Section 3

The **Liquid Diet**

Introduction

The primary goal of the rearing phase is to double the birth weight of the calf by 56 days of age. Good nutrition is fundamental to animal health, welfare and productivity. The liquid diets available for calf feeding are colostrum, transition milk, whole milk and milk replacer. Colostrum must be given for the first feed followed by transition milk for the first two to four days of life.

1. **What is transition milk?**
2. **What should follow the transition milk feeding phase?**
3. **How much milk does a calf need?**
4. **What is meant by 'waste milk'?**
5. **What factors contribute to the microbial load in milk?**
6. **What affect does pasteurisation have on milk fed to calves?**
7. **Do antibiotic residues in milk affect calf performance?**

The Liquid Diet

1 What is transition milk?

Transition milk is the milk following colostrum, i.e. milkings two to eight. This milk is non-saleable and is commonly given to calves for the first few days of life.

2 What should follow the transition milk feeding phase?

The type of liquid feed given to calves following colostrum and transition milk feeding depends on the farm targets, milk price, milk availability, disease status of the farm and labour availability.

Whole milk is the natural follow-on liquid and can be offered until the calf is seven to 14 days of age. The calf is then usually changed over to milk replacer. If available, farmers may choose to feed whole milk to calves until weaning. Calves can also be moved straight to milk replacer following transition milk feeding.

If available, whole milk can be fed to calves up to weaning.

3 How much milk does a calf need?

- At least four feeds of transition milk. This can improve calf health.
- Calves require 10-13% of their birth bodyweight in milk for the first week, and this rises to 13-15% of their birth bodyweight in milk thereafter (e.g. six litres for a 40kg calf).
- Calves fed 15% of BW in milk:
    - Achieve heavier weights at both the end and beginning of the pre-weaning phase.
    - Reach weaning weights earlier.

Liquid feeds	
Colostrum	Must be fed to the calf. Three litres within first two hours of life.
Transition milk	Milk that follows colostrum, 2nd to 8th milking. Calf should receive four feeds. Contains higher levels of antibodies compared to whole milk. Must be stored correctly to minimise bacterial count.
Whole milk	Natural follow on diet for calves. Feeding high levels during the milk feeding phase can increase growth rates. Consistency of whole milk can vary and, where hygiene is poor, bacterial growth can be an issue.
Milk Replacer (MR)	Milk replacer provides increased biosecurity to a farm, especially where Johne's disease is a problem. It is essential that MR is fed and mixed correctly in order to avoid health issues and inferior growth.
Waste milk	Waste milk is often used on farms to feed calves. However it can contain a high bacterial load.

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4 What is meant by 'waste milk'?

Waste milk is milk produced by dairy cows that is unsaleable due to insufficient quality (i.e. mastitis) or due to the presence of antibiotic residues. Waste milk is sometimes fed to calves rather than being discarded.

5 What factors contribute to the microbial load in milk?

The microbial load in milk is a function of several factors including:

- The natural microbial content of milk produced by the cow.
- The cleanliness of the equipment used to collect the milk.
- The cleanliness of the equipment used to store the milk before feeding.
- Storage time (time from collection to feeding).
- Temperature during storage.
- Exposure to microbial sources (faeces, flies, etc.) in the environment.
- Pasteurisation.

Organisms such as *Streptococcus, Staphylococcus,* Enterobacter, *E.coli, Listeria, Salmonella,* BVD and BIV have all been identified in milk.

If milk is stored at, or above, room temperature the microbial content increases. This can be problematic if milk collected at morning milking is not fed until the afternoon. This increases the microbial load dramatically and poses a disease threat to calves.

6 What affect does pasteurisation have on milk fed to calves?

Pasteurisation is an effective means of reducing the microbial load of milk and improving overall milk quality. Some benefits of pasteurising milk include higher mean bodyweight gain, reduced mortality and decreased veterinary costs. However, although pasteurisation reduces the microbial load, it is not sterilization and a heavy bacterial load in milk will not be completely eliminated by the process. In addition, it does not remove potential antibiotic contamination. The costs of collecting milk, pasteurising and storing milk before and after pasteurisation must be evaluated before a producer considers installing pasteurisation equipment.

7 Do antibiotic residues in milk affect calf performance?

Milk containing antibiotic residues can be unpalatable with high rejection rates by calves. This results in poor calf growth. In addition, faecal *E.coli* samples monitored for antibiotic resistance have been found to be significantly higher in calves fed milk containing antibiotics than saleable milk from the bulk tank, whether it was pasteurised or not.

Section 3

Milk
Feeding Systems

Introduction

Pre-weaning nutrition affects calves' growth rates, health and the ability to cope with cold stress. Young animals have the ability to convert feed into growth most efficiently during the first two months of life. Whole milk and milk replacer can be offered to calves once a day, twice a day, through an automated computerised system or *ad lib*. The system chosen depends on the type of calf housing, the labour available and the number of calves to be reared.

