

What is the best Rumen Buffer?

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Introduction:

Buffers are used in ruminant feeds, and specifically dairy feeds, to maintain or improve rumen function and thus productivity. The common types of buffers used over the years have been sodium bicarbonate, magnesium oxide, calcium carbonate, bentonite and Lithothamnium calcareum (Acid Buf).

In Australia the two main buffer options are Lithothamnium calcareum (Acid Buf) and Sodium Bicarbonate.

Summary:

The key attributes we seek from a rumen buffer are:

- 1- That they maintain rumen stability, and thus produce a better response in animal productivity (measured as milk output for instance).
- 2- Focuses clearly on managing subacute ruminal acidosis. SARA is the major form of ruminal dysfunction seen in the field, not Lactic Acidosis.
- 3- Compliments antimicrobial rumen modifiers where they are used.
- 4- They also offer a considerable macro and micro mineral contribution to the diet.
- 5- That the product has a DCAB close to neutral. This makes the product safe for use in pre-calving feeds as well as lactation feeds. This is important to include due to Milk fever risk.
- 6- A concentrated dose rate that takes less space in a ration, and makes it easier to meet nutrient constraints for key nutrients like energy, protein etc. This feature is especially crucial in formulating high density "concentrates" where space in the ration is at a premium.
- 7- The products are derived from sustainable production systems.
- 8- That the product you buy has peer reviewed data supporting its claims. For Australian AgVet regulations this is critical.
- 9- Most importantly of all; it will allow you to formulate better performing feeds at prices that give the best ROI.

In my view the only rumen buffer that hits all the key attribute you are looking for is Acid Buf.

Below I have set out the supporting evidence and comparisons for each facet of performance below.

1- Performance in rumen stability and animal productivity

1A-Bench top trials

The first area to look at when examining acidbuf is its ability to pick up H⁺ ions.

Quite simple bench top trials can show the performance of acidbuf in this manner.



Acid Buf

Buffering capacity between pH 5 – 7



Product	Acid Uptake @ pH5 - pH7
Sodium Bicarbonate	10 ml 0.1N HCl
Acid Buf	24 ml 0.1N HCl



When considered in this simplistic manner, Acidbuf works very well compared to Sodium Bicarb in addressing H⁺ ions...240% of the impact.

This type of evaluation is obviously of limited relevance though, as it fails to take in the importance of the continual fermentation system that is the cow's rumen, the diurnal flux of this system, and the daily slugs and pulses of feed types that enter and are digested in the rumen.

The answer was obviously to do in vivo cow work with cannulated cows to look at real world impact.

1B- Replicated dairy Study

As a result, quite detailed trial work has been carried out comparing the impacts of Acidbuf versus Sodium bicarbonate at commercial rates in dairy rations.

A trial was conducted at the University of Stellenbosch in RSA.

