To Buffer or Not? Supplemental Bicarb and Subacute Ruminal Acidosis

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Summary

- SARA is characterized by elevated total VFA concentration caused by excessive intake of fermentable carbohydrates
- Shortage of ruminal buffers can be met by supplementing dietary buffers
- Including sodium bicarb in corn silage based diets can increase ruminal pH, DM intake, and milk fat production
- Research shows no benefit of feeding above 1.0% sodium bicarb on production
- Access to palatable sodium bicarb can reduce the duration and severity of a SARA challenge

Introduction

Dietary requirements of energy and fiber are not easily met for the high yielding dairy cow. This is especially true for early lactation cows because their energy expenditure exceeds the energy consumed. Diets high in starch and low in fiber are fed to increase intake of energy, but these diets increase the risk of subacute ruminal acidosis (SARA). Subacute ruminal acidosis occurs when the production of fermentation acids exceeds the ability of the animal to remove or neutralize the acids produced (Allen, 1997). This ultimately leads to a drop in rumen pH which has detrimental implications for animal health, including laminitis and death. Increasing the ruminal input of buffers from the diet or from saliva helps prevent such a depression in ruminal pH. Sodium bicarbonate is an important endogenous buffer of ruminal pH (Erdman, 1988) and it is also the most common buffer used in the dairy industry. Although addition of buffers to diets for lactating dairy cows has been extensively investigated the responses often varies, making it hard to determine if an optimal level of buffer addition exists for lactating dairy cows.

Subacute Ruminal Acidosis

Subacute ruminal acidosis (SARA) is defined as periods of moderately depressed ruminal pH (about 5.5-5.0) that are between acute and chronic in duration (Garret et al., 1999; Nordlund et al., 1995). Whereas lactic acid is often associated with acute ruminal acidosis it does not consistently accumulate in the ruminal fluid of dairy cattle affected with SARA (Oetzel et al., 1999); however, transient spikes of ruminal lactate of to 20 mM can be discovered if ruminal lactate concentrations are measured frequently during the day (Krause and Oetzel, 2005). The generally low lactate concentrations measured during SARA suggests that elevated total VFA concentration is the main cause of low ruminal pH.

Excessive intake of rapidly fermentable carbohydrates is the most obvious cause of ruminal acidosis in dairy cattle. Because of their relatively high dry matter intakes, dairy
cattle cannot tolerate diets as proportionately high in concentrates as beef feedlot diets. An important goal of effective dairy cow nutrition is to feed as much concentrate as possible, in order to maximize production, without causing ruminal acidosis.

Several excellent reviews on ruminal acidosis, its implications on animal health, and nutritional approaches to minimize acidosis in dairy and beef cattle have been published (Nocek, 1997; Owens et al., 1998; Stone, 2004; Nagaraja and Titgemeyer, 2007). In short, formulating rations that minimize the risk of SARA and yet optimize production is a balancing act between providing energy in the form of non-fiber carbohydrates (NFC) and stimulating endogenous buffer delivery to the rumen by providing coarse fiber (NDF) for adequate rumination activity. However, the effect of the level of NFC fed varies with the extent and rate of fermentation. Also, dietary fiber level can not be used alone because ruminal fermentation of fiber is variable (Nocek and Tamminga, 1991), and because physical characteristics of fiber influence ruminal fermentation and utilization, animal metabolism, and milk fat production independently of the amount of chemically measured NDF (Mertens, 1997).

The effect of increasing fermentability of the grain source fed and the effect of changing particle size of the forage on ruminal pH variables are illustrated in the figure below. In this experiment cows were fed a TMR with a concentrate to forage ration of 61:39 (DM basis). The concentrate was either based on dry, cracked corn or ground high moisture corn. The sole source of forage was alfalfa silage; either coarsely or finely chopped.

![Figure 1](image-url)

**Figure 1.** Effect of level of ruminally fermentable carbohydrates and forage particle size on mean ruminal pH and area under pH 5.8 (from Krause et al., 2002).

