FARM ADVISORY SERVICE

Colostrum Management

FAS Meeting

6th December 2017

The European Agricultural Fund for Rural Development
Europe investing in rural areas

SAC CONSULTING

Scottish Government
Riaghaltas na h-Alba
gov.scot

The Essence of Success in Calf Rearing

We all hear, read and attended meetings about the importance of colostrum, colostrum feeding and colostrum quality. We also try our best on farms, to get it right and give the best possible start to baby calves. But sometimes, even when everything is done "by the book", the wheels fall off and things go wrong. And unfortunately, there are still areas where colostrum is neglected.

During the next three editions of Milk Manager News, we will provide a summary about everything you need to know and keep in mind about colostrum and colostrum management. In this first part, we will cover the basics and importance around colostrum; followed by in part 2, a practical guide on how much, how soon and what quality of colostrum should be fed. In the final part we will discuss the ways you can monitor, measure and improve colostrum quality.

Colostrum is the milk secreted by the freshly calved cow, within the first 24 hours from calving. Yes, it is milk, but it is very different from whole milk. It looks different, smells different and flows differently and is really like a special essence that cannot be compared to regular milk produced by the cow during other days of her lactation.

After 24 hours post-calving colostrum changes very quickly. It starts to look and become more like regular milk: it changes colour, smell and becomes thinner and is not like the "liquid gold" it used to be. This is what we call transition milk and it is produced by the cow between 24 to 72 hours after calving.

But let's go back to colostrum. Why it is so different from transition milk or regular milk? Firstly, it has much higher solids content (i.e. protein and fat levels) than transition milk or regular milk. Secondly and most importantly, it contains *immunoglobulins*, and contains them at a much higher level than in those transition milk or regular milk (see following table)

Composition of bovine colostrum and transition milk

	First milking	Second milking	Third milking	Regular milk
Solids (%)	23.9	17.9	14.1	12.9
Protein (%)	14.0	8.4	5.1	3.1
Casein (%)	4.8	4.3	3.8	2.5
IgG (g/L)	48	25	15	0.6
Fat (%)	6.7	5.4	3.9	3.5
Lactose (%)	2.7	3.9	4.4	5.5

Source: Foley and Otterby, 1978, J. of Dairy Science 61:1033.

The European Agricultural Fund for Rural Development
Europe investing in rural areas

SAC CONSULTING

Scottish Government
Riaghaltas na h-Alba
gov.scot

We can all understand why higher protein and fat is advantageous (i.e. it will provide more energy for the calf to get up and running as quickly as possible), but what about immunoglobulins? What are they and why do we talk about them so much?

Immunoglobulins are actually proteins, which are large in size and therefore cannot be transferred through the placenta to the foetus via the blood stream during pregnancy. They have vital roles in protecting the newborn calf and one of them is to identify and destroy pathogens that are attacking cells in the animal. That is why we also call them antibodies and often use the Ig abbreviation, when referring to them.

There are three major types of immunoglobulins or Ig's in cows' colostrum; IgG, IgA and IgM. The majority of Ig's are IgG (about 80%) and the amount of IgA and IgM is less (about 10% each). All three types are important and have different major roles: IgG is responsible for recognising and destroying pathogens. IgA attaches to the lining of the gut and protects it from pathogens that can cause intestinal diseases. IgM protects the calf from bacteria that enter the bloodstream and cause blood poisoning.

Ig's are present in very high concentrations in colostrum, but decline rapidly in transition milk and only traces can be found in regular milk. By the third milking, IgG concentration is only a third of that found right after calving!

As calves are born without active immunity, we have to "give" that immunity to them. The only way to protect them from pathogens is to provide them with high quality colostrum containing high levels of Ig's. The newborn calf will have its own immune system fully functioning at about three weeks of age. Until then, the calf relies on passive immunity that is received through Ig's in colostrum.

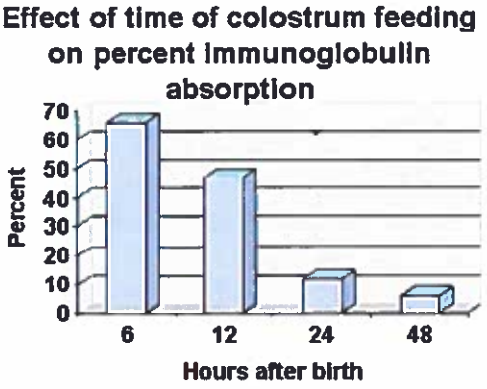
FARM ADVISORY SERVICE

Feeding Management

Quickly, quality and quantity are the three "Qs" we have all heard about regarding colostrum feeding. It might seem repetitive to talk about these over and over again, but the implementation of these "Qs", are going will determine how successful your calf rearing enterprise is. Very often these three "Qs", or some of them, are still neglected on farm. All these "Qs" are equally important and require the same attention.