Cows were fed a “hot” TMR ration twice daily, specs shown below



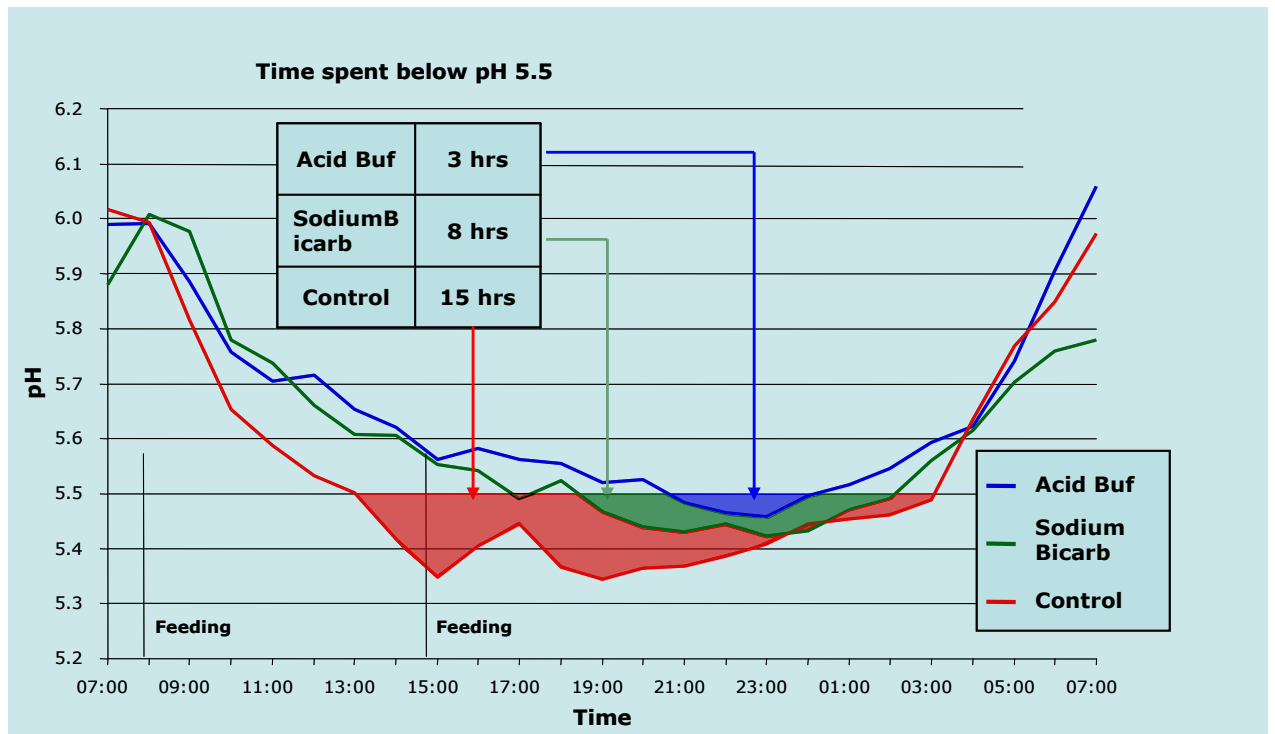
University of Stellenbosch Diet Design

Ingredient (inclusion as % of DM)				
Oat Hay	17.2	Forage	34.5	(%DM)
Lucerne hay	17.6	NDF	27	(%DM)
Wheat bran	3.6	NFC	46	(%DM)
Soybean meal	7.2	Lignin	2.85	(%DM)
Cottonseed meal	3.7	CP	18.2	(%DM)
Fish meal	2.5	RUP	38.4	(%CP)
Ground corn	40.6	Fat	5.3	(%DM)
Urea	0.48	ME	11.98	(MJ/kg)
Molasses	3	Ca	1.20%	
Megalac	2.56	P	0.50%	
MinVit	0.15			
Limestone	0.94			
Salt	0.2			
AcidBuf	0.125			



Acidbuf was used at 50% of the rate of sodium bicarbonate (90g vs. 180g per head per day).

Ruminal pH was measured with indwelling probes every 3 min, and comprehensive milk production data was collected. Rumen pH measurements were as follows:



The time spent under pH 5.5 is quite different for each treatment. That pH point (5.5) is seen by manner as a point that will impact on total VFA yield from the rumen, and especially on fibre yield to acetate. This compromises energy yield to milk and overall feed conversion efficiency.

Interestingly, this seems to be born out in this trial, with FCE trend following pH trend under 5.5

Milk Production results and economic impact are as shown below:

	Acidbuf	Bicarb	control
DMI	23.3	24.2	23.1
4% fat corrected Milk	32.8	29.9	26.9
FCR (Kg feed to make One litre)	0.71	0.81	0.86

	Acidbuf	Bicarb	control
Typical cost Dry matter (cents/kg DMI)	25	25	25
Feed Cost c/L Produced	17.75	20.25	21.5
Benefit over control	3.75c/L	1.25c/L	
Benefit over Bicarb	2.5c/L		

A more complete economic advantage captures both volume and FCR advantage

Assuming milk at 35c/L next season, and Feed at 25c/kg DMI

	Acidbuff	Bicarb	control
Milk income	32.8L @0.35 =\$11.48	29.9L @0.35 \$10.47	26.9L @0.35 =\$9.42
Feed input cost	23.3kg @0.25 =\$5.83	24.2kg @0.25 =\$6.05	23.1kg @0.25 =\$5.78
MOFC/cow/day	\$5.65	\$4.42	\$3.64
Benefit over control	\$2.01	\$0.78	
Benefit over Bicarb	\$1.23		

Nor were milk solids adversely affected by volume improvements as can be seen:

Treatment effect on milk production and milk composition

Item	Treatment			P
	Acid Buf	Bicarb	Control	
Milk production (kg/d)	31.8 ^a	29.1 ^b	27.6 ^b	0.01
4% FCM (kg/d)	32.8 ^a	29.9 ^{ab}	26.9 ^b	0.006
Milk fat (%)	4.21 ^a	4.18 ^a	3.86 ^b	0.057
Milk protein (%)	3.47	3.38	3.43	0.554
DMI (kg/d)	23.3	24.2	23.1	0.863

In terms of rumen stability, Feed conversion and milk productivity, Acidbuf showed considerable advantage over Sodium Bicarbonate.

