Section 4

Development of the **Calf Digestive System**

Introduction

A primary objective of calf-rearing systems is to get the calf off of milk and on to solid feed as early as possible. In other words: moving the calf from the pre-ruminant to the ruminant phase. Much of the skill in calf rearing is making this diet transition as smooth as possible, without set-backs to the calf's performance.

1. **Pre-ruminant digestion.**
2. **The transition phase - development of the digestive system.**
3. **Ruminant digestion.**
4. **Ingredients to initiate rumen development.**

Development of the **Calf Digestive System**

1 Pre-ruminant digestion.

Newly born calves are pre-ruminants. They have the same four stomachs as an adult but the rumen is significantly smaller. In the calf, the largest part of the digestive tract is the abomasum (fourth stomach), making up nearly 70% of the digestive tract. At this point, the immature digestive metabolic systems function similarly to those of a young monogastric animal, and the calf depends on milk or milk replacer as an easily digestible source of carbohydrate and protein.

The act of sucking by the calf causes a fold of muscle to develop in the wall of the rumen called the **reticular or oesophageal groove**. As the calf sucks, the oesophageal groove delivers milk directly to the abomasum where it is digested most efficiently.

In the first weeks of life, rennin is the predominant enzyme in the digestive system of the calf. Rennin allows the calf to efficiently utilise the proteins in milk. In time, as the level of the enzyme pepsin increases, the calf is able to utilise non-milk sources of protein. For this reason, milk replacers that contain non-milk protein should not be fed to the calf in the first three weeks of life.

For the first three to four weeks of life the enzyme lactase also predominates, meaning the calf can effectively utilise lactose, the important carbohydrate in milk. The calf is unable to utilise starch at this stage.

2 The transition phase - development of the digestive system.

The transition phase (period covering the move from the pre-ruminant to the ruminant phase) occurs between four and eight weeks of age, when the rumen begins to take over the main digestion of feed.

When a calf consumes water and starter concentrates, bacterial fermentation is initiated in the rumen. This generates large amounts of Volatile Fatty Acids (VFAs) in the forms of acetate, butyrate and propionate. This production of VFAs is responsible for rapid rumen development.

The time it takes for the calf to change from using just the abomasum to efficiently using all four stomachs depends on the type of food it is fed. If milk is freely available for a long time, the calf will have only a small appetite for dry feeds and rumen development is slow.

If the feed management encourages the calf to eat solid feeds, rumen development is enhanced and the calf reduces its dependence on liquid milk as a source of essential nutrients.

KEY POINT:

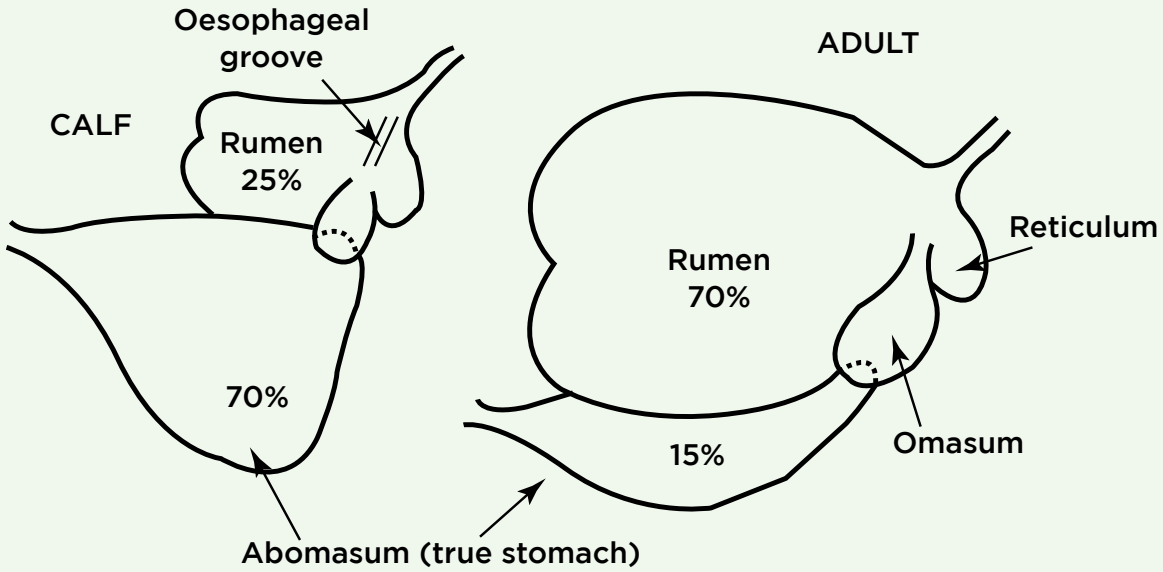
- By one week of age the calf should be encouraged to eat some concentrates and hay/straw.
    - At this time the rumen, reticulum and omasum will begin to develop.
- By one month of age calves should be eating substantial quantities of concentrates and hay/straw.
    - Calves will become less dependent on milk, risk of scours is reduced, calves can be weaned earlier, and labour and rearing costs are lowered.

If the calf is on a restricted liquid diet and has access to solid feed, this transition from pre-ruminant to ruminant digestion can be completed at about six weeks of age.