1. **What are the different milk feeding systems for artificially rearing calves?**
2. **Once-a-day v twice-a-day feeding.**
3. **What are the advantages of once-a-day milk feeding calves?**
4. **Can whole milk be fed *ad lib*?**
5. **Checklist for *ad lib* feeding.**
6. **What are the benefits of acidifying whole milk?**
7. **Should milk be fed warm to calves?**

Milk
Feeding Systems

1 What are the different milk feeding systems for artificially rearing calves?

Milk feeding system*	Brief description
Once-a-day feeding	Calves are fed once daily which reduces labour. Calves must be at least four weeks of age before starting to feed milk once-a-day.
Twice-a-day feeding	Calves fed twice during a 24 hour period. More labour intensive but allows for good calf supervision.
Computerised/ automated feeding	Calves fed little and often over a 24 hour period. Fed according to pre-programmed feeding curve. Good calf housing is essential.
Ad lib feeding	Calves fed *ad lib* (warm/cold), with access to milk 24 hours a day. Maximises early growth but reduces starter intake.

**MR concentration for each feeding system should be as directed by the manufacturer.*

2 Once-a-day v twice-a-day feeding.

Under EU law, calves must be fed twice-a-day. The abomasum of a newborn calf is not large enough to deal with the recommended volume of milk if it is given in one feed. Therefore milk should be fed twice-a-day at the start.
When a calf is consuming concentrates and its rumen is sufficiently developed, one of these daily feeds can be a dry feed in the form of calf starter.

From four weeks of age, studies show that cold whole milk or milk replacer can be fed once-a-day with no difference in weight gain or scour incidence. However, calves must remain being checked thoroughly twice daily and fed concentrate at an alternative time to milk feeding e.g. feed milk in the morning and concentrate in the evening.

After four weeks of age, once-a-day feeding can be implemented with no detriment to calf liveweight gain.

3 What are the advantages of once-a-day milk feeding calves?

- Labour saving (can reduce labour requirement by up to 25%).
- Higher dry feed intakes at an earlier age.
- Early rumen development.
- Up to two weeks earlier weaning.
- Less water used; drier beds, lower humidity and less pneumonia.

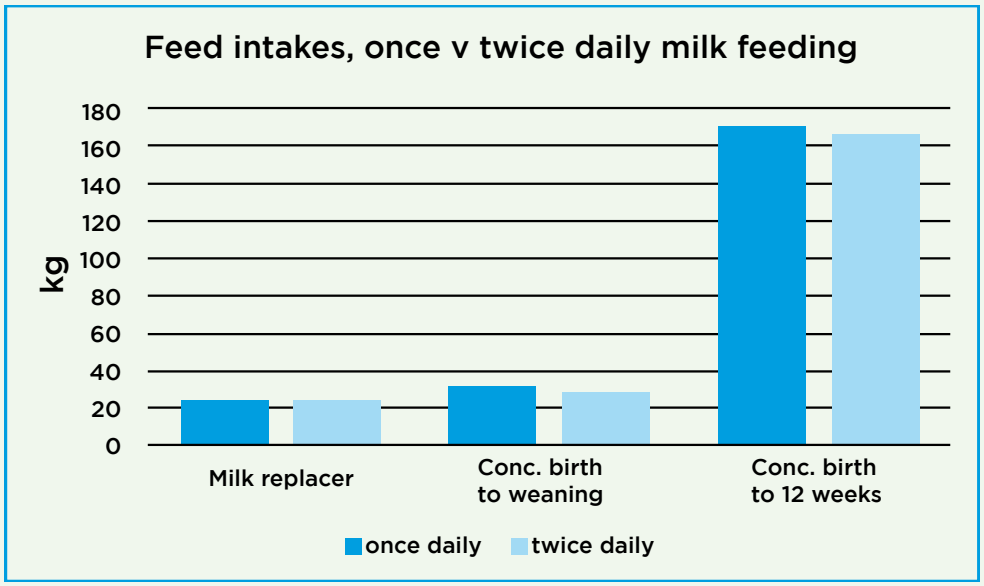


Figure 1. Effect of once versus twice daily milk feeding on calf milk replacer and concentrate intake.

4 Can whole milk be fed *ad lib?*

Whole milk can be offered warm and *ad lib* from specially designed automatic feeders, similar to those which dispense milk replacer. Whole milk can also be *ad lib* fed cold (ambient temperature) to calves. This involves filling a plastic container (e.g. dustbin) and allowing the calves to drink from a teat via a plastic tube.

