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Buffers in dairy rations are the compounds that neutralize the excess acid within the animal's digestive system. A buffer is the one that maintains the pH, within a narrow range when either an acid or a base is added. The dairy animals have natural buffering system in their saliva and increase the animal’s ability to overcome the effects of higher acid production. One should first distinguish the difference between an alkalizer and a buffer. Buffer is the one which maintains a constant level of pH irrespective of the amount added; whereas an alkalizer increases the pH according to the amount added.

**Endogenous buffering**

Ruminant animals possess complex system for buffering the organic acids produced during carbohydrates during the ruminal fermentation. While the total effect of buffering on ruminal pH is relatively small and it accounts for the margin between health and disease in dairy cows when fed large amounts of fermentable carbohydrates (Firkins, 1997). Cows produce a large amount of buffers through their saliva. Saliva buffers the ruminal pH because it is rich in sodium, potassium, bicarbonates and phosphates (Van Soest, 1994).

Unfortunately, saliva secretion is not triggered by reduced ruminal pH, but rather is affected by the amount of physical fiber present in the diet. Saliva is secreted during chewing activity (both during eating and rumination being higher production) in response to the amount of physical fiber present in the diet.

**Acid absorption**

Rumen has the potential to absorb the organic acids rapidly once it’s formed from the rumen which is main reason behind the pH stability inside the rumen. However, the peripheral tissues rarely have the potential to utilize Volatile Fatty Acids (VFAs); however, absorption of these VFA from the rumen can be an important bottleneck. Absorption of VFA via the rumen wall occurs passively. This passive absorption rate depends on the length/number of finger-like papillae.
that project away from the rumen wall. The papillae increase in length when animals fed high grain diets than roughage diets; the dairy animals in dry pregnant periods are fed only with low quality roughages which causes the reduction in the papillae size and number. However, the animals after calving the farmers are feeding high concentrate diets which results in higher acid production in the rumen. But to this change in ruminal papillae the efficient absorption of VFAs is not possible which resulted in development of acidosis in newly calved animals. If the absorptive capacity of these cells is impaired it becomes more difficult for the animal to maintain a stable ruminal pH of 6.5 to 6.8.

**Buffering ability of animals**

Normally, dairy animals will produce about 10 to 32 litres (average of 18.2 lit/kg DMI) of saliva per kg of dry matter intake (DMI). The production of saliva is higher for roughage based diets than grains based diets. Factors important in salivary secretion of dairy animals are the DMI, silage feeding, roughage: concentrate ratio and forage particle size. The saliva produced by cattle, contains 125 milliequivalents (meq)/L bicarbonate with a pH of 8.4. Rumen pH ranges from 5.5 to 6.8 and, which makes the buffering effect of saliva becomes very important in maintaining a desirable rumen pH.

**Buffering capacity of feed**

Forages compared to grains exhibits high degree of buffering capacity as they can resist a large reductions in the pH of rumen. Among the forages, the legume forages has higher buffering capacity when compared to other grass and barley silage. As the buffering capacity varies with forages, the requirement for a dietary buffering agent will vary according to the forage fed to the animals. For instance, cows those fed with a barley silage could respond better to dietary buffers than those fed with a legume silage (eg. alfalfa silage) or hay. The content of various principles in forages such as protein, total ash and cations (Na+, K+) determines the total buffering capacity.

**Where is the need for a dairyman to use the ruminal Buffer?**

The emphasis on increased production and efficiency in dairy cows has led to the increased use of high concentrate or in nutritional terms high energy rations than the roughage based one. These rations contain more readily fermentable starch that results in increased acid production in the rumen. As these rations are low in fibre content resulted in less chewing time, reduced production of saliva and subsequently leads to acidosis. In early lactation or high producing cattle the ruminal buffers will help make the transition from high roughage during dry period to high concentrate rations after calving since the risk of acidosis is greatest at this point of time. During the period of heat stress, there will be reduction in dry matter intake and
loss of electrolytes from the body. Addition of ruminal buffers could help to restore the feed intake and replace lost electrolytes.

