Equine Nutrition

Macro Minerals

Minerals

- What are minerals?
- What are macro minerals?
- Are they more important than micro minerals?
- Organic or inorganic?
- Importance?

Introduction

- Involved in a number of functions including:
  - Acid-base balance
  - Formation of structural components
  - Enzymatic cofactors
  - Energy Transfer

- Examples of necessary body components?
  - Amino acids
  - Hormones
  - Vitamins

Introduction

- Where do horses obtain most minerals?
  - Forages
  - Concentrates
- What effects availability?
  - Soil mineral concentrations
  - Plant species
  - Stage of maturity
  - Conditions of harvesting

Introduction

- Seven Macro-minerals:
  - Generally expressed as % in the diet
    - Ca & P
    - Mg & K
    - Na & Cl
    - S
  - Why should ratios of minerals be considered?
    - Often influence: absorption, metabolism, and excretion

Calcium

- 99% of Ca in body is found where?
  - Bones and teeth
- Makes up ~35% of bone structure
- Also involved in what?
  - Muscle contraction
  - Function of cell membranes
  - Blood coagulation
  - Regulation of enzymes

Calcium

- What are some common inorganic forms of Ca?
  - Calcium carbonate
  - Calcium sulfate
  - Calcium oxide

- Studies have shown that organic calcium
  - did not differ in absorption rate from calcium carbonate

Calcium

- True absorption efficiency declines with what?
  - Age
- Where does absorption take place?
  - Small Intestine
- Absorption Efficiency of Young Horse?
  - 70%
- Absorption Efficiency of Mature Horse?
  - 50%

Calcium

- Deficiencies?
  - Can lead to rickets in the foal
    - Characterized by poor mineralization of the osteoid tissue and probable enlargement of the joints
  - In mature horses, deficiencies can result in
    - Weakening of the bones and lameness

Calcium

- Any ↑ in Ca associated with work
  - Appears to be readily met by ↑ DM consumption
- Needs ↑ in 9, 10, and 11 month of gestation
- Requirements ↓ from late gestation to late lactation

Phosphorus

- Makes up what % of the skeleton?
  - 14-17%
- Required for:
  - Many energy transfer reactions – ATP and ADP
  - Synthesis for:
    - Phospholipids
    - Nucleic acids
    - Phosphoproteins

Phosphorus

- Efficiency of true absorption ~30 to 55
- What causes variation in absorption efficiency?
  - Other dietary constituents
  - How much and what type of P fed
  - Age of horse
- ↑ NaCl diets ↑ P from 1 to 5% absorption
- High dietary Ca depresses P absorption
  - .89% Ca reduces P absorption to 25%

Phosphorus

- Absorption is likely to be higher in foals fed milk
- It is assumed that true absorption efficiency for P is
  - 35% in idle, gestating, & working horses (primarily plant sources)
  - 45% for lactating mares – supplemented sources
  - 8 mo. of age ↑ requirement than 12 mo.
  - Horses housed in warm barns ↓ requirement than cold barn
  - ↑ efficiency when demand for P ↑

Phosphorus

- Deficiencies?
  - Bone problems
- Excesses?
  - Reduces rate of Ca absorption
    - Hyperparathyroidism
- What is the maximum tolerable in total diet?
  - 1%

Magnesium

- Constitutes what % of body mass?
  - ~ 0.05%
    - ~ 60% is associated with skeleton
    - ~ 30% found in muscle
- Importance?
  - Ion in the blood
  - Co-enzyme factor
  - Muscle contraction

Magnesium

- Absorption range?
  - 40 - 60% in feedstuffs
- Inorganic supplemental sources include:
  - Magnesium oxide
  - Magnesium sulfate
  - Magnesium carbonate
    - 70% absorption rate
      - Higher than natural sources

Magnesium

- Absorption higher when fed
  - Alfalfa rather than concentrate
- Excess P caused lower Mg absorption
- Absorbed from both the S.I. and L.I.
  - Majority in S.I.

