

# Vitamin C—an often forgotten vitamin for calves

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**Vitamin C is a relatively low cost micro-nutrient with a strong case for supplementation to milk fed calves.**

Vitamin C (ascorbic acid) often takes a back seat to A, E or B vitamins in calf nutrient discussions. Perhaps it's because ruminants can manufacture their own vitamin C and calves are lumped in with cows by many nutritionists. However, Vitamin C is a relatively low cost micro-nutrient with a strong case for supplementation to milk fed calves.

## **What does vitamin C do for the calf?**

At a cellular level, vitamin C interacts with vitamin E. Vitamin E protects cell membranes, by doing battle with free radicals (out of control molecules that damage cells). Vitamin E gets damaged in this task and vitamin C helps regenerate vitamin E, thus allowing you to get more benefit from your investment in relatively high cost vitamin E supplementation (7).

Vitamin C has been shown to reduce ocular and nasal discharge in calves, possibly due to protection of mucous membranes (7).

Vitamin C has also been shown to enhance IgG production in highly stressed calves (6), reduce scours (9, 11, 14, 15) and naval infections (14). Some data supports benefits of vitamin C for calves during respiratory challenge (14).

Human, mice, guinea pig and rabbit research proves vitamin C can enhance parts of the immune system, leading to overall better health (12). Vitamin C is proving not to be a cure for the common cold and certainly won't stop all scourges of calf production, but it is proven to sup-

port immune function and is worth its nominal investment.

## **Doesn't the calf synthesize its own vitamin C?**

The calf has several sources of vitamin C – 1.) Body reserves at birth, 2.) Colostrum 3.) Milk or vitamin C fortified milk replacer and 4.) Synthesis in tissues such as the calf's liver.

If born from a healthy cow, a calf should have tissue reserves of ~1,000 mg of vitamin C (1). If the calf received a gallon of high quality colostrum, he builds an additional 45 mg of vitamin C reserve (2). Although one study suggests nominal generation of vitamin C by the first week (1), some of the earliest vitamin C research in cattle determined significant vitamin C is not generated within the calf's body until it is 2 – 3 weeks old (3).

One study noted vitamin C wasn't generated by the calf until four months age (4) and another study reported adult levels of vitamin C production did not occur until 3 months age (8). Knowledge of these studies leads us to supplementation with vitamin C during the first few weeks of life and the calf may benefit from supplementation beyond that.

## **Can the calf store vitamin C?**

Since C is a water soluble vitamin that's proven to transport readily from tissue to plasma, many nutritionists have deduced it demands daily supplementation. Thor-



ough, published Canadian calf research proves that blood reserves are in fact depleted by 50% within 6 hours (1). However, total body reserves are not depleted by 50% until 6+ days. This same study showed that mega-doses are not stored.

What's the take home message? Daily doses of realistic fortification levels are ideal, but the calf has some capacity to use reserves for perhaps 1 – 2 weeks.

## **How much vitamin C should I supplement?**

A gallon of whole milk contains 40 – 45 mg of vitamin C (2). To match milk's content, veal feed or calf milk replacer should be fortified with 45 mg of vitamin C per pound of powder. However, this assumes 45 mg is adequate.

In a non-stressed calf not supplemented with any vitamin C, research shows approximately 200 mg of vitamin C is released from stores

## **Bottom line on C -**

- Supports Immune function

## **Calf research on vitamin C demonstrates—**

- ↓ Scours
- ↓ Naval infection
- ↓ Respiratory disease
- ↑ IgG production
- ↑ Gain and F:G

## **Other points on C—**

- Estimated daily requirement for milk fed calves—200 mg
- Under stress, requirement ↑
- Calf doesn't synthesize their own vitamin C until about 3 weeks old
- Anecdotally, C ↑ iron absorption
- Feeding C is extremely safe
- Cost to supplement is \$0.15 to \$0.30 / calf
- Keep vitamin C dry during storage
- ~50% of vitamin C in whole milk is lost in pasteurization

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daily for use (1). If the calf receives a gallon of whole milk, or an equivalent quantity of vitamin C in milk replacer, then approximately 150 mg of vitamin C must be drawn from reserves each day (200 mg minus 50).

Synthesis of adequate vitamin C must occur within a week to prevent a deficit of this important vitamin (1,045 mg Vitamin C body reserve divided by 150 mg daily need over milk supplementation equals approximately 7 days).

