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# Comparison of Solubility of Buffers in Rumen Fluid

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A study recently completed by Dr. Mike Allen at Michigan State University evaluated the *in vitro* solubility of feed grade buffers in rumen fluid. The buffers evaluated were S-Carb®, feed grade sodium sesquicarbonate, feed grade sodium bicarbonate, feed grade Magnesium Oxide supplied by Premier Chemical, Brucite (naturally occurring magnesium oxide), a Trona Buffer (unrefined sodium sesquicarbonate) and combinations of the buffers. The combination buffers were S-Carb® and Brucite ore, and S-Carb® and Magnesium Oxide HR93.

Rumen fluid for this study was collected from a cannulated, non-lactating dairy cow consuming alfalfa hay. The pH of the rumen fluid was measured fifteen minutes after collection. The rumen fluid was then blended and sequentially filtered through 4 layers of cheesecloth and glass wool and autoclaved. The rumen fluid was then stored at 4°C until used.

Buffer samples were weighted into flasks and 25ml of prewarmed rumen fluid was added. Five flasks of each sample were prepared. The flasks were stoppered and incubated in a water bath at 39°C. Solution pH and solubility of sodium and magnesium were analyzed at 0, 3, 6, 12 and 24 hours. All samples were run in triplicate.

Solubility was calculated relative to the rumen fluid control samples for each incubation time and expressed as a percentage of the amount added to each sample. Sodium and magnesium solubility of the individual ingredients is shown in the following table.

**Magnesium and Sodium Solubility of Individual Ingredient.**

| | Magnesium Solubility | | Sodium Solubility | | |
|---|---|---|---|---|---|
| hours | MagOx | $Mg(OH)_2$ | S-Carb® | Sodium Bicarbonate | Trona |
| 3 | 7.60 % | 6.00 % | 54.27 % | 47.16 % | 59.96 % |
| 6 | 8.06 % | 6.90 % | 40.32 % | 45.64 % | 43.94 % |
| 12 | 9.13 % | 6.91 % | 37.15 % | 42.92 % | 40.48 % |
| 24 | 8.49 % | 8.72 % | 35.91 % | 42.45 % | 39.20 % |

* S-Carb® is purified sodium sesquicarbonate.
MagOx is Premier Services HR93 magnesium oxide.
$Mg(OH)_2$ is magnesium hydroxide.

The solubility of the mixture of buffers is shown in the following table. The results show that when analyzed in a mixed buffer, the solubility of sodium and magnesium may be increased. This effect may be due to the increased concentration of $CO_2$ in solution over time

from the solubilization of the S-Carb®. Solubility of MagOx will also increase with increasing concentration of $CO_2$.

**Sodium and Magnesium Solubility Data of Mixed Buffer**

| | S-Carb® / MagOx 3:1 Mix | |
|---|---|---|
| hours | Na | Mg |
| 3 | 54.37 % | -3.61 % |
| 6 | 62.58 % | 5.22 % |
| 12 | 72.60 % | 12.69 % |
| 24 | 65.51 % | 20.86 % |

* S-Carb® is purified sodium sesquicarbonate.
MagOx is Premier Services HR93 magnesium oxide.

The mixes containing S-Carb® and magnesium oxide had pH values that were between S-Carb® and magnesium oxide. The magnesium solubility was highest in the combination of S-Carb® and magnesium oxide. This may be due to increased concentration of $CO_2$ in the solution as S-Carb® solubilizes. Solubility of magnesium oxide has been shown to increase with increasing $CO_2$.

The results of this study may provide insight into the beneficial results achieved in some research and on farm trials with combination buffers that contain sodium bicarbonate or S-Carb® and Magnesium oxide when included in dairy rations.