For Vet Professionals only

Face2Vet
A Clinical Update

Volume 10 Issue 1

Nutrition for Bovine Calves

Calves are the future of dairy herd and deserve the best management, incorporating the latest research and management advice. In return, they will repay the investment through higher milk production and longer productive life. Sound calf feeding and management programs start with the mother, two months prior to calving. The majority of calf growth happens within the dam during the last two months of gestation and the dam provides the nutrients required for growth. Also, the management program of the dam affects the quality and amount of antibodies found in her colostrum, or first milk, which directly influences the calf health after birth. Calves should be reared carefully to obtain optimum gain in body weight so that they attain about 70-75 percent of mature body weight at puberty. Poor feeding of young calves leads to higher age at first calving and higher mortality, thus overall loss of productivity. To rear healthy calves and keep mortality to a minimum, the following aspects of calf feeding must be considered:

- Feeding whole milk/ milk replacer to calves
- Introduction of calf starter from 2nd week onwards
- Introduction of good-quality hay to calves
- Ensuring thermal comfort and sufficient feed intakes
- Monitoring growth rates (weight and height)

3Qs of colostrum management i.e. Quality, Quantity and Quickly

Calves are born with little immunity against disease. They acquire resistance to disease from their dam through timely and adequate intake of high-quality colostrum *i.e* their mother's first milk. Colostrum is vital to the newborn calf because it contains antibodies called immunoglobulins (IgG, IgM and IgA) which provide immunity (**Fig. 1**). It is also rich in energy (carbohydrate, fat) and nutrients like Vitamins (A, D and E) and Minerals (Ca, Mg and P) that are essential for growth. Hormones (insulin) and growth factors (IGF-1) in colostrum also aid metabolism.

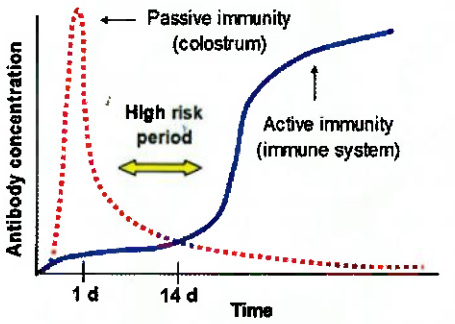

Fig. 1: Initial protection of calf through Ig in colostrum

Quality

High-quality colostrum contains at least 50 g/L of IgG and ensure cows are milked as soon as possible after calving so that the best possible colostrum is collected and fed to newborn calves. Three types of immunoglobulins (Ig) in colostrum are of utmost importance. Immunoglobulin G (IgG) makes up 70 -80 percent of the immunoglobulins and helps identify and destroy invading pathogens. Immunoglobulin M (IgM) comprises 10 -15 percent of immunoglobulins and serves as the first line of defense against septicemia. Immunoglobulin A (IgA) comprises the remaining 15 percent of immunoglobulins in colostrum and protects the mucosal surfaces, such as the intestine, from invasive pathogenic bacteria. Immune status of dam, length of dry period and dry cow nutrition are some major factors that affect IgG concentration in colostrum.

Quantity and Quickly

To optimize immunity, the calf must receive their first colostrum (1/10th of their body weight) feed as soon as possible after birth, ideally within two hours because the ability of calves to absorb Ig (immunoglobulins) fall drastically after 12 hours and is blocked at 24 hours of age (**Fig. 2**). It also has laxative action and helps the calf in evacuating accumulated faecal matter (meconium) from intestine. Feeding colostrum to calves over several days is beneficial for building immunity and fighting against infections.