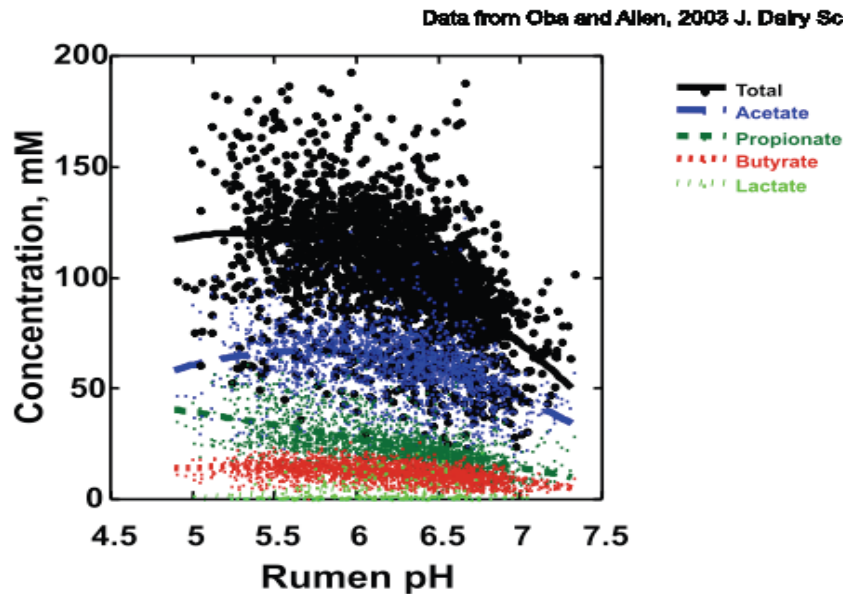
2- Acidbuf is ideally suited to managing SARA, The dominant challenge we face in rumen stability , and far more prevalent then clinical lactic acidosis

- Clinical acidosis is the result of ruminal lactate accumulation
- Sub clinical acidosis is a result of total VFA accumulation and in particular propionate. It is rarely ever related to lactate accumulation. It is a clearly different condition to lactic acidosis and needs a different management approach

“During periods of SARA in dairy cows, lactic acid in the rumen is rarely the cause of depressed pH, unlike the acidosis condition seen in feedlot cattle. SARA results from excessive VFA production that exceeds the ability of the ruminal papillae to absorb them. Volatile fatty acids accumulate in the rumen and, as a result, reduce ruminal pH.”
Mutsvangwa and Wright

“Lactic acid does not consistently accumulate in the rumen fluid of dairy cattle affected by SARA...the depression of ruminal pH in dairy cattle with SARA is apparently due to total accumulation of volatile fatty acids alone, and is not due to lactic acid accumulation” Oetzel et al 1999

Ruminal pH and individual VFA concentration



- SARA is the dominant “acidosis” we see in Australia, and the condition that has far more economic cost compared to the less common lactic acidosis with obvious clinical signs.
- SARA impacts feed and fibre digestibility, dry matter intake, FCE, reproduction and milk solids levels.....all without overt or obvious signs of clear problems, scouring or ill thrift associated with clinical cases
- **Antimicrobials like Tylosin or Virginimycin are commonly used for “acidosis” control. They are effective against lactic acidosis but are less value in the management of SARA.**
- By the time that the antimicrobials kick in, principally against *Strept. Bovis*, we have already allowed the rumen pH to drop considerably (probably to pH 5.6 or 5.7....maybe to pH 5.2 according to Prof Mike Allen) and the rumen environment to alter to the point that will cost significant organic matter and fibre digestibility, and impact on badly on total FCE.

“The fermentation product of *Streptococcus Bovis* depend on both pH and growth rate. Acetate and Ethanol are produced above pH 5.7, while lactate levels do not increase markedly until pH drops below 5.2” Russell and Allen 1984

- Bill Wales work showed a 15% drop in organic matter digestibility of rye grass between pH 6.1 and 5.6. On an 11MJ rye grass that is 1.65MJ/kg. Over 10 kg of intake, that is 16.5MJ/day, or about 3L of

milk. That is in line with the USA work of Stone (1999) who suggested 2.7L loss plus decline of 0.3% fat and 0.1% protein.