**The Bicarbonate System**

The commonly used ruminal buffer is HCO₃⁻ (Counotte et al., 1979; Erdman, 1988). The bicarbonate system includes two major ionic forms: HCO₃⁻ and CO₃²⁻. The HCO₃⁻ is of primary importance to buffering the blood of animals because it may be protonated to H₂CO₃. The pKa for this acid is only 3.80 at 37°C and 0.15 M ionic strength (Segel, 1976).

**Added dietary buffer**

Under normal feeding practices, high producing dairy animals will be fed with large amounts of grain and hence, the addition of buffers might be required to supplement natural endogenous buffer in as saliva. Low fibre diets often result in feeding high grain diets to meet the energy requirements of lactating dairy cows. As the proportion of grain in the diet increases, rumen pH and rumen acetate, acetate: propionate ratios and milk fat percentage decreases whereas proportion of propionate got increases. The process of rumination and its associated salivation also got reduced as a result when the animal has lower fibre intake. Decreased salivary secretion, caused by inadequate effective fibre (long chopped forage) in the diet, may be compensated for by feeding rumen buffers to augment the natural buffering ability of cow. In diets containing low concentrations of fibre, addition of dietary buffers results in increased rumen pH. The effect of added buffers on rumen pH would be most beneficial for about 4 to 9 hours after initial feeding when rumen pH tends to be lowest.

The suggested optimum range of pH for maximum cellulose digestion is 6.4 to 6.8. When rumen pH is at 6.5, 40% of the Neutral Detergent Fibre (NDF) in the diet would be digested, while at pH 5.5 digestion is less than 20%, and at pH 5 there is essentially no NDF digestion. Reduction in rumen pH of dairy cows will result in about 3.6 units decline in Acid detergent fibre (ADF) digestion for each 0.1 pH unit decrease when rumen pH is below 6.3 and may result in depressed feed intake. Maintaining fibre level at a minimum of 19% ADF has been suggested to maintain normal rumen pH and milk fat percent. Milk fat would increase by 0.145 % units if the dietary ADF increases by one percentage unit (at ADF levels above 14%). To increase the butter fat by 0.145 % units, the equivalent of 108 g of bicarbonate and 54 g of magnesium oxide would need to be added to the diet.

**Feeding buffers to dairy animals can help to maintain intake and digestion**

Feeding ruminal buffers will maximise the microbial growth and production will maintain the high milk yields, safeguard herd health and maximise profitability. Rumen microbes are essential for the digestion of forage. These rumen microbes produce volatile fatty acids and microbial
protein and in doing so they can provide up to 75% of the energy and up to 60% of the amino acids required by the high yielding cow. For the rumen to work efficiently and effectively the rumen microbes need a steady supply of fermentable energy and degradable protein and most importantly they need a stable rumen pH between 6.5 and 6.8 pH. Within this pH range the rumen is at its most efficient. Researchers showed that buffer will be helpful in restoration of a depressed fat.

**Conclusion**

The most common reasons for adding buffers to the diet are to compensate for reduced saliva secretion of cows fed inadequate amounts of forage and to neutralize excess rumen acidity resulting from fermentation of starchy grains. Ideally, buffers should be released during the interval of most severe acid production in the rumen or they should provide a continuous release to prevent sudden drops in rumen pH. Palatability is a consideration when selecting a buffer. Palatability is usually not a problem when buffers are fed in a Total Mixed Ration (TMR) or when mixed with the silage portion of the ration.

**REFERENCES**


Firkins, J.L. 1997. Effects of feeding non-forage fiber sources on site of fiber diges-

<table>
<thead>
<tr>
<th>Buffer</th>
<th>Amount to be added</th>
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<tbody>
<tr>
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<tr>
<td>Sodium sequicarbonate</td>
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<tr>
<td>Magnesium oxide</td>
<td>50-100</td>
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<tr>
<td>Potassium carbonate</td>
<td>250-400</td>
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