Babcock Institute for International Dairy Research and Development

University of Wisconsin-Madison

Dairy Essentials

HEIFER RAISING—BIRTH TO WEANING
29) FEEDING MILK AND MILK REPLACERS

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THE STOMACHS OF A NEWBORN CALF

The digestive system of a calf is not fully developed at birth but undergoes drastic development during the first few months of life. At birth, the digestive system of a calf functions as that of a single-stomached animal. The abomasum is the only stomach fully developed and functional (Figure 1). As a result, only liquid feed can be utilized effectively by pre-ruminant calves a few days old.

Milk digestion by calves

Milk is digested primarily by acids and enzymes produced in the abomasum. When whole milk enters the abomasum, it forms a curd. Curd formation results from the coagulation of milk protein, or casein, under the action of two enzymes, rennin and pepsin, and by a strong acid, hydrochloric acid. Milk fat, water and minerals are also trapped in the curd that is retained in the abomasum for digestion.

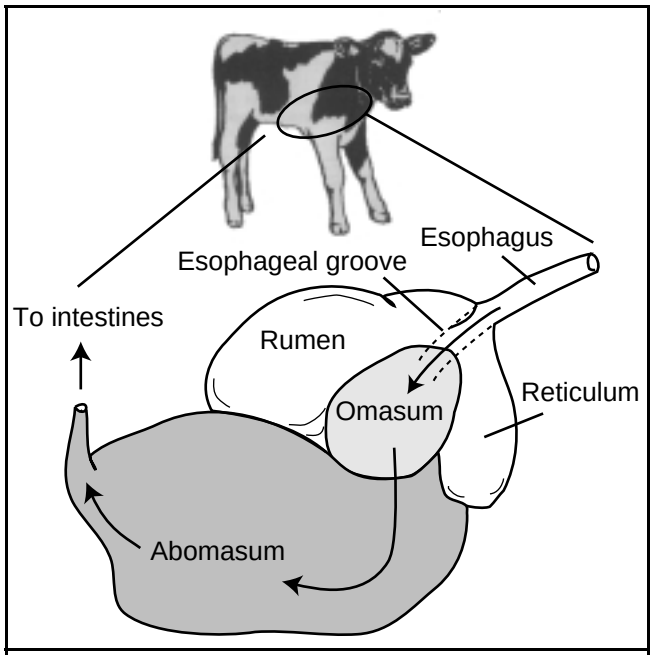


Figure 1: Stomach of a newborn calf

Other milk components, primarily whey proteins, lactose and most minerals separate from the curd and pass into the small intestine rapidly (as much as 200 ml per hour). The lactose is digested quickly and, in contrast to casein and fat, provides immediate energy to the calf.

A few years ago, researchers believed that curd formation had to take place in the abomasum to obtain good protein digestion. Proteins in milk replacers that did not form a firm curd were considered unsatisfactory. However, recent works indicate that despite the lack of clotting ability and curd formation, certain protein sources in milk replacers may produce satisfactory growth rate of calves.

GOALS OF FEEDING BEFORE WEANING

In raising dairy heifers, the major goals for feeding before weaning are to:

- Raise healthy calves;
- Obtain adequate skeletal growth;
- Avoid retarding rumen development by feeding large amounts of milk for a long time.

Good health is more important than rapid growth in calves fed milk or a milk replacer. Actually, rapid growth rates

cannot be achieved with liquid diets (body weight gain of 250-400 g/day). After weaning, muscle and adipose growth may occur at a much faster rate (body weight gain of 700-900 g/day).

FEEDING MILK TO HEIFERS

After colostrum and transitional milk, the calf should be offered milk that has the highest nutritional value to allow satisfactory growth for the lowest price. The following factors are important when feeding milk to young calves:

- Type of milk offered;
- Meal size;
- Frequency of feeding;
- Method of feeding;
- Milk temperature.