Ad lib feeding from teats allows calves to determine their own intake patterns while also improving performance compared to conventional twice-a-day bucket feeding. However, *ad lib* feeding can increase the amount of calf care time required compared to once or twice daily feeding (Table 1). *Ad lib* feeding must be restricted prior to weaning to encourage calf starter intake.

Table 1. The effect of feeding system on calf weight at 77 days and total calf care time.

	Automatic Feeder	Once daily with teats	Twice daily with teats	Twice daily with trough
Total calf care time, incl. vet time (seconds/calf/day)	38	23	36	27
Calf weight at 77 days (kg)	95.0	94.8	93.2	90.5

Milk
Feeding Systems

5 Checklist for *ad lib* feeding.

- Calves must be trained to drink from a teat using a teated bucket.
- Attention must be given to how milk is transported from the bulk tank.
- Equipment used to store, transport and feed milk must be cleaned daily.
- Fresh milk must never be added to old/stale milk.

KEY POINT:

Once/twice-a-day milk feeding	• Once- or twice-daily feedings produce the same weight gain, nutritional status and metabolic stress. • Some farmers start feeding twice-a-day then drop to once-daily feeding of older calves. This allows for close observation of newborn calves.
***Ad lib* automated feeding**	• Provides set amounts of milk at a rate dictated by the calf which mimics the natural feeding behaviour of a calf suckling a cow. • Properly managed systems help reduce scours. • Reduces the need for additional labour.

6 What are the benefits of acidifying whole milk?

The addition of organic acid (and salt) combinations to whole milk to make the milk more acidic (pH 5.9 instead of 6.5) can be beneficial in calf rearing. The practice enhances the acid conditions in the calf's stomach and is effective in:

1. Slowing down the multiplication of *E.coli* scour causing bacteria.
2. Favouring digestive enzyme activity.
3. Encouraging more rapid clotting of milk, which in turn improves nutrient utilisation.

The advantages of acidification are greatest when whole milk is offered *ad lib*. Studies show significantly reduced incidences of diarrhoea and mortality and increased live weight gain.

When an acidifier is used in *ad lib* feeding, milk should be taken cold from the bulk tank. The acidifier should first be dissolved in water before being added to the milk to prevent the milk from curdling.

7 Should milk be fed warm to calves?

Debate regarding the best temperature to feed milk or milk replacer stems from concerns about the impact that temperature has on the energy expenditure of the calf. Some manufacturers recommend that the 'best' milk temperature is between 35° and 38°C, but it may be fed as cold as 6°C.

Very cool milk has the potential to lower the body temperature which means that the calf would need to use energy to increase its body temperature. This diverts energy away from growth and development. In cold climates, the effect of cool milk can be significant, however there is likely to be little impact of this in warmer climates.

KEY FACTS:

The bottom line is that liquid feed is best provided at a constant temperature, i.e. avoid feeding warm milk one day, cool milk the next.

Section 3

Milk
Feeding Methods

Introduction

There are a number of milk feeding methods available for artificially rearing calves. These methods can be divided into two groups: restricted feeding methods and *ad lib* feeding methods. Restricted feeding includes the use of individual or group feeding methods such as individual buckets/teats, nipple bars, calfeterias etc. *Ad lib* feeding can be used for whole milk or MR. For milk replacer there must be an automatic mixing unit/agitator. When employed correctly, restricted and *ad lib* feeding methods both achieve good calf performance.

1. **What is the most appropriate feeding method?**
2. **For restricted feeding, is teat feeding better than bucket feeding?**
3. **What are the benefits of teat feeding on digestion and calf health?**
4. **How do you train a calf to drink?**
5. **What are automated /computerised feeding systems?**
6. **What are the advantages of automated feeding?**
7. **Is a regular feeding routine important for calves?**
8. **Cleaning feeding equipment.**

Milk
Feeding Methods

1 What is the most appropriate feeding method?

The milk feeding method used on a farm depends on:

- Number of calves to be fed.
- Type of housing.
- Amount of milk/MR to be fed.
- Availability of labour.

Bucket feeding is the most common feeding method for calves that are individually penned or in groups of 2-8 per pen. This method has many feeding options including:

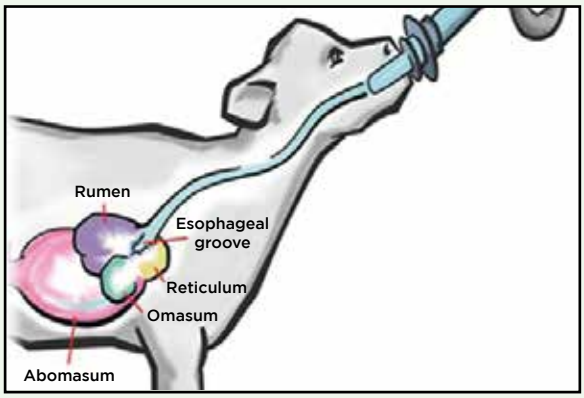
1. Bucket (no teat).
2. Individual teat buckets.
3. Multi teat feeders.
4. Compartment multi teat feeders (with divisions).
5. Mobile multi teat feeders.