Importance of Colostrum feeding

1) Provide passive immunity
2) Laxative effect
3) Antitrypsin action
4) Excellent source of Vit A, D and E
5) Excellent economic diet for both the neonates and older calves
6) Contain antibacterial substances- lactoferrin, lactoperoxidase and lysozyme

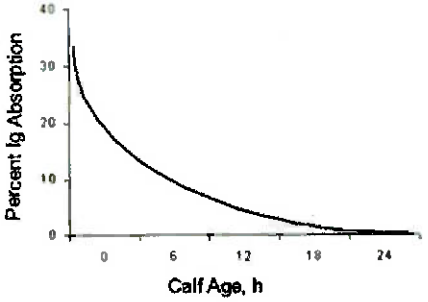

Fig. 2: Age of calf *vs* percent absorption of Ig

Summary of recommendations

Feed appropriate quantity of good quality colostrum to calf as soon as possible after birth. Remember the 3Qs:

- Quantity – 1/10th of body weight
- Quality – contains at least 50 g/L of IgG
- Quickly – within two hours of birth

Whole milk feeding

The best measure of a successful calf rearing system is production of a healthy calf that has reached its targeted weaning weight. Traditionally, the recommendation to feed calves at 10% of body weight and then translated into feeding two litres of milk twice daily. Whole milk is the natural follow-on from colostrum. This does not provide growing calves with sufficient energy. Feed whole milk or a suitable milk replacer @10–15% of calf body weight to suffice the energy requirements (**Table 1**).

Fig 3: Multi teat Calf Milk feeder

Consideration while feeding

1) Milk with high bacterial contamination, e.g. high SCC, risk of Johne's disease, *Salmonella* and *E. coli*, should only be fed to calves after pasteurisation.
2) Milk from cows administered with antibiotics and still within the withdrawal period, should never be fed to calves as it can affect the milk taste leading to calves not drinking as much milk, with resultant lower weight gains. More importantly, bacteria that are resistant to these antibiotics can develop and if animals need to be treated with these antibiotics they may not work as effectively.
3) Teat feeding is more natural. Drinking from teat help calves satisfy their urge to suckle but artificial teat feeders are also used (**Fig. 3**).

Table 1: Nutrient requirements for pre-ruminant calves (ICAR, 2013)

Age (day)	B.Wt (kg)	ADG (g)	CP (g)	DCP (g)	TDN (g)	ME (Mcal)	Ca (g)	P (g)
0-15	25	200	114	80	400	1.5	2.5	1.5
16-30	30	300	129	90	500	1.7	3.0	2.0
30-60	40	300	180	125	800	2.4	3.5	2.5
60-90	50	350	215	150	1000	3.6	4.0	3.8

Milk replacer

Milk needs of young calves can be replaced by milk replacer. During first three weeks of life, calves can be fed with milk replacer that contains all milk proteins made from dried skim milk or whey products and it is more economical than whole milk feeding. Milk replacer powders are reconstituted with warm water and make an excellent liquid feed for baby calves. Milk replacers should contain a minimum of 18 to 22% crude protein, 10 to 22% crude fat, and less than 0.5% crude fiber. Milk replacer has almost all the essential nutrients, similar to milk. It comprises of skim milk powder, soybean meal, edible oils, grains, vitamins, mineral mixture, preservatives, etc. (**Table 2**).

Advantages and disadvantages of using milk replacer

Advantages

- Reduces risk of disease transfer (e.g. Johne's disease and BVD).
- Consistency of product, when mixed correctly – less risk of digestive upsets and scours.

Disadvantages

- Products with plant-based proteins have lower digestibility in calves under 3 weeks old.

Table 2: Ingredients(%) used for formulating the milk replacer (ICAR,2013)

Ingredient	Cattle calves	Buffalo calves
Wheat flour	10	8
Fish meal	12	12
Linseed meal	40	40
Coconut oil	7	7
Linseed oil	3	3
Butyric acid	0.3	0.66
Citric acid	1.4	1.4
Molasses	10	8
Mineral mixture	3	3
Milk	13	6
Vitamin A ,B_{27},D_3	0.015	0.015

Sources of milk replacer

Protein

- Milk-based (ex. dried skimmed milk, dried whey, delactosed whey, casein)
- Egg based
- Plant-based (ex. soya, wheat gluten, pea)

Fibre is an indicator of protein quality

- Products with less than 0.15% fibre contain milk or egg proteins
- Fibre levels over 0.20% indicate the inclusion of plant proteins

The new borne calf can digest protein in milk and 14th day onwards they are able to digest non-milk proteins. After four weeks of age microbes in the rumen may digest some feed.

Oil and fat

Generally, vegetable fats (palm oil, coconut or soybean) have similar digestibility to milk fat in calves over three weeks old.

