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Animal Nutrition

Evaluation of Minerals as Rumen Buffers
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The efficacy of traditional buffers such as sodium bicarbonate or sodium sesquicarbonate is well documented. Increasing use over the years is a testament to the consistent response and economic return associated with their use. The use of other mineral ingredients as buffers has seen varying acceptance and response. In order to be effective as a buffer, the ingredient must be soluble in the common range of rumen pH, 5.5-6.5, the common range of rumen pH. If the solubility is low, little reaction can occur and consequently, no buffering. Table 1 shows the solubility of reagent grade materials in hot and cold water. As shown, the solubility of S-Carb® and sodium bicarbonate are relatively high, and the solubility of calcium carbonate (limestone) and magnesium oxide are significantly lower.

As sodium bicarbonate becomes solubilized in the rumen, the resulting reaction can be shown as:

$$NaHCO3 \longrightarrow Na^{+} + HCO_3^{-}$$

The sodium and bicarbonate are available for absorption across the rumen wall, or maintaining the bicarbonate buffer system in the rumen.

S-Carb's reaction in the rumen is first to absorb an hydrogen ion [H^{+}] then to solubilize as shown:

$$NaCO_3 \bullet NaHCO_3 \bullet 2H_20 + H^{+} \longrightarrow 2Na^{++} + 2HCO_3^{-} + 2H_20$$

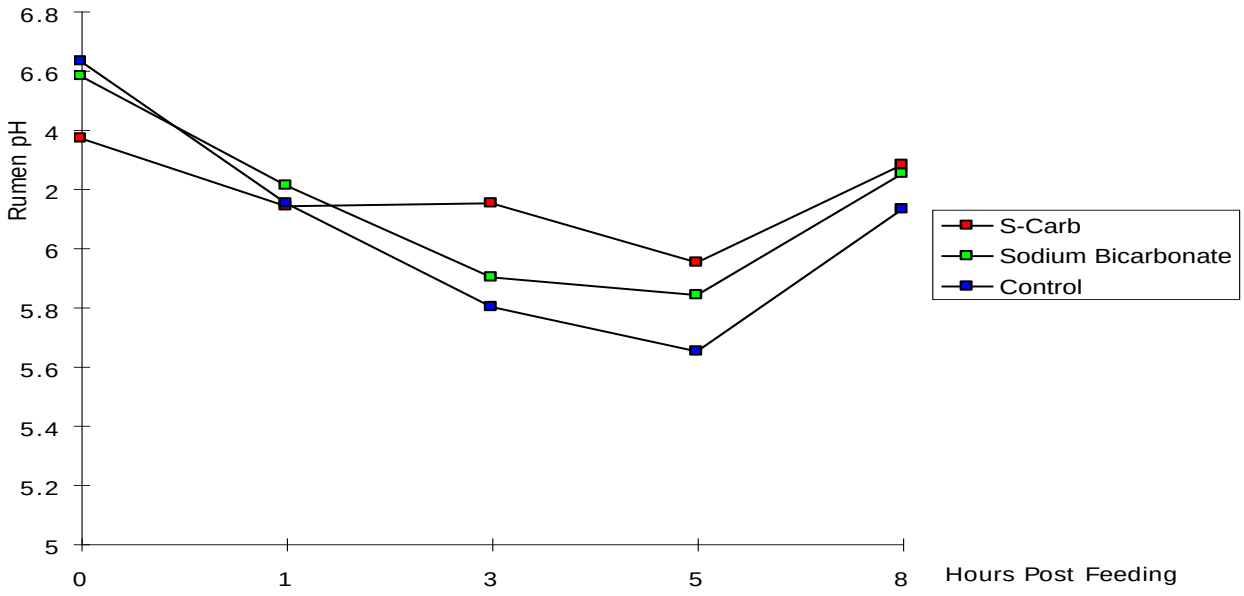
This reaction is dependant on the amount of hydrogen ion [H^{+}] present. Thus the more acid the rumen, the more hydrogen ion is present, and the effectiveness of S-Carb is greater. The effect of both S-Carb and sodium bicarbonate on rumen pH in rumen fluid is shown in figure 1. Both sodium bicarbonate and S-Carb significantly aid in the maintenance of optimum rumen pH.

Table 1: Comparitive Solubility of Minerals

Ingredient	Cold Water Solubility gms/100 cc	Hot Water Solubility gms/100 cc
Sodium bicarbonate (NaHCO3)	6.9	16.4
S-Carb® (sodium sesquicarbonate)	13.0	42.0
Calcium Carbonate	0.0015	0.0019
Magnesium Oxide	0.0062	0.0086

CRC Handbook of Chemistry & Physics, 1971

Figure 1: Effect of S-Carb and Sodium Bicarbonate on Rumen pH



It must be remembered that rumen solubility is not necessarily indicative of bioavailability. As these minerals pass through the abomasum, where the pH is significantly lower, they may become soluble and hence, available for absorption across the intestinal wall. *This process will make the mineral availble to meet mineral requirements, but as it only becomes available past the rumen, is not effective as a rumen buffer.*

Magnesium Oxide (MgO):

Magnesium is one of many minerals that is commonly accounted for and balanced in livestock rations. To meet requirements it is often necessary to add magnesium directly from mineral sources. Commonly, the source of added magnesium is magnesium oxide. Magnesium oxide quality will vary widely with processing. Although Magnesium oxide is chemically classified as an alkalizer, it is often included in buffer mixes. Research data shows buffer response, as measured by changes in milk components, may be improved when sodium buffers and magnesium oxide are fed in combination.

Calcium Carbonate ($CaCO_3$):

Calcium is essential to bone formation, muscle function, nerve function, and many enzymatic systems found in the body. Calcium may be the most commonly supplemented mineral in animal nutrition. A common source of supplementation is calcium carbonate. Feed grade calcium carbonates, often referred to as limestone, vary widely in quality and bioavailability, dependant on source and processing. The use of calcium carbonates as a rumen buffer is of limited value as indicated by the limited

solubility. However, the benefits of adequate calcium on performance often require inclusion in diets – as a calcium source, not a buffer.

Conclusion:

There are many reasons to add minerals such as magnesium oxide or calcium carbonate to dairy diets. Not the least of these is to insure adequate mineral levels and optimum performance. However, when evaluated only as a rumen buffer, there is little justification for their use.

If a rumen buffer is deemed necessary by a nutritionist, the addition of S-Carb, or sodium bicarbonate are the 'gold standards' of the industry.