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Calf Note #274 – Sodium butyrate, too much of a "good thing"?

Introduction

Sodium butyrate supplementation has become a common practice in feeding dairy calves, particularly during the preweaning period. Butyrate, a naturally occurring product of microbial fermentation, plays an important role in gut development, epithelial health, and energy metabolism. Because young calves have an immature rumen and limited endogenous butyrate production, adding sodium butyrate to milk or milk replacer has been widely promoted as a way to enhance early growth and gastrointestinal development. Typical inclusion rates in calf milk replacers and additives to whole milk are typically about 0.2 to 0.3% (Gorka et al., 2009). When calves are fed between 750 and 1,000 g of liquid DM per day (from milk or milk replacer), this calculates to about 1.5 to 3 g of butyrate per day.

Many studies have reported positive effects of sodium butyrate on gut development and performance, leading to its increasing use in calf nutrition programs. Recent research (Nicola et al 2023) also suggests that inclusion sodium butyrate (**SB**) to whole milk (4 g of SB/d; 0.5% of milk DM; calves fed 800 g/d of milk DM) improved recovery from diarrhea and reduced the risk of relapse of disease. Higher doses (e.g., 45 g/d; Liu et al., 2021) have shown short-term improvements in growth and antioxidant status, highlighting that responses to sodium butyrate may differ depending on dose. However, an important question remains: can too much sodium butyrate have unintended consequences?

A recent study by Wu et al. (2026) published in the Journal of Dairy Science helps answer this question by examining how different levels of sodium butyrate supplementation in milk affect not only early-life responses, but also long-term growth and metabolism.

The Research

In this study , researchers assigned 80 Holstein calves (2 to 4 days of age) to one of four treatments:

- Control (no SB)
- Low dose (4.4 g/day)
- Medium dose (8.8 g/day)
- High dose (17.6 g/day)

Calves were fed milk with the assigned level of SB during the preweaning period (approximately 6 weeks). The amount of milk fed increased from 4.4 L/d from d 4 to 10, then 8.8 L/d from day 11 to 45. From day 46 to 58, milk was diluted 1:1 with milk replacer and volumes were reduced to 8 L/d (d 46-50), 6 L/d (51-55), and 4 L/d (56-58) with weaning on d 59. The concentration of SB added to the milk varied as the quantity of milk changed. Because daily SB dose was fixed but milk allowance changed, SB concentration in milk varied during the study. When calves were fed 4.4 L/day, concentrations were 1, 2, and 4 g/L for the low, medium, and high treatments, respectively; when calves were fed 8.8 L/day, concentrations were 0.5, 1, and 2 g/L.

At 15 months, researchers evaluated growth, metabolic status (via blood biochemistry and metabolomics), and gastrointestinal microbiota. This design allowed the researchers to assess not only short-term effects, but also long-term "programming" effects of early-life nutrition.

Key Results

High dose impaired structural growth. Heifers that received the high dose of SB had reduced withers height compared with control animals, indicating impaired skeletal growth. Interestingly, body weight was not significantly different, suggesting subtle but meaningful effects on frame development rather than overall mass. The table below shows the differences in withers height among treatments.

Supplemental Table S2. Growth and reproductive performance indices of dairy heifers at 15 months of age.

Items	Supplementation Level (g/d)				SEM	*P*-value
	0	4.4	8.8	17.6		
Growth related indices						
Number of heifers	10	10	12	10	-	-
Body weight (kg)	414.95	403.47	404.17	397.90	3.161	0.397
Withers height (cm)	129.19^{a}	126.76^{ab}	127.04^{ab}	125.65^{b}	0.433	0.040
Hearth girth (cm)	182.13	180.38	181.02	178.87	0.582	0.298
Body length (cm)	142.12	141.62	140.54	141.86	0.607	0.813
Reproductive related indices						
Age of first estrus (month)	13.40	13.08	13.02	13.16	0.072	0.271
Number of artificial insemination (n)	1.82	1.70	1.86	1.50	0.148	0.814

SEM = standard error of the means. $^{a–b}$ Means without a common superscript within a row differ significantly ($P < 0.05$).

Metabolism was altered in high-dose animals. High-dose supplementation resulted in clear changes in metabolic profiles increased indicators of liver stress (e.g., elevated ALT and bilirubin), altered lipid and sterol metabolism, reduced circulating cholesterol and changes in key metabolites. These findings indicate that early high-dose supplementation disrupted normal metabolic regulation later in life.

Rumen microbiota were negatively affected. Heifers that received high levels of SB as calves had reduced microbial diversity and richness in the rumen, decreases in beneficial bacterial populations, altered predicted microbial functions, including reduced steroid biosynthesis. These changes suggest that excessive supplementation may interfere with normal rumen microbial development, with lasting consequences.

Effects were dose dependent. Importantly, these negative outcomes were primarily observed at the highest dose. Lower and moderate levels did not show the same detrimental effects and, in some cases, showed modest positive responses in metabolic indicators. This reinforces the idea that responses to sodium butyrate are not simply "good or bad," but depend heavily on dose.

One additional challenge in interpreting sodium butyrate research is the wide variation in feeding rates used across studies. Reported supplementation levels range from approximately 3 g/day in some practical feeding programs to as high as 45 g/day (e.g., Liu et al., 2021; Ma et al., 2023) – or even more when expressed on a milk concentration basis – creating substantial differences in actual intake.

This lack of consistency makes it difficult to compare results among studies and may help explain why responses to sodium butyrate are sometimes inconsistent. Clearly, the difference between moderate and high supplementation can be quite large—and biologically important.

Summary

Sodium butyrate remains a valuable tool in calf nutrition. Its ability to support gut development and early performance is well documented, and its use in milk or milk replacer is now common on many farms. However, this research highlights an important principle: more is not always better.

High levels of SB supplementation during early life can disrupt rumen development, alter metabolism, and impair long-term growth. These effects appear to be driven, at least in part, by changes in the rumen microbiota and downstream metabolic pathways.

The practical takeaway is clear:

- Sodium butyrate can be beneficial at appropriate levels
- Excessive supplementation may do more harm than good
- Feeding programs should focus on optimal—not maximal—levels

As with many aspects of calf nutrition, success comes from balance. Even beneficial additives must be used thoughtfully, because there can indeed be too much of a good thing.

References

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