Vitamin and Minerals

Calves require many of the same vitamins as monogastrics, including vitamin K and the water-soluble B vitamins: thiamine, riboflavin, niacin, choline, biotin, pyridoxine, folic acid, B_{12} and pantothenic acid. These vitamins can be added in milk and milk replacer.

Ash

- Ash indicates the overall level of minerals
- The ash content should not be higher than 8%.

Calf starter

- At birth, the first three compartments of stomach *i.e.* rumen, reticulum and omasum are undeveloped and do not aid in digesting feeds (**Fig. 4**).
- When the calf starts digesting calf starter (mixture of grains, protein source, vitamins and minerals) and water, the rumen starts to develop.

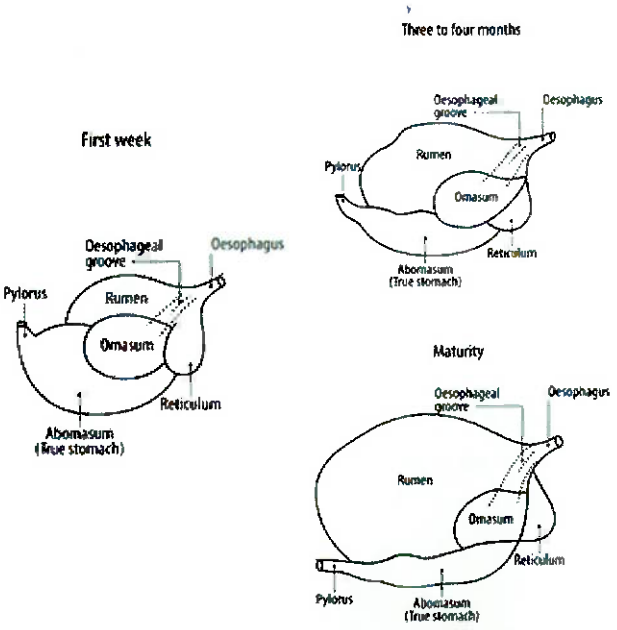

Fig 4: Relative size of bovine stomach compartments from birth to maturity

- Calf starter should be introduced from second week onward.
- Calf starter should be formulated to include palatable ingredients and to contain adequate protein, minerals, and vitamins (**Table 3**).
- It should have CP(min) 23-26%, DCP(min) 18.8-19.5% and TDN(min) 75%.
- Feeding calf starter and good quality leguminous hay stimulate early development of rumen papillae (**Fig. 5**) essential for rumen function and favours digestion of large proportion of fodder at an early age.
- Calf starter ration should contain traditionally available highly palatable ingredients such as soybean meal, decorticated cotton seed meal, crushed maize, wheat bran, rice polish, molasses, skim milk powder, etc.
- After three weeks of eating calf starter, the rumen will have enough microbes to ferment the feed and supply the calf with energy.

Calf starter increases the number and variety of rumen bacteria and protozoa. These microorganisms grow rapidly on grain carbohydrates and produce volatile fatty acids i.e butyrate and propionate. These acids provide nutrients for calf

and stimulate rumen development. Dietary requirements during early age are best met with high quality diets formulated from sources of carbohydrates, proteins and fats, having good digestibility. Proteins supply in calf helps in maintaining biological processes on daily basis, as well as germinal regeneration, enhance growth and form blood. Animal proteins, such as fish meal, are more valuable to calves than plant proteins because their amino acid makeup more closely matches those of the rapidly growing calf. Some commercially available formulations containing quality nutrients **(CAFPLAN)** can be prescribed for better growth.

