



Choosing the best oral electrolyte solution for your calves

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Calf diarrhea or “scours” continues to be a major health problem for dairy and beef producers in the United States. In fact, according to data from the last National Animal Health Monitoring Survey (NAHMS) dairy study, greater than 60% of all mortality in calves less than 2 months of age is a direct result of scours. Diarrhea has several profound metabolic effects on the calf including dehydration, a decrease in the pH of their blood (referred to as an “acidosis”), and a loss of energy (most all calves with diarrhea are in a state of negative energy balance). Therefore when treating calves with diarrhea we have five important therapeutic goals: 1) correcting dehydration; 2) correcting acidosis and restoring blood pH to normal; 3) correcting electrolyte abnormalities (like sodium, potassium, and chloride); 4) reversing the negative energy balance; and 5) preventing the growth of pathogenic bacteria such as E. coli and Salmonella in the intestinal tract.

Oral electrolyte solutions have classically been used to replace fluid losses, correct acid-base balance and electrolyte abnormalities, and to provide nutritional support, because they are cheap and easy to administer on-farm. They are indicated in any diarrheic calf that has at least a partially functional gastrointestinal tract. If oral electrolytes are administered to a calf with no intestinal motility, the fluid will just pool in the stomach resulting in bloat and rumen acidosis. In general, a calf with any sort of suckle reflex or that demonstrates any “chewing” action can be considered to safely tolerate oral fluids. Considerable variability exists in the quality of commercial oral electrolyte solutions available today and there are several important factors to consider when deciding on a product. Current knowledge indicates that an oral electrolyte solution must satisfy the following four requirements: supply sufficient sodium to correct dehydration, provide agents (either glucose, acetate, propionate, or glycine) that facilitate absorption of sodium and water from the intestine; provide an alkalinizing agent (acetate, propionate, or bicarbonate) to correct acidosis, and provide energy.

Factors to consider when choosing an oral electrolyte solution include:

1) Sodium concentration

The loss of sodium in feces of a calf with diarrhea is the main cause of dehydration. Therefore in order to improve the calf’s hydration and restore proper blood flow, sodium must be present in an oral electrolyte solution. The ideal sodium concentration is 90 to 130 mM/L. Low sodium oral electrolyte solutions (those containing less than 90 mM/L) are not recommended because they cannot adequately resuscitate dehydrated calves. Conversely, oral electrolyte solutions containing extremely high concentrations of sodium (>150 mM/L) should also be avoided as they would be likely to induce sodium toxicity (called “hyponatremia”) in calves.

2) Amino acids

Not only does sodium have to be present in an oral electrolyte solution, but the calf must absorb this electrolyte to correct dehydration. Even in calves that have diarrhea and intestinal damage, there are three major pathways for sodium absorption: glucose; volatile fatty acids (such as acetate or propionate); and neutral amino acids (such as glycine). Glycine is present in several commercially available oral electrolyte solutions sold in the United States. The presence of acetate in an oral electrolyte solution would also help the intestine absorb sodium.

3) Osmolality

The term “osmolality” is a measure of the concentration of particles in a solution. Thus, the higher the concentration of a solution, the higher the osmolality will be. Commercially available oral electrolyte solutions for use in calves range from 300 mOsm/L (called “isotonic” because this is equal to the osmolality of blood) to 750 mOsm/L (which would be considered very “hypertonic” or concentrated). Simply stated, the higher the osmolality of a product the more concentrated it is or

generally the more electrolytes and energy (glucose) the product contains. However too high of an osmolality can cause problems.

The maximum osmolality normally found in the intestinal tract is about 600 mOsm/L and any electrolyte solutions with values above this should be avoided as they could worsen the damage that has already been done to the digestive system. It is important to understand that milk or milk replacer contains much more energy than any type of oral electrolyte solution, and therefore it's important not to discontinue milk feeding for any prolonged period.

4) Alkalinizing agent

Virtually all calves with diarrhea have a decrease in their blood pH as compared to normal. This acidosis is largely responsible for the abnormal clinical signs seen in these animals including loss of suckle reflex, depression, inability to stand, etc. Therefore it is imperative that any oral electrolyte solution used to resuscitate calves contain an alkalinizing agent.