Magnesium

- Deficiencies and Excess:
  - 5 to 6 mg/kg of BW/d resulted in hypomagnesia
  - 20mg/kg of BW/d resulted in normal serum levels
  - Deficiencies will result in?
    - Nervousness and muscle tremors
    - Ataxia (lack of muscle coordination)
      - After initial signs:
        - Collapse, profuse sweating, convulsive paddling, and death in some instances

Magnesium

- Hypomagnesemia induces
  - Ca and P mineralization in the aorta
  - Histological changes occur within 30 d
- Pastures that are conducive to Mg deficiency (tetany)
  - Death in ruminants do not affect horses similarly
- However:
  - Tetany in transported horses has been attributed to hypomagnesemia

Magnesium

- Maximum tolerable levels are estimated at 0.3%
- However, some alfalfa hays with 0.5% have been
  - Fed without any negative affects
- Other research has indicated that as high as .86% has been fed from MgO sources for 1 month
  - Without negative affects

Potassium

- Major intracellular cation
- Most body K found in skeletal muscle
- Involved in the maintenance of
  - Acid-base balance and osmotic pressure
- Forages and oilseeds generally contain
  - 1 to 2% K (DM basis)
- Cereal grains typically contain 0.3 to 0.4%

Potassium

- Required concentration in a purified-type diet for growing foals ~ 1%
- Mature horses require ~0.4%
- Because forages usually makeup a significant portion of the diet
  - K requirements should be easily met

Potassium

- Deficiencies:
  - Foals fed K deficient diets
  - Gradually refused to eat and lost weight
  - Also became unthrifty in appearance
  - After K was entered back into the diet, normal feed intake resumed

Potassium

- Excesses:
  - Excreted readily via urine
  - Adequate water very important
  - Excesses not heavily studied
  - Assumed that extreme excesses could lead to hyperkalemia
    - Would be expected to cause cardiac arrest

Sodium

- Major extracellular cation
- Major electrolyte involved in
  - Maintenance of acid-base balance
  - Osmotic regulation of body fluids
- Typical concentrations of feedstuffs are > 0.1%
- NaCl is often added to concentrates at
  - 0.5 to 1.0% or fed free choice

Sodium

- Endogenous losses in the idle adult horse
  - ~15 to20 mg/kg of BW/d
- Prolonged exercise and elevated temperatures
  - ↑ Na requirements
- Na concentrations in maintenance diet should be
  - At least 0.1%

Sodium

- Deficiencies:
  - Chronic depletion results in
    - ↓skin turgor
  - Slowed rate of eating
  - Decreased water intake
  - Eventual cessation of eating

Sodium

- Deficiencies:
  - Acute depletion lead to muscle contractions
  - Uncoordinated chewing
  - Unsteady gait
- Excesses have not been reported

Chloride

- Important extracellular anion
  - Normally accompanies Na
- Involved in
  - Acid-base balance
  - Osmotic regulation
- Essential component of
  - Bile
  - HCl

Chloride

- Requirements have not been specifically established
- Presumed to be adequate when
  - Na requirements are met
- Common feedstuffs range from
  - 0.05% in corn to 3.0% in molasses

Chloride

- Deficiencies:
  - Not been described in horses
  - However, if occurred, would result in
    - Blood alkalosis because of compensatory ↑ in bicarbonate
  - Clinical signs would include
    - ↓ food intake, weight loss, muscle weakness, ↓ milk production, dehydration, and constipation

Chloride

- Horses are considered tolerant to
  - High levels of salt in their diets
  - Given ad-libitum water
- High salt concentrations are
  - sometimes used to limit feed intake
  - Example: supplements
- ↑ salt ↑ water intake

Sulfur

- In the form of:
  - Sulfur-containing amino acids
  - Biotin
  - Heparin
  - Thiamin
  - Insulin
  - Chondroitin sulfate

- Make up ~0.15% of BW

Sulfur

- Requirements not established
- High quality dietary protein usually provides
  - At least 0.15% organic sulfur
    - Appears to meet requirements
- Deficiencies and maximum tolerable levels not described
- Research reports that excessive sulfur
  - May lead to ill effects including death