**Physiology of Ruminal pH**

Ruminal pH drops below physiological levels when ruminants consume excessive amounts of easily fermentable carbohydrates. Each cow’s inherent capacity to absorb fermentation acids and to buffer the rumen contents determines how much her ruminal pH will decrease after a meal containing large amounts of fermentable carbohydrates. This is illustrated by the large animal to animal variation in ruminal pH between cows fed the same diet.
Ruminal pH varies considerably during the course of a day, and is particularly driven by the amount of fermentable carbohydrate in each meal. Shifts of 0.5 to 1.0 pH unit within a 24-hour period are common (Dado and Allen, 1993; Nocek et al., 2002). This represents a 5- to 10-fold change in hydrogen ion concentration in the rumen (pH is a log base 10 transformation of hydrogen ion concentration). A typical pattern of ruminal pH variation during the day is presented in Figure 2. The enormous changes in ruminal pH after eating make it very difficult to evaluate ruminal pH, even in research settings. Continuous acquisition of ruminal pH data by indwelling electrode, as illustrated in Figure 2, provides the most information possible about post-feeding variations in ruminal pH.

Figure 2. Diurnal variations in ruminal pH over a period of 24 hours. The cow was fed dry, cracked corn grain and finely chopped alfalfa silage twice daily (12 h interval). Dry matter intake of the current day was 50.0 lbs. Average ruminal pH for that day was 5.87 with a standard deviation of 0.25 and a range from 5.40 to 6.61 (previously unpublished data from Krause and Combs, 2003).

Because ruminal acid production from fermentation of carbohydrates varies so much from meal to meal, ruminants possess highly developed systems to maintain ruminal pH within a physiological range of about 5.5 to 7.0. Low ruminal pH may be associated with increased osmolality of the ruminal contents, which in turn inhibits feed intake (Carter and Grovum, 1990). In beef cattle, depressed dry matter intake becomes especially evident if ruminal pH falls below about 5.6 (Fulton et al., 1979). Inflammation of the ruminal epithelium (rumenitis) could also play a role in depressing feed intake following ruminal acidosis. The precise pH thresholds for subtle reduction or variation of intake in dairy cattle are not known.

Although accumulation of lactate is not generally associated with SARA even small amounts of lactate affects ruminal pH negatively, as lactate is a 10 times stronger acid than the VFA (pKa of 3.0 versus 4.8 for the VFA). When feeding high levels of starch and/or sugars combined with low ruminal pH *Streptococcus bovis* begins to ferment glucose...
to lactate instead of VFA, which further decreases ruminal pH (Russell and Hino, 1985). An adaptive response to this scenario is invoked and lactate-utilising bacteria, such as *Megashaera elsdenii* and *Selenomonas ruminantium*, start metabolising lactate and begin to proliferate (Goad et al, 1998). Periods of very high ruminal pH, as during feed deprivation, or during periods of high forage intake, such as the far-off dry period, may inhibit the growth rate of certain populations of lactate utilizers, which are sensitive to higher ruminal pH (Mackie and Gilchrist, 1979), and leave the rumen ecosystem more susceptible to severe ruminal acidosis. Feed deprivation may also reduce the buffering capacity of the rumen contents, as rumen contents, in the form of ingested forages, have inherent buffering or acid-consuming capacities (McDonald et al., 1991). Impaired buffering capacity can cause a greater decrease in ruminal pH when the animal is re-fed. Besides disrupting microbial balance and reducing buffering capacity, feed deprivation causes cattle to overeat when feed is re-introduced (see Table 1).

**Table 1.** Size and length of the first meal in cows fed a TMR once daily and challenged with SARA by restricting feed intake to 50% on day 5 and spiking the TMR with 7.7 lbs barley/wheat pellet on day 6 (from previously unpublished data by Krause and Oetzel).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline (Days 1-4)</th>
<th>Restricted (Day 5)</th>
<th>SARA Challenge (Day 6)</th>
<th>Recovery (Days 7-9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size, lbs as fed</td>
<td>17.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>15.0&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>24.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>12.3&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Length, min</td>
<td>36.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>30.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>55.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27.3&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total DMI, lbs</td>
<td>43.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>22.7&lt;sup&gt;c&lt;/sup&gt;</td>
<td>51.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>41.4&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a,b,c</sup>Means within a row with different superscripts differ (*P* < 0.05).