In addition, the health of the calf is better protected when a few basic hygienic rules are followed:

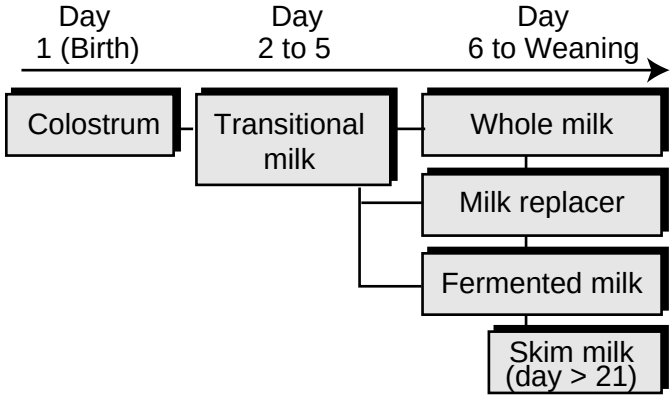
- Clothing (including shoes) and hands of the person preparing and feeding milk must be clean;
- Equipment used to store, prepare and feed milk must be thoroughly cleaned and dried between each use.

How much milk should be fed per day?

A good rule of thumb is to feed 1 kg of milk per day for each 10 to 12 kg of body weight at birth. In other words, a calf should receive 8 to 10% of its body weight at birth as milk every day (2.5 kg of milk for a 25 kg calf, 3.5 kg milk for a 35 kg calf, etc.). Calves should be fed the same amount of milk until they are weaned. As calves grow, they can utilize larger amounts of milk. However, by limiting milk consumption, calves are encouraged to consume solid feed at an early age.

Frequency of feeding

Preferably, milk should be offered in two equal meals per day, each 4 to 5% of body weight. When the amount of milk needed per day is offered in one meal, the capacity of the abomasum is exceeded and excess milk flows back into the rumen where it may cause digestive upset (e.g., bloating). Once a day feeding is successful only under very strict and skillful management control. Under most conditions, once a day feeding leads to increased frequency of diarrhea and other health problems.



Body weight	Amounts to feed	Number of meals
25 kg heifer	1.25 kg/meal	2 meals per day
30 kg heifer	1.50 kg/meal	2 meals per day
35 kg heifer	1.75 kg/meal	2 meals per day
40 kg heifer	2.00 kg/meal	2 meals per day
45 kg heifer	2.25 kg/meal	2 meals per day

Figure 2: Liquid feeding program for dairy calves

Method of feeding: Pail feeding or nipple feeding

Nipple feeding forces the calf to drink slowly and reduces the risk of diarrhea and other digestive disturbances. However, the benefits of nipple feeding may be lost if strict equipment hygiene is not maintained.

A calf can be taught how to drink from a bucket within a few days after birth. This technique is easy, rapid and requires little cleaning work.

Milk temperature

It is particularly important to control milk temperature during the first few weeks after birth. Cold milk leads to more digestive upset than warm milk. During the first week after birth, milk should be fed at body temperature (39°C), but lower temperatures are acceptable for older calves (25-30°C).

Figure 3: Measuring the amount of milk, feeding with a nipple bottle or bucket and adjusting the milk temperature are important aspects of feeding a calf well.

Type of milk that can be fed

Not all milk produced on the farm can be sold, but calves can make use of most milk that is unacceptable for commercial use. The various kinds of milk available at the farm to feed young calves may include:

1) Extra available colostrum;
2) Extra transitional milk;
3) Unsaleable milk (mastitic milk or milk containing antibiotics);
4) Skim milk or other by-products derived from on-farm processing;
5) Whole milk.

Fermented milk

Colostrum, transitional milk or whole milk stored at room temperature (less than 21°C) will ferment. During storage, fermentation transforms lactose to lactic acid, the product becomes acidified and may be preserved for several weeks.

Compared to whole milk, the average daily gain of calves is slightly decreased when a well-prepared fermented milk is fed. However, poorly managed fermented milk is likely to be less palatable than fresh whole milk and may lead to a reduction in average body weight gain.