A compartment multi teat feeder allows calves to be allocated the correct amount of milk and reduces the effect of bullying.

For restricted feeding, it is important to have groups of calves in pens of eight and of the same age and size. A washing up area, milk replacer mixing unit, measuring container, open container on wheels for transferring milk and wide passageways all are important for successful and time efficient restricted feeding methods.

2 For restricted feeding, is teat feeding better than non-teated feeding?

Although the method of calf feeding does not have a major impact on weight gain, feeding calves from a nipple/teat is more natural. It takes longer and helps the calves satisfy their urge to suckle. Teat feeding is preferable from a behavioural point of view.



3 What are the benefits of teat feeding on digestion and calf health?

When a calf is born, the abomasum or fourth stomach is the only stomach that is functioning. Teat feeding triggers a reflex which causes a groove in the rumen (oesophageal groove) to close. This directs milk past the rumen and into the abomasum where it is digested. In addition, using a teat may also stimulate saliva production and maintain fluid intake in scouring calves.

If a calf drinks from a bucket the oesophageal groove may not be activated and the milk will go into the rumen. As the rumen is not functioning, the milk is not digested and ferments, causing the calf to scour.

If a non-teated bucket is used its base should be placed at least 30cm above the ground to help the oesophageal groove to close. When teat feeding ensure that the height of the teat is at normal nose height to the calf and that the calf keeps her neck and head up while drinking.

Whichever feeding method is used, each calf must receive the correct amount of milk daily.

4 How do you train a calf to drink?

Training calves to drink requires both patience and skill. Let the calf suck your fingers and gradually guide the calf's mouth onto the teat or its nose to the milk in the bucket.

The speed that calves learn will differ; some calves learn quickly to come to the milk feeder, while others require more training. Gentle handling of hungry calves helps speed up independent feeding.

5 What are automated /computerised feeding systems?

In general, for warm *ad lib* feeding, automated feeders dispense a pre-determined concentration of milk replacer at a set temperature continuously. The most common type has a dry milk replacer hopper and a water-tank attached to the main water supply. A thermostatically controlled immersion heater controls the water temperature. The feed is mixed in a mixing bowl after the required amount of milk replacer powder and heated water are dispensed into it. The mixing bowl services either two or four feeding teats through a milk line. Each feeder can service up to 50 calves.

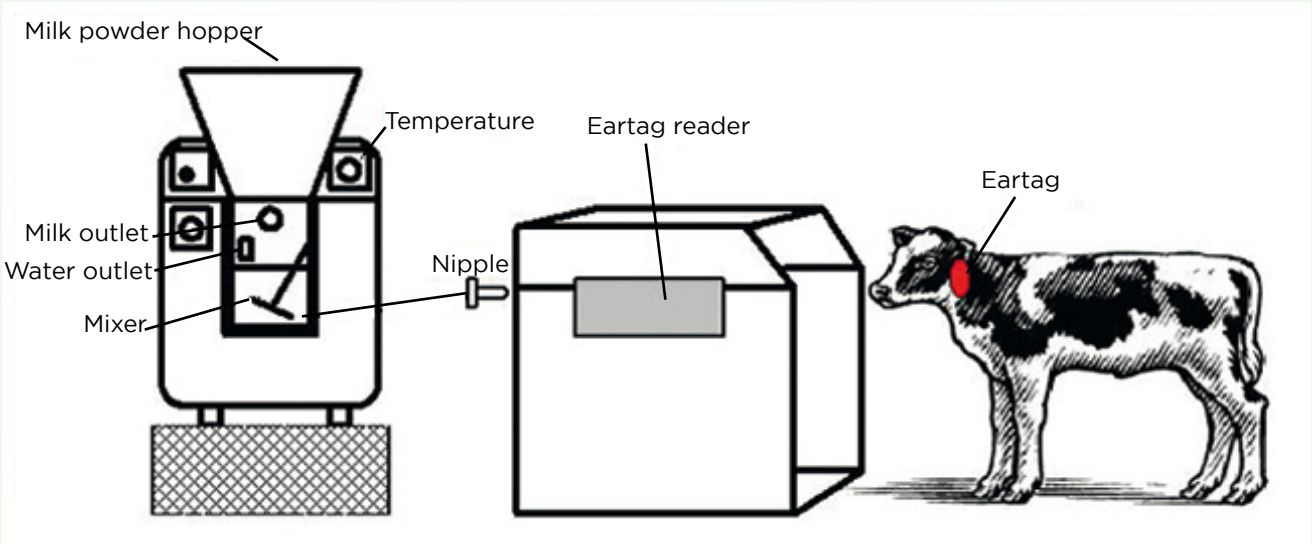
Key points for automated feeding:

- Calibrate the feeder at weekly intervals and also for different brands of milk replacer and different batches of the same brand.
- Only use milk replacers which are free-flowing.
- Clean the feeder mixing-bowl daily and "milk lines" three times a week.
- Ensure that the feeder nipple in the calf pen is always set 700-800 mm above floor level.
- Provide a drain adjacent to the feeder to remove all liquid out of the building.
- Ensure the floor area is always sloping away from the bedded area.