- Should we simply accept this 2-3 L loss, or should we look at how we can take steps to correct the conditions that lead to SARA (as opposed to lactic acidosis).
- Management for SARA is about rumen optimisation, not disaster prevention. In that role, traditional buffers, effective fibre, slug feeding, starch digestion rates and silage acid load all need to be considered because antimicrobials can not offset the impacts of SARA (as opposed to lactic acidosis).
- The use of proven effective buffers like ACIDBUF in conjunction with antimicrobials offers a synergistic approach to acidosis control. In the case of SARA management, more traditional buffers may offer a better approach than antimicrobials which are best applied to clinical lactic acidosis control.

3- Acidbuf offer considerable macro mineral content, and of a high availability relative to common mineral sources

The product itself offers a great supply of calcium (30%) and magnesium (6%) but in addition a range of minerals. These minerals are highly available relative to sources such as lime or mag ox. This is at least partly because of the unique physical honey combed form of Acidbuf, a massive surface area and a valuable rate of degradation.

Acid Buf

Mineral Analysis		95%
<i>Ash</i>		
<i>Calcium</i>	<i>Ca</i>	30%
<i>Magnesium</i>	<i>Mg</i>	6%
<i>Sulphur</i>	<i>S</i>	0.5%
<i>Sodium</i>	<i>Na</i>	1.2%
<i>Chloride</i>	<i>Cl</i>	2.0%
<i>Phosphorus</i>	<i>P</i>	575ppm
<i>Potassium</i>	<i>K</i>	650ppm
<i>Boron</i>	<i>B</i>	9.5ppm
<i>Fluorine</i>	<i>F</i>	190ppm
<i>Iron</i>	<i>Fe</i>	1825ppm
<i>Cobalt</i>	<i>Co</i>	4ppm
<i>Copper</i>	<i>Cu</i>	16ppm
<i>Zinc</i>	<i>Zn</i>	25ppm
<i>Molybdenum</i>	<i>Mo</i>	2.25ppm
<i>Selenium</i>	<i>Se</i>	1ppm
<i>Iodine</i>	<i>I</i>	160ppm

This mineral analysis is given as a guide only and not as a specification.

We have done solubility tests on the calcium and magnesium availability at pH 5.5-6.0. This is especially crucial in the case of magnesium, where absorption is virtually 100% via the rumen, so mineral must go into solution to be absorbed across the rumen wall.

Mag Solubility tests on local mins (ph 6)

	2 hours	4 hours	6 hours	8 hours
Acidbuff	86%	88%	97%	99%
Mag sulphate	100%			
Mag oxide	1.5%	3%	5%	6%

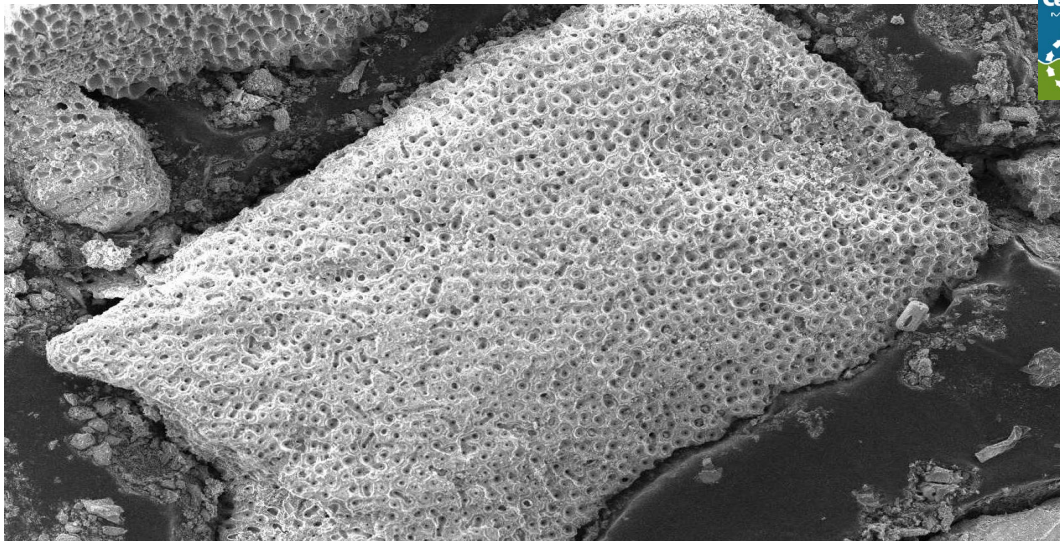
Acid Buff is like Mag sulphate, and far superior to Mag oxide.