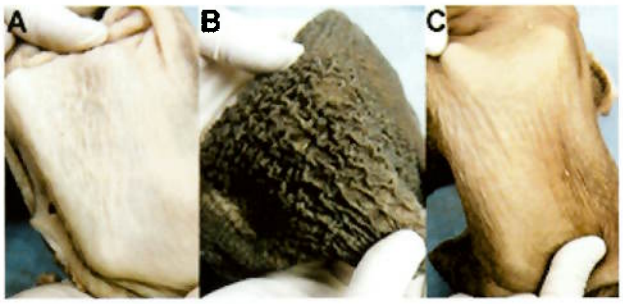

Fig 5: Rumen papillae development at 6 weeks in calves fed (A) Milk only (B) Milk and grain (C) milk and hay

The followings should be considered while selecting calf starter:

Physical form and ingredients

Select whole, coarsely ground, cracked, crushed, rolled, steam-flaked, or texturized grains. Do not feed high-moisture corn in a calf starter as it often heats and gets moldy. Avoid dusty, moldy or off-flavor feeds.

a) Pellet quality: Avoid pellets that are too hard or too soft; pellets at both extremes will affect intake.

b) Fines: Finely ground mixtures are not recommended as fine feeds tend to cake together when wet and deteriorate intake

c) Protein sources: Protein sources like, urea, raw soybeans and feather meal should be avoided. The inclusion of Vit-B complex is necessary.

d) Molasses or molasses-based products: It can be included between 5 to 8 percent of total mixture because higher levels can adversely affect handling and storage, especially when bags become cold in the winter months.

e) Coccidostats: Must be included to increase shelf life and viability.

Table 3: Requirement of calf starter and calf growth meal on DM basis (NDDB)

Characteristics	Calf starter meal	Calf growth meal
Crude protein % (min)	23	22
Crude fat % (min)	4	3
Crude fibre % (min)	7	10
Acid insoluble ash% (max)	2.5	3.5
Ionised common salt % (max)	1	1
Calcium % (min)	0.5	0.5
Phosphorus % (min)	0.5	0.5
Available phosphorus % (min)	0.2	0.2
Calcite powder % (max)	1	1
Vitamin A (min) IU/kg	10,000	10,000
Vitamin D_3 (min) IU/kg	2,000	2,000
Vitamin E (min) IU/kg	150	150
Aflatoxin B_1 (max) ppb	20	20

Note: After six months of age, calf starter should be replaced with calf growth meal which is more economical.

Hay feeding in calves

The concentrate feed is significantly more important than the roughage to develop the calf's stomach but forages are a good source of fibre, which promotes the growth of muscular layer of the rumen and helps to maintain the health of rumen lining. In addition to starter, good quality forage should be offered from 2nd week onwards (**Table 4**), little and often basis to ensure freshness and encourage intake (**Fig. 6**). Amount should be increased gradually. The forage/hay should be of good quality and free of mold. Do not feed haylage or forages with protein levels exceeding 22 percent as these feeds can contain high levels of non–protein nitrogen. Young calves are not very efficient at processing non-protein nitrogen because the rumen is not fully functioning. Calves fed forages high in non-protein nitrogen will often scour and look unthrifty with symptoms similar to coccidiosis.


Fig 6: Calves eating hay

Calves need small quantities of roughage – hay or straw. This is more important if feeding a pelleted ration. Avoid feeding too much as it can result in pot belly condition. There is a greater risk of this with overeating of hay. Where pot bellies (or hay bellies) are observed it indicates that the rumen is packed with hay which can not be digested properly.

Water

- Water accounts for 70–75% of a calf's body weight. Water should be provided free-choice starting at four days of age.
- Feeding calves free-choice water increases starter intake and weight gain.
- As per reported study, calves deprived of drinking water decreased starter intake by 31% and decreased weight gain by 38% over those calves provided water free-choice.
- Free-choice water enters the rumen and along with high-quality calf starter helps convert a calf from a simple-stomached animal to one with a functional rumen that can utilize forages and grains.
- Providing warm water (16–18°C) during cold weather may stimulate starter intake.
- In hot weather, particularly in temperatures above 25°C, the calf's water intake will increase to maintain hydration and normal body function.

Table 4: Feeding schedule of calf up to 3 month age (Reddy, 2010)

Age of calf	Whole milk/Colostrum	Calf starter	Good quality hay
1-3 days	Colostrum 1/10th bwt	-	-
4-7 days	Whole milk 1/10th bwt	-	-
8-14 days	Whole milk 1/10th bwt	-	-
15-21 days	Whole milk 1/10th bwt	A little	A little
22-35 days	Whole milk 1/15th bwt	100g	*Ad lib*
Up to 2 month	Whole milk 1/20th bwt	250 g	*Ad lib*
2-3 months	Milk is gradually reduced and tapered	500 g	*Ad lib*

- During periods of scours, dehydration will result in reduced feed intake, feed conversion and growth.
- Scouring calves will consume greater volumes of water so must be provided with continual access to water.
- By 20 days of age, water intake increases dramatically and in parallel with reductions in feeding of milk replacer and increasing starter intake.
- Calves require four times more water than feed (dry matter) or a water to feed intake ratio of 4:1 (kg basis).