6 What are the advantages and disadvantages of computerised/automated feeding?

Advantages	Disadvantages
• Reduction in labour requirement. • Calves have access to a constant supply of warm milk in smaller amounts; as they would from the cow. • You have control over the feed intake of individual calves. • Each calf's consumption is recorded in the computer so you know exactly how much feed each animal is getting. • The system generates a list of calves that aren't drinking so you know which ones to watch. • The computer can be programmed for gradual weaning.	• Automated feeders are an expensive investment per calf reared. • Can lead to less effective calf husbandry. Producers may forget that calves must still be checked twice daily, as they would if they were being fed manually. • It is difficult to rear more than one batch of calves per year with an automated system because of the seasonal nature of Irish dairy calf production.

Milk
Feeding Methods



7 **Is a regular feeding routine important for calves?**

Following a feeding routine is important for calves, especially over the first few days to ensure the calves settle in comfortably to their new regime and environment. During calf rearing the same person should be involved every day in order to alleviate stress on the calves. It is vital that whoever looks after the calves must have plenty of time to do the job properly.

Feeding, cleaning and animal health requirements should be prioritised and not put off due to time constraints.

8 **Cleaning of feeding equipment.**

Poor cleaning practices can lead to the development of biofilms on feeding equipment. A biofilm is an invisible layer of protein and fat which bacteria can bind to. The bacteria can multiply quickly leading to calf infection and scours. In extreme cases, a biofilm may cause a yellow or white scum, but usually biofilms are not visible.

If feeders are not cleaned correctly and biofilms develop, the biofilms can release bacteria and contaminate the milk or milk replacer being fed to calves when the equipment is used.

HOW TO:

Correctly clean milk feeding equipment

There are five simple steps:

1. First rinse the equipment with water (32 - 38°C).
2. Soak the equipment in hot water (>50°C) with detergent for 30 minutes.
3. Scrub the equipment well and re-wash with hot water.
4. Rinse the equipment and spray with sanitiser.
5. Leave the buckets to dry, preferably on a designated drying stand/rack.

Section 3

Milk
Replacer Feeding

Introduction

Feeding milk replacer is common practice on many farms. There is a wide range of milk replacer powders available, each with their advantages and disadvantages on nutritional content and cost. Some milk powders are suited to specific rearing systems so it is important to match the powder to the system employed.

1. **Milk replacer v whole milk - is there a difference in calf performance?**
2. **How much milk replacer should you feed?**
3. **How soon can milk replacer be fed?**
4. **Different milk replacer feeding schedules.**
5. **Can milk replacers be fed cold?**
6. **Cold weather MR feeding.**
7. **What is meant by 'skim powder'?**
8. **What is meant by 'whey-powder'?**

Milk
Replacer Feeding

1 Milk replacer v whole milk - is there a difference in calf performance?

Provided the MR is formulated correctly from good-quality ingredients and fed according to the instructions, calves can grow equally well and their rumens can develop just as well as they would on a whole milk diet.

In the case of dairy heifers, studies have shown heifer calves will achieve the same weight gain and performance on good quality milk replacer (25% crude protein) as on whole milk.

Feeding a high quality whey-based milk replacer can actually improve calf performance above whole milk diets. In trials, calves that received MR of 27% protein and 16.6% fat on a dry matter basis up until weaning at 56 days were on average 6kg heavier than those fed whole milk from the tank. In addition, the weight differential continued to day 70, possibly due to the fact the calves consumed 33% more concentrate over the trial period.

Table 2. The effect of feeding whole milk versus milk replacer on calf weight gain. Source: Teagasc Moorepark research centre.

	Whole milk	Milk replacer
Average 56 day weaning weight (kg)	75.5	81.5
Average 70 day weaning weight (kg)	85.8	91.5
Average overall weight gain (kg)	47.7	55.4

Advantages of milk replacer	Disadvantages of milk replacer
• Flexibility - feeding anytime. • Feeding away from parlour. • Johne's control. • Consistent. • Regular system of feeding. • Don't have to divide calves. • Potentially less labour.	• Perceived to be labour intensive. • Perceived poorer calf performance. • Huge variety of powder products. • Mixing of milk powder. • Have to pay for the milk powder. • Requires a plan.