1. Quickly – how soon the calf should receive colostrum?

The answer is simple: as soon as possible and the earlier the better. Remember, colostrum contains large size proteins, immunoglobulins (Ig's), of which IgG is the most important. They provide passive immunity by passing through the intestine into the bloodstream and protect the calf from disease. The efficiency of Ig absorption declines rapidly after birth. By 12 hours, absorption is only 50% and after 24 hours it is less than 10% (see graph below).



Source: Besser and Gay, 1994. Vet. Clinics of North America

The first few hours are critical. Any delay in the first feed of colostrum can lead to disease challenge if bacteria get into the digestive tract of the calf sooner than colostrum. This often occurs when calves are left in the calving pen with their dam. The calf can ingest bacteria from its environment quicker than it can find the teat and start nursing. We can all picture a newly born calf, trying to stand, stumbling around, bumping into objects and "sampling" all sorts of material that is left behind after birth.

This must be avoided by taking the calf away from the calving pen immediately after birth and feeding colostrum as soon as possible. Leaving the calf with its mother and replying on it to suckle the appropriate amount of colostrum can lead to poor immunity and increased risk of health problems such as scour or pneumonia.

2. Quality – what is good quality colostrum?

The answer is again simple: it has to contain a certain level of IgG's. But how much is enough? This is where problems start, by leaving the calf to suckle. We actually have no idea about the quality of colostrum consumed. As we don't see or handle it, the quality cannot be determined.

The European Agricultural Fund for Rural Development
Europe investing in rural areas

SAC CONSULTING

Scottish Government
Riaghaltas na h-Alba
gov.scot

It is highly recommended to administer colostrum to newborn calves and not rely on nature or instinct at this stage. The udder and teats of modern dairy breeds are not designed for easy nursing, but designed for machine milking. If the calf is either bottle fed or stomach-tubed both the quality and quantity fed can be measured, ensuring requirements are met.

Good quality colostrum should contain about 50g of IgG in every litre. This applies to the first milking, right after calving. Twelve hours later, at the second milking, the IgG content will be halved and only traces of IgG can be found in milk after 72 hours. It is extremely important to measure and only use colostrum that is the highest quality, as a first feed.

3. Quantity – how much colostrum should be fed?

A third simple answer: 150g of IgG, as a first feed. But how many litres is that? If the colostrum is good quality (i.e. contains 50g of IgG per litre) the calf requires three litres for its first feed.

If the colostrum is lower quality, it is important to make sure the calf receives an adequate intake of IgG. The lower the quality, the higher amount of colostrum that has to be fed to realise the required IgG intake. For example, if the colostrum has only 35g of IgG/l, 4.3 litres of that colostrum must be fed. However, keep in mind some calves will struggle to consume this amount voluntarily, especially smaller calves or calves of smaller breeds. In this situation, the use of an oesophageal feeder is recommended and necessary to make sure the calf gets sufficient IgG.

There is a limit to how much colostrum can be fed in one feed and it depends very much on the size of the calf. Generally it is not practical and can present health hazards if more than four litres of colostrum are fed in one feed. When only lower quality colostrum is available, administer up to four litres as a first feed and top up with the required amount six hours later.

A good rule of thumb is to feed 10% of body weight for the first feed where birth weight is recorded by a weigh scale or weigh band. But please remember, assessing colostrum quality is always the first step. Without knowing the quality, it is impossible to know the actual quantity required to be fed to provide the correct level of immunity.

Colostrometers, refractometers or densometers are perfectly adequate tools to assess colostrum quality on farm.

FARM ADVISORY SERVICE

Measuring Quality

In our last edition we talked about the important three "Qs" in relation to colostrum feeding: quickly, quality and quantity. When it comes down to judging colostrum quality there are a few golden rules that can help us to make the "go or no-go" decision:

- Never use colostrum with bloody spots.
- Discard dirty colostrum, especially if it is contaminated with faeces (always remember to milk colostrum into a clean, disinfected bucket!).
- Do not use very watery and thin colostrum.