This assumes body reserves were high at birth, the calf received adequate colostrum, a gallon of fresh whole milk equivalent was fed each day, the vitamin C wasn't destroyed prior consumption and stressors like disease challenge weren't higher than normal. Each of these variables has huge variation in typical production systems.

Considering vitamin C is inexpensive, I would build a strong cushion of fortification in the first few weeks of life. Animix recommends 250 – 500 mg / calf / day vitamin C formulated in calf milk replacer or veal starter formulas.

If supplementing waste milk, consider the same fortification levels. Pasteurization will likely reduce vitamin C concentration of waste milk.

In veal production, I would recommend additional fortification during periods of stress such as respiratory challenge, nutritional or bacterial scours or heat stress. In veal formulas, low levels might be warranted during the entire growth period. A rumen protected vitamin C source would be necessary post milk feeding period in heifer replacement or dairy beef production (12).

### Does demand for vitamin C increase with disease challenge or other stressors?

Published calf research shows that more highly stressed calves have lower blood concentration of ascorbate (vitamin C) at 21 days

(6) indicating either higher demand or less ability to produce vitamin C. Research in other species supports increased vitamin C uptake and release under periods of animal stress.

Calves with enteric or respiratory infection have lower blood ascorbate content indicating increased demand (9,10, 11). Pasture back-ground calves subjected to high transport stress on their way to a feedlot, showed vitamin C stores nearly depleted due to shipping stress (13).

### Does vitamin C impact iron absorption?

Most experienced veal growers and advisors believe it does. I could not find data in animal agriculture journals (any species) supporting this hypothesis; however one human study conducted on strict vegetarians in India noted a 13% increase in iron absorption due to supplementation of one gram of vitamin C daily in adult people. My guess is there's a significant interaction.

### Can I feed too much vitamin C to calves?

Research supports high upper range latitude in feeding vitamin C. In healthy calves that likely didn't have heightened vitamin C demand, no negative (or positive) effects were noted from 2,000 mg of vitamin C per day (5). High health status calves that received 3,000 mg per day vitamin C in the first week, 1,500 mg per day in the second and 750 per day in the third noted no deleterious effects and some improvements in scours.

The only detrimental feeding rate noted in the body of research on vitamin C was when 10,000 mg of vitamin C was supplemented to non-stressed calves and added vitamin E was not included. Scours significantly increased in this scenario, but interestingly when 67 IU of vitamin E was also added in addition

to this extremely high level of C scours incidence did not increase and calf performance was improved versus the negative control group receiving neither added vitamin C nor E.

Bottom line: vitamin C is a very safe compound.

### How much will it cost to supplement vitamin C?

Supplementing 250 mg of vitamin C each day for 8 weeks as a supplement would cost approximately \$0.25 - \$0.30 per calf, using retail prices.

If supplementing in the tank to veal or large dairy beef/heifer systems, perhaps supplementing 500 mg per day for 14 days and 250 mg / day for an additional 14 days would be a sound practice. This regiment would cost approximately \$0.15 - \$0.25 per calf.

When formulated into the veal feed or calf milk replacer premix, there is considerable savings but inventories of blended premix should be turned to avoid oxidation of the vitamin C.

### Is there a difference in vitamin C sources?

Products like DSM's STAY-C are very stable. They resist degradation caused by moisture, aggressive trace mineral co-ingredients or heat. Lower cost un-protected vitamin C sources are equally available to the calf if stored properly prior feeding.

If vitamin C is added to a premix, make sure inventories are turned often. According to DSM, a leading manufacturer and marketer of vitamin C, STAY-C degrades in an "aggressive" premix at approximately 10% per month from manufacture date. An "aggressive" premix is defined as one containing moisture drawing choline chloride and / or trace minerals. Un-protected vitamin C degrades at a rate of 30 - 40% per month in the same type of mix.

Moisture, and to a lesser degree heat, are the leading enemies of vitamin C stability. Make sure to keep all vitamin C handling equipment dry (scoops, your hand when reaching into the pail, etc.) to prevent degradation. Also keep containers of vitamin C sealed between use and out of direct sunlight or intense heat.

DSM estimates that 50% of vitamin C content in milk is lost in pasteurization due to heat. This estimate is based upon measured losses in pelleting pig feed.

### Vitamin C Literature Review

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