2 How much milk replacer should you feed?

As previously mentioned, the calf should receive at least 13-15% of its birthweight in good quality milk replacer. This is generally mixed at 125g/litre of water; however the recommendation will vary between MR manufacturers. Always adhere to the manufacturer's directions.

There is growing evidence that high growth rates in early life (0.6-0.8kg/d by feeding 750g to 900g MR per day) promote health in calves. However, feeding a high level of MR can decrease concentrate intake prior to weaning.

KEY POINT:

The amount of milk fed and concentrate intake determines calf growth rate in the period up to 12 weeks, with the target being to get the calf to grow from 40-45kg at birth to about 100kg. This can be achieved with inputs of about 25kg of milk replacer and 120kg of concentrates. If higher levels of milk replacer are given (50kg or more as in *ad lib* systems) the calf weight at 12 weeks will be 105-110kg. Concentrate intake per calf will be approximately 100kg.

3 How soon can milk replacer be fed?

Once calves have received 8.5% of their birth bodyweight in colostrum within two hours of birth there is no difference in their weight gain pre- or post-weaning compared to calves fed colostrum and four feeds of transition milk before moving on to milk replacer.

This suggests that in well managed systems, where the transfer of disease may be an issue, milk replacer can be offered immediately after colostrum feeding, but the colostrum 1,2,3 rule must be strictly adhered to.

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4 Different milk replacer feeding schedules

Days	Milk Replacer (g/day)	MR (l/feed)	No. of feeds per day	Concentrates
1	Colostrum	3L within 2 hours	---	---
1-5	500	2	2	Handful from day 3
6-28	750	3	2	*Ad lib*
29-42	375	3	1	*Ad lib*
*42 day feeding period starting at seven days of age, 25kg of milk replacer fed over 42 day period				

Days	Milk/MR per day per calf	Litres per feed	No. of feeds per day	Concentrates
1-2	Colostrum	3 litres first feed, 2 litres thereafter	2/3	---
3-6	Whole/transition milk	2	2	Handful
7-12	500g of milk replacer	2	2	*Ad lib*
13-35	750g of milk replacer	3	2	*Ad lib*
35-49	375g of milk replacer	3	1	*Ad lib*
50+	None	---	---	*Ad lib* up to 2kg/day
Milk replacer feeding schedule for bucket feeding, 49 day feeding period.				

KEY TIPS:

Start baby and weak calves on 250 ml of milk, five times a day for the first 24-48 hours and work up to 2L twice a day.

5 Can milk replacers be fed cold?

Milk replacers can be fed cold by bucket feeding or *ad lib*. For cold *ad lib* feeding, no direct running water or power supply is required. Acidified milk replacer is used as it reduces scouring and the issue of fat rising to the top. The milk replacer is mixed in a container and calves drink from a teat via a plastic tube. This system is cheaper than warm *ad lib*, but it requires extra labour due to the mixing and washing up.

Milk
Replacer Feeding

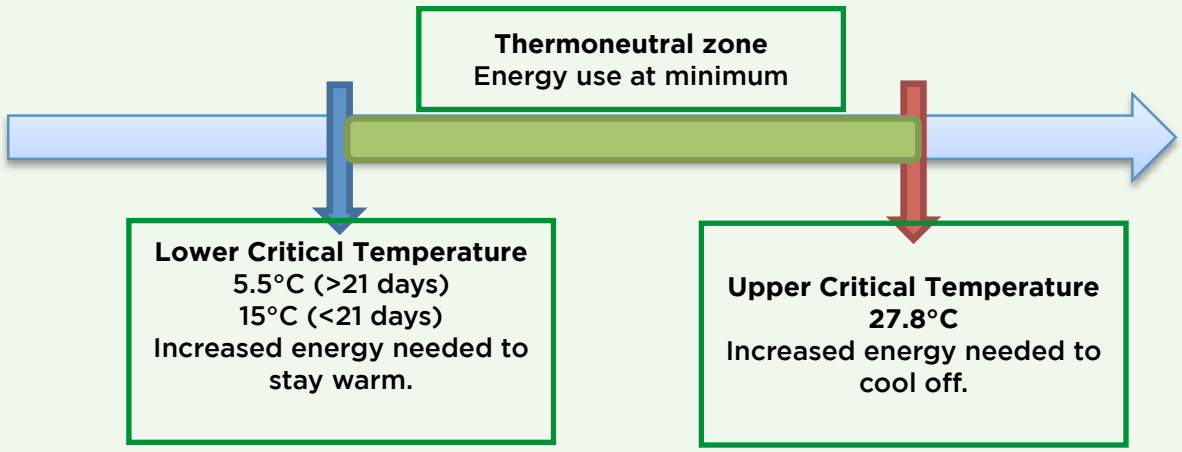
Milk replacer can be fed cold without reducing animal performance.