This creates a double effect in lowering ruminal pH. As a result, cycles of feed deprivation and re-feeding are more important risk factors for SARA than is diet formulation itself. In fact, this scenario is utilized to induce SARA in research settings (Krause and Oetzel, 2005). Figure 3 shows an example of the change in ruminal pH in a cow which was 50% feed restricted on one day and then fed a normal amount of TMR spiked with 7.7 lbs barley/wheat pellet on the following day (SARA challenge day).
Figure 3. Example of changes in ruminal pH in a cow during a SARA challenge experiment. The cow was fed a TMR once daily and on the SARA challenge day the TMR was spiked with 7.7 lbs of barley/wheat pellet. Ruminal pH values have been averaged by hour. Gaps in graph represents missing data (Previously unpublished data by Krause and Oetzel).

Removal and Neutralization of Fermentation Acids

The ability of the rumen to rapidly absorb organic acids also contributes to the stability of ruminal pH. Absorption of VFA from the rumen occurs passively across the ruminal wall (Bergman, 1990). If the absorptive capacity of these cells is impaired (e.g., chronic rumenitis with fibrosis), then it becomes much more difficult for the animal to maintain a stable ruminal pH.

As ruminal pH drops below the physiological threshold of about 5.5, cattle develop SARA. Fortunately, ruminal VFA have a pKa of about 4.9, which means that they are rapidly shifting toward the undissociated (protonated) form at this pH. This removes a free hydrogen ion from the ruminal fluid and greatly facilitates their absorption across the ruminal epithelium, since only undissociated acids can be passively absorbed.

Hydrogen ions produced in the rumen are removed rapidly by absorption as VFA, but the hydrogen ions remaining in the rumen must be removed in order to maintain physiological pH. Hydrogen ions are removed by alkalinization and buffering by saliva, by feed, and by feed degradation products, but saliva is by far the most important. The two major buffers in saliva are bicarbonate and phosphate. Saliva composition is relatively constant and not greatly affected by diet or level of intake (Erdman, 1988). However, saliva composition might change during heat stress. It has been hypothesized that the increased loss of CO2 with panting during heat stress may decrease the bicarbonate pool available for buffering in the rumen via salivary secretion (Schneider et al., 1984).

Bicarbonate is the most prevalent and most important ruminal buffer (Counotte et
al., 1979) and includes two major ionic forms: \( \text{HCO}_3^- \) and \( \text{CO}_3^{2-} \). The \( \text{HCO}_3^- \) is of importance to buffering the blood because it may be protonated to \( \text{H}_2\text{CO}_3 \) and establish equilibrium with dissolved \( \text{CO}_2 \) and \( \text{H}_2\text{O} \):

\[
\text{CO}_2 + \text{H}_2 \Leftrightarrow \text{H}_2\text{CO}_3 \Leftrightarrow \text{HCO}_3^- + \text{H}^+
\]

The \( \text{CO}_2 \) is exhaled or removed by urine, thus resulting in removal of a proton equivalent. Ruminal pH is usually lower than blood pH and exchange between the rumen fluid and the outside air is not regulated like breathing. Kohn and Dunlap (1998) investigated the buffering capacity of bicarbonate in ruminal fluid. Ruminal gasses and liquid are in close contact, so equilibrium can be attained. The authors pointed out that \( \text{HCO}_3^- \) added to the rumen in saliva or feed will be protonated and result in \( \text{CO}_2 \) formation in the gas phase. Eventually, the \( \text{HCO}_3^- \) added is removed from the system via eructation. As more acid is produced by fermentation, the buffer is consumed to maintain the pH.

The amount of saliva secreted each day depends on the physical nature and the moisture of the feed consumed (Baily, 1961). However, when forages are adjusted for dry matter content, the differences in saliva secretion are minor. In fact, most of the differences in amount of saliva added to a given amount of feed are caused by differences in eating rate between feeds. Unfortunately, saliva production is not triggered by declining ruminal pH, but rather is determined by the amount of time the cow spends eating, ruminating and resting.

**Supplemental Bicarbonate**

Dietary buffers, particularly sodium bicarbonate (SB), have been added to dairy cattle diets in an attempt to meet this shortage in ruminal buffers and decrease the incidence of SARA. Buffers can either be force-fed to cattle (i.e., added directly to the cow’s mixed ration or grain mix) or offered free choice.