Whole milk

Whole milk can be fed until weaning, after colostrum and transitional milk feeding phases. Limited amounts of whole milk supplemented with a good grain starter is an excellent feed combination for dairy calves. Growth performance obtained with whole milk and a grain starter is often considered the standard to evaluate other products or feeding management techniques.

Mastitic milk

Mastitic milk or milk from cows treated for mastitis can be fed to calves as long as contact between calves is not allowed for at least 30 minutes after feeding. This recommendation is to prevent bacteria causing diarrhea (*Escherichia coli*) or pneumonia (*Pasteurella*) and other infectious agents from being transmitted from calf to calf. The milk of cows treated for mastitis may contain a large number of pathogenic bacteria that may increase the risk of health problems. In addition, the use of milk containing antibiotic residues may lead to the selection of resistant bacteria. As a result, antibiotic treatments may become less effective over time.

Skim milk

Skim milk is relatively high in protein, but contains less energy (50%) and fat soluble vitamins (vitamin A and vitamin D) than whole milk because the fat has been removed.

Skim milk should be used only when calves are eating significant amounts of a good grain starter, usually at three weeks of age. Consumption of a grain starter is important to provide energy and vitamins that are lacking in skim milk. Feeding skim milk to calves in cold housing during a cold winter should be discouraged as calves actually need additional energy to protect themselves against low temperatures.

Milk replacer

Calves may receive a milk replacer beginning at 4-6 days of age. Replacers usually contain less fat and thus less energy (75% to 86%) than whole milk on a dry matter basis. Calves fed milk replacer usually gain slightly less body weight per day than calves fed whole milk.

The reputation of the manufacturer, the chemical analysis and the list of ingredients used in a milk replacer are important parameters to assess its quality prior to purchase. The recommended composition for milk replacer is shown in Table 1. Protein content should be at least 22%. A higher content of fat (ether extract) than the minimum presented in Table 1 may have beneficial effects as it:

- Reduces the severity of diarrhea when it occurs;
- Provides additional energy when calves are raised in cold environments (temperate regions and high altitudes).

The preferred ingredients in milk replacer are derived from whole milk. Whey protein, concentrated fish proteins or soy proteins may be acceptable ingredients, but other products such as fish meal, soy flours, single cell proteins and distillers soluble (a by-product of cereal grain fermentation in distilleries) are not well accepted or well utilized by calves.

When using milk replacer, the manufacturer's instructions regarding dilution rate should be followed carefully.

Table 1: Recommended nutrient concentration of milk replacer (NRC, 1989)

Nutrient	Amount
Metabolizable energy, Mcal / kg	**3.78**
Crude protein, %	**22.0**
Ether extract (lipids), min. %	**10.0**[1]
Macro minerals	
Calcium - Ca, %	**0.70**
Phosphorus - P, %	**0.60**
Magnesium - Mg, %	**0.07**
Potassium - K, %	**0.65**
Sodium - Na, %	**0.10**
Chloride - Cl, %	**0.20**
Sulfur - S, %	**0.29**
Micro minerals	
Iron - Fe, ppm (or mg / kg)	**100.0**
Cobalt - Co, ppm	**0.10**
Copper - Cu, ppm	**10.0**
Manganese - Mn, ppm	**40.0**
Zinc - Zn, ppm	**40.0**
Iodine - I, ppm	**0.25**
Selenium - Se, ppm	**0.30**
Vitamins	
Vitamin A, IU[2] / kg	**3800.0**
Vitamin D, IU / kg	**600.0**
Vitamin E, IU / kg	**40.0**[3]

[1] In warm weather, should be at least 15%; in cold weather, 20%

[2] IU = International Unit

[3] Preferably 200 IU / kg to enhance the function of the immune system

Most milk replacers should be mixed using one part milk for seven parts water to obtain a product with a solid content similar to whole milk (12.5%).