Feed Management

A Key Ingredient in Livestock and Poultry Nutrient Management

Dietary Cation-Anion Difference for Dairy Rations

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Disclaimer
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USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

Introduction

This fact sheet has been developed to support the implementation of the Natural Resources Conservation Service Feed Management 592 Practice Standard. The Feed Management 592 Practice Standard was adopted by NRCS in 2003 as another tool to assist with addressing resource concerns on livestock and poultry operations. Feed management can assist with reducing the import of nutrients to the farm and reduce the excretion of nutrients in manure.

The Natural Resources Conservation Service has adopted a practice standard called Feed Management (592) and is defined as “managing the quantity of available nutrients fed to livestock and poultry for their intended purpose”. The national version of the practice standard can be found in a companion fact sheet entitled “An Introduction to Natural Resources Feed Management Practice Standard 592”. Please check in your own state for a state-specific version of the standard.

Definition

Dietary cation-anion difference (DCAD) typically includes two cations [potassium (K) and sodium (Na)] and two anions [chlorine (Cl) and sulfur (S)]. The DCAD equation most often applied in the field equals: milliequivalents (meq) [(%K divided by 0.039) + (%Na divided by 0.023)] – [(%Cl divided by 0.0355) + (%S divided by 0.016)]/100 grams of dietary dry matter (DM). Considerable research and field application of the DCAD concept have occurred in the last 2 decades (NRC, 2001). Physiologically, DCAD influences the animal’s acid-base homeostasis, Ca status around calving, and mineral element utilization. Much of the early work addressed effects of DCAD on Ca status and metabolic health of late pregnant, transition cows (NRC, 2001; Goff and Horst, 1997; Block, 1994). Also, direct effects of DCAD on lactational performance were examined (Beede, 2005; Hu and Murphy, 2004).

DCAD for late pregnant dry cows

The primary goal in late pregnancy is to provide a ration with a low (less than +5 meq/100 grams of dietary DM) or negative DCAD to reduce the risk of hypocalcemia (low blood Ca) and clinical milk fever around calving. Minimizing the incidence of hypocalcemia and milk fever reduces the incidence of other associated metabolic disorders such as retained fetal membranes, abomasal displacement, and metritis. In many cases, simply using feedstuffs with lower concentrations of K and Na will lower DCAD enough to improve transition cow performance. This also may reduce udder edema. When it is not possible to reduce dietary K and Na enough, supplementation with anions (chloride and sulfate) will reduce DCAD. A target DCAD of -5 to -10 meq may improve transition cow health and performance.

Anion sources to reduce DCAD include the so-called anionic salts such as ammonium chloride, calcium chloride, magnesium chloride, ammonium sulfate, calcium sulfate, and magnesium sulfate. ***Note:*** Flowers of Sulfur (elemental sulfur) is not bioavailable or bio-reactive and is not effective to reduce DCAD or affect the cow's physiology, health, or performance. Anionic salts are not very palatable and may reduce feed intake if too much is supplemented. Commercial anion supplements such as those prepared by treatment of feedstuffs with hydrochloric acid or other anions can be effective with less risk to reduce feed intake than anionic salts.

With a DCAD of -5 to -10 meq/100 grams of dietary DM, urine pH of 6.0 to 6.7 indicates that anion supplementation is effective. Urine pH of less than 6.0 indicates it is not necessary to feed so much anion source. ***Note:*** Urine pH of dairy cows fed typical rations without anion supplementation (DCAD of +20 meq or greater) is between 7.8 and 8.2, a normal value for ruminants. Even if significant K and Na are removed from the ration and the DCAD is still +20 meq or greater, without anion supplementation, urine pH values will be within the normal range. In this case, the transition performance of cows fed low, positive DCAD rations may be normal. Therefore, DCAD can not be used to predict whether or not a particular ration will predispose late pregnant dry cows to hypocalcemia and other transition disorders. Only when supplemental anions are used to reduce DCAD can urine pH be an indicator of the effectiveness to affect acid-base and Ca status. If the ration is actually -5 to -10 meq and transition cows are eating well, reduced urine pH will be a good indicator of proper anion intake after 3 to 7 days of feeding the ration.

DCAD for lactating cows

Increasing DCAD of lactation rations with supplementation of cations [Na and (or) K] may be beneficial for lactating dairy cows to neutralize tremendous amounts of acids produced in ruminal fermentation and systemic metabolism. The DCAD may be increased by reducing anions or high anion-containing feed ingredients, or by supplementing with sodium bicarbonate or potassium carbonate.

In lactation rations, DCAD between +25 to +30 meq/100 grams of dietary DM is effective and sufficient to achieve maximum feed intake and milk yield (Beede, 2005). Magnitude and differences in lactational responses were small between +20 to +40 meq. Less than +20 meq or greater than +40 meq was quite detrimental to performance in some studies. As long as DCAD is between the optimal range of +20 to +40 meq, little (or no) benefit is expected by supplementing additional cations. Both Na and K are equally efficacious to lactational performance if a greater DCAD is desired. Thus, use of the cation source with the least cost on a milliequivalent basis is recommended. There are few reported studies trying to determine optimal DCAD with very high producing cows; these studies would be useful.

During heat stress the best DCAD may be at the upper end of the optimal DCAD range. For example, a ration with 1.5% K, 0.5% Na, 0.3% Cl, and 0.25% S, DM basis, has a DCAD of +36 meq/100 grams of dietary DM. If the Cl and S concentrations exceed those listed above, the first formulation step should be to try to reduce Cl and S concentrations in the basal ration by replacement of high anion-containing ingredients with other ingredients. If this is not possible, inclusion of more Na and (or) K from sodium bicarbonate and (or) potassium carbonate can be used to increase ration DCAD. However, doing this may not be sustainable for dairy production and environmental management because higher concentrations of these cations may occur in soils, crops (feeds), and surface and ground waters.

For overall farm nutrient balance, reducing the amounts of ration-supplemented K, Na, Cl and sulfate is a critical consideration. Amounts consumed that are in excess of the cows' requirements are excreted, and must be recycled effectively via crops or exported, or problems can occur in dairy farming systems.

References

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Project Information

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