Addition of SB to diets for lactating dairy cows has been extensively investigated. Hu and Murphy (2005) evaluated the addition of SB to diets fed to early- and mid-lactation cows by a statistical analysis of 27 published studies. The NDF, ADF, and forage content of the diets fed in these studies ranged from 27.2-44.3%, 7.7-28.2%, 25-60%, respectively (DM basis). Dietary SB was categorized according to amount in the diet (DM basis) as control (0%), moderate (0.7-1.0%), or high (1.05-1.5%). Forage type in the ration was categorized as corn silage, when it was the sole or main forage, or as forage other than corn silage, when alfalfa hay, or silages based on alfalfa, barley, sorghum, triticale, or wheat were the sole or main forages. There was no benefit of feeding buffer on DMI or milk production when the forages fed were others than corn silage. However, cows fed corn silage without SB ate 2.73 lbs/d less DM than cows supplemented with SB (Table 2). This increase in DMI did not result in an increase in milk yield, but milk fat percentage and yield increased when cows were supplemented with SB. Ruminal pH increased 0.13 units and the acetate:propionate ratio increased by 0.26. There was no difference between the moderate and high levels of SB supplementation, indicating that addition of 0.7-1.0% SB was optimal for early- and mid-lactation cows.
Table 2. Contrast of NaHCO₃ addition in dairy cows fed corn silage based diets (modified from Hu and Murphy, 2005).

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Control vs. Moderate + High SB</th>
<th>Moderate vs. High SB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate*</td>
<td>P</td>
</tr>
<tr>
<td>DMI, lbs/d</td>
<td>-2.73</td>
<td>0.02</td>
</tr>
<tr>
<td>Milk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield, lbs/d</td>
<td>-1.63</td>
<td>0.45</td>
</tr>
<tr>
<td>Fat %</td>
<td>-0.27</td>
<td>0.02</td>
</tr>
<tr>
<td>Fat yield, lbs/d</td>
<td>-0.23</td>
<td>0.01</td>
</tr>
<tr>
<td>Rumen pH</td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Ace:Prop</td>
<td>-0.26</td>
<td>0.04</td>
</tr>
</tbody>
</table>

* A negative estimate indicates an increase when adding SB to the diet.

Other reviews of effects of buffers (Erdman, 1988; Stables and Lough, 1989) also concluded that there was no response to their addition when diets not containing corn silage were fed. This can possibly relate to the effectiveness of alfalfa hay in stimulating rumination, the relatively high intrinsic buffering capacity of alfalfa, and also to the higher initial pH of alfalfa or grass silage compare to corn silage (Erdman, 1988). However, in the review by Hu and Murphy (2005) forage type was confounded with ADF content of the diet, so the differences in response to buffer treatments related to forage type might be associated with variation in the ADF contents of the forages fed.

Force feeding buffers may result in higher expenses than necessary, since not all cows require the same extent of dietary buffering. Free-choice feeding of buffers could be economically efficient, since in theory it allows cows to consume buffers only as needed. This requires that the cow have the ‘nutritional wisdom’ to consume buffers in proportion to her need for dietary buffering. This theory was not supported by Cottee et al. (2004), who reported that cows, when subjected to SARA (significant decrease in mean ruminal pH of 0.28 pH units and significant increases in time and area below ruminal pH 5.6), showed no difference in preference of a SB supplemented water source to unsupplemented water. Similarly, Keunen et al. (2003) found no preference to free-choice SB in cows induced with SARA. These studies indicate that cows do not attempt to ‘correct’ an imbalance in rumen environment by increasing intake of SB.

Since undiluted SB may be unpalatable, it is possible that cows with low ruminal pH may not consume enough free choice SB in order to elicit a positive reinforcement. When SB was included in a pelleted, high-energy density feed, Cooper et al. (1996) found that feed intake of sheep increased. Also, Phy and Provenza (1998) found that after feeding rolled barley, lambs preferred pellets with SB (2% as fed basis) to pellets with NaCl. These findings suggest that incorporating SB into a highly palatable free-choice supplement might increase intake of SB during a bout of SARA.