Note: Supplementation of electrolyte (**INTALYTE ORAL**) is often needed for calves to replace lost fluids, restore acid-base balance and furnish nutrients and energy to the calf with moderate to severe scours.

Growth rate

Growth rate measurement of young calves provides useful information about how well they are growing. Indirectly it measures the efficiency of feed conversion. Meeting growth rate targets ensures maximum return on investment. Growth is at its most efficient in the first two months of life, so high growth rates should be targeted during milk feeding. Monitoring growth from birth can guide continual management improvements to ensure that every calf is pregnant heifer by 18-24 months of age. If both the mother and the newborn are anemic, Iron supplementation **(3D Red)** is recommended for cow health and calf's growth as well as daily weight gain.

Benefits of recording growth

- Maximize growth efficiency cost-effectively
- Identification of poor-performing and sick calves
- Achieve targeted growth rates for breeding
- Determination of Management status

For growth calculation at least two measurements should have to be done. Initial weight (birth weight) of the calf should be recorded first as this figure provide a baseline against which average daily gain (also known as daily live weight gain, DLWG) is recorded.

Effective Deworming optimizes growth

Deworming ensures the utilisation of nutrients for better and effective weight gain and improved immune status of

$$\textbf{ADG (Average Daily Gain)} = \frac{\text{Final weight} - \text{Initial weight}}{\text{Time interval (in days)}}$$

calves. Worms like *Ascaris* and *Toxocara vitulorum* in addition to neonatal diarrhoea and pneumonia are major causes of calf mortality. Nematode infestation is commonly described in India and Southeast countries hence special attention should be paid to effective prevention by following the prescribed deworming protocol *i.e.*, Piperazine, Levamisole etc

and boosting immunity through appropriate formulations. Benzimidazoles (Fenbendazole, Albendazole and Oxfendazole) *viz* **FENTAS/FENTAS PLUS**; Macrocyclic lactones (Ivermectin, Doramectin etc.) *viz* **NEOMEC/FENTAS XP/NEOMEC SX** and Imidazothiazoles (Levamisole) *viz* **NEOZIDE PLUS** are advocated with rotational deworming system to minimise parasitic resistance.

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DO YOU KNOW

- A calf is born with sterilized (2–4 litres size) stomach but rapidly colonized by bacteria within the first 24 hours of life.
- At birth abomasum makes up to 70% of the total volume of stomach.
- The rumen is very small (1 litre) in the new-born calf and develops with the provision of solid feed into the most important part of the gut (5 - 30 litre) by three months of age.
- Volatile fatty acids (VFA) produced by ruminal microbes are among the major determinants of ruminal papillary size and shape.
- Giving calves access to starter grain encourages bacterial growth and production of butyrate which in turn is utilized by the rumen wall for energy and growth. Bacteria that digest fiber produce mostly acetate.
- It takes 2 to 3 weeks for the bacterial population to grow to a number that can efficiently digest grain.
- Ruminal volume accounts for 29% of total stomach compartments at birth but increases to 55% at maturity.
- Sequential pattern of colonization with bacteria as the first colonizers, followed by methanogenic archaea, anaerobic fungi and protozoa.
- The microbial density in the fluid fraction of the rumen microbiota quickly attains concentrations as high as 109 cells ml^{-1}.
- Strict anaerobic bacteria become predominant by the 2nd day after birth.
- Cellulolytic bacteria appear in 3–5 days old calf and become abundant in 2-3 weeks.
- Rumen microbiota of 42-day-old calves contain Bacteroidetes 74.8% followed by Firmicutes (12.0%), Proteobacteria (10.4%), Verrucomicrobia (1.2%) and Synergistetes (1.1%).

For suggestions and comments, please write to us

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