You cannot tell the quality of colostrum just by looking at it. Two relatively inexpensive tools to measure colostrum quality are colostrometers and refractometers (see below).

A colostrometer (left) with measuring cylinder and BRIX refractometer (right)

While colostrometers are easily available, cheap (or even free!) they are not always put to good use! It is not unusual to come across them still in their original packaging on farm and excuses for not using them are often due to their fragility and fear of breaking them. Also, the accuracy of the colostrometer reading is affected by temperature. Manufacturers advise colostrum to be at room temperature (20-25°C) when testing, which unfortunately is not very practical, having to wait until it has cooled down and then warmed up again to feed at body temperature. No wonder some farmers may find this process too time-consuming and colostrometers remain in their packaging!

Despite this, a colostrometer is a perfectly adequate tool to measure colostrum quality if you can manage the working protocol to take account of temperature. Colostrometers usually come with a measuring cylinder. Whisk the colostrum with a clean stainless steel whisk and pour some into the measuring cylinder. Place the colostrometer into the sample of colostrum and allow it to settle. Note the colour level at which the colostrometer settles to determine quality.

The European Agricultural Fund for Rural Development
Europe investing in rural areas

SAC CONSULTING

Scottish Government
Riaghaltas na h-Alba
gov.scot

FARM ADVISORY SERVICE

Guide to colostrum quality measured with a colostrometer

Reading	Quality	
Green	SUPERIOR	≥ 50 g/litre IgG
Amber	MEDIUM	20-49 g/litre IgG
Red	POOR	≤ 20 g/litre IgG

BRIX refractometers are very easy to use and are more robust than colostrometers. They provide an instant reading and are very reliable as they are not affected by temperature. There are expensive digital versions available, but more simple ones, can be purchased for less than £30. They should become an essential tool on every farm to assess colostrum quality.

When using the refractometer, a drop of colostrum is placed on the lens and made airtight. A beam of light is shone through the colostrum sample. The amount of light that is refracted by the solids in the sample is measured and read on a scale (0-30%) within the device. On the BRIX scale, 22% is equivalent to 50g of IgG in a litre of colostrum (so 3 litres of colostrum at 22% will provide the recommended 150g of IgG for the calf's first feed).

Feeding recommendations based on quality as measured by a BRIX refractomoter

BRIX Reading	Colostrum Quality	Action
> 22%	Superior	Use as a first feed
20-22%	Medium	Only use for second or third feed
< 20%	Poor	Do not use as colostrum

The next step is to then monitor the success of colostrum management within the calf. This can be done using blood tests in calves less than seven days old. Serum refractometry and ZST testing are both simple and cheap methods which provide a guide to antibody (or immunoglobulin) levels in the calf. Specific ELISA tests for directly measuring immunoglobulins are becoming more widely available. Ask your vet for details.

Blood antibody levels should be measured routinely as part of regular calf health monitoring. This means that a problem can be detected quickly, before levels of disease and mortality begin to increase. On a herd basis at least 80% of sampled calves should have absorbed adequate levels of antibodies. If blood antibody levels are not measured routinely, then this should be undertaken when levels of navel ill, scour or pneumonia are at unacceptable levels. Blood sample healthy, rather than sick calves, as dehydration affects the validity of the test.

The European Agricultural Fund for Rural Development
Europe investing in rural areas

SAC CONSULTING

Scottish Government
Riaghaltas na h-Alba
gov.scot

FARM ADVISORY SERVICE

Pasteurisation and Storage

Colostrum cleanliness has a big impact on calf health and performance. Dirty colostrum contaminated with bacteria is a major concern, as bacterial growth will reduce the absorption of antibodies through the gut wall of the new-born calf. The pathogens *Salmonella*, *E. Coli* and *Mycoplasma* are the most commonly found bacteria in contaminated colostrum. Their presence is mainly the result of poor hygiene while collecting colostrum, and not refrigerating colostrum immediately after collection.

Laboratory measures for determining colostrum cleanliness are the Total Plate Count (TPC), which should be below 100,000cfu/ml and the Total Coliform Count (TCC) which should be below 10,000cfu/ml. This is not practical to measure and monitor in an on-farm situation, but to help to understand these values, even a little dirt in colostrum can produce higher numbers than those described above if the sample is tested in a laboratory.

A national study from the US (Morrill et al. 2012) showed 43% of samples taken from 67 herds across the country failed to meet the requirement for clean colostrum, as either TPC or TCC was higher than described above. To avoid this happening, follow the best advice: properly clean and disinfect udder before milking; milk into a clean, .disinfected bucket; always discard dirty, contaminated colostrum; refrigerate or freeze excess colostrum immediately.