### Supplemental bicarb and SARA

Krause et al. (2008) evaluated the effects of a low-moisture molasses buffer block on ruminal pH and milk production in cows induced with SARA. The experimental
schedule consisted of a 3-day initial baseline period (days 1-3, without buffer blocks available), a 4-day period to evaluate the response to the buffer blocks (Buffer-lyx™, Ridley Block Operations, MN; days 4-7, with buffer blocks available to the cows assigned to the buffer block treatment), one day of 50% feed restriction (day 8), one day of induced SARA (day 9), and a 3-day recovery period (days 10-12). Daily block intakes ranged from 0.13 to 1.96 lbs DM, with cows consuming more of the buffer blocks on the days they were first introduced and on the day of restricted feed intake. Cows did not consume more buffer block when their ruminal pH was low on the SARA challenge day indicating that they were not ‘nutritionally wise’. However, the increased buffer intake on the day prior to the SARA challenge might have ‘prepared the cows better’ for the SARA challenge.

Average buffer block intake was 0.73 lbs DM/d, which would result in an intake of approximately 0.29 lbs NaHCO₃. According to Kohn and Dunlap (1998) this should increase ruminal pH from 6.00 (mean pH during baseline period for cows with access to buffer blocks) to 6.53, assuming a rumen fluid volume of 50 L, however, no increase in ruminal pH was observed when cows were given access to buffer blocks.

Although there was no statistically difference in daily mean ruminal pH, hours and area spent below pH 5.6, and daily nadir pH between cow with and without access to buffer blocks, there was still a difference in how cows responded to the SARA challenge (Table 3). Cows on the control treatment tended \( (P = 0.06) \) to experience a greater decrease in mean ruminal pH when induced with SARA than cows with access to buffer blocks \(-0.55 \text{ versus } -0.20 \text{ pH units}\). The cows with access to buffer blocks also tended to recover from the SARA incident better than the control cows \( (P = 0.06) \), and their ruminal pH actually increased \( (0.15 \text{ pH units}) \) during recovery compared to the period before the SARA challenge. In contrast, control cows had lower ruminal pH during recovery than the period before the SARA challenge \(-0.16 \text{ pH units}\). Cows with access to buffer blocks also had numerically higher daily DMI during the recovery period than control cows \( (39.0 \text{ versus } 32.2 \text{ lbs}) \); these findings are consistent with the higher ruminal pH values.

Table 3. Effect of treatment (access or no access to buffer blocks) on change of selected ruminal pH variables.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Control</th>
<th>Buffer Block</th>
<th>SED¹</th>
<th>( P )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change from buffer access period to SARA challenge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean pH</td>
<td>-0.55</td>
<td>-0.20</td>
<td>0.15</td>
<td>0.06</td>
</tr>
<tr>
<td>Hrs &lt; 5.6, h/d</td>
<td>9.7</td>
<td>4.1</td>
<td>2.0</td>
<td>0.02</td>
</tr>
<tr>
<td>Area &lt;5.6, pH × minutes/d</td>
<td>249</td>
<td>83</td>
<td>55</td>
<td>0.01</td>
</tr>
<tr>
<td>Nadir pH</td>
<td>-0.77</td>
<td>-0.47</td>
<td>0.21</td>
<td>0.34</td>
</tr>
<tr>
<td>Change from buffer access period to recovery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean pH</td>
<td>-0.16</td>
<td>0.18</td>
<td>0.15</td>
<td>0.06</td>
</tr>
<tr>
<td>Hrs &lt; 5.6, h/d</td>
<td>1.5</td>
<td>-3.0</td>
<td>2.0</td>
<td>0.06</td>
</tr>
<tr>
<td>Area &lt;5.6, pH × minutes/d</td>
<td>21</td>
<td>-69</td>
<td>52</td>
<td>0.20</td>
</tr>
<tr>
<td>Nadir pH</td>
<td>-0.11</td>
<td>0.39</td>
<td>0.21</td>
<td>0.06</td>
</tr>
</tbody>
</table>

¹SED = standard error of the difference.
These results indicate that cows with access to buffer blocks were able to handle the SARA challenge better than the control cows. Although there was no significant difference in mean ruminal pH on the SARA challenge day (5.70 and 5.94, for the control and buffer block cows, respectively), cows with access to buffer blocks had numerically higher ruminal pH than control cows from 10 hours post feeding and until next feeding (Figure 4).

