

## Review Article

<https://doi.org/10.20546/ijcmas.2018.707.023>**An Update on B Vitamin Nutrition for Cattle**

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B vitamin supplementation in ruminants is ignored conventionally following an earlier observation that they are synthesized in adequate quantities in the rumen by rumen microbes. Recent researchers reported that major cellulolytic organisms in the rumen had specific requirements for certain B vitamins. Apart from the requirements of the rumen microbes, high producing cattle also require a higher amount of vitamins to maintain their productivity and health. Sub-clinical vitamin deficiencies often go unnoticed due to the lack of proper clinical symptoms. The present review aimed at providing an update on B vitamin nutrition to cattle.

**Introduction**

B complex vitamins perform a variety of functions in the body. In ruminants, supplementation of B vitamin is largely debated owing to the general misconception that they are produced in sufficient quantity within the rumen by rumen microbes (Bechdel *et al.*, 1928). The major source of vitamins in dairy cattle is green roughages (Schwab *et al.*, 2006). In the present scenario, there is an acute shortage for high-quality green roughages, especially in the tropics. The major aim of the dairy industry nowadays is to boost milk production. Higher milk production is always associated with higher vitamin

requirements as it is utilized for higher metabolism and milk production. This situation produces vitamin deficit in cattle, which often go unnoticed due to lack of visible clinical symptoms. The present review underlines the need to revisit the fundamental concept of vitamin nutrition in dairy cows.

**Rumen microbes require specific vitamins**

Baldwin and Allison (1983) reported that all cellulolytic organisms in the rumen had obligate requirement for biotin. Biotin also improved propionate production by bacteria and thereby glucose availability for the ruminant. In addition, the growth of

*Ruminococcus* species was enhanced on supplementation of cyanocobalamin and pyridoxine. Thiamine (Orpin and Greenwood, 1986), riboflavin (Fletcher, 1956), niacin (Niehoff *et al.*, 2013), biotin (Cruyven and Bunge, 2004) and pyridoxine (McLeod and Murray, 1956) supplementation improved microbial fermentation in the rumen. This also improved the microbial proliferation and availability of microbial protein for the ruminants.

### **B complex vitamins improved health in ruminants**

Sato *et al.*, (1999) reported improvement in the neutrophil function and reduction in somatic cell count in the milk of cows with intra-mammary infections of *Staphylococcus aureus*. Niacin improved the efficiency of glucose metabolism and, supplementation at 12 g/day reduced blood levels of triglycerides and  $\beta$ -hydroxybutyric acid, and thereby

ketosis occurrence (Ghorbani *et al.*, 2008). Kaur *et al.*, (2003) reported improved conception rates in cows supplemented with niacin at 6 g/day. When niacin was supplemented in the rumen-protected form, it caused peripheral vasodilation ('flushing') that reduced heat stress by reducing core body temperature (Wrinkle *et al.*, 2012). Heat stress reduced the feed intake and milk yield by 15 to 30% (Di Costanzo *et al.*, 1997). Therefore rumen-protected niacin supplementation could nullify heat stress-induced reduction in the milk yield. Niacin, choline and Pantothenic acid, in rumen-protected form, improved the blood glucose levels (Pinotti *et al.*, 2005). Therefore supplementation of these vitamins could produce beneficial results in ketosis. Biotin is involved in the synthesis of keratin and, biotin supplementation daily at a dose rate of 20 mg/kg body weight reduced sole ulcers. Hence, biotin could be regarded as a potential beneficial agent in laminitis therapy (Bergsten *et al.*, 2003).

**Table.1** B vitamin supplementation influenced milk yield and composition

	Vitamin, dose	Findings
<b>Shaver and Bal, 2005</b>	Thiamine, 150 mg/day/cow	Higher total milk, protein and fat (2.7, 0.13 and 0.10 kg/day) yield
<b>Graulet <i>et al.</i>, 2007</b>	Folic acid (2.6 g/day), B <sub>12</sub> (0.5 g/day)	Higher total milk and milk protein yield
<b>Sacadura <i>et al.</i>, 2008</b>	Rumen protected biotin, folic acid, pantothenic acid and pyridoxine blend (3.2, 4, 40, and 25 mg/g respectively) at 3 g/day/cow	Higher total milk, protein and fat yield
<b>Karkoodi and Tamizrad, 2009</b>	Niacin at 12, 14 and 16 g/day/cow	With 14 g/day/cow, there was higher milk fat, protein yield; higher blood glucose; lower $\beta$ hydroxy butyrate
<b>Rungruang <i>et al.</i>, 2014</b>	Rumen protected niacin at 4, 8 or 12 g/day/cow	No change in milk yield
<b>Duplessis <i>et al.</i>, 2014</b>	Intramuscular injection of folic acid (320 mg) and B <sub>12</sub> (10 mg) in early lactation	Improved milk protein yield

## **B vitamin supplementation for high producing cows**

Some of the recent researches that reported the influence of B vitamin supplementation on milk yield and composition are summarized in Table 1. As folic acid is involved in the metabolism of single carbon units, it played a major role in the synthesis of methionine. Methionine is involved in the initiation step of protein synthesis. Tissues with a high rate of cell division (for e.g., hematopoietic cells, mammary gland cells) responded positively to folic acid supplementation. Bonomi *et al.*, (1998) reported improved milk production when biotin was supplemented at 10 to 20 mg/day. Ferreira (2006) concluded that the improvement in milk yield through biotin supplementation was possible in high producing cows only. Choline is one of the important 'methyl donors' in the animal system along with folic acid and B<sub>12</sub>. In dairy cattle, the output of methylated compound through milk is high. Methionine along with other compounds that supply methyl group is likely to be in short supply, especially during the early lactation when the feed intake is considerably lower compared to the actual requirement. Supplementation of choline spared other methyl donors like methionine. Higher methionine availability within the body improved protein content in the milk. Pinotti *et al.*, (2005) studied the effect of rumen-protected choline supplementation in transition cows and observed that it improved the efficiency of milk production, and lipid and methyl group metabolism in these cows. The high metabolic rates during lactation in high producing cows make it susceptible to marginal B vitamin deficiencies. NRC (2001) have quantified the ruminal escape percentage of biotin, folic acid, niacin, pantothenic acid, riboflavin, thiamine, pyridoxine and B<sub>12</sub> as 100, 3, 6, 22, 1, 52, 100 and 10% respectively. This implied that the higher

demands for certain vitamins that undergo ruminal degradation can only be met if they are supplemented in the rumen-protected or parenteral form. Fat-based encapsulation method is usually practiced when B vitamins are supplemented to high producing animals.

In conclusions, each rumen microbe has specific requirements for certain B vitamins. In the rumen, there is a phenomenon called as "cross-feeding of vitamins" between the rumen microbes through which, the B vitamins produced by certain microbes is utilized for the growth of others and vice-versa. Supplementation of B vitamins improved the microbial growth and activity in the rumen, which further raised the host nutritional status. Apart from this, there was an improvement in the host immunity, health and milk production when B vitamins were fed in the rumen-protected form. The NRC (2001) calculated daily B vitamin requirement for a dairy cow (weighed 650 kg and produced 35 kg milk/day) as 41, 156, 289, 425, 48, 6, 35, and 0.6 mg/day respectively for thiamin, riboflavin, niacin, pantothenic acid, pyridoxine, biotin, folic acid and B<sub>12</sub>. However, these values were extrapolated from the tissue level requirements of a lactating swine. Optimization of the dose of vitamins using rumen or, rumen simulation model followed by its validation through clinical trials are required for further improvement in productivity and nutrient utilization.

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