3 Ruminant digestion.

Ruminant digestion is based on the function of the rumen, where micro-organisms transform carbohydrate, protein and all other fermentable substances into volatile fatty acids, ammonia, methane, carbon dioxide and microbial protein.

The ruminant phase begins at about six to eight weeks of age. At this point, dry feed is the sole source of feed, and the rumen accounts for approximately 70% of all stomach compartments. A calf will usually have full rumen development at 12 weeks of age and its ability to eat and digest dry food will then be more or less similar to that of an adult animal.



4 Ingredients to initiate rumen development.

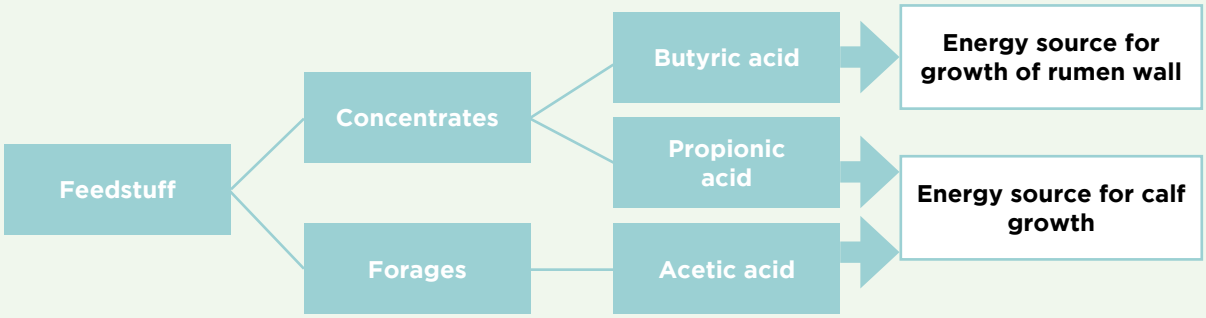
Rumen development is defined as the development of the epithelium and it is critical to successful weaning and good calf growth rates. There are five key ingredients that are required to initiate rumen development:

I. *Bacteria*

Rumen bacteria are absent when a calf is born and are introduced as the calf begins to eat calf starter concentrates. Bacteria help the digestive process. Bacterial end products of digestion (VFAs) cause significant changes in the rumen. The type of VFA produced is crucial. Calf starter contains carbohydrates in the form of starch which is fermented by bacteria that produce propionic and butyric acids. In contrast, when forages are digested the primary end product is acetic acid.

Acetic and propionic acids are absorbed through the rumen wall and are converted into metabolites that the calf uses as energy sources. Butyric acid is not absorbed through the rumen wall and is instead converted into an energy source used by cells in the rumen wall.

The production of VFAs lowers the pH of the rumen and establishes an ideal growing environment for bacteria, especially for bacteria that digest starch and produce propionic and butyric acids.



Development of the Calf Digestive System

II. *Liquid in the rumen*

Liquid in the rumen provides an ideal environment, combined with the absence of oxygen, for the rapid growth of bacteria. As milk bypasses the rumen, it does not provide enough liquid for optimal rumen development and therefore the calf must have access to 'free water' (see chapter 14).

Offering water from three days of age helps to increase calf weight gain, promotes starter intake and reduces the incidence of scour.

III. *Muscular movement - outflow of material from the rumen*

Feedstuffs that enter the rumen must be able to leave it. Therefore the development of rumen activity, such as contractions, pressure and regurgitation, is necessary. This muscular movement also helps mix the feedstuffs.

When the calf is born, the rumen has little muscular activity, few contractions and no regurgitation. As the calf's dry feed intake increases, rumen contractions begin. If calves are fed milk, hay, and starter from shortly after birth, normal rumen contractions can be detected as early as three weeks of age. In contrast, if calves are only fed milk, normal rumen contractions may not be measurable for extended periods.

IV. *Absorptive ability of the tissue*

From a structural point of view, the rumen is made up of two layers: the muscular and the epithelial, the latter is responsible for absorption of VFAs.

At birth, the epithelium does not have any ability to absorb. It is the production and subsequent absorption of VFAs in the rumen, from the fermentation of starter feedstuff that stimulates epithelium development by increasing the surface area through the development of the epithelium into finger-like projections called papillae.

V. *Availability of feed stuff in the rumen*

The key factor to promote early rumen development, and thereby early weaning, is dry feed intake. As concentrates are fermented to propionate and butyrate, they are a good choice to ensure early rumen development. Offer clean, fresh, starter at three days of age which is both highly palatable and meets the nutrient recommendations for dairy beef calves.

KEY TIPS:

A concentrate to roughage ratio of 8:1 by weight is necessary to avoid the development of 'pot belly' condition in calves and to optimise rumen muscle tone.

Diet: Milk only | Diet: Milk and hay | Diet: Milk and grain

Rumen development at six weeks. When fed milk only (left) the rumen has no papillae and is white in colour (no blood circulation), meaning there is little feed absorption possible. When fed milk and starter (right) the rumen at six weeks shows developed papillae and is dark colour, allowing for significant feed absorption. Source: Penn State University.