Proliferation of bacteria in stored colostrum is one of the biggest pitfalls on many farms. It is common to see colostrum stored in a bucket in the tank room, usually uncovered, and here bacteria can double every 20 minutes in warm weather. Colostrum must be placed in the refrigerator after it is harvested (labelled with collection date, cow number and BRIX refractometer reading) and should be used within 24 hours. Any excess colostrum can be frozen (again clearly labelled), ideally in large, zip-lock plastic bags with a large surface area for easier and quicker thawing. Colostrum must be thawed at temperatures below 60°C to avoid damage to antibodies. Always rotate colostrum stock in both the refrigerator and freezer, using the oldest colostrum first. Colostrum can be frozen for up to 12 months without any significant deterioration in quality.

Heat treating or pasteurising colostrum is another management tool to reduce pathogen exposure to calves. Pasteurisation of colostrum is not the same as sterilisation. It will significantly reduce pathogen numbers, but will not kill 100% of the bacteria.

The most common pasteurisation methods are the High Temperature – Short Time (HTST) or Continuous Flow Pasteurisers, the Ultraviolet Radiation Pasteurisers and the Batch Pasteurisers.

The European Agricultural Fund for Rural Development
Europe investing in rural areas

SAC CONSULTING

Scottish Government
Riaghaltas na h-Alba
gov.scot

The summary table below highlights the main differences between these systems:

	Continuous Flow	Ultraviolet Radiation	Batch
Method	High temperature/ Short time	UV light passed through column of milk	Lower temper-ature/ Longer time
Temper-ature/ length	72°C x 15 seconds	1.5 – 2 hours/batch	63°C x 30 minutes
Capacity	1 to 40 gallons per minute	50, 100 or 150 gallon batches	10 – 150 gallon batches
Cleaning	Automated CIP wash system	Automated CIP wash system	Manual wash
Cost	+++ very high	++ high	+ medium
Other details	Unacceptable thickening of colostrum	Emerging research suggests poorer efficacy in killing bacteria	Includes agitator

Continuous Flow Pasteurisers have a very high rate of success of eliminating pathogens (even Johne's causing *Mycoplasma*) and used to be popular in the US. However, research has shown 25 to 32% loss of IgG in colostrum after pasteurisation, as well as lower serum levels in calves (McMartin et al. 2006, Godden et al. 2006). Also the lack of agitation during pasteurisation leads to thickening of the colostrum, which makes administration more difficult.

Ultraviolet Radiation Pasteurisers have intermediate ability to inactivate 'regular' bugs like *E. coli*, *S. aureus*, environmental *Streptococcus* species, but it has poorer efficacy than heat pasteurisers. Their biggest problem is that they denature 43 to 50% of IgG in colostrum.

Batch Pasteurisers are thought to be the best bet, as they significantly reduce or eliminate the most common pathogens. Thanks to their built-in agitators, colostrum is continuously mixed during the process, and the more gentle lower operating temperature does not affect colostrum IgG content. Their initial cost is also much lower than the two other systems. As an additional benefit, some types of pasteuriser can be used as a water bath to thaw frozen colostrum.

Using pasteurised unsalable whole milk is also attractive financially, but there are downsides too i.e. inconsistent nutrient composition, inadequate milk supply and possible recontamination of pasteurised milk during storage, transport and feeding. Perhaps most importantly, pasteurisation does not inactivate antibiotics in milk, which can negatively affect the developing beneficial bacterial population within the gut of the calf.

FARM ADVISORY SERVICE

References:

- Morrill et al., 2012. Nationwide evaluation of quality and composition of colostrum on dairy farms in the United States. *Journal of Dairy Science*, 95(7): 3997-4005.
- McMartin et al., 2006. Heat treatment of bovine colostrum. I: Effects of temperature on viscosity and immunoglobulin G level. *Journal of Dairy Science*. 89:2110-2118.
- Godden et al., 2006. Heat treatment of bovine colostrum. II: Effects of heating duration on pathogen viability and immunoglobulin G. *Journal of Dairy Science*. 89:3476-3483.

csaba.adamik@sac.co.uk, 07880 472661

The European Agricultural Fund for Rural Development
Europe investing in rural areas

SAC CONSULTING

Scottish Government
Riaghaltas na h-Alba
gov.scot