6 Cold weather MR feeding.

Cold weather is stressful for calves and those that are exposed to the cold are predisposed to pneumonia. When calves are not fed adequately in cold temperatures they don't grow as quickly since they are using their energy to keep warm instead. If calves are shivering after feeding it is a sign that they are cold and not being fed adequately.

KEY TIPS:

A good rule of thumb is to increase the amount of milk replacer by 2% for every degree the temperature falls below 10°C.



Temperature	50kg calf, <3 weeks	50kg calf, >3 weeks	75kg calf
	*Additional milk replacer (L)		
20 °C	0	0	0
10 °C	0.9	0	0
20 °	1.8	0.9	1.4
-10 °C	2.7	1.8	2.7

**20% protein, 20% fat milk replacer mixed at 125g/L. Provided the calves are dry, well-bedded and kept out of draughts.*

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7 What is meant by 'skim powder'?

The term skim refers to a dairy protein which contains approximately 80% casein and 20% whey proteins. Skim powder is derived from butter-making. When the powder is reconstituted in the manufacture of milk replacers, vegetable oils replace the butter fat.

Traditionally, skim based milk replacers contain a defined skim content but today the levels can vary from 20 to 60%. Skim based powders tend to be more expensive

Pros	Cons
• If processed correctly, skim milk proteins can be highly digestible and deliver good calf performance.	• At low levels of inclusion in milk replacer, the casein in skim will not form a firm clot which can have an adverse effect on animal health and performance. • If skim milk proteins have been subjected to high heat treatment they may be poorly digested by the calf.

8 What is meant by 'whey-powder'?

Whey-based powders are derived from cheese making. When made into a milk replacer, vegetable proteins are used to replace the milk proteins extracted to make the cheese.

Whey proteins contain a higher level of essential amino acids than skim proteins. In addition, at low processing temperatures whey proteins can also contain high levels of the immunoglobulins found naturally in milk and colostrum.

Pros	Cons
• Result in calf growth rates as good as those achieved with high quality skim based milk replacers. • Whey protein contains higher levels of the first limiting amino acids than skim.	• If processed at high temperatures, both digestibility and the activity of whey proteins can be reduced.

KEY POINT:

Although some farmers believe that artificially-reared calves should be fed skim-based replacers, studies have shown that calves fed whey-based milk replacer perform at least as well as those on skim-milk based replacer in terms of daily live weight gain.

HOW TO:

Choose the correct milk replacer

Deciding which milk replacer to use can be challenging. There is significant variation in quality. The following factors should be considered:

- The age of the calf you are feeding. Calves less than three weeks of age cannot digest the same ingredients as older animals.
- How the milk replacer is manufactured.
- How much hot water you have available.
- The ingredients - the milk replacer label will have the list of ingredients on the tag listed in order from highest to lowest.

Section 3

Milk replacer
Nutritional Specification

Introduction

The primary nutrients in milk replacer are protein, fat, carbohydrates, vitamins and minerals. It is a legal requirement for milk replacers to have a declaration of ingredients in descending order of inclusion. It is therefore almost impossible to accurately assess the quality of milk replacer from the label. A farmer can only get a rough idea of the suitability of a given milk replacer for the purpose of rearing calves from the oil, protein, fibre, and ash content.

1. **What is the optimum protein content of milk replacer?**
2. **Why is the protein source in milk replacer important?**
3. **What is the ideal fat content in milk replacer?**
4. **What fibre content should there be in milk replacer?**
5. **Ash, vitamins and minerals in milk replacer.**
6. **Milk replacer appearance.**
7. **What are acidified milk replacers?**
8. **Are there any benefits to feeding acidified milk replacers?**
9. **Practical considerations for mixing and feeding milk replacer.**

Milk replacer
Nutritional Specification

1 What is the optimum protein content of milk replacer?

A good quality milk replacer will contain only milk derived protein sources.

Most research studies in calf-to-beef systems have shown no economic or animal performance advantages to feeding milk replacer with greater than 20% crude protein content. However, feeding milk replacer with protein levels below 20% reduces liveweight gain.

For farmers aiming to achieve very high levels of calf growth (i.e. greater than 900g/day), higher levels of crude protein are required (i.e. 25-27%).

2 Why is the protein source in milk replacer important?

Protein sources can be either milk or plant/vegetable proteins. For the first 2-3 weeks of a calf's life, milk-derived proteins are important as these are the only proteins a calf can digest efficiently. After three weeks of age, a higher level of plant-derived proteins can be tolerated with no ill-effects on the calf.

Milk Proteins: milk-derived proteins sources include skim milk powder and whey powder. Young calves should receive MR based on skim milk powder or whey protein concentrate.

Vegetable proteins: commonly used vegetable proteins are soya protein, wheat gluten, and pea protein. In general, digestibility and subsequent calf growth and feed efficiency are lower with vegetable proteins than with milk derived proteins.