In the case of calcium, we have both active and passive uptake mechanisms. The solubility of Acidbuff will benefit the passive uptake mechanism, and this will be greatly beneficial post calving when the active uptake mechanism driven on Parathyroid hormone may not yet have kicked in properly, and metabolic disorders can result.

Solubility is thus important in Calcium Too !

	2 hours	4 hours	6 hours	8 hours
Acidbuff	57%	75%	88%	100%
Fine Lime	3.5%	11%	12%	13%

The reason for its great difference is its marine nature, and massive surface area as can be seen in this photo. It is like a sponge structure, and much softer and more soluble than most mineral alternatives.



SEM (Scanning Electron Microscopy) image of Red algae As can be seen from the image above the entire surface of the Red Algae seems to be covered with pores.

4- A near neutral DCAB is a great benefit in flexible formulating of both precalver and lactating rations

The need for a negative DCAB in transition feeds to manage metabolic disorders has long precluded the use of sodium Bicarbonate from such rations.....generally no buffers are used. This is unfortunate in that this period is often a prime time for SARA. However, it is certainly wiser to use nothing than to induce metabolic disorders with an imbalanced DCAB.

Acidbuf has a virtually neutral DCAB. It can be used safely in precalving rations.

DCAB specs of buffers (plus Amm. Sulphate for comparison)

Bicarb	Acidbuff	Bentonite	NH4So 4
38 Na%	1.2 Na%	0.51 Na%	0 Na%
K%	0.065 K%	0.25 K%	K%
Cl%	2 Cl%	0.45 Cl%	0 Cl%
S%	0.5 S%	0.008 S%	24 S%
1652.174 meq/100g	-33.7474 meq/100g	15.40811 meq/100g	-1500 meq/100g
16521.74 meq/kg	-337.474 meq/kg	154.0811 meq/kg	-15000 meq/kg

Like wise, the near neutral DCAB means that positive DCAB in lactating rations is also easily achievable. It is my experience that the potassium levels in many Australian forages and production systems produce a strong positive DCAB in most cases, so this is a fairly simple goal achieve with a buffer that is near neutral DCAB.

5- Acidbuf aids ration density by having a smaller dose rate than alternatives , and also contributing Calcium and magnesium

It is a simple fact of rations that “space” is crucial. This is particularly so in the case of high mineral concentrates. These products need small doses to facilitate lower manufacturing cost, lower transport cost and thus a best cost possible in cents/cow/day on farm.

We have already put forward some strong data that shows that Acidbuf used at 50% dose of Bicarb will outperform the more common buffer in sodium bicarb.

The ability to use half the volume for same or better animal impact is crucial in achieving smaller dose rates that make for a more competitive on farm price.

A further advantage is the large contribution of calcium and Magnesium in Acidbuf that spares lime and mag Oxide inclusion, further saving space.

Acidbuf is truly an ideal buffer for application in dairy concentrates.

To further illustrate this, let's look at a cost per dose of product alone, before we even consider the "density" issues which can be shown most effectively via linear programming in any case.

Product	Acidbuf	Sodium Bicarbonate
\$/t	\$1000	\$450
Manufacturing/t	\$200	\$200
Transport/t	\$100	\$100
Total	\$1300	\$750
Typical dose	50g	100g
Cost/dose	6.5c	7.5c

So Acidbuf is cheaper per dose once cost of extra volume processing and transported is considered. This is before we even consider what we can "fit in" a small dose, and that fact that the product is a superior buffer.

6- Acidbuf has "green" credentials

The primary focus of our product is to do its job.....a great tool in rumen management, and nutrient delivery. We know it does that.

Happily, it also has some good green credentials that we are quite pleased with.

Firstly, it is a renewable resource, being harvested from the skeletal remains of red algae seaweed in the North Sea. It is redeposited every season as the weed dies and breaks down.

It is not "mined"...it is effectively grown.

It is organic certified as well, if that is relevant.

7- Summary

Lithothamnium calcareum (Acid Buf) is a great tool in rumen stability. It addresses the key challenge of SARA, as well as the more uncommon clinical lactic acidosis.

Lithothamnium calcareum (Acid Buf) does this in a manner superior to Sodium Bicarb and does it while taking up a smaller dose and providing valuable sources of highly available macro minerals.