![Graph](image.png)

**Figure 4.** Hourly mean ruminal pH on SARA challenge day for control cows and cows with access to buffer blocks. Control: ▲; Buffer block treatment: ●.

**Heat Stress and SARA**

Cows challenged with heat stress are at increased risk of developing SARA. Several researchers have hypothesized that the increased loss of CO₂ associated with increased panting may decrease the bicarbonate pool available for buffering the rumen via salivary secretion. Also, panting cows often drool more, thereby reducing the amount of saliva entering the rumen. A reduction in DMI is the primary reason milk production declines during heat stress periods. In addition to decreasing intake cows might be selecting against forages, as the heat increment (associated with digesting and metabolizing the feedstuff) is higher for forages than for concentrates. Due to the reduced DMI and the higher heat increment of forages, nutritionists frequently increase the energy density of the diet. This is often done by increasing the amount of concentrates fed, thereby further increasing the heat stressed cow’s risk of developing SARA. Several researchers have found that dietary addition of SB increased DMI and milk production in cows subjected to heat stress (Escobosa et al., 1984; Schneider et al., 1984; Schneider et al., 1986).

Feeding SB during heat stress can be beneficial for two reasons. First, as mentioned above, SB can help meet the shortage of salivary buffers, probably increase ruminal pH and prevent or reduce problems with SARA. Secondly, addition of Na to the diet can increase the dietary cation-anion balance (DCAB). Research has demonstrated that heat
stressed cows responded to increasing DCAB (Na + K – Cl) from 120 to 464 meq/kg DM regardless of whether Na or K was used (West et al., 1992).

Hu and Murphy (2005) did not find any further increase in DMI and milk production when supplementing SB above the level of 0.7-1.0% of diet DM, indicating that this is the optimal level of supplementation with regard to production. The authors did not report a difference in ruminal pH between the moderate (0.7-1.0%) and high (1.05-1.5%) level of SB supplementation. However, the studies evaluated by Hu and Murphy (2005) did not measure ruminal pH continuously, but sampled ruminal pH throughout the day. Detecting treatment difference in ruminal pH requires a substantial number of samples both within a day, but also across days (Leonardi et al., 2006). Also, mean ruminal pH can often remain unchanged while hours and area below a certain pH value is affected by a dietary treatment (Krause and Combs, 2003; Kennelly et al., 1999). It is possible that the optimal level of SB supplementation with regard to long-term cow health is not the same as the optimal level for short-term production parameters. In addition, none of the studies evaluated in the analysis by Hu and Murphy (2005) included cows experiencing heat stress. Unfortunately, no research is available to address the optimal level of buffer supplementation with regard to long-term animal health in cows experiencing SARA.

Palatability is usually not an issue when buffers are fed as part of a TMR. Early studies showed a decrease in concentrate intake when feeding 3.0% bicarb as part of the concentrate mix (Davis et al., 1964). But as mentioned above, there is no research available that supports feeding buffers at levels above 0.7-1.0% of DM. The NRC (2001) recommends that buffers be fed at 0.6 to 0.8% of DMI. When increasing SB supplementation above this level one needs to consider the cost of supplementation and if the response is economical. Also, when increasing the level of buffers in the ration, the amount of some other ingredient will invariably be decreased and energy density of the diet is likely to decrease.

**Summary**

Subacute ruminal acidosis occurs because of either excessive intake of fermentable carbohydrates or inadequate intake of coarse fiber, or a combination of the two. The shortage of ruminal buffers experienced during SARA can be met by addition of dietary buffers such as SB. Research shows that addition of SB to the diet can increase DMI, milk production and milk fat percentage. Access to palatable SB can also reduce the duration and the severity of a SARA challenge. Based on the current research the recommended level of buffer addition is between 0.6 and 0.8% of DMI. However, more research is needed in order to determine the optimal amount of buffer supplementation for cows experiencing SARA.

**References**