Soya protein products can contain a variety of anti-nutritional factors that further decrease the digestibility in young calves, although recent advancements in processing have improved the quality of soy-protein products. Pea proteins are known for their rapid sedimentation, which puts them at a disadvantage.

3 What is the ideal fat content in milk replacer?

Milk replacers can contain 10-25% crude fat, with 18-20% fat content ideal. Research at Teagasc Grange has shown no benefit to feeding MR with higher than 18% fat content. Calves less than two weeks old cannot digest non-milk fats as well as milk fats, so milk replacer high in milk fat lowers the risk of diarrhoea. Higher fat milk replacers may suppress concentrate intake, so may not be suited to systems requiring early weaning. However, studies have shown that reducing the fat content of the MR from 18% to 12% does not have any effect on concentrate intake or live weight gain.

Fat sources should be highly digestible and preserved with an antioxidant.

4 What fibre content should there be in milk replacer?

Crude fibre content over 0.15% generally indicates the inclusion of plant protein in a product. However, just because a product has low crude fibre does not rule out the inclusion of plant protein entirely, as soya protein concentrate is low in fibre.

Diets of calves under three weeks of age should contain <0.15% crude fibre.

KEY FACTS:

For every 0.1% increase in fibre content in milk replacers, about 10% of the total protein has been derived from plant, rather than milk, sources.

5 Ash, vitamins and minerals in milk replacer.

Some manufacturing processes can lead to a high mineral content in whey protein products (e.g. delactosed whey), which can increase the risk of diarrhoea. The ash content of milk replacer should therefore not be higher than 8%, with target ash content of 6.5-7.5%.

Table 3. Mineral and vitamin requirements of calves.

Calcium	1.0%
Phosphorus	0.7%
Vitamin A	9,000 IU/kg
Vitamin D	600 IU/kg
Vitamin E	50 IU/kg

Source: Nutrient Requirements of Dairy Cattle. National Research Council, 2001.

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6 Milk replacer appearance.

Milk replacer powder should be easily dissolved and not leave any sediment at the bottom of the feeder. It should be free of lumps and foreign material. Even though the colour and odour is not necessarily a guide to its quality, MR should not have any unpleasant, burnt or other off-odours and should be cream in colour.

If the powder is orange to orange-brown in colour and has a burned or caramelized smell, it may have undergone Maillard Browning as a result of excessive heat during storage. In this case, there will be some loss of nutrient quality and product palatability.

7 What are acidified milk replacers?

Acidified milk replacers are essentially normal milk replacers to which organic acids (sorbic, citric, malic or fumaric) and/or organic salts (calcium sorbate, sodium formate or calcium formate) have been added in various combinations to give an overall inclusion level of 1.0 to 2.0%. Extra quantities of emulsifiers are added also to prevent fat separation when the milk is left standing.

Acidified milk replacers have a pH of 5.7 to 5.9 (pH of normal milk replacer is 6.3 to 6.5) and are guaranteed to remain stable for a minimum of 48 hours. However, prevailing temperatures will affect the length of time they remain stable. Since most calf-rearing takes place in spring, temperature is not usually a problem.

8 Are there any benefits to feeding acidified MR?

In addition to the longer shelf-life, the following nutritional advantages may result from acidification:

- Less diarrhoea, due to the acid conditions controlling the rapid multiplication of harmful bacteria such as *E.coli.*
- Better feed efficiency due to improved clotting time and improved enzyme activity.

9 Practical considerations for mixing and feeding milk replacer.

Feeding:

- MR should contain at least 20% protein, >10% fat and no more than 10% starch and sugars (sucrose).
- Ideally start feeding MR once the calf has received adequate colostrum and transition milk (generally at three to four days of age).
- Do not over-feed calves, especially during the first three weeks of life, as it may cause scouring.
- Consider MR as a feed, not a drink. *Ad lib* clean water is essential from day three for proper rumen development and feed intake.

Mixing:

- MR is usually reconstituted at a concentration of 125g/litre of mixed milk. Add 125g of powder to 875ml of water to give one litre of mixed milk at 12.5% milk solids. It is essential to always read and follow the manufacturer's recommendations.
- Use scales to measure the powder correctly and ensure consistency.
- Never suddenly change the quantity of milk being fed.
- Reconstitute by adding the total amount of powder required to half the measured volume of water, mix thoroughly and then add the balance of warm water (ideally 39°C; never greater than 45°C) to make up the correct volume.
- Aim to feed calves at body temperature (37-39°C).
- Maintain a high standard of cleanliness throughout the preparation and feeding process.

Always add the replacer to the water. Adding the water to the dry milk replacer will cause the powder to stick to the sides of the container, resulting in poor mixing.


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