Acetate, propionate, and bicarbonate are all considered alkalinizing agents. Bicarbonate is commonly available in oral electrolyte solutions available in the United States. Acetate and propionate are commonly found in oral electrolyte solutions sold in Europe but are only found in two products sold in the United States. Recent research has shown that acetate and propionate containing oral electrolyte solutions are preferred over bicarbonate for several reasons:

- Acetate and propionate are volatile fatty acids and can facilitate sodium absorption in the calf small intestine whereas bicarbonate does not.
- Acetate and propionate produce energy when metabolized, whereas bicarbonate does not.
- Acetate and propionate do not increase abomasal pH whereas bicarbonate does
- Acetate and propionate inhibit the growth of Salmonella species

Several pathogenic bacteria are killed at a low pH, for example both E. coli and Salmonella are killed at a pH around 3.0 and begin to multiply at a pH above 5.5. Normally the stomach (abomasum) maintains a very low (acidic) pH which is critical for decreasing the number of pathogenic bacteria reaching the small intestine and increasing the resistance to intestinal colonization by bacteria. More simply stated, the calf needs to maintain a low abomasal pH to decrease the incidence of infection and clinical disease. Recent research has shown oral electrolyte solutions containing bicarbonate induce a significant increase in abomasal pH for a prolonged period of time which may increase the number of bacteria that are able to colonize the small intestine. This effect is not observed when using acetate based oral electrolyte solutions. Therefore abomasal and small intestinal alkalinization due to bicarbonate-containing oral electrolytes may promote bacterial growth, and actually prolong or worsen the diarrhea in calves.

Although acetate or propionate based products would be preferred, as stated above they are not widely available in the United States. Even with the possible drawbacks associated with using bicarbonate, it is still critical that your oral electrolyte solution contain an alkalinizing agent. While they may not be ideal, products containing bicarbonate have been used effectively for years to resuscitate calves and will likely be used for years to come. However, there are several products on the market that do not contain any of the three alkalinizing agents listed above and should not be used in calves. These products may correct dehydration and electrolyte abnormalities, however they will not have any ability to increase blood pH (correct the acidosis) which is one of our primary therapeutic goals. A calf that has normal electrolyte levels (ie. sodium, calcium, potassium) may still very likely die of an acidosis if this is not addressed. Therefore always make sure either bicarbonate, acetate, or propionate are listed on the ingredients list of the oral electrolyte product you are using, and if an analysis is present, the minimum recommended concentration for an alkalinizing agent would be 50 to 60 mM/L (lower concentrations are likely to have a very weak alkalinizing ability).

5) Psyllium

It has been hypothesized that adding dietary fiber in the form of psyllium (or dialine) to oral electrolyte solutions would enhance nutrient absorption from the digestive tract and improve glucose absorption by slowing the rate at which the stomach (abomasum) empties. However research has shown that the addition of psyllium to oral electrolyte solutions actually produces a decrease in glucose absorption. Producers sometimes like oral electrolyte solutions that contain psyllium (often referred to as "electrolyte gels") because the manure will thicken somewhat and it appears the diarrhea is resolving. However these products actually reduce the calf's energy levels and are not recommended as an additive to oral electrolyte solutions.

Summary

There are tremendous variations in the formulations of oral electrolyte solutions currently available in the United States. Table 1 shows an analysis of ten popular products and gives some comments on their suitability for use in calves. As you can see not all of these products would be ideal and in fact a few would not be recommended at all. It is important to work closely with your veterinarian to select the product that is most appropriate for your herd to optimize your calf diarrhea treatment protocols.

Table 1. Analysis of several oral electrolyte solutions commercially available in the United States

	Sodium (mM/L)	Amino Acid	Osmolality (mOsm/L)	Alkalinizing Agent (mM/L)	Comments
Dr. Geof Smith's Recommendations	90 to 130	Glycine	400-600	Acetate 50 to 80	
Blue Ribbon*	144	Glycine	390	None	No alkalinizing agent present - would not be a good choice for calves with diarrhea
Bounce Back*	136	Glycine	573	Bicarbonate 48 mM/L	Adequate oral electrolyte for calves - better choices exist
Calf Quencher*	142	None	731	Bicarbonate 86 mM/L	Although this product could be used in calves, it has a very high osmolality (hypertonic) and may worsen diarrhea
Deliver*	67	Glycine	305	Bicarbonate 36 mM/L	Sodium concentration is very low - this product would also have a very weak alkalinizing ability. Also contains dialine (psyllium)
Diaque*	90	Glycine	377	Bicarbonate 25 mM/L and Acetate 12 mM/L	Good oral electrolyte solution for use in calves
Entrolyte HE*	105	Glycine	739	Bicarbonate 80 mM/L	Osmolality is too high - which can worsen diarrhea. High osmolality solutions also slow stomach (abomasal) emptying and can lead to bloat.
Hydrafeed*	110	Glycine	380	Bicarbonate 80 mM/L	Bicarbonate based which is not ideal - but could potentially be used in calves with diarrhea
BlueLite® Replenish™	90	Glycine	400	Acetate 59 mM/L and Sodium Propionate 21 mM/L	Very good oral electrolyte solution for use in calves
Resorb*	75	Glycine	315	None	Sodium concentration is too low and no alkalinizing agent present - would not be a good choice for use in calves
Revitilyte*	184	Glycine	577	Bicarbonate 110 mM/L	Sodium concentration too high - can cause Sodium toxicity in calves

