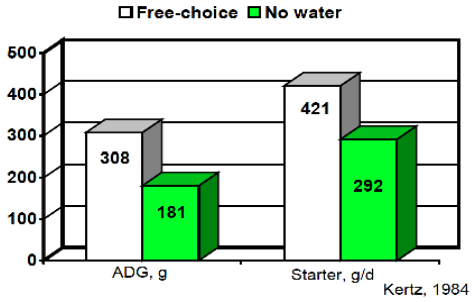
Hay does not have a major beneficial effect on rumen growth. Its presence in the diet reduces energy density, takes up space in the digestive tract, retards rumen development and tends to increase the time to weaning. Hay should generally be reserved as an after weaning feed, after the calf has fully transitioned to its new diet and new environment, when it is important to develop rumen musculature.

Water. Fresh, clean water is critical for successful rumen development and should be made available as soon as the calf begins drinking milk replacer. Bacteria must be present in the rumen for rumen development to occur. Since the calf is born without rumen bacteria, it must build the bacterial population over time. Bacteria live and growth in a water environment, making water consumption critical for this process.

The water contained in milk replacer does not contribute to water in the rumen. Additional water must be fed separately from milk replacer for water to enter the rumen.. When milk or milk replacer is fed, muscles in the esophagus contract, forming a groove that prevents the liquid from entering the rumen. This esophageal groove carries the liquid past the rumen and delivers it directly to the abomasum (the true stomach).



Since the groove remains for up to 10 minutes after feeding milk replacer, water should be fed later, after the groove opens in order for water to enter the rumen. Research shows that calves receiving free choice water had 127g higher average daily gain compared to calves receiving no additional water. Starter intake was 129g per day more for the calves receiving free-choice water.



Weaning. A calf can be weaned when its rumen is sufficiently developed to support the calf without supplemental milk replacer feeding. The best measure of rumen development is feed intake. A calf can easily be weaned when it is consuming 3 pounds of starter feed per day. The calf should be eating starter at this level for at least three consecutive days prior to beginning the weaning process.

To minimize stress on the calf, reduce the amount of milk replacer fed at each feeding by 1/2. Feed half the normal feeding rate for at least 3 days. Do not skip meals. If the calf is still eating at least 3 pounds of starter each day after three days, milk replacer can be removed completely from the calf's diet.

Calves should remain on their current starter feed and in their current location for at least a week after weaning to help reduce stress and to keep a close eye on the calf's eating behavior. Hay can be added to the diet after this time.

Big changes such as large dietary adjustments, grouping calves into pens, dehorning and vaccinations should not occur all at once. Large changes should be make separately in order to minimize stress and susceptibility to disease challenges.